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Enterprise Systems Adoption and Firm Performance in Europe: The Role of Innovation

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ABSTRACT

Despite the ubiquitous proliferation and importance of Enterprise Systems (ES), little research exists on their performance impact, especially in Europe. This paper provides large-sample, economy-wide evidence on the differential effects of enterprise systems on performance of European enterprises. It also highlights the important mediating role of innovation in the process of value creation from ES investments. This study uses data on the adoption of ERP (Enterprise Resource Planning), SCM (Supply Chain Management), CRM (Customer Relationship Management), KMS (Knowledge Management System), and DMS (Document Management System) and investigates the effects on product and process innovation, revenue, productivity and market share growth, and profitability. The results show that all ES categories significantly contribute to product and process innovation. Most of ES categories affect revenue, productivity and market share growth positively. More domain-specific and simpler system types lead to stronger positive effects. None of ES categories contribute to profitability likelihood. The findings imply that innovation acts as a full or partial mediator in the relationship between ES adoption and firm performance.

Keywords

Enterprise Systems, ERP, SCM, CRM, KMS, DMS, IT Adoption, Innovation, Firm Performance, Europe.

INTRODUCTION

Enterprise Systems (ES) yield efficiency gains in some areas, although might cause performance decline elsewhere. The costly, lengthy and complex nature of ES projects makes the systematic and rigorous assessment of their outcomes particularly important for corporate decision-makers. Despite the ubiquitous proliferation and importance of enterprise applications, their impacts on innovation and business performance of the firm have received little attention (Hendricks et al. 2007; Hitt et al. 2002). The present paper analyzes *whether* and *how* the adoption of enterprise applications affects performance of companies after these systems go live for a sufficiently large period of time. The existing body of the empirical literature usually focuses on the immediate or short-term effects of a single type of enterprise software (and mainly ERP) and uses case studies or, to a lesser degree, surveyed data from a limited number of (mainly US) sectors (Gattiker and Goodhue 2005; McAfee 2002). The literature on the innovation and performance impacts of other system types rather than ERP is either sparse or absent. This paper differs from the previous studies in the field in four aspects. First, it provides large-sample, representative evidence of the performance effects of ES adoption across the major sectors of the economy in Europe. Second, it enables cross-system comparison by analyzing the differential effects of different enterprise systems on various innovation and performance measures of the firm. Third, it concentrates on the post-implementation or adoption stage of ES applications, rather than their announcement or implementation phase. Fourth, it differentiates between the direct and indirect effects of ES adoption on firm performance and thereby identifies innovation as an important mediating factor.

LITERATURE REVIEW

Two streams of research can be distinguished. First, the IT Business Value literature investigates the performance impacts of information technology at different levels of analysis (e.g. Brynjolfsson and Hitt 2003; Stiroh 2002). In this strand, IT is typically considered as one whole system, without any attention to its specific subcomponents. The second stream is more specialized and focuses on performance impacts of enterprise systems as a subclass of information technologies (e.g. Hendricks et al. 2007; Hitt et al. 2002). In this strand, the empirical literature largely consists of trade articles, (collection of) case studies, field experiments, and (self-reported) industry surveys, mostly from the US (e.g. Gattiker and Goodhue 2005;

McAfee 2002). These studies are useful by offering concrete lessons for implementation strategies but lack a certain generalization of their results that is achievable through rigorous and representative empirical analyses.

Enterprise System Types

We distinguish two categories of enterprise systems, which differ by the extent of the organization that is (fundamentally) affected by installation of the system. Implementation of some enterprise systems requires a wide range of organizational units to be involved and changed, for these systems to provide full functionality according to their design specifications. ERP (Davenport 1998), SCM (Mentzer et al 2001) and KMS (Alavi and Leidner 1999) are examples of *organization-wide enterprise systems*. Another group of enterprise systems is more confined to a limited number of organizational units. These systems are typically less complex and not necessarily implemented throughout the whole organization. CRM (Richards and Jones 2008) and DMS are instances of *domain-specific enterprise systems*.

Performance Effects of Enterprise Systems

The existing literature is equivocal about the performance effects of different types of enterprise systems. A number of studies report negative impacts during or one to two years after implementation of ERP systems and only positive effects after two to three years of continued use (Hitt et al. 2002; Nicolaou and Reck 2004). Several studies also report insignificant differences in profitability or financial performance between ERP-adopters and non-adopters (Poston and Grabski 2001; Wieder et al. 2006). In contrast, a group of the literature observes profound positive impacts of ERP adoption on order lead times (Cotteleer and Bendoly 2006), profitability (Hendricks et al. 2007), return on assets, return on investment and asset turnover (Hunton et al. 2003) or information response times, intra-organizational interactions and order cycles (Mabert et al. 2000).

Although the majority of the existing literature focuses on ERP and uses US data (Botta-Genoulaz et al. 2005), there are a handful of studies on other types of enterprise systems and based on non-US data. Here, a distinction shall be made between two types of available studies. The first group treats SCM, CRM and KMS concepts as a corporate policy or management practice (e.g. Almashari et al. 2002; Kim 2006; Massey et al. 2002). The second group explicitly focuses on these applications as IT-based enterprise systems (e.g. Dehning et al. 2007; Feng and Chen 2007; Karakostas et al. 2005; Shin 2006). Overall, the published results are mixed in pronouncing the performance impact of enterprise systems.

Innovation Effects of Enterprise Systems

Enterprise systems impede but also stimulate innovation. Enterprise applications can impose structural and procedural constraints, as they bring and install with themselves a set of generic, pre-programmed and fixed or hard-to-customize routines and procedures in the organization, which might fit the information needs, internal structures and specific idiosyncrasies of some organizations but misfit those of others (Kremers and Van Dissel, 2000; Soh et al. 2000). The tight coupling and cross-departmental integration of, especially organization-wide, enterprise systems make them highly complex, vulnerable to change and difficult to understand/manipulate and thereby hamper innovation as well (Davenport 1998; Robey et al. 2002).

Enterprise systems are also enablers of innovation and change as information and knowledge are essential elements in the innovation process of the firm. Enterprise systems enhance the access to and flow of timely and accurate information and relevant ideas internally and externally. This accelerates the problem solvings and decision makings involved in any innovation process. Furthermore, enterprise applications have the potential to significantly enhance the knowledge capabilities of the firm through increasing its absorptive capacity (Sirvardhana and Pawlowski 2007) and providing opportunities to acquire new knowledge (Ko et al. 2005; Volkoff et al. 2004).

CONCEPTUAL MODEL AND HYPOTHESES

The conceptual model, displayed in Figure 1, focuses on the post-implementation phase of enterprise systems. Two notions are relevant: *the facilitating or supportive role of ES* and *the enabling or innovative role of ES*. As far as the first notion is concerned, IT in general and ES in particular can support and facilitate the current situation in the firm. This includes increasing the efficiency of current workflows, automating existing business processes, facilitating present information routines and communication channels, and supporting available product portfolios and service offerings of the firm. With regard to the second notion, IT and especially ES can substantially change the current state of affairs and enable new or significantly modified practices, routines, processes, methods, channels, services, and/or products and thus indirectly affect firm performance through these innovations.

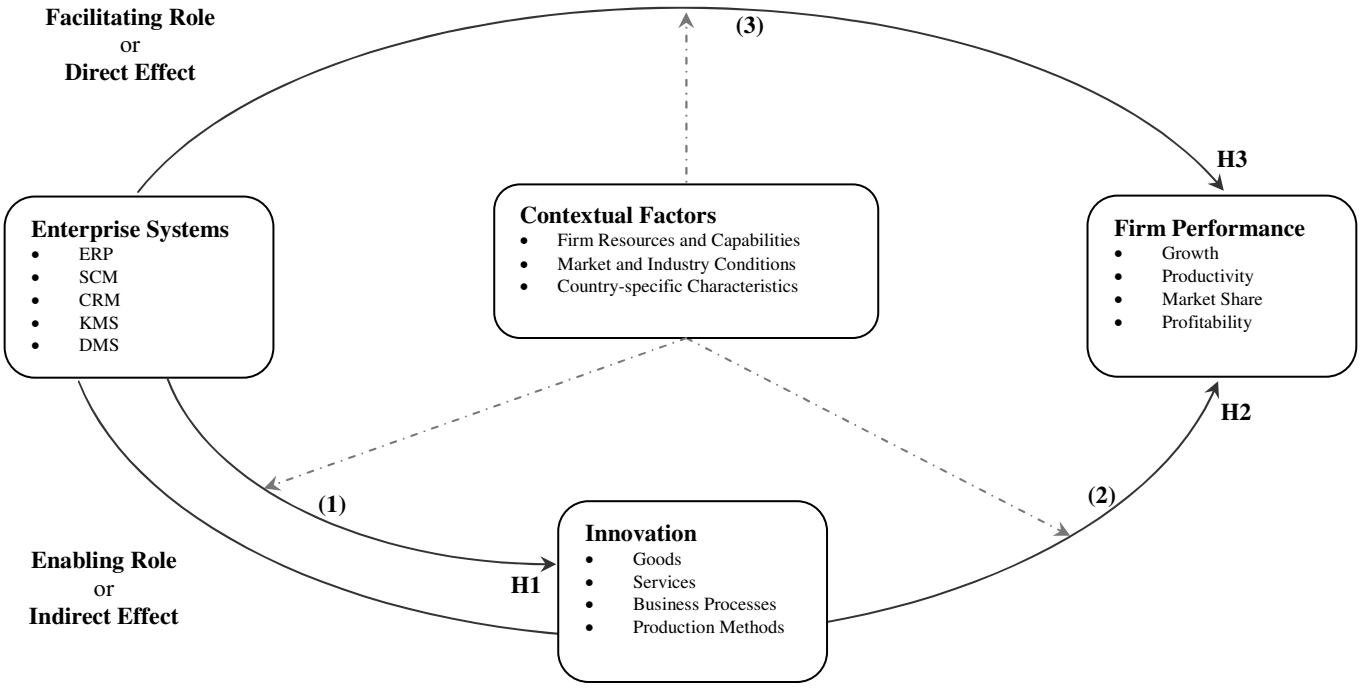

Figure 1. Conceptual Model of Relationships among Enterprise Systems, Innovation and Firm Performance

The Relationship between Enterprise Systems Adoption and Innovativeness

Innovation is a knowledge-intensive organizational process, where information and knowledge are the key determinants of success (Adamides and Karacapilidis 2006). Innovation is a process where creative and knowledgeable people and communities frame problems and then search, select and combine information to enhance their understanding and resolve the problems (Von Hippel, 1994). Enterprise systems help the firm to be more innovative as they collect, organize, aggregate and integrate data, from internal and external sources, into useful information. They also support transformation of information into organizational knowledge. Even more, they facilitate information flow and communication among the diverse set of actors and teams involved in an innovation process. This leads to the following hypothesis:

Hypothesis 1: Continued adoption of enterprise systems enhances innovativeness of the firm as measured by product and process innovation, controlling for contextual factors

The Relationship between Innovation and Firm Performance

Product innovation corresponds to the generation of a new production function. If demand for the new product in the market exists, sales can be expected to increase. Even if the new product substitutes an existing product of the firm, premium prices can be charged and sales growth is achievable, providing the new product is substantially differentiated from the existing offerings of the firm. Process innovation corresponds to the outward shift of an existing production function. This can be translated to productivity increase, which can be captured in lower production costs of the process output(s). The resulting cost saving can be further transformed to lower prices. Assuming that the price elasticity of buyers is high enough, process innovation leads to more revenues.

The discussion in this and the previous section point to a positive relationship between ES adoption and innovation and between innovation and firm performance respectively. We then hypothesize that:

Hypothesis 2: Continued adoption of enterprise systems enhances performance of the firm as measured by revenue, productivity and market share growth and profitability via product and process innovation, controlling for contextual factors.

The Direct Relationship between Enterprise Systems Adoption and Firm Performance

The direct impact of enterprise systems on firm performance is observable when they facilitate or support current processes, routines, work policies or product/service offerings of the firm. For example, ERP systems result in administrative and

operational saving by eliminating manual, repetitive tasks of data entry and reporting, SCM systems lead to lower inventory levels and order processing times and KMS systems result in internal efficiencies through facilitating knowledge sharing and document searching. These effects can be translated to lower variable costs of production and lower prices and subsequently to higher sales if demand is price-elastic.

The discussion leads us to hypothesize that:

Hypothesis 3: Continued adoption of enterprise systems enhances performance of the firm as measured by revenue, productivity and market share growth and profitability directly (by improving the efficiency of current practices and routines), controlling for contextual factors.

DATA AND DESCRIPTIVE STATISTICS

Data

The data in this study originates from the *Decision-maker Surveys* in years 2003, 2005, 2006, and 2007, executed by e-Business Market W@tch and sponsored by the Enterprise and Industry Directorate General of the European Commission. The surveys are conducted at the enterprise-level, from random, representative samples of the respective industry sector populations in each country. The surveys use a mix of CATI (computer-assisted telephone interviews) method and face-to-face interviews. The target decision-maker in the enterprise is normally the person responsible for IT within the company, typically the IT manager. If one harmonizes and pools[1] all the datasets, there are in total 33442 enterprises in 29 distinct European countries (EU-27 plus Norway and Turkey) and 29 different sectors (Manufacturing {NACE codes: 15, 17, 18, 19, 20, 21, 22, 24, 25, 17, 29, 30, 31, 32, 34, 35, and 36}; Construction {NACE code 45}; Services {NACE codes: 50, 52, 55, 60, 62, 63, 64, 72, 74, 85, and 92}). The pooled version of the dataset includes 448 unique markets (sector-country groups) with an average of 75 firms in each group. Table 1 shows the distribution of enterprise observations in each market.

Country / Sector	Manufacturing (%)	Construction (%)	Services (%)	% Sample (N= 33442)
Austria	0.68	0.36	1.06	2.09
Belgium	0.78	0.30	1.02	2.10
Bulgaria	0.48	0.36	0.36	1.20
Cyprus	0.15	0.24	0.43	0.82
Czech Republic	3.28	0.48	1.62	5.38
Denmark	0.39	0.30	1.11	1.80
Estonia	0.68	0.45	1.26	2.39
Finland	1.50	0.42	1.01	2.92
France	4.87	0.69	3.58	9.13
Germany	5.33	0.62	3.37	9.31
Greece	1.21	0.53	0.68	2.41
Hungary	1.55	0.45	1.02	3.03
Ireland	0.48	0.36	0.99	1.83
Italy	5.42	0.61	3.16	9.20
Latvia	0.46	0.39	0.89	1.74
Lithuania	0.31	0.36	0.71	1.38
Luxembourg	0.00	0.19	0.16	0.35
Malta	0.00	0.10	0.36	0.45
Netherlands	0.88	0.16	1.07	2.10

[1] Since enterprise unique identifiers are not available, constructing a panel data through linking the datasets is not possible; a pooled dataset is the only viable option for conducting a longitudinal analysis at the firm-level.

Norway	0.23	0.55	0.72	1.50
Poland	4.69	0.59	3.23	8.52
Portugal	0.94	0.00	1.17	2.11
Romania	0.39	0.36	0.57	1.32
Slovakia	0.53	0.38	0.91	1.82
Slovenia	0.36	0.50	1.15	2.01
Spain	5.20	0.64	3.32	9.16
Sweden	1.71	0.00	2.04	3.76
Turkey	0.52	0.22	0.45	1.20
United Kingdom	4.84	0.62	3.51	8.98
Total	48.00	11.06	40.94	100.00

- *Manufacturing sector* includes: Foods and beverages (NACE 15), Textile, apparel, footwear and leather products (17, 18 & 19), Wood, wood products and furniture (20& 36), Publishing, printing and pulp/paper products (21 & 22), Chemicals, chemical products, pharmaceuticals, rubber and plastics (24 & 25), Metals, metal products and machinery/equipment manufacturing (27 & 29), ICT manufacturing, consumer electronics, electrical machinery and office equipment (30, 31 & 32), and Automotive/transport equipment manufacturing and aerospace industries (34 & 35).
- *Construction sector* includes: Construction (NACE 45).
-*Services sector* includes: Retail and Wholesale (NACE 50 & 52), Tourism, hotels and recreational/cultural activities (55, 62, 63 & 92), Transport and logistics (60 & 63), ICT services and telecommunications (64 & 72), Business services (74), and Health, hospital and social services (85).

Table 1. Composition of Enterprise Observations in the Pooled Dataset (% of Sample Total)

To assess the representativeness of the sample, we compare the sample characteristics with those of the National Accounts data for the available countries on the basis of two criteria: (1) relative distribution of different sectors (in terms of the number of enterprises) in the surveyed countries, and (2) relative distribution of different enterprise size classes in the sampled sectors. The comparisons corroborate the idea that the sample is a good representation of the underlying population in the respective countries, though, for those sectors of the economy which are relatively heavier and more advanced users of IT and e-Business. [2, 3]

Descriptive Statistics

Table 2 gives the descriptive statistics of the relevant variables. With respect to the variables of main interest, i.e. enterprise systems, two-fifth of the sampled enterprises is using at least one type of ES software by 2007. ERP and DMS are the most commonly used applications, with an average adoption rate of 1 out of 5 enterprises, followed by CRM, KMS, and SCM; this can be partly explained by the fact that ERP usually acts as a common platform for installing CRM and SCM (Ragowsky and Somen 2002) and that many companies prefer a less complex system of information management like DMS to a sophisticated one like KMS. Moreover, CRM, KMS, and SCM systems are relatively new compared to ERP and DMS.

An important notion is that the surveyed firms in our sample, on average, are using their ERP, SCM, CRM, and KMS systems for 66, 48, 42, and 44 months respectively, by the time they were questioned.4,5 Comparing these numbers with the available observations in the literature, which is an average of 17-21 months for installation and a comparable or shorter period for customization (e.g. Umble and Umble 2002), indicates that the average firm in our sample has already passed the implementation, customization and adaption phases of enterprise systems and is likely in a diffusion, routinization or institutionalization stage where it is capable of utilizing these applications effectively and productively (Rajagopal 2002).

[2] The correlation tables are not presented due to space constraints but accessible upon request.
[3] The Financial sector is an exception, whereas it is an intensive user of IT but non-represented in the sample. Our sample is also not a good representation of sectors such Agriculture, Fishery, Mining and Energy with relatively low levels of IT usage. Among the different size classes, large enterprises (more than 250 employees) are slightly under-represented in the sample.
[4] Taking into account the adoption frequency of different enterprise systems in the sample, these figures are translated into a weighted average of more than 52 months (or about 4.5 years) as an overall maturity indicator.
[5] The medians are 54, 38, 30, and 35 months and the percentiles with less than a year of adoption are 7%, 13%, 15%, and 14% for ERP, SCM, CRM and KMS respectively. The minimum for all the groups is one month and the maximum more than 167 months.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Innovation					
Product/Service Innovation	29681	.444	.497	0	1
Internal Process Innovation	29705	.393	.488	0	1
Firm Performance					
Revenue Growth	30064	.511	.500	0	1
Productivity Growth	12464	.533	.499	0	1
Market share Growth	15819	.447	.497	0	1
Profitability	11182	.837	.369	0	1
Firm & Market Characteristics					
# of Employees	32529	133.787	850.874	1	60000
% Higher Education	27909	26.058	30.724	0	100
% R&D Employees	14876	11.032	22.228	0	100
International Competition	22846	.176	.380	0	1
Western Europe*	33442	.687	.464	0	1
Eastern Europe**	33442	.288	.453	0	1
Manufacturing	33442	.479	.500	0	1
Services	33442	.409	.492	0	1
Construction	33442	.112	.316	0	1
Market Share $\in$ [0,5]	33442	.178	.383	0	1
Market Share $\in$ (5,10]	33442	.051	.221	0	1
Market Share $\in$ (10,25]	33442	.068	.251	0	1
Market Share $\in$ (25,100]	33442	.229	.420	0	1
IT Infrastructure & Enterprise Systems					
Broadband Internet	31346	.711	.453	0	1
% Internet-enabled Employees	22232	29.757	38.889	0	100
e-Business Maturity	32844	.190	.393	0	1
Enterprise Resource Planning	31711	.200	.400	0	1
Supply Chain Management	31698	.111	.314	0	1
Customer Relationship Management	31798	.141	.348	0	1
Knowledge Management System	27355	.112	.315	0	1
Document Management System	20005	.192	.394	0	1
Enterprise System (of any type)	30463	.398	.489	0	1

*Western Europe include: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Norway, Portugal, Spain, Sweden, and United Kingdom.
**Eastern Europe include: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

Table 2. Descriptive Statistics of the Variables

ECONOMETRIC MODEL, OPERATIONALIZATION AND REGRESSION METHOD

Model Specifications

The following general logistic model is used to relate enterprise systems adoption to firm-level innovativeness.

$$\ln\left[\frac{p(Innovation_{i,j}=1)}{1-p(Innovation_{i,j}=1)}\right]=\alpha_0+\overline{\alpha}_1\overline{ES}_{i,j}+\alpha_2 Size_{i,j}+\alpha_3 Education_{i,j}+\alpha_4 Internet_{i,j}+\alpha_5 eBusiness_{i,j}+$$
$$\sum Market_{i,j}+\sum Time_{i,j}+u_j+\varepsilon_{i,j} \quad (1)$$

where *i* and *j* refer to the firm and the market in which the firm operates respectively and u_j and $\varepsilon_{i,j}$ specify unobserved market- and firm-specific effects.

A similar estimating equation is used to model the total effects of enterprise systems adoption on firm performance.

$$\ln\left[\frac{p(Performance_{i,j}=1)}{1-p(Performance_{i,j}=1)}\right]=\beta_0+\overline{\beta}_1\overline{ES}_{i,j}+\beta_2 Size_{i,j}+\beta_3 Education_{i,j}+\beta_4 Internet_{i,j}+\beta_5 eBusiness_{i,j}+$$
$$\sum Market_{i,j}+\sum Time_{i,j}+u_j+\varepsilon_{i,j} \quad (2)$$

The dependent variable in the above estimation models is the log odds of a measure of innovativeness or performance. We distinguish between two innovation types: product and process innovation. We also deal with four performance indicators: revenue, productivity and market share growth and profitability.[6]

As noted earlier, we differentiate between direct (or facilitating) and indirect (or enabling) effects of enterprise systems on firm performance. Innovation acts as a mediator in transmitting the indirect effects. Robust and systematic identification of indirect effects, especially when the mediation factor is dichotomous, presents conceptual and practical difficulties in nonlinear models such as logit (Li et. al 2007; MacKinnon 2007). Among the available path-analytic methods, we employ the following approach to yield easy-to-interpret results (Cohen et al. 2003):

1. Model (2) is used to estimate the total effect of ES on firm performance.
2. We develop model (3) below where two innovation dummies are included as additional predictors of firm performance. This model extracts and only estimates the direct effect of ES on firm performance.

$$\ln\left[\frac{p(Performance_{i,j}=1)}{1-p(Performance_{i,j}=1)}\right]=\gamma_0+\overline{\gamma}_1\overline{ES}_{i,j}+\overline{\gamma}_2\overline{Innovation}_{i,j}+\gamma_3 Size_{i,j}+\gamma_4 Education_{i,j}+\gamma_5 Internet_{i,j}+\gamma_6 eBusiness_{i,j}+$$
$$\sum Market_{i,j}+\sum Time_{i,j}+u_j+\varepsilon_{i,j} \quad (3)$$

3. We compare the estimation results of model (2) and (3). If the relationship between ES adoption and firm performance remains significant and unchanged once innovation is included in the model, then mediation (and, consequently, indirect effect) is not supported. If the relationship reduces but still remains significant, then *partial mediation* is supported. If the relationship is reduced to a point where it is not significant anymore, then *full mediation* is supported (Hair et al. 2006).

Because our data is of a cross-sectional character, endogeniety or simultaneity problem arises when interpreting the regression results. This leads us to draw cautious conclusions. We carefully suggest with models (1)-(3) that causality indeed runs from independent ES variables to dependent performance indicators based on the following three arguments:

(1) There are a few theoretical and empirical academic studies that explicitly deal with this causality issue and indeed support the interpretation of causality from ES adoption to firm performance (Aral et al. 2006; Byrd and Marshall 1997; Melville et al. 2004; Pare et al. 2008). Especially, Aral et al. (2006) provide strong empirical evidence (and theoretical explanation) for the fact that the use of enterprise systems actually causes performance gains rather than strong performance inspiring or driving the purchase or adoption of enterprise systems.

(2) As to a very important assumption of causality, the cause must precede the effect temporally. A careful look at the dependent and main independent variables in this study reveals that the dependent variables capture a phenomenon (i.e. change in performance or occurrence of innovation) within the past year of survey while the ES adoption variables deal with an incident (i.e. adoption of an enterprise system) much further back in time (on average between 3.5 and 5.5 years, depending on the type of system). This time-lag increases the plausibility of the assumption that causality runs from ES adoption to firm performance.

[6] As expected, the output measures are not independent. The Pearson correlation coefficients reveal the highest correlations among the growth indicators: revenue growth and productivity growth (0.61) and revenue growth and market share growth (0.56). The lowest correlations exist between innovation measures and profitability: process innovation and profitability (0.05) and product innovation and profitability (0.07).

(3) The dependent variables used in this analysis indicate a change while the independent adoption variables point to a continuing action. This dynamic versus static nature of the dependent and independent variables makes it more intuitive to presume the causality from independent to dependent variables.

Construction of Variables

Table 3 summarizes the output measures in models (1)-(3) and their definitions. These variables take a value of 1 if the firm exhibits a certain characteristic and 0 otherwise. In other words, if the response is "yes" or indicates a positive change (i.e. "increased") the measure is coded 1 and 0 otherwise. "Don't Know [DK]", "Refused to Say", and "Not Applicable [NA]" responses are recoded as missing. The set of explanatory variables consists of both the ES adoption variables and the observed control variables.

Dependent Variable	Type	Relevant Question from the Survey to Construct the Variable
Innovativeness		
Product Innovation	Dummy	During the past 12 months, has your company launched any new or substantially improved product or services? (yes/ no/ DK, refused or NA)*
Process Innovation	Dummy	During the past 12 months, has your company introduced any new or significantly improved internal processes, for example for producing or supplying goods or services? (yes/ no/ DK, refused or NA)
Performance		
Revenue Growth	Dummy	Has the turnover of your company changed when comparing the last financial year with the year before? (increased/ decreased/ stayed roughly the same/ DK/ NA)
Productivity Enhancement	Dummy	Has the productivity of your company changed when comparing the last financial year with the year before? (increased/ decreased/ stayed roughly the same/ DK)
Market Share Increase	Dummy	Has the share of your company in its most significant market changed over the past 12 months? (increased/ decreased/ remained roughly the same/ DK/ NA)
Profitability	Dummy	Has your company been profitable over the past 12 months? (yes/ no/ DK, refused or NA)

*DK: Don't Know; NA: Not Applicable

Table 3. Measures of Firm Innovativeness and Performance and their Source Questions in the Survey

Table 4 summarizes the relevant covariates and describes their source question(s) in the survey. $\overline{ES_{i,j}}$ is a vector of variables that takes two versions. The basic specification only includes a dummy variable tracking if the firm uses enterprise systems (of any type). The comprehensive specification extends this overall indicator into a set of five dummies referring to ERP, SCM, CRM, KMS and DMS adoption separately. We include the natural log number of employees ($Size_{i,j}$) to control for size and hence economies-of-scale effects. The logarithmic form is used to reduce the effect of skewness, as the number of employees is right-skewed. Percentage of higher-educated employees ($Education_{i,j}$) is a measure of general skills- and knowledge-level of the firm. Broadband internet connectivity and strong IT infrastructure lead many companies to rethink their business practices and encourage them to utilize enterprise systems and e-Business applications (Zhu 2004). In the regressions, we use $Internet_{i,j}$ as a dummy variable to indicate if the firm uses any type of broadband internet. It is questionable to compare the effect of ES adoption on firm performance in firms with divergent degrees of engagement in (or reliance on) e-Business. We therefore use $eBusiness_{i,j}$ as a binary variable to distinguish firms with a significant part of their business processes being conducted electronically from those with only minor or none involvement in e-Business. Finally, we control for market effects through a set of four dummies for different market share classes, as explained in Table 4. We also correct for economy-wide, transitory shocks to performance by including a dummy variable for each survey year.

Independent Variable	Type	Relevant Question(s) from the Survey to Construct the Variable
Enterprise Systems		
ERP	Dummy	Does your company use an ERP (i.e. Enterprise Resource Planning) system?* (yes/ no/ don't know what this is/ DK)
SCM	Dummy	Does your company use a SCM (i.e. Supply Chain Management) system?* (yes/ no/ don't know what this is/ DK)
CRM	Dummy	Does your company use a CRM (i.e. Customer Relationship Management) system?* (yes/ no/ don't know what this is/ DK)
KMS	Dummy	Does your company use a KMS (i.e. Knowledge Management System) system?* (yes/ no/ don't know what this is/ DK)
DMS	Dummy	Does your company use a DMS (i.e. Document Management System) system?* (yes/ no/ don't know what this is/ DK)
Control Variables		
# of Employees	Continuous	How many employees does your company have in total, including yourself? (numerical value/ DK/ no answer)
% Highly-educated Employees	Continuous	What is the estimated percentage share of employees with a college or university degree in your company? (numerical value/ DK/ no answer)
Broadband Internet	Dummy	Does your company have access to broadband internet, i.e. via DSL/ADSL/SDSL, Cable, direct Fibre/Fixed connection, Wireless connection, or other Broadband connections? (yes/ no/ DK)**
e-Business Maturity	Dummy	According to the overall experience of your company, would you say that e-business constitutes a significant part of the way your company operates today, or some part or none at all? (significant part/ some part/ none at all/ DK)*** or Would you say that most of your business processes are conducted electronically as e-business, a good deal of them, some, or none? (most/ a good deal/ some/ none/ DK)
Market Share	Set of Dummies	How large is the market share of your company in its primary, most significant market? (0-5%/ 5%-10%/ 10%-25%/ 25-100%/ DK)

DK: Don't Know; NA: Not Applicable
* The ES questions are accompanied by short descriptions about what the system is and what it is used for.
** Depending on the year of the survey, all or a combination of different connection types has been questioned.
*** Depending on the year of the survey, one of these two questions has been asked in the interview questionnaire.

Table 4. Independent Variables and their Source Questions in the Survey

Regression Method

We employ conditional fixed-effects logit for qualitative outcomes to estimate the models explained above (Chamberlain, 1980). This method is required to generate consistent results, taking into account the nature of our data. Correction is needed for unobserved firm-, sector-, and country-specific effects in order to attain unbiased estimates. We opt for using a conditional variation of fixed-effects logit for three reasons. First, maximization of the fixed-effects likelihood function can generate seriously inconsistent estimations if there is a considerable large number of matched case-control groups (i.e. sector-country pairs) with a rather small number of observations per group relative to the sample size. Second, contrary to an unconditional fixed-effects model, the error components in model (1)-(3) relax the assumptions that market effects are independent of observed and unobserved firm effects (i.e. $E\left[u_j \mid \bar{x}_{i,j}\right] \neq 0$ and $E\left[u_j \mid \varepsilon_{i,j}\right] \neq 0$). These assumptions are generally unrealistic, as market and country characteristics have certain effects on formation, development and decline of firms as well as their characteristics that are shaped over time. Third, adding separate industry and country dummies into the regression model (i.e. DV method) is not the preferred approach to control for sector- and country-specific effects as: (1) the DV method implies that a sector, although different from other sectors, is identical in all countries, while sectors expose diverse structural

and economic characteristics in different countries; and (2) this method would confound sampling and real effects, due to the heterogeneous coverage of industries among the sampled countries (Koellinger 2008).[7]

REGRESSION RESULTS AND DISCUSSIONS

The Impact of Enterprise Systems Adoption on Firm Innovativeness

Table 5 reports the regression results for model (1). As shown in Table 5, the adoption of enterprise systems in general increases the likelihood of being product and process innovator by 77.6% and 102.5% respectively.[8] As expected, the impact of enterprise applications on process innovation is stronger as ES adoption entails various process changes in the organization and provides vast process information that can be later used for process innovation. All five types of ES software are significantly and positively associated with product and process innovation. Comparatively, CRM exhibits the largest impact on both types of innovation. This highlights the very crucial role of customers (as lead users) in innovation processes of the firm as emphasized by Von Hippel (1988; 2005). On the basis of the findings, we cannot reject *Hypothesis 1* for any of the ES types we studied. The results also suggest that larger firms and those with higher shares of educated workforce have more access to the required resources and expertise to innovative and thus are more likely to be innovator. Moreover, broadband connectivity and e-Business maturity substantially matter for innovation.

Regression	**1**	**2**	**3**	**4**
	Product Innovation (Model 1)		**Process Innovation (Model 1)**	
	Odds Ratio (Standard Error)			
ES	1.776*** (.060)	---	2.025*** (.070)	---
ERP	---	1.275*** (.069)	---	1.328*** (.072)
SCM	---	1.231*** (.077)	---	1.522*** (.096)
CRM	---	1.783*** (.105)	---	1.691*** (.099)
KMS	---	1.298*** (.082)	---	1.423*** (.090)
DMS	---	1.287*** (.076)	---	1.477*** (.088)
ln(Employees)	1.136*** (.011)	1.135*** (.015)	1.270*** (.013)	1.216*** (.017)
%Higher Education	1.007*** (.001)	1.006*** (.001)	1.005*** (.001)	1.004*** (.001)
Broadband Internet	1.250*** (.048)	1.266*** (.063)	1.529*** (.061)	1.519*** (.081)
e-Business Maturity	1.790*** (.071)	1.826*** (.094)	1.857*** (.073)	1.916*** (.099)
Market Share controls	Yes	Yes	Yes	Yes
Time controls	Yes	Yes	Yes	Yes

[7] We observe data for a number of industry sectors in different countries but it is not necessarily the case that all sectors are covered in each country.
[8] For all the regressions, we also calculated the Average Marginal Effects (AME) in addition to Odds Ratios (OR). Because the results are perfectly comparable and yield similar conclusions, we stick to the more common representation, i.e. OR.

Model Diagnostics				
Observations	22666	13712	22703	13731
Groups	256	189	257	190
Ave. Obs./Group	88.5	72.6	88.3	72.3
Log-likelihood	-13215	-7764	-12658	-7307
Model Significance	0.000	0.000	0.000	0.000

*, **, and *** indicate significance at 90%, 95%, and 99% confidence level respectively. Fixed-effects logit, conditioned on market-specific effects, is used. Estimates are shown in Odds Ratios (OR = exp(b)). Standard Errors have also been transformed according to OR presentation. Groups indicate sector-country pairs.

Table 5. Regression Results for Assessing the Effect of ES Adoption on Firm Innovativeness

The Overall Impact of Enterprise Systems Adoption on Firm Performance

Table 6 reports the estimation results of model (2).

Regression	5	6	7	8	9	10	11	12
	Revenue Growth (Model 2)		Productivity Growth (Model 2)		Market Share Growth (Model 2)		Profitability (Model 2)	
	Odds Ratio (Standard Error)							
ES	1.239*** (.042)	---	1.340*** (.064)	---	1.267*** (.054)	---	0.973 (.078)	---
ERP	---	1.107* (.060)	---	1.099 (.072)	---	1.025 (.067)	---	0.771* (.110)
SCM	---	1.069 (.067)	---	1.148* (.083)	---	1.177** (.085)	---	1.113 (.218)
CRM	---	1.288*** (.076)	---	1.224*** (.085)	---	1.126* (.077)	---	1.202 (.212)
KMS	---	1.003 (.063)	---	1.197** (.090)	---	1.342*** (.098)	---	0.928 (.167)
DMS	---	1.131** (.066)	---	1.156** (.080)	---	1.195*** (.082)	---	1.071 (.176)
ln(Employees)	1.145*** (.012)	1.150*** (.016)	1.179*** (.018)	1.178*** (.020)	1.075*** (.015)	1.069*** (.018)	1.065*** (.022)	1.125*** (.039)
%Higher Education	1.004*** (.001)	1.004*** (.001)	1.005*** (.001)	1.005*** (.001)	1.004*** (.001)	1.003*** (.001)	1.001 (.001)	1.002 (.002)
Broadband Internet	1.261*** (.047)	1.238*** (.059)	1.276*** (.071)	1.280*** (.074)	1.292*** (.069)	1.282*** (.076)	1.157** (.085)	1.257* (.150)
e-Business Maturity	1.445*** (.058)	1.433*** (.074)	1.672*** (.097)	1.627*** (.100)	1.565*** (.077)	1.634*** (.098)	1.289*** (.126)	1.251 (.184)
Market Share controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Model Diagnostics								
Observations	21337	13049	9799	9126	12212	8963	8610	3557
Groups	256	190	160	160	194	159	143	62

Ave. Obs./Group	83.3	68.7	61.2	57.0	62.9	56.4	60.2	57.4
Log-likelihood	-13130	-7968	-5946	-5514	-7505	-5408	-3287	-1262
Model Significance	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

*, **, and *** indicate significance at 90%, 95%, and 99% confidence level respectively. Fixed-effects logit, conditioned on market-specific effects, is used. Estimates are shown in Odds Ratios (OR = exp(b)). Standard Errors have also been transformed according to OR presentation. Groups indicate sector-country pairs.

Table 6. Regression Results for Assessing the Total Effect of ES Adoption on Firm Performance

Ceteris paribus, adopting enterprise systems goes together with more sales, productivity, and market share but not profit. Distinguishing between different types of ES applications, CRM has the largest total impact on corporate revenue and productivity and KMS on market share. CRM-adopting enterprises are 28.8 and 22.4 percent more likely than their non-adopting peers to experience revenue and productivity growth respectively. A customer-centric shift in the company culture and structure leads to better brand recognition and customer satisfaction and retention and thus more sales (and productivity) (Karakostas et al. 2005). The likelihood of market share growth, ceteris paribus, is 34.2% higher for KMS-adopters. This finding endorses previous studies that report the competitive advantage of KMS-adopters over their non-adopting peers (Feng and Chen 2007) and highlights the important role of organizational learning and knowledge management in the contemporary firm (Almashari et al. 2002).

Some surprising findings are that SCM and KMS do not significantly improve corporate turnover (regression 6), SCM improves productivity only at 10% significance level (regression 8), and the ERP effect on corporate turnover growth is only weakly significant (regression 6) and on productivity and market share growth is insignificant (regression 8 and 10). This suggests that European enterprises have not managed to effectively utilize their ERP, SCM and to some extent KMS investments, which can be attributed to more sophisticated and extensive nature of these systems compared to simpler and smaller applications such as CRM and DMS. Organization-wide systems involve and affect a larger number of parties and domains inside or outside the organization, while domain-specific applications require lower degrees of cross-functional integration and process standardization and, therefore, are more likely to be implemented successfully and become fruitful (at least in the short- and medium-term).

Another surprising finding relates to the ambiguous relationship between enterprise systems adoption and profitability. Adopting an enterprise system per se does not make the firm more likely to be in the group of profitable firms (regression 11). A closer look reveals that, everything else constant, ERP adoption might be disadvantageous for firm profitability while other system types are not related to profitability at all; ERP-adopters are 22.9% less likely to be profitable (regression 12). Four possible explanations can be put forward. First, due to their complex and expansive nature, enterprise systems might require much larger investment time-lags (than the average time span of 52 months observable in our sample) after full implementation in order to be properly embedded in the organization and reveal substantial benefits that cancel out the huge initial investment costs of them. Second, the main stakeholders of ES projects (i.e. software vendors, consultants, and the adopting organization), on average, might not yet have reached a high level of maturity and expertise in implementing these systems, adapting them to the profit-making objectives of the firm and reengineering the necessary business processes.[9] Third, for the positive contribution of enterprise systems to be captured in performance measures, certain critical success factors should be in place, which firms in our sample have seemingly failed to provide in time (e.g. Hong and Kim 2002; Nah et al. 2001). If these complementarities are not present or are not advanced enough, adopting enterprise systems might yield suboptimal returns. Fourth, the average firm in the sample might have failed to effectively protect the strategic advantages of adopting enterprise systems from being imitated by the competition. In that case, the firm is only able to generate temporary excess returns at best, lasting only insofar as replication occurs.

The Direct versus Indirect Impact of Enterprise Systems Adoption on Firm Performance

Table 7 reports the estimation results of model (3).

[9] This suggests a shallow *learning curve* of progress in the mastery of enterprise systems.

Regression	13	14	15	16
	Revenue Growth (Model 3)	Productivity Growth (Model 3)	Market Share Growth (Model 3)	Profitability (Model 3)
	Odds Ratio (Standard Error)			
ERP	1.047 (.058)	1.028 (.069)	0.977 (.066)	0.756* (.109)
SCM	1.006 (.064)	1.050 (.079)	1.087 (.081)	1.105 (.217)
CRM	1.163** (.071)	1.055 (.076)	0.971 (.068)	1.163 (.206)
KMS	0.959 (.061)	1.121 (.086)	1.270*** (.095)	0.899 (.162)
DMS	1.058 (.063)	1.064 (.076)	1.109 (.079)	1.038 (.172)
Product Innovation	1.585*** (.067)	1.667*** (.086)	1.811*** (.093)	1.211* (.133)
Process Innovation	1.537*** (.068)	1,783*** (.097)	1.549*** (.083)	1.222* (.136)
ln(Employees)	1.122*** (.016)	1.147*** (.020)	1.042** (.018)	1.106*** (.039)
%Higher Education	1.003*** (.001)	1.003*** (.001)	1.002** (.001)	1.001 (.002)
Broadband Internet	1.181*** (.058)	1.220*** (.072)	1.225*** (.074)	1.199 (.145)
e-Business Maturity	1.305*** (.069)	1.404*** (.089)	1.423*** (.088)	1.237 (.184)
Market Share controls	Yes	Yes	Yes	Yes
Time controls	Yes	Yes	Yes	Yes
Model Diagnostics				
Observations	12824	8960	8811	3502
Groups	190	160	159	62
Ave. Obs./Group	67.5	56.0	55.4	56.5
Log-likelihood	-7675	-5265	-5178	-1243
Model Significance	0.000	0.000	0.000	0.000

*, **, and *** indicate significance at 90%, 95%, and 99% confidence level respectively. Fixed-effects logit, conditioned on market-specific effects, is used. Estimates are shown in Odds Ratios. Standard Errors have been transformed according to OR presentation. Groups indicate sector-country pairs.

Table 7. Regression Results for Assessing the Direct Effect of ES Adoption on Firm Performance

The estimates of model (2) in Table 6 and model (3) in Table 7 denote the total and direct effects of ES adoption on performance respectively; the qualitative difference between the two estimates then represents the indirect effects (i.e. mediation through innovation).[10] As expected, being innovative boosts the chance of being a better performer irrespective of the performance measure considered. When comparing the results in Table 6 and 7, the most interesting finding is that the estimates of almost all the ES variables lose their significance when innovation is explicitly included in the model. The two exceptions here are the effects of CRM on revenue growth and KMS on market share growth (regression 13 and 15); even in these cases, the effects are diminished.[11] This finding means that innovation plays the role of a *full mediation* factor in mediating the positive impact of several types of enterprise systems on firm performance. In some instances, though, the role of innovation is reduced to *partial mediation*. Put it differently, we conclude that the enabling role of enterprise systems represents a very substantial part of their performance effects and that their facilitating role only accounts for a minor (and mainly statistically insignificant) part.

The findings indicate that *Hypothesis 2* can not be rejected for most of ES application types and performance measures under investigation, except for profitability. As far as firm profitability is concerned, *Hypothesis 2* is rejected for all ES categories even at 10% significance level. In contrast, our observations lead us to reject *Hypothesis 3* for almost all ES types and performance measures studied, except for the two incidents noted above.

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

Conclusions

The central issue to investigate in this paper is *whether* and *how* enterprise systems affect innovativeness and performance of the firm. This paper contributes to the debate on the performance payoffs of enterprise systems by providing new evidence (to answer the "what" question) and insights (to answer the "how" question). We use a representative pooled dataset of 33,442 enterprises across 29 European countries (EU-27 plus Norway and Turkey) and 29 sectors (covering all the major non-financial economic activities) over a 5-year period (2003-2007). Six measures of organizational performance (i.e. product and process innovation, revenue, productivity and market share growth and profitability) in a conditional fixed-effects logit model are analyzed.

We draw four major and two minor conclusions based on the research results. First, with regard to the innovation effects, the findings support a significant contribution of ES adoption to product and more strongly to process innovation for all the application types studied. As a consequence, this research can be seen as an attempt to mitigate the argument on the hampering effects of enterprise systems with respect to innovation. Second, as to the performance effects of ES adoption, the analysis reveals that almost all enterprise applications significantly contribute to corporate sales, productivity and market share. However, no ES software is found to be helpful to profitability of the firm, which makes profit a critical measure of performance that requires special attention when it comes to assessing the business value of enterprise systems. Third, this research sheds light on the considerable mediating role of innovation in the ES value creation process of the firm. Enterprise systems are found to significantly contribute to organizational performance insofar as they enable the adopting firm to substantially change/improve its internal production processes and/or introduce new products/services to the market. In general, those systems that solely facilitate the existing business processes and product portfolios of the firm do not seem to generate significant performance improvements. This result gives weight to the necessity of innovating with enterprise systems when optimum outcomes are sought for. As to the fourth major conclusion of the research, the findings reflect the fact that discrete, departmental applications that are less complex and easier to understand/use such as CRM and DMS are more likely to result in a successful implementation and thus be beneficial to firm performance compared to expansive and sophisticated counterparts such as ERP, SCM, and KMS that demand major organizational changes and affect the whole structure of the firm.[12]

Concerning the minor conclusions of the research, we find that ERP systems, as the most common type of ES software in business, are on average ineffective in boosting the productivity and market share of the firm; their impact on corporate revenue is also not highly significant. This finding supports the hampering view about ERP systems that is mainly attributed to their structural inflexibility, gigantic size and complicated interactions with many organizational entities. Finally, our

[10] A simple arithmetic difference does not give a precise estimate as we work with log-linear models.
[11] Running the Wald Test in a simultaneous Seemingly Unrelated Regression (SUR) model also confirms that the ES estimates in model (2) and (3) differ significantly (at 1%). The test results are available upon request.
[12] Domain-specific systems were found to be the only group of applications with a significantly positive impact on all the output measures under investigation in this study (except for profitability).

observations corroborate the idea that educated workforce, broadband accessibility, and e-business processes are (very) strong determinants of organizational innovation and performance.

Limitations and Recommendations for Future Research

The pooled data at our disposal is limited in the sense that it does not allow for panel data techniques or dynamic specifications, which would provide the opportunity to observe lagged variables, to better control for unobserved heterogeneities, and to test causality. In connection to this issue, future research should concentrate on the longer-term performance effects of enterprise systems that would lead us to better understand the ultimate value of these systems and the extent of time-lags between costs incurred and benefits accrued. Additionally, we did not really conduct a cross-sectoral or -country analysis, as we aimed at the overall, economy-wide effects of enterprise systems. However, such analyses can be very illuminating by unraveling the considerable differences among different sectors and countries with regards to how they use and create value from information technology in general and enterprise systems in particular. Furthermore, more research should be devoted to analyzing complementarities between enterprise systems and certain organizational characteristics and firm-specific practices that ultimately make a specific ES project a success or a failure.

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REFERENCES

1. Adamides, E.D. and Karacapilidis, N. (2006), Information technology support for the knowledge and social processes of innovation management, *Technovation*, 26, 50–59.

2. Alavi, M. and Leidner, D. (1999), Knowledge Management Systems: Issues, Challenges, and Benefits, *Communications of the AIS*, 1(2).

3. Almashari, M., Zairi, M. and Alathari, A. (2002), An empirical study of the impact of knowledge management on organization performance, *The Journal of Computer Information Systems*, January 2002.

4. Aral, S., Brynjolfsson, E. and Wu, D.J. (2006), Which Came First, IT or Productivity? The Virtuous Cycle of Investment and Use in Enterprise Systems, *Proceedings of the 27th ICIS*, Milwaukee, WI, December 2006.

5. Botta-Genoulaz, V., Millet, P-A. and Grabot, B. (2005), A survey on the recent research literature on ERP systems, *Computers in Industry*, 56, 510-522.

6. Brynjolfsson, E. and Hitt, L.M. (2003), Computing productivity: Firm-level evidence, *Review of Economics and Statistics*, 85(4), 793-808.

7. Byrd, T.A. and Marshall, T. (1997), Relating Information Technology Investment to Organizational Performance: A Causal Model Analysis, *Omega*, 25(1), 43-56.

8. Chamberlain, G. (1980), Analysis of covariance with qualitative data, *Review of Economic Studies*, 47(1), 225–238.

9. Cohen, J., Cohen, P., West, S.G. and Aiken, L.S. (2003), *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*, Lawrence Erlbaum Associates Inc., Mahwah, NJ.

10. Cotteleer, M., Bendoly, E. (2006), Order lead-time improvement following enterprise-IT implementation: An empirical study, *MISQ*, 30 (3).

11. Davenport, T.H. (1998), Putting the enterprise into the enterprise system, *Harvard Business Review*, 76(4), 121–131.

12. Dehning, B., Richardson, V.J. and Zmud, R.W. (2007), The financial performance effects of IT-based supply chain management systems in manufacturing firms, *Journal of Operations Management*, 25, 806–824.

13. Feng, D. and Chen, E.T. (2007), Firm performance effects in relations to the implementation and use of knowledge management systems, *International Journal of Innovation and Learning*, 4(2), 172–185.

14. Gattiker, T. and Goodhue, D. (2005), What happens after ERP implementation: understanding the impact of interdependence and differentiation on plant-level outcomes? *MISQ*, 29(3), 559 - 585.

15. Hair Jr., J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L. (2006), *Multivariate Data Analysis*, Pearson Education Inc., Upper Saddle River, NJ.

16. Hendricks, K.B., Singhal, V.R. and Stratman, J.K. (2007), The impact of enterprise systems on corporate performance: A study of ERP, SCM, and CRM system implementations, *Journal of Operations Management*, 25, 65–82.

17. Hitt, L.M., Wu, D.J. and Zhou, X. (2002), Investment in enterprise resource planning: Business impact and productivity measures, *JMIS*, 19(1), 71-98.

18. Hong, K.K. and Kim, Y.G. (2002), The critical success factors for ERP implementation: an organizational fit perspective, *Information & Management*, 40, 25–40.

19. Hunton, J.E., Lippincott, B. and Reck, J.L. (2003), Enterprise resource planning systems: comparing firm performance of adopters and non-adopters, *International Journal of Accounting Information Systems*, 4, 165–184.

20. Karakostas, B., Kardaras, D. and Papathanassiou, E. (2005), The state of CRM adoption by the financial services in the UK: an empirical investigation, *Information & Management*, 42, 853–863.

21. Kim, S.W. (2006), Effects of supply chain management practices, integration and competition capability on performance, *Supply Chain Management*, 11(3), 241–248.

22. Ko, D-G., Kirsch, L.J. and King, W.R. (2005), Antecedents of knowledge transfer from consultants to clients in enterprise system implementation, *MISQ*, 29(1), 59–85.

23. Koellinger, P. (2008), The relationship between technology, innovation, and firm performance-Empirical evidence from e-business in Europe, *Research Policy*, 37, 1317–1328.

24. Kremers, M. and Van Dissel, H. (2000), Enterprise resource planning: ERP system migrations, *Communications of the ACM*, 43(4), 53–56.

25. Mabert, V.A., Soni, A.K. and Venkataramanan, M.A. (2000), Enterprise resource planning survey of US manufacturing firms, *Production & Inventory Management Journal*, 41(20), 52–58.

26. Massey, A.P., Montoya-Weiss, M.M. and O'Driscoll, T.M. (2002), Knowledge Management in Pursuit of Performance: Insights from Nortel Networks, *MISQ*, 26(3), 269-289.

27. McAfee, A. (2002), The impact of enterprise information technology adoption on operational performance: an empirical investigation, *Production and Operations Management*, 11(1), 33–53.

28. Melville, N., Kraemer, K. and Gurbaxani, V. (2004), Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value, *MISQ*, 28(2), 283-322.

29. Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia, Z.G. (2001), Defining supply chain management, *Journal of Business Logistics*, 22(2), 1-25.

30. Nah, F., Lau, J. and Kuang, J. (2001), Critical factors for successful implementation of enterprise systems, *Business Process Management Journal*, 7, 285–296.

31. Nicolaou, A.I. and Reck, J.L. (2004), Firm Performance Effects in Relation to the Implementation and Use of Enterprise Resource Planning Systems, *Journal of Information Systems*, 18(2), 79-105.

32. Pare´, G., Bourdeau, S., Marsan, J., Nach, H. and Shuraida, S. (2008), Re-examining the causal structure of information technology impact research, *European Journal of Information Systems*, 17, 403–416.

33. Poston, R. and Grabski, S. (2001), The financial impacts of enterprise resource planning implementations, *International Journal of Accounting Information Systems*, 2, 271–294.

34. Ragowsky, A. and Somers, T.M. (2002), Enterprise Resource Planning, *JMIS*, 19(1), 11–15.

35. Rajagopal, P. (2002), An innovation-diffusion view of implementation of enterprise resource planning systems and development of a research model, *Information & Management*, 40, 87-114.

36. Richards, K.A. and Jones, E. (2008), Customer Relationship Management: Finding Value Drivers, *Industrial Marketing Management*, 37, 120–130.

37. Robey, D., Ross, J.W. and Boudreau, M-C. (2002), Learning to implement enterprise systems: an exploratory study of the dialectics of change, *JMIS*, 19(1), 17–46.

38. Shin I. (2006), Adoption of Enterprise System Software and Firm Performance, *Small Business Economics*, 26, 241–256.

39. Soh, C., Kien, S.S. and Tay-Yap, J. (2000), Cultural fits and misfits: is ERP a universal solution? *Communications of the ACM*, 43(4), 47–51.

40. Srivardhana, T. and Pawlowski, S.D. (2007), ERP systems as an enabler of sustained business process innovation: A knowledge-based view, *Journal of Strategic Information Systems*, 16, 51–69.

41. Stiroh, K.J. (2002), Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say? *The American Economic Review*, 92(5), 1559-1576.

42. Umble, E.J. and Umble, M.M. (2002), Avoiding ERP Implementation Failure, *Industrial Management*, 44 (1), 25-33.

43. Volkoff, O., Elmes, M.B. and Strong, D.M. (2004), Enterprise systems, knowledge transfer and power users, *Journal of Strategic Information Systems*, 13 (4), 279–304.

44. Von Hippel, E. (1988), *The Sources of Innovation*, Oxford University Press, Oxford, UK.

45. Von Hippel, E. (1994), "Sticky Information" and the Locus of Problem Solving: Implications for Innovation, *Management Science*, 40(4), 429-439.

46. Von Hippel, E. (2005), *Democratizing Innovation*, MIT Press, Cambridge, MA.

47. Wieder, B., Booth, P., Matolcsy, Z.P. and Ossimitz, M.L. (2006), The impact of ERP systems on firm and business process performance, *Journal of Enterprise Information Management*, 19(1), 13-29.

48. Zhu, K. (2004), The Complementarity of Information Technology Infrastructure and E-Commerce Capability: A Resource-Based Assessment of Their Business Value Source, *JMIS*, 21(1), 167-202.