A LOG LINEAR ANALYSIS OF FACTORS AFFECTING PERFORMANCE OF EUROPEAN MANUFACTURING SMEs

Christina Beneki, Technological Educational Institute of Ionian Islands
Avraam Papastathopoulos, Technological Educational Institute of Ionian Islands

ABSTRACT

The purpose of this exploratory study is the examination of the complex interactions among variables that affect the performance of European manufacturing SMEs by using a hierarchical log linear model. In the present study, firm performance is empirically measured in terms of turnover growth. The raw data were drawn from an official survey conducted by European Commission's "Sectoral e-Business Watch" in 2007. This survey took place among SMEs from the 'Chemical, rubber and plastics', 'Steel' and 'Furniture' industries consisted of 1.716 telephone interviews with ICT decision-makers in seven selected EU countries (UK, France, Germany, Sweden, Spain, Italy and Poland). The seven variables, which take place in our study, concern employment of ICT practitioners, investments in ICTs, product-services innovations related to or enabled by ICTs, adoption of e-commerce and e-business activities, implementation of e-CRM and rivalry in the market. All these variables were found to be associated with the outcome variable firm performance in a chi-square test analysis. The results revealed seventeen out of an original twenty-eight possible two-way interrelationships between the chosen variables were identified as remaining in the hierarchical log linear model. This paper expands the research of factors affecting the firms' performance and allows a better understanding of the complex interactions and associations at multiple scales of manufacturing in Europe.

JEL: L25; L26; L6; M15

KEYWORDS: Firm performance, SME, ICT, manufacturing firms, hierarchical log linear analysis

INTRODUCTION

Within strategic management research there is a strong continuing emphasis on performance as a dependent variable (Eisenhardt and Zbaracki, 1992; Porter, 1980, 1985; Rumelt, 1974; Pettigrew et al., 2002; Schendel and Hofer, 1979). The selection of performance measures that reflect the true situation of small businesses with some degree of certainty and reliability is indeed a crucial process (Murphy et al., 1996). Researchers acknowledged that performance is a complex and multidimensional construct (Carton and Hofer, 2005; Dvir et al., 1993). Venkatraman and Ramanujam (1986) discussed organizational performance measurement in terms of organizational effectiveness, operational performance and financial performance. Financial performance measures allow for competitive analysis where firms compare financial data regarding market share, sales, production costs or the budgets of competitors (Yasin, 2002). The Report for the Enterprise Directorate of the UK Department of Business, Enterprise and Regularity Reform (2008) defined business performance both in terms of processes (start-up, resource acquisition, development and deployment (i.e., the strategic direction of the business) and outcomes (sales, profit, asset value, intrinsic work satisfactions). However, multiple performance indicators have been widely adopted by most researchers. Carton and Hofer (2006) revealed a total of 133 different measures of enterprise performance by reviewing empirical articles published from July 1996 to June 2001. In empirical studies, the choice of the performance measure is often limited by the availability of data.

In our model, business performance is measured in terms of turnover growth. Several studies (Barkham et al., 1996; Hoy et al., 1992) concluded that an analysis of a company's growth should, at least in part, be

based on changes in turnover because it reflects both short and long-term changes in the firm, is easily obtainable, and is a common performance indicator among entrepreneurs themselves. Our analysis is designed to capture the various factors that interact with turnover growth of European manufacturing SMEs. The research is based on an official survey conducted by European Commission's "Sectoral e-Business Watch" in 2007, which took place among SMEs from the 'Chemical, rubber and plastics', 'Steel' and 'Furniture' industries, consisted of 1716 telephone interviews with ICT decision makers in seven selected EU countries (UK, France, Germany, Sweden, Spain, Italy, and Poland). The paper focuses on proposing a hierarchical log linear model of seven factors influencing business performance. Specifically, the seven predictors which take place in our study, concern *employment of ICT practitioners*, *investments in ICTs*, *product-services innovations related to or enabled by ICTs*, *adoption of e-commerce* and *e-business activities*, *adoption of enterprise application system-CRM* and *rivalry in the market*. We included the last variable on the basis of business research plausibility.

While the univariate analysis identifies the relationship between the predictors and outcome, the hierarchical log linear model is a simply pragmatic approach based on the need to get a clear hierarchical picture and to uncover a web of complex interactions among the chosen variables. Numerous statistical methods have been utilized to generate predictive models that identify factors affecting performance of businesses. While these models provide an accurate statistical description between these variables and outcome, they are difficult to present the complex interactions visually. This study contributes toward this direction and it is an inspiring source for those who want to investigate systematically all orders of interactions of factors affecting the performance of European manufacturing firms. Additionally, the analysis strongly suggests that companies taking into account different factors can improve the chances to make better implementation of ICTs, and thus attain better levels of business performance.

The paper is organized as follows. First, an extensive review of the influential literature is presented. Secondly, we present a discussion of the methodological issues regarding survey development, sampling and data collection. Thirdly, the results of our research are followed not only by an analysis, but also by relevant interpretations. The last section contains a discussion on these findings as well as our conclusions, while a discussion on the limitations of our research and its implications for further future research is also included.

LITERATURE REVIEW

Background to the Small Firm Sector in the European Union

The EU has adopted a new categorization of SMEs since 2003, revising their earlier definition of 1996. According to this new definition, the basic prerequisite for an enterprise to be recognized as a small and medium one is to respect the limits regarding Staff headcount and financial ceilings (annual turnover or annual balance sheet). The new definition introduces three different categories of enterprises (micro, small and medium). Each corresponds to a different type of relationship which an enterprise might have with another. This distinction is necessary in order to establish a clear picture of an enterprise's economic situation and to exclude those that are not genuine SMEs. The definition categorizes SMEs as follows (European Committee, 2003):

1. The category of micro, small and medium-sized enterprises (SMEs) are made up of enterprises, which employ fewer than 250 persons and, which have an annual turnover not exceeding 50 million EUR, and/or an annual balance sheet total not exceeding EUR 43 million.
2. Within the SME category, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million.

3. Within the SME category, a micro-enterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million.

In our days, SMEs are the component elements of the structure of all economies and societies in the world. Small and medium sized enterprises contribute significantly to the economic development, production, competitiveness, employment, as well as to the decentralization and social coherence. They also function as the source of new enterprises, innovative products and applications and flexible business forms, while they meet the local needs and form the zoning plan for the distribution of employment and income (Singh and Garg, 2008; Thomson and Gray, 1999; Storey, 1994).

E-Business And Business Performance: The OECD Working Party on Indicators for the Information Society proposes a definition of e-business as "automated business processes (both intra- and inter-firm) over computer- mediated networks", with the imperative conditions that "the process integrates tasks (i.e. a value chain) and extends beyond a standalone / individual application" and that "the processes should describe functionality provided by a technology, not a specific technology per se" (OECD, 2003; Sectoral e-Business Watch, 2009). E-business has a pervasive impact across the entire span of the organisation's structure (from the purchasing department to the field sales force) and across a range of its business processes (from internal administration to supply-chain coordination) (Wu et al., 2003). Using internet technologies in conjunction with office automation software and Enterprise Resource Planning (ERP) may help reduce fixed and overhead costs, while internet Electronic Data Interchange (EDI), Business to Business (B2B), and Business to Consumer (B2C) applications may reduce the variable cost of the manufacturing and distribution processes of the product (Quan et al., 2003). Advances in e-business applications and technologies present many opportunities for contemporary businesses to redefine their strategic objectives and enhance or transform products, services, markets, work processes and business communication. By integrating strategy content and process perspectives we begin to more fully explain why, when and how certain firms are successful with e-business systems while others remain hesitant, unwilling or unable to change (Cotman et al., 2007).

E-Commerce And Business Performance: The OECD proposed two definitions of e-commerce - one narrow and one broad. While the narrow definition focuses on "internet transactions" alone, the broad definition defines e-commerce as "the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organizations, conducted over computer-mediated networks. The goods and services are ordered over those networks, but the payment and the ultimate delivery of the goods or service may be conducted on- or offline" (OECD, 2001). The OECD's Electronic Commerce Business Impacts Project studied a set of 220 early successful adopters of e-business strategies in a range of established sectors in eleven different countries. This study showed the positive impacts of e-commerce on their turnover and profitability and to a lesser extent on employment, most notably when e-commerce is part of larger business strategies of firms (OECD, 2002). Numerous studies attempted to examine the benefits to be gained from e-commerce (EC) adoption towards firm's performance. There are many evidences to support the positive impact of EC on firm performance such as firm growth (Raymond et al., 2005), financial gain (Beck et al., 2005; Johnston et al., 2007; Raymond et al., 2005), competitive advantage (Teo, 2007; Teo and Pian, 2003) and implementation success/satisfaction (Chong, 2008). Such studies are highly welcomed as SMEs use of EC depends on its expected benefits apart of the cost that firm have invested (Mohamad and Ismail, 2009).

E-CRM And Business Performance : Customer relationship management (CRM) is a tool designed to integrate and automate management of all client-facing tasks in order to help build and retain their loyalty. CRM refers to the utilization of extensive strategies and engineering to find, obtain, cultivate advantaged customers, and hence maintain long-term partnerships (Sin et al., 2005). In the CRM context ICT allows for an efficient processing of customer data (Brady et al., 2002), a wide geographical reach

(Javalgi and Ramsey, 2001) and for cost-effective forms of interaction between the organization and its customers (Schroder and Madeja, 2004; Kim and Umanath, 2005). Much electronic customer relationship management (e-CRM) research has been carried out in larger firms with little attention to SME's needs (Adebanjo, 2003; Boyle, 2001; Koh et al., 2007). In practice, only a small percentage of SMEs have implemented sophisticated ICT to support CRM objectives (Ritchie and Brindley, 2005; Maguire et al., 2007). Those firms serving international markets, tend to place greater emphasis on e-CRM and are reaping greater benefits. Benefits range from entry into new markets, enhanced customer service, generation of greater efficiencies in marketing, reduced business cost, increased sales, and improved profitability (Harrigan et al., 2008; 2009). Nevertheless, Kula and Tatoglu (2003) and Harrigan et al. (2008) reported that the ultimate impact of e-CRM on an organisations' profitability is debatable in the absence of more conclusive empirical evidence.

Employment of ICT practioners and business performance: "ICT practitioner skills" are the capabilities required for researching, developing, designing, strategic planning, managing, producing, consulting, marketing, selling, integrating, installing, administering, maintaining, supporting and servicing ICT systems (Sectoral e-Business Watch, 2009). Hwang (2004), in a study of the relationship between the diffusion of ICTs and changes in skills in the UK within business organizations, found that education and training were important in adjusting skill changes to the rapid expansion of ICTs. Inadequate ICT skills impacts firm performance. Forth and Mason (2006) assessed the impact of ICT skill shortages on financial performance at firm level for UK enterprises in 1999 and there was a clear evidence about the negative effects on performance experienced by those companies in which ICT skill shortages inhibited the adoption or intensive utilisation of ICTs.

ICT Investments And Business Performance: According to the Special Report of e-Business Watch (2006), the effects of ICT on performance are subject to debate because not all studies have demonstrated clear payoffs from ICT investments (Chan, 2000, Kohli and Devaraj, 2003). Also, the results vary depending on how performance and ICT payoffs are measured and analysed. For example, one empirical study finds positive impacts of ICT investments on productivity, but not on profits (Brynjolfsson and Hitt, 1996). Another study did not find positive effects of ICT capital on productivity, while ICT labor positively contributed to output and profitability (Prasad and Harker, 1997). An analysis of the profitability of ICT investments in an empirical study that explicitly considered the competitive dynamics in a market showed that the profits of non-adopters of ICT are reduced as other firms adopt new ICT (Stoneman and Kwon, 1996).

Product-services innovations related or enabled by ICTs and business performance The relationship between ICT and turnover growth is straightforward: The implementation of new ICT and complementary investments can lead to innovations, and innovations are positively associated with turnover growth. In other words, innovative firms are more likely to grow. This holds for ICT- and for non-ICT-related innovations, as well as for process- and product-innovations. The empirical results support this view and indicate that innovative firms exhibit increasing turnovers significantly more frequently than non-innovative firms (e-Business Watch, 2006). Hempell et al. (2004) using panel data for German and Dutch firms from the services sector found evidence for direct benefits from ICT product and process innovation on total factor productivity (TFP) in services. Firms that innovate permanently show higher TFP levels. However, the direct impacts of innovation on multi-factor productivity seem to be more robust for Germany than for the Netherlands.

DATA AND METHODOLOGY

Research Design

In order to address the preceding research questions, we used data from the 'Sectoral e-Business Survey (SeBW) 2007'. This global survey is part of the "e-Business Watch", a service launched in 2007 and provided by "empirica GmbH" to the European Commission, Enterprise and Industry Directorate General, in co-operation with renowned international partners (European Commission and the Sectoral e-Business Watch, 2007) while it was presented as a Confidentialized Unit Record File. The key objective of the SeBW is to gather information about the usage of ICT and their application to the electronic business in companies, in order to derive indicators on industrial sector level. The fieldwork was carried out from August 13 to October 08, 2007 and had a scope of 2.121 telephone interviews with decision-makers from three industry sectors (chemical, steel and furniture) in seven EU countries (UK, France, Germany, Sweden, Spain, Italy and Poland). The target respondent within the company was a person responsible for or taking part in decisions concerning the use of information and communication technologies and of e-business. This person could have been in different positions, depending on the size and kind of company or organisation – usually the IT manager or a senior professional in the IT department. Particularly in the case of larger companies, there are dedicated positions for e-business management while in micro and small enterprises, the respondent rather is someone at the level of managing director or owner. The questionnaire collected information on the background information of the firms, ICT-related characteristics (such as infrastructure, software systems, skills requirements, costs, impacts, drivers and inhibitors) and innovation activity (if any) of the firm during the past 12 months.

Sample and Data Collection

The sample drawn (for each sector) was a random sample of companies, stratified by sector and, where possible, size (number of employees in the company), was selected per country. The quality of the survey frame was of very high importance. In order to ensure the best possible quality of results in terms of raising the survey data, SeBW explicitly instructed the institutes that the sampling/ address purchase and the universe figures (sample frame) should be based to the largest possible extent on "official" business registers and company statistics, which are usually run by the National Statistical Office in the country. Wherever possible for the drawing of the sample the same source was chosen as for building-up the universe. However, in some countries the statistical offices that were used for the universe figures were not able (resp. were not allowed) to provide the institutes with full and up-to-date addresses or telephone numbers of companies at all. In case where the sampling/ address purchasing could not be obtained directly from the respective national statistical offices, the countries used renowned address supplier of the highest possible quality in terms of coverage and up-to-dateness. This is common practise in business-to-business surveys. Furthermore, the usage of computer/PC (including desktop computers and notebooks) within the company was required in order to qualify for an interview.

The final allocation of our sample (n = 1.716 SMEs) according to firm size, industry and country is illustrated as follows (Table 1):

In this survey, a cut-off was introduced with regard to company size: only companies with at least 10 employees were interviewed. The highest level of the population (at least 10 employees) was the set of all computer-using enterprises which were active within the national territory of one of the seven countries covered, and which had their primary business activity in one of the three industry sectors specified on the basis of NACE Rev. 1.1.

Table 1: Industry and Country Distribution of the Sample and Sampling Sources

			Firm Size Small (10-49)			Firm Size Medium (50-249)			
			Survey Sectors			Survey Sectors			
Countries	Germany	Count	Chemical, rubber & 45	Steel 72	Furniture 67	Chemical, rubber & 39	Steel 23	Furniture 36	Total 282
		% within sector	16.0%	25.5%	23.8%	13.8%	8.2%	12.8%	100.0%
	Spain	Count	65	43	114	52	5	6	285
		% within sector	22.8%	15.1%	40.0%	18.2%	1.8%	2.1%	100.0%
	France	Count	70	8	69	57	8	10	222
		%within sector	31.5%	3.6%	31.1%	25.7%	3.6%	4.5%	100.0%
	Italy	Count	57	61	67	39	24	41	289
		%within sector	19.7%	21.1%	23.2%	13.5%	8.3%	14.2%	100.0%
	Sweden	Count	74	17	26	26	8	9	160
		%within sector	46.3%	10.6%	16.3%	16.3%	5.0%	5.6%	100.0%
	United Kingdom	Count	69	30	84	48	8	12	251
		%within sector	27.5%	12.0%	33.5%	19.1%	3.2%	4.8%	100.0%
	Poland	Count	67	3	79	46	12	20	227
		% within sector	29.5%	1.3%	34.8%	20.3%	5.3%	8.8%	100.0%
Total		Count	447	234	506	307	88	134	***1.716***
		% within sector	27.6%	12.7%	28.9%	18.1%	5.0%	7.5%	100.0%

This table shows the allocation of sample by country, industry sector and firm size.

Measure Development and Statistical Method

In order to examine the complex two-way interactions among variables that affect the performance of European manufacturing SMEs, a hierarchical log linear analysis was applied. The major emphasis of log-linear analysis is to obtain a log-linear model that is linear in logarithms of the expected frequencies of a contingency table and that adequately describes or fits the associations and interactions that exist in the contingency table as closely as possible (Wrigley, 1985). The principal reason for utilizing log-linear procedures in this study lies in the fact that interactions and interrelationships underlying categorical survey data can be analytically highlighted. A backwards elimination was used to remove non-significant two-way interactions between variables using a statistical significance cut-off of 0.05. Associations for each predictor against dichotomized outcome were tested using chi-squared test analyses. At this point, we need to say that we decide to limit the number of variables to eight (including outcome) in the model for three reasons. First, in accordance with log linear modeling theory (Norusis, 2008), the inclusion of excess numbers of variables increases the number of cells with few observations and, as a result, we can neither estimate the parameters well nor assess the goodness of fit of the model well. Secondly, the technique of hierarchical log linear analysis excludes the missing values, limiting the sample size further. In our analysis, 228 out of 1.716 cases were excluded as missing values, reducing our sample size to 1.448 cases. Thirdly, with log linear models, we need at least 5 times the number of cases as cells in our data (Christensen, 1997). In this case, we have a 2^8 table; this means we need to have at least 1.280 cases (2^8 * 5). Indeed, we have 168 cases (1.448 – 1.280) more than lower level of 1.280, but we could not add up an extra variable because in that case we would need a sample consisting of at least 2.560 cases (2^9 *

5). We therefore, eventuate that the complex interactions-relationships among variables identified in this study are statistically robust. Table 2 details the research variables used to this study including concept, operational measure and sampling source. In log linear models, all variables that are used for classification are independent or predictor variables and the dependent variable is the log of the number of cases in a cell of the multiway cross-tabulation (Norusis, 2008). The outcome variable *firm performance* is empirically measured in terms of turnover growth. The raw data were coded and analyzed using the PASW Statistics 18.

Table 2: Summary of Research Variables

Predictor Variables	**Abbreviations of Variables**	**Description – Operational Measure**	**Source**
Firm Performance (outcome)	FP	Respondents were asked to rank their firm's turnover level when compared the last financial year with the year before. The scale used was a three-item measure with a 1 = increased, 2 = stayed the same and 3 = decreased. The outcome variable was converted into a binary variable prior to analysis within the hierarchical log linear model (0 = increased/stayed the same and 1 = decreased).	European Commission 'SeBW 2007'
Implementation of e-CRM	e-CRM	The respondents were asked whether their firm had implemented an e-CRM system (0 = yes and 1 = no).	European Commission 'SeBW 2007'
ICT Practitioners	ICTP	The respondents were asked whether their firm had employed personnel with ICT qualification (0 = employment and 1 = non- employment).	European Commission 'SeBW 2007'
ICT Investments	ICTI	The respondents were asked whether their firm had made investments in ICT during the past 12 months, for example for new hardware, software or networks (0 = yes and 1 = no).	European Commission 'SeBW 2007'
ICT-related Product-services Innovations	ICTInv	The respondents were asked whether their firm had launched any new or substantially improved products or services, which had been directly related to or enabled by ICT (0 = yes and 1 = no).	European Commission 'SeBW 2007'
E-Commerce Activities	eCom	The respondents were asked whether their firm had used the internet or other computer-mediated networks to order goods or services from suppliers online, not counting manually typed e-mails (0 = yes and 1 = no).	European Commission 'SeBW 2007'
E-Business Activities	eBus	The respondents were asked whether their firm had used automated business processes to collaborate with business partners in the design of new products or services (0 = yes and 1 = no).	European Commission 'SeBW 2007'
Rivalry in the Market	RM	The respondents were asked whether the rivalry in their market was increasing (0 = yes and 1 = no).	European Commission 'SeBW 2007'

This table lists the variables that were incorporated into the hierarchical log linear model, their abbreviations, the operational measures as well as the sampling source.

EMPIRICAL RESULTS

Analysis of Associations between Outcome Variable and Response Variables Prior to testing the complex interactions among variables that affect the performance of European manufacturing SMEs, we first ran cross-tabulations of all response variables with outcome variable (firm performance). The results are shown in Table 3.

As seen in Table 3, using the chi-square tests, all the related *p*-values are less than the traditional threshold of 0.05. Thus, it can be verified that there are statistically significant association between the employment of ICT practitioners, investments in ICTs, ICT-product/services innovations, adoption of e-commerce and e-business activities, implementation of e-CRM system, competitive pressure and whether firms had experienced a constant annual rate of turnover growth or not.

Table 3: Respondent Profile and Chi-Squared Tests

		Firm Performance (outcome variable)		Total	Chi-Square Test
		Increased / Stayed the Same	Decreased		
Employment of ICT practitioners	**yes**	Count	347	13	360	5.857*
		% within FP	23.1%	12.7%	22.4%	
		Adjusted Residual	**2.4**	**-2.4**		
	no	Count	1157	89	1246	
		% within FP	76.9%	87.3%	77.6%	
		Adjusted Residual	**-2.4**	**2.4**		
Total		Count	1504	102	1606	
		% within FP	100.0%	100.0%	100.0%	
Investments in ICT during the past 12 months	**yes**	Count	1089	52	1141	19.775***
		% within FP	72.7%	52.0%	71.4%	
		Adjusted Residual	**4.4**	**-4.4**		
	no	Count	408	48	456	
		% within FP	27.3%	48.0%	28.6%	
		Adjusted Residual	**-4.4**	**4.4**		
Total		Count	1497	100	1.597	
		% within FP	100.0%	100.0%	100.0%	
Innovation of Products-Services during the past 12 months	**yes**	Count	616	28	644	7.648**
		% within FP	41.3%	27.5%	40.5%	
		Adjusted Residual	**2.8**	**-2.8**		
	no	Count	874	74	948	
		% within FP	58.7%	72.5%	59.5%	
		Adjusted Residual	**-2.8**	**2.8**		
Total		Count	1490	102	1592	
		% within FP	100.0%	100.0%	100.0%	
Implementation of e-CRM system	**yes**	Count	302	10	312	6.490*
		% within FP	20.3%	9.9%	19.6%	
		Adjusted Residual	**2.5**	**-2.5**		
	no	Count	1185	91	1276	
		% within FP	79.7%	90.1%	80.4%	
		Adjusted Residual	**-2.5**	**2.5**		
Total		Count	1487	101	1588	
		% within FP	100.0%	100.0%	100.0%	
E-Commerce Activities	**yes**	Count	932	45	977	12.712***
		% within FP	61.9%	44.1%	60.8%	
		Adjusted Residual	**3.6**	**-3.6**		
	no	Count	573	57	630	
		% within FP	38.1%	55.9%	39.2%	
		Adjusted Residual	**-3.6**	**3.6**		
Total		Count	1505	102	1607	
		% within FP	100.0%	100.0%	100.0%	
E-Business Activities	**yes**	Count	197	3	200	8.924**
		% within FP	13.2%	3.0%	12.6%	
		Adjusted Residual	**3.0**	**-3.0**		
	no	Count	1291	97	1388	
		% within FP	86.8%	97.0%	87.4%	
		Adjusted Residual	**-3.0**	**3.0**		
Total		Count	1488	100	1588	
		% within FP	100.0%	100.0%	100.0%	
Rivalry in the market is increasing	**yes, agree**	Count	1041	88	1129	13.369***
		% within FP	71.1%	88.0%	72.1%	
		Adjusted Residual	**-3.7**	**3.7**		
	no, disagree	Count	424	12	436	
		% within FP	28.9%	12.0%	27.9%	
		Adjusted Residual	**3.7**	**-3.7**		
Total		Count	1465	100	1565	
		% within FP	100.0%	100.0%	100.0%	

*This table shows the count, percentage use, adjusted residuals and the statistical results of the Chi-square test between firm performance (outcome variable) and response variables. In all above tests, there is no violation of the basic rule for using chi-square test (the expected values in each cell be greater than 1 and that most cells have expected values greater than 5 (Norusis, 2008). * The value is significant at the 0.05 level. ** The value is significant at the 0.01 level. *** The value is significant at the 0.001 level.*

The Chi-square test tells us that there is some departure from statistical independence, but it says nothing about the nature of this departure or how strong it is. Post hoc analyses of the contingency table cells are based on adjusted residuals that are calculated by dividing the residual (i.e., the difference between observed and expected cell frequency) by the standard error of the contingency table cell. The adjusted residuals (highlighted in pale orange) of all categories of response variables are greater than 1.96 in their absolute magnitude, indicating significant deviations from the independency assumption.

Hierarchical Log Linear Analysis

The results reveal seventeen out of an original twenty-eight possible two-way interrelationships between the chosen variables were identified as remaining in the hierarchical log linear model. Two-way interactions were investigated only because trying to make sense of three-way and higher-way interactions is notoriously difficult, so the reason for limiting to two-way was simple pragmatic, based on the need to keep any interpretations as simple as could be. Making the interactions any more complex does not help and may actually hinder interpretation of what the multivariate data are saying.

Table 4 lists the individual statistical inter-relationships between the various predictors, the chi-square value and the *p*-value. The inter-relationships are ranked with the strongest statistical association at the top of the table.

Table 4: Statistical Inter-Relationships between Parameters within Hierarchical Log Linear Model

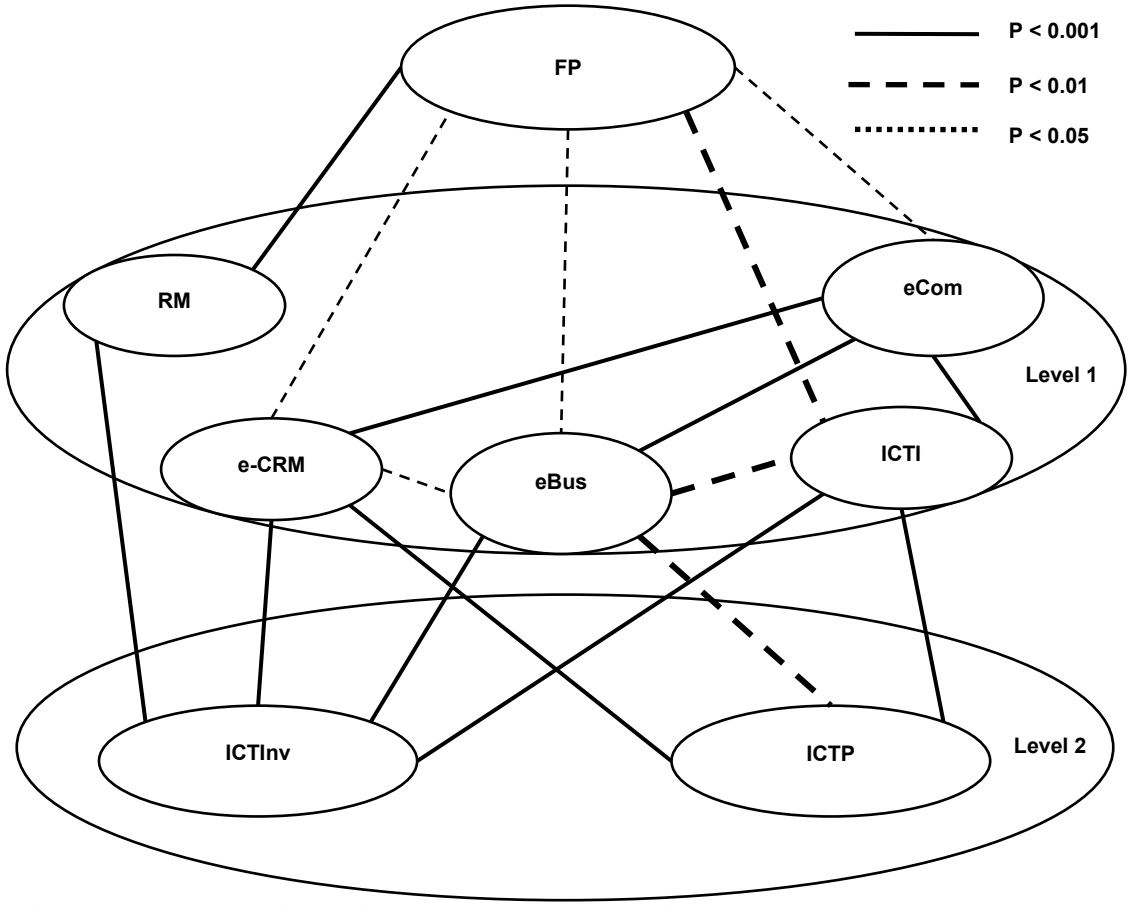
Two-Way Interaction Parameters	Chi-square	df	*p*-value
eCom*e-CRM	26.221	1	0.0001
eCom*ICTI	14.650	1	0.0001
eCom*eBus	30.590	1	0.0001
e-CRM*ICTInv	14.341	1	0.0001
e-CRM*ICTP	28.356	1	0.0001
ICTInv *ICTI	65.771	1	0.0001
ICTInv *RM	15.201	1	0.0001
ICTInv *eBus	17.897	1	0.0001
ICTP*ICTI	40.368	1	0.0001
RM*FP (outcome)	16.684	1	0.0001
ICTP*eBus	10.375	1	0.001
ICTI*FP (outcome)	10.946	1	0.001
ICTI*eBus	8.400	1	0.004
FP (outcome)*eBus	6.097	1	0.014
eCom* FP (outcome)	4.353	1	0.037
e-CRM* FP (outcome)	4.183	1	0.041
e-CRM*eBus	3.873	1	0.049

This table lists all the statistical inter-relationships between the various variables with a p-value <0.05.

At this point we have to make clear that the above statistical association does not in itself imply the direction of the relationship, for instance, the statistical relationship between e-CRM x FP (outcome) in this model does not tell us whether the implementation of e-CRM of non- implementation is responsible for a firm's turnover growth.

Figure 1 illustrates the model graphically by linking the various predictors by lines whose thickness is representative of the strength of association between the predictors. The predictors have been structured into a hierarchy to illustrate the directness of the impact of the variable on outcome.

Figure 1: Hierarchy of Relationship between Outcome and Variables



The figure illustrates the statistical inter-relationships between the various predictors using the lines linking them.

As seen in above figure, five variables within the hierarchical log linear model (ICT investments, e-commerce and e-business adoption, e-CRM implementation and rivalry in the market) had a direct independent statistical relationship with firm performance. The remaining two variables (ICT-related product/service innovations and employment of ICT practitioners) only had a statistical relationship with business performance via at least one other variable. The thickness of the lines relates to the strength of statistical association in the model ranked by p-value.

Regarding the overall model's fit, two statistics were used; the Pearson and the likelihood ratio chi-square. The value for the first was 184.67 and for the latter was, 189.36 and the related observed significance levels were 0.98 for both statistics. This means, that both indices do not detect a lack of fit of the model. The overall goodness-of-fit test tells us if the model appears to fit the data. It does not tell us whether there are particular cells that the model fits poorly or whether there is a systematic lack of fit. In order to see how well the model fits the individual cell, we examined the residuals for each cell. Only five out of 256 cells were found with standardized residuals greater than 1.96, indicating that the model fits poorly (only for these five cells), while the model fits very well for the remaining 249 cells. We can

conclude by saying, that goodness-of-fit test and residuals give a strong indication that the fit of the log linear model that was applied is fully satisfactory.

DISCUSSION

From the results, we are able to make multiple observations. More precisely, the log linear analysis revealed seventeen appreciable complex interactions among variables affecting direct or indirect the performance of European manufacturing SMEs. The findings are presented and discussed as follows:

Interrelationships between ICTs (e-CRM, e-Commerce and e-Business) and firm's Performance ($P_{e\text{-}CRM}$ = 0.041, P_{eCom} = 0.037 and P_{eBus} = 0.014): A large body of content research shows that various ICTs influence business performance. Johnston and Carrico (1988), in their study of 11 industries found that external pressures played a significant role in explaining the link between IT implementation and performance. Along the same line, Santhanam and Hartono (2003) find that superior ICT capability is associated with improved performance. While it is generally accepted that ICT implementation affects company performance and characteristics as well as the environment in which companies operate, different companies in different sectors exhibit varying payoffs despite similar investments in ICT (Dhar and Sundararajan, 2007). The European e-Business Report 2008 found strong evidence at the company level that IC T use is associated with increases in turnover, whilst at the sector level, the results were much less pronounced (European Communities, 2008). Building on these findings, we lead to Melville's statement that firm performance improvement will result, if the right ICT is applied in the right way (Melville et al., 2004).

Strong Interrelationship between e-CRM and e-Commerce ($P_{e\text{-}Com}$ < 0.0001): Several studies primarily focused on the relationship between CRM and customers relationships. Day and Hubbard (2003) argue that the personalization of relationships is a significant benefit of CRM. By electronically recording the purchasing history of customers and providing the metrics for calculating each customer's profitability, CRM allows SMEs to tailor offerings and predict future behavior. Likewise, Ramani and Kumar (2008) found that good CRM between manufacturing firms and industrial customers not only retains customers but also encourages them to provide important suggestions for improving products and service. Finally, Sin et al., (2005) indicated that CRM involves activities that manufacturers practice to satisfy customer needs, identify customer preferences, resolve customer complaints, provide after-sale service and establish long-term relationships with their customers.

Interrelationship between CRM adoption and Firm's e-Business Activities ($P_{e\text{-}Bus}$ = 0.049): Numerous studies have proven that using information provided by clients facilitates the development of more diverse new products and modifications to the functions of existing products to meet the needs of specific target markets (Verhoef, 2003; and Lagrosen, 2005; Souder et al., 1997). A more recent study conducted by Groznik et al., (2008) concludes that technology-based CRM apparently enhances operational efficiency, increases productivity and improves collaboration and service quality.

Interrelationships between ICT – Practitioners and ICTs (e-CRM, e-Business and ICT investments) ($P_{CRM\ e}$ < 0.0001, P_{eBus} = 0.001 and P_{ICTI} < 0.0001): Our empirical results reveal a strong interrelationship between e-CRM adoption or non-adoption and the employment or non-employment of ICT qualified users. Several studies have confirmed the relationship between ICT usage and employment of ICT-qualified personnel. Specifically, the empirical study of Brynjolfsson and Hitt, (2000) indicates that ICT is most productive when combined with complementary investments in working practices, human capital, and company restructuring. Moreover, the efficient use of information and communication systems demands significant investment in qualified personnel and employee education (Cooper et al., 2005). The 2003 OECD Ministerial report, "seizing the benefits of ICT in a digital economy" concluded that having a good supply of qualified personnel helps, but education policies need to be supplemented with actions to

foster lifelong learning. Policies aimed at enhancing basic literacy in ICT, at building high-level ICT skills, at lifelong learning in ICT and at enhancing the managerial and networking skills needed for the effective use of ICT are particularly important.

Strong interrelationships between ICTs (e-CRM and e-Business) and ICT-related product/service innovations (both P values < 0.0001): Several studies recognized the role of ICTs in supporting product and service innovations. For example, Lin et al., (2010), based on a completed survey by 107 Taiwanese manufacturing firms, finds that technology-based CRM has a positive effect on product and service innovations. Other recent studies found that the effectiveness and efficiency of e-business systems are increasingly recognized as means for developing innovation capability and providing a lasting competitive advantage (Ramani and Kumar, 2008; Sahay and Ranjan, 2008). The European e-Business Report (2008) continued in the same vein, indicated that ICTs are increasingly recognized as an important tool for innovation and increasing revenues by enabling new services and new ways of working within value networks (European Communities, 2008).

Strong interrelationships investments in ICTs and e-Commerce - e-Business ($P_{eCom} < 0.0001$ and $P_{eBus} = 0.004$): A thorough literature review of factors affecting SMEs e-commerce adoption shows that one of the most significant factors include resource constraints such as financial and human resources of the firm (Jeyaraj et al., 2006). In the same way, a recent research conducted by Scupola, (2009) indicates that the firm's resource constraints, both human and financial, have been a significant factor in e-business adoption and implementation in Denmark and Australia.

Strong interrelationship between e-Commerce and e-Business (P < 0.0001): Considering a significant report conducted by OECD (2004) some businesses, mainly early adopters of e-commerce, are entering the next stage of ICT use, e-business. They have begun to engage in increasingly sophisticated uses of ICT, involving business process reengineering and more technology that is complex. In such firms, B2C and B2B e-commerce are components of an overall e-business strategy. External relations with customers as well as internal processes are being linked. Marketing and sales, logistics and delivery, after-sales service, supply chain management and other business functions are integrated in an overall e-business strategy. Additionally, the report predicts that in the near future, electronic commerce and electronic business will have to become components of SMEs' overall e-business strategy and "normal" business processes that are supported by ICTs and carried out on electronic networks.

Strong interrelationship between ICT-related product/services innovations and ICT investments (P < 0.0001). A recent empirical study conducted by Dibrel et al., (2008) argues that in order to optimize investment in innovation activities, IT initiatives should be aligned with innovation. Furthermore, the same study concludes that managers who are able to integrate either a product or a process-oriented innovation strategy with investments in IT enhance their firms' relative performance along two essential dimensions: profitability and growth. In contrast, a failure to invest in IT can cause a firm to be unable to support its innovation initiatives. Perhaps, a lack of investment in IT over time may render the firm incapable of meeting customer requirements.

Strong interrelationships between firm performance, ICT-related innovations and rivalry (both P values < 0.0001): Log linear analysis obviously shows strong interrelationships between firm performance, ICT-related innovation and rivalry in the market. This is in line with the findings from European Communities (2008), indicating that as companies are facing more intense competition, they are under pressure to cut costs and to look for more innovative ways of conducting business. In addition, empirical studies have consistently shown that external pressures played a significant role in explaining the link between ICT implementation and performance (Coltman et al., 2007). According the OECD (2003) "Ministerial Report", competition is the key to selecting successful firms and makes them innovate and

grow. A competitive environment is more likely to lead a firm to invest in ICT, as a way to strengthen performance and survive, than a more sheltered environment.

Interrelationship between firm performance and investments in ICTs (P = 0.001): Regarding this relationship, the related literature refers that firm performance is enhanced when there are synergies among the elements of a system. Complementary factors of a system of mutually enhancing elements operate in such a way that doing more of one thing increases the returns of doing more of another (Huang and Liu, 2005). As such, investment in ICT does not stimulate productivity and growth (i.e., firm performance) without a number of complementary developments, and, even then, resource commitment in ICT may detract from short-run profitability (Johannessen, Olaisen, and Olsen 1999).

The above findings support the suggestion that there are complex interactions between the outcome variable and the seven-predictor variables. Of course, we have to reiterate that this statistical technique does not imply by itself the direction of the above interrelationships, but only the existence of those interrelationships.

CONCLUSION, IMPLICATIONS AND FUTURE RESEARCH

The purpose of this exploratory study was to use the hierarchical log linear model to analyze a set of cross-classified categorical data in order to examine the complex interactions among variables that affect the performance of European manufacturing SMEs. Seven variables (*employment of ICT practitioners, investments in ICTs, product-services innovations related to or enabled by ICTs, adoption of e-commerce and e-business activities, implementation of e-CRM and competitive pressure)* that associated with the outcome variable *firm performance* in a chi-square test analysis were used to derive and present a hierarchical log linear model.

The results reveal seventeen out of an original twenty-eight possible two-way interrelationships between the chosen variables were identified as remaining in the hierarchical log linear model. Five variables within the hierarchical log linear model (ICT investments, e-commerce and e-business adoption, e-CRM implementation and pressure from competition) had a direct independent statistical relationship with firm performance. The remaining two variables (ICT-related product-service innovations and employment of ICT –qualified personnel) only had a statistical relationship with business performance via at least one other variable.

Although hierarchical log linear analysis is a well established, powerful, multivariate statistical method, it has not been widely employed in business research. Numerous statistical methods have been utilized to generate predictive models that identify factors affecting performance of businesses. While these models provide an accurate statistical description between these variables and outcome, they are difficult to present the complex interactions visually. This study contributes toward this direction and it is an inspiring source for those who want to investigate pictorially the complex interactions of factors affecting the performance of European manufacturing firms. Additionally, the analysis strongly suggests that companies taking into account different factors can improve the chances to make better implementation of ICTs, and thus attain better levels of business performance.

Of course, this work is not free from limitations. Taken that the findings in this study are based on seven selected European countries, they cannot be generalized to the entire population of manufacturing SMEs. The analytical investigation of hypothesized associations has been approached from a European point of view. Thus, the interpretation and utilization of the research findings should be thoroughly scrutinized. Additionally, the particular statistical method reveals the complex associations between variables but does not reveal the direction of those associations. Future researches would be interesting to see them too.

REFERENCES

Barkham, R., Gudgin, G., Hart, M., and Hanvey. E. (1996), *The Determinants of Small Firm Growth. Gateshead*, Tyne and Wear, UK: Athenaeum.

Beck, R., Wigand, R. T., and Konig, W. (2005), The Diffusion and Efficient Use of Electronic Commerce among Small and Medium-sized Enterprises: An International Three-Industry Survey. *Electronic Markets,* 15(1), 38 - 52.

Boyle, A.B. (2001), The internet in industrial channels: its use in (and effects on) exchange relationships. *Journal of Business & Industrial Marketing*, 16 (6/7), 452.

Brynjolfsson, E. and Hitt, L.M. (1996), Paradox lost? Firm-level evidence on the returns to information systems spending. *Management Science* 42(4), 541-558.

Brynjolfsson, E. and Hitt, L.M. (2000), Beyond Computation: Information Technology, Organizational Transformation and Business Performance. *Journal of Economic Perspectives,* 14(4), 23-48.

Carton, R. B., and Hofer, C. W. (2005), Organizational financial performance: Identifying and testing multiple dimensions. *Proceedings of the ICSB 50th World Conference-2005*.

Carton, R. B, and Hofer, C. W. (2006), *Measuring Organizational Performance--Metrics for Entrepreneurship and Strategic Management Research*, Edward Elgar, Cheltenham.

Chan, Y. (2000), IT value: The great divide between qualitative and quantitative and individual and organizational measures. *Journal of Management Information Systems* 16(4), 225-261.

Chong, S. (2008), Success in Electronic Commerce Implementation: A Cross -country of Small and Medium-sized Enterprises. *Journal of Enterprise Information Management,* 21(5), 468 - 492.

Christensen, R. (1997), *Log-Linear Models to Categorical Data Analysis,* Springer-Verlag Inc., New York, USA.

Coltman, T.R., Devinney, T.M and Midgley, D.F. (2007), e-Business Strategy and Firm Performance: A Latent Class Assessment of the Drivers and Impediments to Success. *Journal of Information Technology,* 22, 87-101.

Cooper, M., Upton, N. and Seaman, S. (2005), Customer Relationship Management: A Comparative Analysis of Family and Nonfamily Business Practices. *Journal of Small Business Management,* 43(3), 242-256.

Day, S.G. and Hubbard, J.K. (2003), Customer relationships go digital. *Business Strategy Review,* 14(1), 17-26.

Dhar, V. and Sundararajan, A. (2007), Issues and Opinions—Information Technologies in Business: A Blueprint for Education and Research. *Information Systems Research,* 18(2), 125-141.

Dibrell, C., Davis, P. and Craig, J. (2008), Fueling Innovation through Information Technology in SMEs. *Journal of Small Business Management,* 46(2), 203-218.

Dvir, D. E., Segev, E., and Shenhar, A. (1993), Technology's varying impact on the success of strategic business units within the miles and snow typology. *Strategic Management Journal* 14, 155-162.

e-Business Watch (2006), Impact of ICT on Corporate Performance, Productivity and Employment Dynamics, authored by Dr. Philipp Koellinger, Special Report No. 01/2006.

Eisenhardt, K.M., and Zbaracki, M.J. (1992), Strategic Decision Making. *Strategic Management Journal* 13, 17–37.

European Communities (2008), *The European e-Business Report 2008: The impact of ICT and e-business on firms, sectors and the economy,* 6th Synthesis Report of the Sectoral e-Business Watch, European Commission, Enterprise and Industry Directorate General, in cooperation with, DIW econ, IDC EMEA, Ipsos GmbH and GOPA-Cartermill, Luxembourg.

European Commission (2003), Commission recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. *Official Journal of the European Union,* 2003/361/EC, May, 36-41.

Forth, J. and Mason, G. (2006), Do ICT Skill Shortages Hamper Firms' Performance? Evidence from UK Benchmarking Surveys. National Institute of Economic and Social Research, London, Sep.2006

Groznik, A., Kovacic, A. and Trkman, P. (2008), The role of business renovation and information in e-government. *The Journal of Computer Information Systems,* 49(1), 81-89.

Harrigan, P., Ramsey, E., and Ibbotson, P. (2008), e-CRM in SMEs: An exploratory study in Northearn Ireland, Marketing Intelligence and Planning. 26(4), 385-404.

Harrigan, P., Ramsey, E., and Ibbotson, P. (2009), Investigating the e-CRM activities of Irish SMEs. *Journal of Small Business and Enterprise Development*, 16(3), 443-465.

Hempell,T. Leeuwen,G. and Wiel, H. (2004), ICT, Innovation and Business Performance in Services: Evidence for Germany and the Netherlands" ZEW Discussion Paper No. 04-06, Centre for European Economic Research (available at ftp://ftp.zew.de/pub/zew-docs/dp/dp0406.pdf)

Hoy, F., McDougall, P. P. and Dsouza D. E. (1992), *Strategies and Environments of High-Growth Firms, The State of the Art of Entrepreneurship*. Eds. D. L. Sexton and J. D. Kasarda. Boston: PWS-Kent Publishing, 341-357.

Huang, C. J., and Liu, C. J. (2005), Exploration for the Relationship between Innovation, IT, and Performance. *Journal of Intellectual Capital,* 6(2), 237–252.

Hwang, G. (2004), Diffusion of information and communication technologies and changes in skills", available at: www.emcc.eurofound.eu.int/content/source/uk02010s.html?p1=sector&p2= Information_Technology

Javalgi, R. and Ramsey, R. (2001), Strategic issues of e-commerce as an alternative global distributions system. *International Marketing Review*, 18 (4), 376-391.

Jeyaraj, A., Rottman, J., Lacity, M.J. (2006), A review of the predictors, linkages, and biases in IT innovation adoption research. *Journal of Information Technology*, 21(1), 1-23.

Johannessen, J. A., J. Olaisen, and B. Olsen (1999), Strategic Use of Information Technology for Increased Innovation and Performance. *Information Management and Computer Security,* 7(1), 5–22.

Johnston, R.H. and Carrico, S.R. (1988), Developing Capabilities to Use Information Strategically. *MIS Quarterly,* 12(1), 37–47.

Johnston, D. A., Wade, M., and McClean, R. (2007), Does e-Business Matter to SMEs? A Comparison of the Financial Impacts of Internet Business Solutions on European and North American SMEs. *Journal of Small Business Management,* 45(3), 354-361.

Kim, K.K. and Umanath, N.S. (2005), Information transfer in B2B procurement: An empirical analysis and measurement. *Information and Management*, 42 (6), 813-828.

Koh, C.E., Nam, K.T., Prybutok, V.R. and Lee, S. (2007), A value chain perspective of internet practices, e-readiness and organizational performance: A comparison of US and South Korean firms. *Industrial Management & Data Systems*, 107 (4), 519-536.

Kohli, R. and Devaraj, S. (2003), Measuring information technology payoff: A metaanalysis of structural variables in firm-level empirical research. *Information Systems Research* 14(2), 127-145.

Kula, V., and Tatoglu, E. (2003), An exploratory study of Internet adoption by SMEs in an emerging market economy. *European Business Review,* 15(5), 324 -333.

Lagrosen, S. (2005), Customer involvement in new product development: a relationship marketing perspective. *European Journal of Innovation Management*, 8(4), 424-36.

Lin, R. J., Chen, R. H. and Chiu, K. K S. (2010), Customer relationship management and innovation capability: an empirical study. *Industrial Management & Data Systems,* 110(1), 111-133.

Maguire, S., Koh, S.C.L. and Magrys, A. (2007), The adoption of e-business and knowledge management in SMEs. *Benchmarking: An International Journal*, 14 (1), 37-58.

McGowan, P., Durkin, M.G., Allen, L., Dougan, C. and Nixon, S. (2001), Developing competencies in the entrepreneurial small firm for use of the internet in the management of customer relationships. *Journal of European Industrial Training*, 25 (2/4), 126.

Mohamad, R., and Ismail, N. A. (2009), Electronic Commerce Adoption in SME: The trend of prior studies. *Journal of Internet Banking and Commerce*, 14(2), 1-16 (http://www.arraydev.com/commerce/jibc/)

Melville, N., Kraemer, K. and Gurbaxani, V. (2004), Information Technology and Organizational Performance: An integrative model of IT business value. *MIS Quarterly*, 28(2), 283–322.

Murphy, G. B., Trailer, J. W., & Hill, *R. C.* (1996), Measuring Performance in Entrepreneurship Research. *Journal of Business Research*, 36(1), 15-23.

Norusis, M. (2008), *SPSS Statistics 17.0 Advanced Statistical Procedures Companion,* Prentice Hall, USA.

OECD (2001), Organisational Change and Firm Performance, DSTI/IND(2001)6, Sep. 6.

OECD (2002), The Impacts of Electronic Commerce on Business: Summary, DSTI/ICCP/IE(2002)5/FINAL, OECD, Paris.

OECD (2003), *Seizing the Benefits of ICT in a Digital Economy,* Meeting of the OECD Council at Ministerial Level, Paris, France.

OECD (2004), ICT, E-BUSINESS AND SMEs. DSTI/IND/PME(2002)7/FINAL, OECD, Paris. (available at http://www.oecd.org)

Pettigrew, A. M., Thomas, H., and Whittington, R. (2002), *The Strengths and Limitations of a Field, Handbook of Strategy and Management*. Eds. A. M. Pettigrew, H. Thomas and R. Whittington. London: Sage Publications Ltd, 3-30.

Porter, M. (1980), *Competitive Strategy*. New York: Free Press.

Porter, M. (1985), *Competitive Advantage*. New York: Free Press.

Prasad, B. and Harker, P.T. (1997), Examining the contribution of information technology toward productivity and profitability in U.S. retail banking. *Wharton School Working Paper* 97-07, University of Pennsylvania, Philadelphia.

Quan, J., Hu, Q. and Hart, P.J. (2003), Information technology investments and firms performance – a duopoly perspective', *Journal of Management Information Systems*, Vol. 20, No. 3, pp.121–158.

Ramani, G. and Kumar, V. (2008), Interaction orientation and firm performance. *Journal of Marketing,* 72(1), 27-45.

Raymond, L., Bergeron, F. O., and Blili, S. (2005), The Assimilation of E-business in Manufacturing SMEs - Determinants and Effects on Growth and Internationalization. *Electronic Markets,* 15(2), 106 - 118.

Report for the Enterprise Directorate of BERR, *The Impact of Regulation on Small Business Performance*, Small Business Research Centre, Kingston University, London, URN 08/806, April 2008.

Ritchie, B. and Brindley, C. (2005), ICT Adoption by SMEs: Implications for Relationships and Management. *New Technology, Work and Employment*, 20 (3), 205-217.

Rumelt, R. (1974), *Strategy, Structure, and Economic Performance*. Boston, MA: Harvard Business School Press.

Sahay, B.S. and Ranjan, J. (2008), Real time business intelligence in supply chain analytics. *Information Management & Computer Security*, 16(1), 28-48.

Santhanam, R. and Hartono, E. (2003), Issues in Linking IT Capability to Firm Performance. *MIS Quarterly*, 27(1), 125–153.

Schendel, D. E. and C. W. Hofer (1979), *Strategic Management: A New View of Business Policy and Planning*. Boston, MA: Little, Brown.

Schroder, D. and Madeja, N. (2004), Is Customer Relationship Management a Success Factor in Electronic Commerce? *Journal of Electronic Commerce Research*, 5, 38-52.

Scupola, A. (2009), SMEs' E-Commerce Adoption: Perspectives from Den mark and Australia. *Journal of Enterprise Information Management,* 22(1/2), 152-166.

Sectoral e-Business Watch (2009), e-Skills Demand Developments and Challenges, Impact Study, European Commission, DG Enterprise & Industry No 05/2009.

Sectoral e-Business Watch (2009), An economic assessment of ICT-related industrial policy, Impact Study, European Commission, DG Enterprise & Industry No 04/2009.

Singh, R., Garg, S. and Deshmukh, S. (2008), Strategy Development by SMEs for Competitiveness: A Review. *Emerald Group Publishing Limited,* 15(5), 525-547.

Sin, L.Y.M., Tse, A.C.B. and Yim, F.H.K. (2005), CRM: conceptualization and scale development. *European Journal of Marketing,* 39(11/12), 1264-1290.

Souder, W.E., Buisson, D. and Garrett, T. (1997), Success through customer driven new product development: a comparison of US and New Zealand small entrepreneurial high technology firms. *Journal of Product Innovation Management,* 14(6), 459-472.

Stoneman, P. and Kwon, M.J. (1996), Technology adoption and firm profitability. *Economic Journal* 106(437), 952-962.

Storey, D.J. (1994), *Understanding The Small Business Sector*, London: International Thompson Business Press.

Teo, T.S.H. and Pian, Y. (2003), A contingency perspective on Internet adoption and competitive advantage. *European Journal of Information Systems*, 12(2), 78-92.

Teo, T. S. H. (2007), Organizational characteristics, modes of internet adoption and their impact: A Singapore perspective. *Journal of Global Information Management,* 15(2), 91-117.

Thomson, A. and Gray, C. (1999), Determinants of Management Development in Small Business. *Journal of Small Business and Enterprise Development,* 6(2), 113-127.

Yasin, M. M. (2002), *The theory and practice of benchmarking: then and now*. *Benchmarking. An International Journal*, 9(3), 217-243.

Verhoef, P.C. (2003), Understanding the effect of customer retention and customer share development. *Journal of Marketing,* 67(4), 30-45.

Wrigley, N (1985), *Categorical Data Analysis for Geographers and Environmental Scientists,* Longman, Harlow.

Wu, F., Mahajan, V. and Balasubamanian, S. (2003), An analysis of e-business adoption and its impacts on business performance. *Journal of the Academy of Marketing Science*, 31(4), 425–447.

ACKNOWLEDGEMENTS

The authors wish to express their sincere appreciation to the European Commission and the Sectoral e-Business Watch for supplying the raw data sets of their e-Business Surveys (2002, 2003, 2005, 2006,

2007). These valuable raw data sets help the authors to develop the ideas put forward here. The authors are grateful for the publisher's generous permission to use the raw data sets.

BIOGRAPHY

Christina C. Beneki is an Assistant Professor of Mathematics-Statistics and Associate Head at the Department of Business Administration, Technological Institute of Ionian Islands. She is teaching Quantitative Research Methods, Statistics for Business and Economics and Operations Research. Her current research interests and publications are focused on applied statistical and econometric methods. She can be contacted at: Department of Business Administration, Technological Institute of Ionian Islands, Stylianou Typaldou, 28200 Lixouri, Kefallinia, GREECE. E-mail: benekic@teiion.gr

Dr. Avraam Papastathopoulos is an Adjunct Lecturer of Entrepreneurship at Technological Educational Institute of Ionian Islands. He can be contacted at: Department of Business Administration, Technological Institute of Ionian Islands, Stylianou Typaldou, 28200 Lixouri, Kefallinia, GREECE. E-mail: apapast@hotmail.com