

1-1-2009

Strategy, ICT Investment, BPR And Business Performance: An Empirical Investigation

Euripides Loukis

of the Aegean, Department of Information & Communication Systems Engineering, eloukis@aegean.gr

Konstantinos Pazalos

of the Aegean, Department of Information & Communication Systems Engineering, kpaz@aegean.gr

Recommended Citation

Loukis, Euripides and Pazalos, Konstantinos, "Strategy, ICT Investment, BPR And Business Performance: An Empirical Investigation" (2009). *MCIS 2009 Proceedings*. Paper 121.
<http://aisel.aisnet.org/mcis2009/121>

This material is brought to you by the Mediterranean Conference on Information Systems (MCIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in MCIS 2009 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

STRATEGY, ICT INVESTMENT, BPR AND BUSINESS PERFORMANCE: AN EMPIRICAL INVESTIGATION

Loukis, Euripides, University of the Aegean, Department of Information & Communication Systems Engineering, 83200, Karlovasi, Samos, Greece, eloukis@aegean.gr

Pazalos, Konstantinos, University of the Aegean, Department of Information & Communication Systems Engineering, 83200, Karlovasi, Samos, Greece, kpaz@aegean.gr

Abstract

The study on the links between strategy, structure and performance has been for long time a fundamental and highly important research topic for the management researchers and practitioners. In this direction this paper presents a 'holistic' empirical investigation of the whole network of relations between business strategy (at a first level), information and communication technologies (ICT) investment, non-ICT investment and BPR (at a second level), and finally business performance (at a third level). It is based on firm-level data from 271 Greek firms, which are used for the estimation of structural equation models (SEM) connecting the above variables, theoretically based on the Cobb-Douglas Production Function. It is concluded that none of the three generic business strategies defined by M. Porter (cost leadership, differentiation and focus) has a significant effect on ICT and non-ICT investment; on the contrary, particular strategic choices (differentiation and focus strategy) have been found to drive process change. Also, it has been found that all the investigated internal factors, ICT investment, non-ICT investment and BPR, have a positive impact on business performance. Concerning their interrelations, ICT investment affects positively BPR, which indicates that BPR is a partial mediator in the relationship between ICT and performance; on the contrary, this does not happen with non-ICT investment, indicating an important difference between these two types of capital investment as to their relation with process change.

Keywords: *Enterprise Information Systems (IS), Information and Communication Technologies (ICT) Investment, Non-ICT Investment, Business Strategy, Business Process Reengineering (BPR), Business Performance, Cobb-Douglas Production Function*

1 INTRODUCTION

The investigation of the relations between strategy, structure and performance has been for long time a fundamental and important research topic. Understanding the structural adaptations caused by different strategies and their impact on business performance is of critical importance for the successful implementation of these strategies. For this reason since the initial study of Chandler (1962) on this topic there has been extensive literature investigating how various strategies affect various elements of firm's structure, and what is the impact on business performance (e.g. Miller 1988, Jennings and Seaman 1994, Vorhies and Morgan 2003, Rhee and Mehra 2006). In the same direction the Structural Contingency Theory (Donaldson 2001) posits that organizational effectiveness results from fitting the structure of a firm to some important contingencies, one of them being firm strategy. Also, Porter (1980 and 1985) argues that each strategy requires different structures and resources in order to be successful and finally result in high business performance. Similar arguments have been expressed for the information systems (IS) as well, which constitute a new important structural element of enterprises in the 'new economy' era; for instance, Melville et al (2004) from an extensive review concludes that in order to get a better understanding of value generation by enterprise IS, it is necessary to examine their associations with the external environment and strategy, their 'complementary resources' (such as the work practices supported by IS) and finally business performance.

In this direction this paper presents an empirical investigation of the relations between business

strategy, information and communication technologies (ICT) and business process reengineering (BPR), both of them being important elements of the structure of modern enterprises, and finally business performance. It aims at providing an understanding on how business strategy affects business performance through the two fundamental and interrelated new structural elements of modern economy, ICT and BPR. Enterprises today make big investments for developing complex IS in order to support and improve their processes and functions. Also, there is a renewed interest in BPR, mainly enabled by ICT, which is reflected in the results of a recent survey of the key IS management issues conducted by the Society for Information Management (SIM) of USA (www.simnet.org), in which BPR has been ranked as the fifth most important issue that IS managers face (Luftman et al 2006). Furthermore, our study investigates, for comparison purposes, the same issues for 'non-ICT' investment (in 'regular capital', such as production equipment, physical structures, etc.) as well, which - despite the growing investment of firms in ICT - constitutes (in most sectors) the biggest part of firms' total investment. This allows a comparison with ICT investment in the above respect, in order to identify similarities and differences between these two types of capital investment.

Previous empirical literature (reviewed in the following section 2) has mainly examined small parts (subsets) of the above network of relations. In particular, it has focused on the impact of ICT investment, non-ICT investment and BPR on business performance (e.g. Guimaraes and Bond 1996, Brynjolfsson and Hitt 1996, Arvanitis 2005, Altinkemer et al 2007). Also, there is considerable literature dealing with the relation between ICT and BPR, emphasizing mainly through theoretical arguments the innovative potential of ICTs as catalysts and enablers of big improvements of existing business processes, which, in turn, can result in high levels of performance improvements (e.g. Brynjolfsson and Hitt 1996, Brynjolfsson and Hitt 2000, Bresnahan et al 2002); this literature argues that the main mechanism of business value creation from ICT will be not the simple automation of existing business processes, but the ICT-enabled change and improvement of them, which can result in big business benefits. However, there are only a very small number of empirical investigations of the mediating effect of BPR on the relationship between ICT and business performance (Grover et al 1998, Albadvi et al 2007); even these few studies have some important limitations as explained in the following section. However, there is a lack of empirical investigations of the effect of business strategy on ICT investment, non-ICT investment and BPR. Furthermore, are missing 'holistic' empirical investigations based on a common dataset of the whole network of relations between business strategy, ICT investment, non-ICT investment, BPR and business performance, which would enable a more complete understanding of the mechanism of value generation by enterprise IS (Melville et al 2004).

The empirical investigation presented in this paper attempts to fill those research gaps. Its main contributions are:

- It empirically investigates the whole network of relations between business strategy (at a first level), ICT investment, BPR and non-ICT investment (at a second level) and business performance (at a third level), using a common dataset.
- It is based on a sound theoretical foundation from the area of microeconomics, the Cobb-Douglas Production Function, and uses objective measures of business performance.
- It measures BPR through a multi-item scale, which has been developed through extensive review of the relevant BPR literature, and then validated using the methods proposed by the relevant statistical literature.
- It compares ICT investment and non-ICT investment from the above perspectives and identifies similarities and differences among them.

The results of this study are useful to researchers, practitioners, managers, firms, consulting companies and ICT vendors interested in ICT business value maximization.

In the following section 2 a brief review of relevant literature is presented. Then in section 3 the research hypotheses are formulated, while in section 4 method and data of this study are described. The results of the estimation of structural equation models (SEM) connecting the above variables are

presented and discussed in section 5. The final section 6 summarizes the main conclusions and their implications.

2 LITERATURE REVIEW

As mentioned in the introduction previous empirical literature has examined small parts (subsets) of the above network of relations, focusing mainly on the impact of the ICT investment, non-ICT investment and BPR on business performance. In particular, the relationship between ICT investment and business performance has been a major and highly debated research topic for more than two decades. The earlier empirical studies on this topic, which were conducted during the 80s and 90s, failed to find evidence of a positive association between ICT investment and business performance (Roach 1987, Strassman 1997, Brynjolfsson 1993) (ICT Productivity Paradox). However, subsequent empirical studies have found considerable evidence of positive impact of ICT investment on various measures of business performance (Brynjolfsson and Hitt 1996, Stolarick 1999, Devaraj and Kohli, 2000, Wan et al 2007), reflecting firms' gradual learning on how to exploit ICT and make the required process adjustments. Many of these studies have also investigated the impact of non-ICT investment on business performance and found considerable evidence of its positive impact on business performance.

Also, there have been several empirical studies that dealt with the effect of BPR on business performance and provided evidence of a positive association between business process change and various measures of business performance (Black and Lynch 2004, Tai and Huang 2007, Altinkemer et al 2007). Another research stream examines the relationship of ICT with BPR and proposes ways of using ICT for enabling and supporting BPR (Gunasekaran and Nath 1997, Champy 2002, Eardley et al 2008). Some other studies analyse the innovative potential of ICT as catalysts and enablers of big improvements of existing business processes, which can result in significant performance improvements (e.g. Brynjolfsson & Hitt 1996, Bresnahan et al 2002). In this direction Brynjolfsson and Hitt (2000) argue that the most useful aspect of ICTs is that they are catalysts and enablers of big improvements of existing business processes and work practices, which, in turn, lead to very high levels of benefits; for this reason they expect that the main mechanism of business value creation from ICT will be not the simple automation of existing business processes, but the IT-enabled change and improvement of them, which can result in quite big business benefits. However, despite the theoretical arguments of this literature concerning the mediating effect of BPR on the relationship between ICT and business performance, there is only a very small number of empirical investigations of it (Grover et al 1998, Albadvi et al 2007). Additionally, these few empirical studies have some important limitations: they are not based on theoretically sound models, omitting thus important variables, use subjective measures of business performance (usually perceptions of management) as dependent variables, and measure the extent of BPR in a very simplistic way through only one item, even though it is a quite abstract and multidimensional concept.

On the other hand there is a lack of empirical investigations on the effect of business strategy on ICT investment and BPR. Another notable gap of previous literature is the lack of empirical investigations of the above issues for non-ICT investment (i.e. investment in 'regular capital', such as mechanical production equipment, physical structures, etc.), which would allow comparisons to be made with ICT investment in this respect. Previous literature has identified fundamental differences between ICT capital and non-ICT (regular) capital (e.g. Bresnahan and Trajtenberg 1995, Melville et al 2007, etc.): ICT capital is a 'general purpose technology', highly adaptable and flexible, so it can be used in many different ways and for many various purposes, and can be an enabler of important innovations; on the contrary, non-ICT capital is not a general purpose technology, being much less flexible and adaptable to different uses, so it can serve much fewer functions. It is therefore interesting and useful to examine whether the above fundamental difference between ICT capital and non-ICT capital results in differences between ICT and business performance strategy, BPR and business performance. Finally, there is a lack of 'holistic' empirical investigations of the whole network of relations between business strategy, ICT investment, non-ICT investment, BPR and business performance, despite the fact that

previous literature has emphasized that such studies would be necessary for getting a more complete understanding of the mechanism of value generation by enterprise IS (e.g. Melville et al 2004).

3 RESEARCH HYPOTHESES

Taking into account the above gaps of previous empirical literature, this study investigates the whole network of relations between business strategy, ICT investment, non-ICT investment, BPR and business performance. The research model is shown in Figure 1.

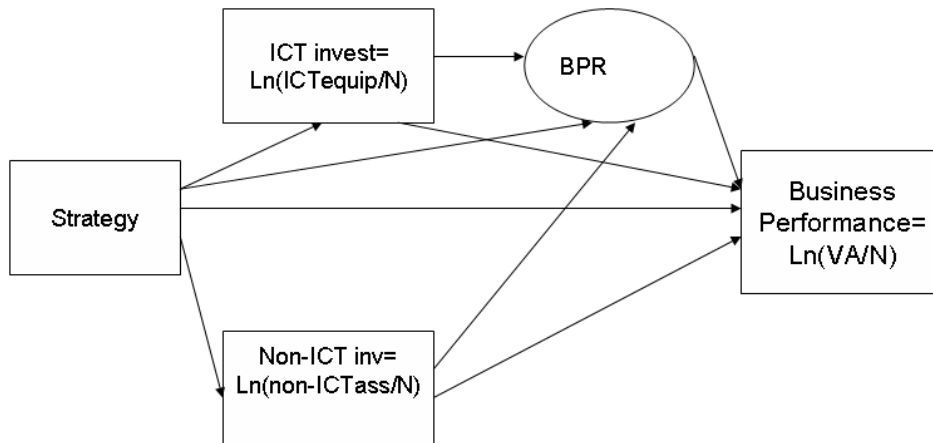


Figure 1. The research model

Our first set of research hypotheses concerns the effect of ICT investment, BPR and non-ICT investment on business performance. As mentioned in the previous section 2 there are several previous empirical studies that have provided evidence for a positive effect of all three of them on business performance (Brynjolfsson and Hitt 1996, Stolarick 1999, Devaraj and Kohli, 2000, Arvanitis 2005, Altinkemer et al 2007, Wan et al 2007). So our first three research hypotheses are:

Hypothesis 1: ICT Investment has a positive and significant effect on business performance.

Hypothesis 2: Non-ICT Investment has a positive and significant effect on business performance.

Hypothesis 3: The extent of BPR has a positive and significant effect on business performance.

The second set of research hypotheses concerns the relations between ICT investment, non-ICT investment and BPR. As mentioned previously, ICTs are ‘general purpose’ technologies, which can be used for many different purposes and functions and can be easily adapted to new needs and processes, so they have high potential for enabling important innovations (Bresnahan and Trajtenberg 1995, Melville et al 2007, etc.). In this direction, as described in the previous section, there is considerable literature supporting the relation between ICT and BPR and proposing ways of using ICT for enabling and supporting BPR (Gunasekaran and Nath 1997, Champy 2002, Attaran 2004, Eardley et al 2008); also there are several studies analysing the innovative potential of ICT as catalysts and enablers of significant improvements of existing business processes (e.g. Brynjolfsson & Hitt 1996, Bresnahan et al 2002). On the contrary, non-ICT (regular) capital, such as mechanical production equipment, physical structures, etc., is not a ‘general purpose’ technology, and is not characterised by high flexibility and adaptability, so it does not have such a potential for enabling important innovations. Therefore we expect that ICT investment affects positively the extent of BPR, whereas non-ICT investment does not, so our next two research hypotheses are (we expect only the first of them to be supported):

Hypothesis 4: ICT investment has a positive and significant effect on the extent of BPR.

Hypothesis 5: Non-ICT investment has a positive and significant effect on the extent of BPR.

The third set of research hypotheses concerns the effect of business strategy on ICT investment, non-ICT investment, BPR, and also its direct effect on business performance. For developing those hypotheses we reviewed the existing strategy typologies and categorizations that have been proposed by researchers in the strategy domain (a review of them is provided by Langfield-Smith (1997); the two most widely known and broadly used are the ones developed by Miles and Snow (1978) and Porter (1980 and 1985). For the present study we adopted Porter's strategy typology (Porter 1980 and 1985), which is a highly mature one and has been extensively used in the past both in research (e.g. Chenhall and Langfield-Smith 1988, Govindarajan and Fisher 1990, Jordan et al 1998, Jermias, 2008) and management/consulting practice. Porter (1980, 1985) proposed three generic business strategies: cost leadership, differentiation, and focus. A cost leadership strategy focuses on gaining a low-cost position relative to competitors through the construction of efficient-scale facilities, the achievement of economies of scale, the vigorous pursuit of cost reductions from experience, tight cost and overhead control, avoidance of marginal customers accounts, and cost minimization in areas like R&D, service, sales force, advertising and so on. A differentiation strategy focuses on creating and providing products or services that customers perceive as unique and valuable in comparison with those of its competitors. A focus strategy concentrates on a narrow segment of the market, attempting to focus and adapt products and services to its particular needs, and achieve either cost advantage or differentiation within this segment.

The relevant literature (e.g. Porter 1980 and 1985, Porter and Millar 1985, Ward 1987, Klouwenberg et al 1995, Mattson et al 2000, Luftman 2000, Cragg et al 2002) emphasizes that all three business strategies proposed by Porter, in order to be successful, require support by appropriate ICT and non-ICT capital (regular assets), which, however, are quite different for each strategy. For instance a cost leadership strategy requires information systems (IS) oriented towards the automation to the highest possible extent of firm's processes so that the required personnel is minimized, the improvement of the exploitation and management of its resources, and the control and reduction of its costs. On the other hand, a differentiation strategy requires IS oriented towards achieving the quality features of firms' products and services that have been chosen as the basis of the differentiation, as well as designing better products and services. A focus strategy, which aims at focusing products and services to the needs of one or more customer groups, requires IS oriented towards analysing the particular needs of these groups, and the design and production of appropriate products and services for them. We therefore expect that higher extent of implementing any of these three strategies will necessitate higher investment in ICT and non-ICT assets, even though of different type and orientation for each strategy; so we can postulate the following six research hypotheses:

Hypothesis 6: The extent of implementing a low-cost strategy has a positive and significant effect on ICT Investment.

Hypothesis 7: The extent of implementing a differentiation strategy has a positive and significant effect on ICT Investment.

Hypothesis 8: The extent of implementing a focus strategy has a positive and significant effect on ICT Investment.

Hypothesis 9: The extent of implementing a low-cost strategy has a positive and significant effect on non-ICT Investment.

Hypothesis 10: The extent of implementing a differentiation strategy has a positive and significant effect on non-ICT Investment.

Hypothesis 11: The extent of implementing a focus strategy has a positive and significant effect on non-ICT Investment.

The third set of our research hypotheses concerns the effect of business strategy on the extent of BPR. Porter (1980 and 1985) emphasizes that each of the three business strategies he has proposed requires appropriate adaptations of firm's business processes, which are different for each strategy. Relevant

literature (e.g. Hammer and Champy 1993, Davenport 1993, Altinkemer et al 1998, Al Mashari et al 2001, Wu 2002) states clearly that BPR can have objectives related either to cost leadership strategy (e.g. cost reduction) or to differentiation strategy (e.g. improving customer service and satisfaction), so it can be adopted as part of either of these strategies. Terziofski et al (2003) from an empirical investigation in the financial sector found that focusing BPR in customer-related processes results in higher levels of success. We therefore expect that higher extent of implementing any of these three strategies will necessitate higher extent of BPR, even though of different type for each strategy; so our next three research hypotheses are:

Hypothesis 12: The extent of implementing a low-cost strategy has a positive and significant effect on the extent of BPR.

Hypothesis 13: The extent of implementing a differentiation strategy has a positive and significant effect on the extent of BPR.

Hypothesis 14: The extent of implementing a focus strategy has a positive and significant effect on the extent of BPR.

Finally we expect that these three strategies research hypotheses will have not only the abovementioned indirect effects on business performance (through ICT investment, non-ICT investment and BPR), but also direct effects as well, so our final research hypotheses are:

Hypothesis 15: The extent of implementing a low-cost strategy has a positive and significant direct effect on business performance.

Hypothesis 16: The extent of implementing a differentiation strategy has a positive and significant direct effect on business performance.

Hypothesis 17: The extent of implementing a focus strategy has a positive and significant direct effect on business performance.

4 METHOD AND DATA

The data we used for this empirical study were collected through a survey among Greek companies, which was conducted in cooperation with ICAP SA, one of the largest business information and consulting companies of Greece. The sample of the survey was randomly selected from the database of ICAP. It included 304 Greek firms from the 27 most important sectors of Greek economy, with an equal representation of small, medium and large firms (103 small firms with more than 10 and less than 50 employees, 103 medium ones with more than or equal to 50 and less than 250 employees, and 98 large ones with more than or equal to 250 employees); also two more samples were randomly created from the database of ICAP with similar proportions of the size and sectoral classes. The questionnaire was sent by mail to the managing directors of the 304 firms of the first sample; one month later the recipients who had not responded were contacted by phone again and reminded of the questionnaire; firms that refused to participate were replaced by 'similar' ones (i.e. of the same size and industry class) from the second sample and then (in case it is exhausted) from the third sample. In this way we managed to have a balanced sample concerning company size and industry. Finally we received complete questionnaires from 271 companies (88 small, 105 medium and 78 large ones).

We also examined whether there is non-response bias. According to the relevant literature (Armstrong and Overton; 1977; Chapman, 1992) a practically feasible and reliable method for that is to compare variables' means of the early respondents with the ones of the late respondents; if there are not statistically significant differences, then it is highly likely that non-response bias does not exist. Adopting this approach we divided the answered questionnaires we received into two groups: the ones we received within the first month (first group), and the ones we received later (second group). Then we tested for all variables whether there are statistically significant differences between the means of

these two groups. Since we did not find any statistically significant differences it is highly likely that non-response bias does not exist.

The basic theoretical foundation of this study is the Cobb-Douglas Production Function (Nicholson, 1998). It posits that firm output in a given time period is an exponential function of the capital and labour employed in this period; in particular, we used an extended form of it, which divides capital into computer capital (ICT) and non-computer capital (non-ICT):

$$VA = e^{\beta_0} L^{\beta_1} K^{\beta_2} CK^{\beta_3} \quad (4.1)$$

where yearly firm value added (VA), being equal to yearly sales revenue minus yearly expenses for buying materials and services, is regarded as the dependent variable and the fundamental business performance measure, while the independent variables are the yearly labour expenses L, the value of the non-computer capital K and the value of the computer capital CK. By log-transforming (4.1) and adding the 'stochastic disturbance' term u_t , which models characteristics of strategy and management of each particular firm that affect the value added production, we obtain the following linear form

$$\ln VA = \beta_0 + \beta_1 \ln(L) + \beta_2 \ln(K) + \beta_3 \ln(CK) + u_t \quad (4.2)$$

By dividing both sides of (4.2) by the number of firm employees (N) we can infer that the log-transformed value added per employee (labour productivity) of a firm is a linear function of the log-transformed value of its ICT capital, the log-transformed value of its non-ICT capital and also its strategy and management (including BPR). We used this as the theoretical foundation of the research model of this study shown in Figure 1. So we used as an objective measure of business performance the log-transformed value added per employee (labour productivity); this is a fundamental measure of business performance that has been used as dependent variable in many empirical studies of the effect of ICT and organizational change on business performance (e.g. Bertschek & Kaiser 2001, Black & Lynch 2004, Arvanitis 2005). Also, we used as objective measures of ICT investment and non-ICT investment the log-transformed value of firm's ICT equipment (hardware, software and networks) per employee and the log-transformed value of firms' non-ICT assets (= value of assets minus value of ICT equipment) per employee respectively. The corresponding questions of the survey questionnaire are shown in Appendix A.

Since the extent of BPR constitutes a more abstract and multidimensional concept, which cannot be measured by one single variable, we decided to measure it as a multi-item reflective construct, using a nine-item scale developed through extensive review of the relevant BPR literature (Hammer 1990, Davenport 1990, Hammer & Champy 1993, Davenport 1993, Davenport and Nohria 1994, Martinsons 1995, Gunasekaran & Nath 1997, O'Neill et al 1999, Al Mashari & Zairi 2000, Champy 2002). The corresponding nine questions of the survey questionnaire are shown in Appendix A. In Appendix B we can see the supporting literature for each of these items of the BPR construct.

Finally, we measured the extent of adopting each of the three generic business strategies defined by M. Porter (cost leadership, differentiation and focus) (Porter 1980 and 1985) by three corresponding items. The questions of the survey questionnaire that correspond to the BPR and strategy items are also shown in Appendix A.

The research hypotheses described in section 3 were tested by estimating the research model shown in Figure 1 using the above operationalizations three times, setting each time the strategy variable equal to the extent of implementing a strategy of cost leadership, a strategy of differentiation, and a focus strategy respectively. The estimation has been made using the Structural Equation Modelling (SEM) approach (Kline 2005) implemented through the AMOS 6 software (Byrne, 2001).

5 RESULTS

Initially the BPR construct was tested in terms of validity and reliability in all the three hypothesized models using the methods proposed by the relevant statistical literature. In particular, we assessed convergent validity, which is the most important dimension of construct validity according to the relevant literature (Straub et al 2004). Convergent validity requires that items that have been selected as reflecting a construct show statistically significant and high correlations with one another as well as with the construct. We assessed it by examining the BPR items loadings in all three models, which are shown in Table 1; all of them are statistically significant and exceed the cut-off level of 0.6 suggested by Chin (1998) indicating the convergent validity of the BPR construct.

Item	Cost Lead.	Differentiation	Focus
BPR_1	.753	.754	.756
BPR_2	.683	.683	.683
BPR_3	.773	.773	.775
BPR_4	.698	.695	.693
BPR_5	.717	.717	.718
BPR_6	.810	.810	.811
BPR_7	.725	.726	.724
BPR_8	.700	.701	.697
BPR_9	.666	.666	.664

Table 1. Item loadings of the BPR construct in the three models.

Then, we assessed the reliability of the BPR construct, which shows the extent to which its items constitute an error-prone operationalization of it (Straub et al 2004). For this purpose we calculated the Cronbach's Alpha of this construct using the SPSS 15.0 software, and the result was 0.914, exceeding the minimum acceptable level of 0.7 recommended by the relevant literature (Gefen et al 2000, Straub et al 2004), confirming therefore the reliability of this construct.

As a second step we examined the basic fit indices of the three structural equation models, which quantify how well these specified models fit the observed data. We can see that for all three models we have acceptable values for both the incremental fit indexes (≥ 0.9 according to Gefen et al 2000) and for RMSEA (≤ 0.08 according to Browne and Cudeck 1993).

BPR	Chi-square	NFI	RFI	IFI	TLI	CFI	RMSEA
Cost Lead.	84.35	.947	.921	.979	.969	.979	.047
Differentiation	91.30	.943	.915	.975	.963	.975	.052
Focus	85.60	.947	.922	.979	.969	.979	.048

Table 2. Model fit indices for the three structural equation models

Having confirmed BPR construct validity and reliability, and also acceptable fit for all three models, we examined their structural parts (path coefficients), which are shown in Figures 2-4 (we can see the standardised coefficients only for the statistically significant paths).

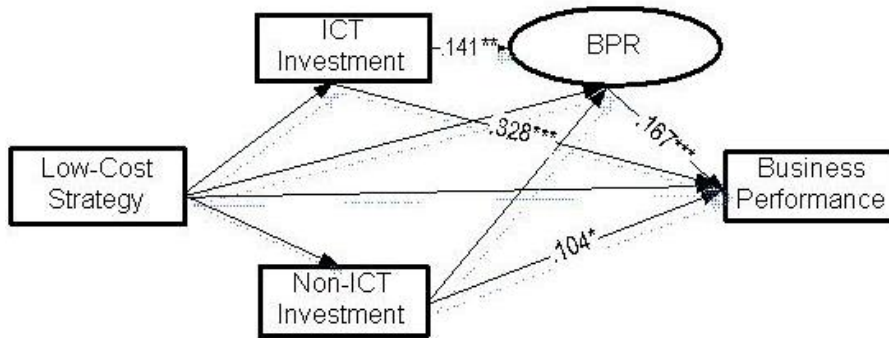


Figure 2. The cost leadership strategy structural model

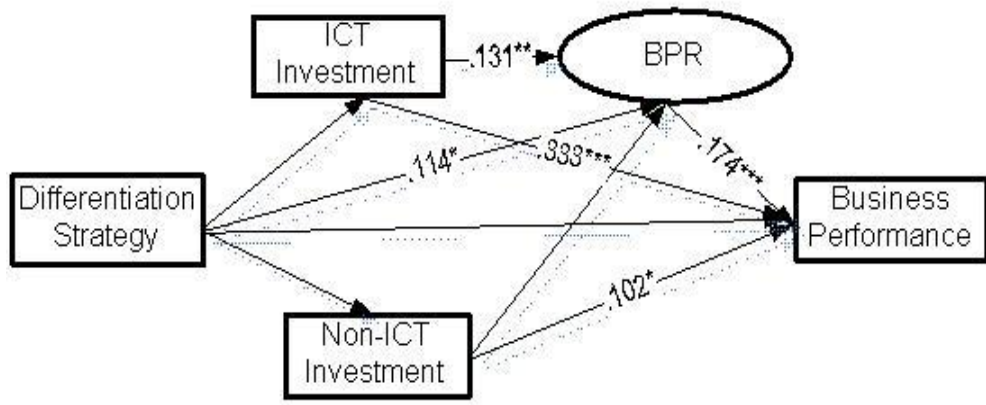


Figure 3. The differentiation strategy structural model

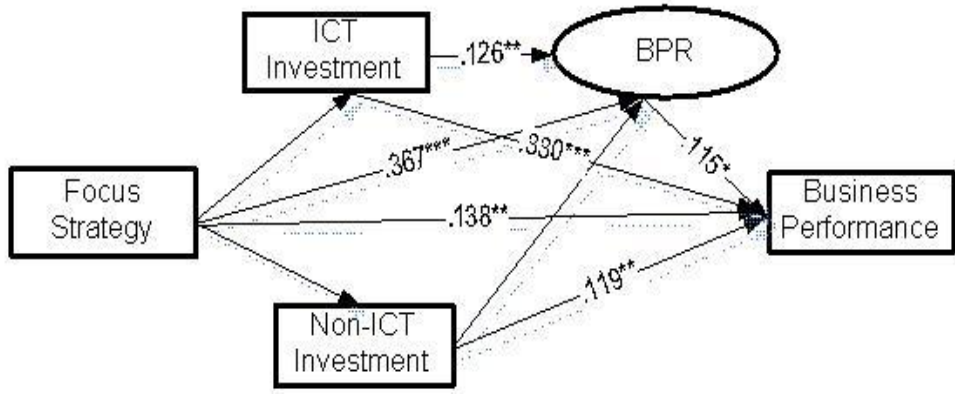


Figure 4. The focus strategy structural model

We can see that all the investigated internal factors, ICT investment, non-ICT investment and BPR, have statistically significant positive effect on business performance, so hypotheses 1, 2 and 3 are supported, with the effect of ICT investment being the highest (standardised coefficient 0.300, versus 0.119 and 0.115 for non-ICT investment and BPR respectively). Concerning the relations between these internal factors, we can see that ICT investment has a statistically significant positive effect on the extent of BPR, so hypothesis 4 is supported; on the contrary non-ICT investment does not have a statistically significant effect on the extent of BPR, so hypothesis 5 is not supported (both conclusions agree with our initial expectations which are mentioned in section 3). This conclusion reveals an important difference between the two types of investment as to their relation with business process change: ICT

investment, being a general purpose technology with high adaptability and flexibility, drives and facilitates BPR, while this does not happen with non-ICT investment, since it is not a general purpose technology and has much lower adaptability and flexibility. This leads us to the conclusion that ICT investment has not only a direct effect on business performance, but also an indirect one through BPR, therefore BPR 'partially mediates' (according to the terminology of Venkatraman, 1989) the relationship between ICT investment and business performance; this finding is in agreement with the ones of the two empirical studies that have been conducted on this topic (Grover et al 1998, Albadvi et al 2007).

Concerning the effects of strategy, we can see that none of the three examined business strategies (cost leadership, differentiation, focus) has a statistically significant effect on ICT investment or non-ICT investment, so hypotheses 6 to 11 are not supported. However, business strategy seems to affect more the extent of BPR; in particular, while the extent of implementing a low-cost strategy does not have a significant effect on the extent of BPR, on the contrary the extent of implementing a differentiation strategy has a statistically significant small to medium positive effect on the extent of BPR (0.114), and the extent of implementing a focus strategy has a statistically significant medium to large positive effect on the extent of BPR (0.367). Therefore hypothesis 12 is not supported, whereas hypotheses 13 and 14 are. This means that the adoption of a differentiation strategy results in a small to medium extent of reengineering of existing business processes, oriented mainly towards achieving the quality features of firms' products and services that have been chosen as the basis of the differentiation. Also, the adoption of a focus strategy drives a medium to large extent of reengineering of existing business processes, oriented mainly towards increasing firm's capabilities for analysing and understanding the particular needs of the targeted market segments, and also for designing and producing appropriate specialised products and services for them.

Also, we can see that only the extent of implementing a focus strategy has a statistically significant direct positive effect on business performance, so hypothesis 17 is supported, while hypotheses 15 and 16 are not. The above findings indicate that the positive effect of implementing a differentiation strategy on business performance is completely mediated by the BPR it drives. This means that the improvement of business performance a result of a differentiation strategy is mainly due to the 'soft action' of re-engineering existing business processes, which aims to support the differentiation basis that the firm has chosen, and not due to 'hard actions' of increasing its ICT capital or non-ICT capital per employee. Concerning focus strategy, its positive effect on business performance is partially mediated by BPR (according to Venkatraman, 1989). This means that the improvement of business performance a result of a focus strategy is to some extent due to the 'soft action' of re-engineering existing business processes, in order to get a better understanding of the market segment(s) it targets and also design and produce specialised products and services for them, and to some extent through other mechanisms; again it is not due to 'hard actions' of acquiring more ICT capital or non-ICT capital per employee. Finally, the implementation of cost leadership strategy does not affect ICT capital, non-ICT capital or BPR, and finally does not improve business performance.

6 CONCLUSIONS AND DISCUSSION

Management researchers and practitioners have been for long time interested in understanding the structural adaptations and transformations that enterprises make as a result of their strategic orientations and their impact on business performance. In this direction the present study has presented an empirical investigation of the whole network of relations between business strategy (at a first level), ICT investment, BPR (both of them being important elements of the structure of modern enterprises) and non-ICT investment (at a second level) and business performance (at a third level). It is theoretically founded on the Cobb-Douglas Production Function and uses objective measures of business performance and ICT and non-ICT investment. For the reliable measurement of the abstract and multidimensional BPR concept a multi-item scale has been used, developed through extensive review of the relevant BPR literature, and then validated using the methods proposed by the relevant statistical literature.

It has been found that the extent of implementing any of the three examined Porter's generic business strategies (cost leadership, differentiation and focus) does not have an effect on investments, either in ICT or in non-ICT assets. This means that firms seem not to implement their strategy through 'hard actions' of additional investment in ICT and non-ICT assets. However, particular strategic choices have an effect on the extent of process change within the organizations: a differentiation strategy has a small to medium positive effect on BPR, while a focus strategy has a medium to high positive effect on BPR. A differentiation strategy necessitates adaptation of business processes oriented towards achieving the quality features of firms' products and services that have been chosen as the basis of the differentiation. Similarly a focus strategy necessitates adaptation of business processes oriented towards increasing firm's capabilities for analysing and understanding the particular needs of the targeted market segments and also for designing and producing appropriate specialised products and services for them. This means that firms implement differentiation and focus strategies mainly through 'soft actions' of process adaptations.

On the other hand all the examined internal factors, ICT investment, non-ICT investment and BPR, have all positive impact on business performance, findings that are consistent with the existing literature (Brynjolfsson & Hitt 1996, Arvanitis 2005, Bresnahan et al 2002). ICT investment has a positive effect on BPR, but this does not happen with non-ICT investment. Thus, the relationship between ICT and business performance is partially mediated by BPR, but this does not hold for the relationship between non-ICT investment and business performance. These results indicate an important difference between these two types of investment: ICT assets are much more closely associated with business processes (supporting and influencing them significantly) in comparison with non-ICT assets (e.g. production machinery, buildings, etc.), which are less associated with business processes, so they do not influence them significantly. Furthermore, while ICT are 'general purpose' technologies, non-ICT assets are not, so they can serve much fewer functions, and are much less flexible and adaptable to different uses in comparison with ICT; for this reason they have a much lower potential for facilitating and enabling radical innovations in processes (e.g. radical improvements, simplifications or even abolitions of business processes, etc.) than ICT (Bresnahan and Trajtenberg 1995, Melville et al 2007).

The present study has two basic limitations. First, it has been based on a sample of Greek firms, so its conclusions may have been influenced by the characteristics (e.g. economic, cultural, social, etc.) of the Greek national context. Greece does not belong to the highly developed countries, though it has made considerable progress in the last twenty years, having become a full member of the European Economic and Monetary Union. Also, it is characterised by a small size of internal market and small average firm size. Culturally it is characterised by higher Uncertainty Avoidance Index (UAI) values than the other European countries and USA according to Geert Hofstede's website (<http://www.geert-hofstede.com/>), which might affect negatively the attitudes towards ICT investment and BPR. Therefore it would be useful to conduct similar empirical studies in other national contexts as well. A second limitation is that this study uses only one business performance measure, value added per employee (labour productivity); even though it is a fundamental one, since it incorporates the value of the products and services a firm produces, the value of the materials and services it buys from external suppliers and also the number of its employees, and also widely used by researchers, it would be interesting to conduct similar empirical studies using more measures of business performance.

References

- Al Mashari, M. and Zairi, M. (2000). Revisiting BPR: a holistic review of practice and development. *Business Process Management Journal*, 6(1), 10-42.
- Al Mashari, M., Irani, Z. and Zairi, M. (2001). Business process reengineering: A survey of international experience. *Business Process Management Journal*, 7 (5), 437-453.
- Albadvi, A., Keramati, A., Razmi, J. (2007). Assessing the impact of information technology on firm performance considering the role of intervening variables: Organizational infrastructures and business process reengineering. *International Journal of Production Research*, 12 (15), 2697-2734.

- Altinkemer, K., Ozcelik, Y., and Ozdemir, Z. (2007). Productivity and performance effects of IT-enabled reengineering: A firm-level analysis. Proceedings of the European Conference of Information Systems, St. Gallen, Switzerland.
- Armstrong, J. S. and Overton, T. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, 14 (3), 396-402.
- Arvanitis, S. (2005). Computerization, workplace organization, skilled labor and firm productivity: Evidence for the Swiss business sector. *Economics of Innovation and New Technology*, 14(4), 225-249.
- Attaran, M. (2004). Exploring the relationship between information technology and business process reengineering. *Information and Management*, 41, 585-596.
- Black, S. E. and Lynch, L. M. (2004). What's driving the New Economy?: The Benefits of Workplace Innovation. *The Economic Journal*, 114, 97-116.
- Bresnahan, T. and Trajtenberg, M. (1995). General purpose technologies – 'Engines of growth'? *Journal of Econometrics*, 65, 83-108.
- Bresnahan, T., Brynjolfsson, E., Hitt, L. M. (2002). Information technology, workplace organization and the demand for skilled labor: Firm-level evidence. *The Quarterly Journal of Economics*, 117, 339-376.
- Browne, M. W. and Cudeck, R. (1993). Alternative Ways of Assessing Model Fit. In *Testing Structural Equation Models*, eds. K. A. Bollen and S. Long, Newbury Park, CA, Sage Publications, Inc.
- Brynjolfsson, E. (1993). The productivity paradox of information technology: review and assessment, *Communications of the ACM*, 36(12), 67-77.
- Brynjolfsson, E., Hitt, L. M. (1996). Paradox lost? Firm level evidence on the returns to information systems spending, *Management Science*, 42 (4), 541–558.
- Brynjolfsson, E., Hitt, L. M. (2000). Beyond Computation: Information technology, organizational transformation and business performance. *Journal of Economic Perspectives*, 14 (4), 23–48.
- Byrne, B. M (2001). *Structural equation modeling With AMOS: Basic concepts, applications and programming*. Lawrence Erlbaum Associates, New Jersey.
- Champy, J. (2002). *X-Engineering the corporation: Reinventing your business in the digital age*. Warner Books, New York, NY.
- Chandler, A. (1962). *Strategy and Structure*. MIT Press, Cambridge, MA.
- Chapman, R. G. (1992). Assessing non-response bias the right way: a customer satisfaction case study. *American Marketing Association Summer Educators Proceedings*, 322-329.
- Chenhall, R. H., Langfield-Smith, K. (1998). The relationship Between Strategic Priorities, Management Techniques, and Management Accounting: An Empirical Investigation Using a System Approach. *Accounting, Organizations and Society*, 23(3), 243-264
- Chin, W. W. (1998). Issues and opinion on structural equation modeling. *Management Information Systems Quarterly*, 22(1), 7-16.
- Cragg, P., King, M., Hussin, H. (2002). IT alignment and firm performance in small manufacturing firms. *Journal of Strategic Information Systems*, 11, 109-132.
- Davenport, T. and Nohria, N. (1994). Case management and the integration of labor. *Sloan Management Review*, 31, 11-27.
- Davenport, T. and Short, J. (1990). The new industrial engineering: information technology and business process redesign. *Sloan Management Review*, 31(4), 11-27.
- Devaraj, S., and Kohli, R. (2000). Information technology payoff in the health-care industry: A longitudinal study. *Journal of Management Information Systems*, 16 (4), 41-65.
- Donaldson, L. (2001). *The Contingency Theory of Organizations*. Sage Publications Inc., USA.
- Eardley, A., Shah, H. and Radman, A. (2008). A model for improving the role of IT in BPR. *Business Process Management Journal*, 14(5), 629-653.
- Gefen, D., Straub, D. and Boudreau, M. (2000). Structural equation modelling and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, 4, 1-78.
- Govindarajan, V. and Fisher, J. (1990). Strategy, control systems and resource sharing: effects on business unit performance. *Academy of Management Journal*, 33, 259-285.

- Grover, V., Teng, J., Segars, A. H., Fiedler, K. (1998). The influence of information technology diffusion and business process change on perceived productivity: the IS executive's perspective. *Information and Management*, 34, 141-159.
- Gunasekaran, A and Nath, B. (1997). The role of information technology in business process reengineering. *International Journal of Production Economics*, 50, 91-104.
- Hammer, M. and Champy, J. (1993). *Re-engineering the corporation: A manifesto for business revolution*. Harper Press, New York, USA.
- Henderson, J.C., Venkatraman, H. (1999). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Systems Journal*, 38(2), pp. 472 -484.
- Jennings, D. F. and Seaman, S. L. (1994). High and low levels of organizational adaptation: an empirical analysis of strategy, structure and performance. *Strategic Management Journal*, 15(6), 459-475.
- Jordan, J., Lowe, J. and Taylor, P. (1998). Strategy and financial policy in UK small firms. *Journal of Business Finance and Accounting*, 25, 1-27.
- Kline, R. B. (2005). *Principles and practice of structural equation modeling*. Guilford Press, New York, NY.
- Klouwenberg, M. K., Koot, W. J. D. and Van Schaik, J. A. M. (1995). Establishing business strategy with information technology. *Information Management & Computer Security*, 3(5), 8-20.
- Langfield-Smith, K. (1997). Management control systems and strategy: A critical review. *Accounting, Organizations and Society*, 22, 207-232.
- Luftman, J. (2000). Assessing Business-IT Alignment Maturity. *Communications of the Association for Information Systems*, 4, 1-51.
- Luftman, J., Kempaiah, R. and Nash, E. (2006). Key Issues for IT Executives 2005. *MIS Quarterly Executive*, 5(2), 81-100.
- Martinsons, M. G. (1995). The Theory, the Practice and the Future of Reengineering. *International Journal of Information Management*, 15(4), 253-269.
- Mattson M. R., Beheshti H. M. and Salehi-Sangari, E. (2000). A two-country comparison of the use of information technology in competitive strategy: Sweden and the United States. *Competitiveness Review: An International Business Journal incorporating Journal of Global Competitiveness*, 10(2), 98 - 113
- 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.
- Melville, N., Gurbaxani, V. and Kraemer, K. (2007). The productivity impact of information technology across competitive regimes: The role of industry concentration and dynamism. *Decision Support Systems*, 43, 229-242.
- Miles, R. W. and Snow, C. C. (1978). *Organizational Strategy, Structure and Process*. McGraw-Hill, New York, USA.
- Miller, D. (1988). Relating Porter's business strategies to environment and structure: analysis and performance implications. *Academy of Management Journal*, 31(2), 280-308.
- Nicholson, W. (1998). *Microeconomic theory: Basic principles and extensions - 7th edition*. The Dryden Press, Orlando, Florida.
- O'Neill, P., and Sohal, A. S. (1999). Business process reengineering: A review of recent literature. *Technovation*, 19, 571-581.
- Rhee, M. and Mehra, S. (2006). Aligning operations, marketing and competitive strategies to enhance performance: an empirical test in the retail banking industry. *Omega – The International Journal of Management Science*, 34, 505-515.
- Porter, M. E. (1980). *Competitive Strategy*. Free Press, New York, USA.
- Porter, M. E. (1985). *Competitive Advantage*. Free Press, New York, USA.
- Porter, M. E., Millar, V. E. (1985). How information gives you competitive advantage. *Harvard Business Review*, 63(4), 149-160.
- Roach, S. (1987). *America's technology dilemma: A profile of the information economy*. Morgan Stanley Special Economic Study, New York, USA.

Stolarick, K. (1999). IT spending and firm productivity: Additional evidence from the manufacturing sector. Center for Economic Studies, U.S. Census Bureau, Working Paper, 99-10.

Strassman, P. (1997). The squandered computer. The Information Economic Press, New Canaan, Connecticut.

Straub, D., Boudreau, M. and Gefen, D. (2004). Validation guidelines for IS positivist research. Communications of the Association for Information Systems, 13, 380-427.

Tai, D. W., and Huang, C. E. (2007). The relationship between business process reengineering and organizational performance in Taiwan. Journal of American Academy of Business, Cambridge, 10 (2), 296-301.

Terziofski, M., Fitzpatrick, P. and O'Neil, P. (2003). Successful predictors of business process reengineering in financial services. International Journal of Production Economics, 84, 35-50.

Venkatraman, N. (1989). The concept of fit in strategy research: Towards verbal and statistical correspondence. Academy of Management Review, 14(3), 423-444.

Vorhies, D. W. and Morgan, N. A. (2003). A configuration theory assessment of marketing organization fit with business strategy and its relationship with marketing performance. Journal of Marketing, 67(1), 100-115.

Wan, Z, Fang, Y. and Wade, M. (2007). A ten-year odyssey of the 'IS productivity paradox' - A citation analysis (1996-2006). The Americas Conference on Information Systems (AMCIS) 2007, Keystone, Colorado, USA.

Ward, J. M. (1987). Integrating Information Systems into Business Strategies. Long Range Planning, 20(3), pp. 19-29

Wu, I (2002). A model for implementing BPR based on strategic perspectives: an empirical study. Information & Management, 39, 313-324.

Appendix A : Survey Questions

- Yearly total sales revenue (without VAT) : _____ Euro
- Yearly total expenses for buying materials and services (without VAT): _____ Euro
- Number of employees: _____
- Value of assets at the end of the year (without VAT) : _____ Euro
- Value of ICT equipment (hardware, software and networks) at the end of the year (without VAT): _____ Euro

Answer the following questions in a scale 1 – 5, where 1 = Not at all, 2 = To a small extent, 3 = To a moderate extent, 4 = To a large extent, 5 = To a very large extent, by clicking the appropriate box in the right of each question

- To what extent have you performed the following business process reengineering (BPR) activities in the last 5 years?

BPR ACTIVITIES	1	2	3	4	5
BPR_1: Creation of new horizontal (inter-departmental) processes (that cross more than one departments)					
BPR_2: Creation of new inter-departmental units/workgroups (e.g. customer or product-focused)					
BPR_3: Creation of new horizontal coordination roles (process coordinators) for monitoring and coordinating the efficient and faster execution of process crossing more than one department.					
BPR_4: Simplification of processes					
BPR_5: Improvement of processes					
BPR_6: Abolition of processes					

BPR_7: Redesign of processes so that they become customer-focused					
BPR_8: Job enrichment - increase of decision making competences authorization for employees involved in some processes					
BPR_9: Decrease of supervision and number of supervisors in some processes					

- To what extent does your firm follow a strategy of:

	1	2	3	4	5
Cost Leadership					
Differentiation of your products/services from those of competitors					
Focus of your products/services to the needs of specific customer group(s)					

APPENDIX B: Supporting literature for the Items of the BPR Construct

BPR items	
BPR_1	Hammer and Champy, 1993; Gunasekaran and Nath, 1997
BPR_2	Gunasekaran and Nath, 1997; Autor et al., 1998
BPR_3	Al Mashari and Zairi, 2000
BPR_4	Hammer and Champy, 1993
BPR_5	Hammer and Champy, 1993
BPR_6	Hammer and Champy, 1993
BPR_7	Champy, 2002
BPR_8	Brynjolfsson and Mendelson, 1993; Lawler et al., 2001
BPR_9	Gurbaxani and Whang, 1991; Gunasekaran and Nath, 1997