

Using structural equation modelling for investigating the impact of e-business on ICT and non-ICT assets, processes and business performance

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Abstract This paper investigates the impact of adopting an e-business strategy on two organizational characteristics which have gradually become highly important for organizations in the last 20 years, information and communication technology (ICT) assets and business processes, and also on a ‘traditional’ one, the non-ICT (regular) assets, and finally through them on business performance. Its theoretical foundations are the Contingency Theory of Organizations in combination with the Cobb-Douglas Production Function. Advanced quantitative techniques of structural equation modelling (SEM) have been employed, which allow the estimation of complex multi-layer models including mediator variables that are both dependent (i.e. affected by others) and independent (i.e. affecting some others) at the same time, and enable the investigation of complex networks of relationships. Firm-level data collected through a survey of 271 Greek firms have been used for estimating a SEM connecting the above variables. The results show that the adoption of e-business strategy by Greek firms leads to adaptation of their business processes, which has a positive impact on their business performance, but not to additional investment to ICT or non-ICT assets. In particular, e-business drives Greek firms’ processes adaptations aiming mainly to increase the non-hierarchical decentralized coordination within the firm, in order to cope with the higher task complexity and uncertainty that e-business gives rise

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to, and also to respond to the specific technical and operational requirements that this strategy poses.

Keywords e-business · Strategy · Information and Communication Technologies (ICT) · Business Process Re-engineering (BPR) · Business performance · Structural equations modelling (SEM) · Contingency theory of organizations · Cobb-Douglas production function

1 Introduction

The Contingency Theory of Organizations posits that in order to increase their performance organizations adapt basic characteristics of them to a number of contingencies, such as the environment, strategy and size (Burns and Stalker 1961; Chandler 1962; Child 1975; Pennings 1992; Donaldson 2001). In this line, considerable research has been conducted in order to understand the effect of various contingencies on various organizational variables, with main emphasis on structural ones, and finally through them on business performance (Chandler 1962; Suzuki 1980; Miller 1988; Gresov 1990; Jennings and Seaman 1994; Rhee and Mehra 2006; Pertusa-Ortega et al. 2008). However, limited research has been conducted beyond these ‘traditional’ contingencies, concerning the effect of some more recent ICT-based contingencies, which have gradually emerged in the last 20 years, such as the adoption of e-business strategy. Furthermore, the effect of both the traditional and these more recently emerged contingencies on some organizational characteristics that have gradually become highly important for organizations in the last 20 years as well, such as ICT assets and business processes, and through them on business performance, has not been researched.

This paper contributes to filling this research gap by empirically investigating the impact of adopting an e-business strategy on ICT assets and business processes, and also on the ‘traditional’ non-ICT (regular) assets, and finally on business performance. E-business, defined as ‘the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organisations, conducted over computer-mediated networks’ (OECD 2002), is a strategy for growth and development, which is being increasingly adopted by firms all over the world, in order to increase their market share, target new market segments, enter new markets and introduce new products and services (Johnson and Scholes 2006; European Commission 2008; Turban et al. 2008). It is therefore important to investigate its impact on business performance, and also the mediators of this impact; identifying and understanding these mediators is very useful for firms adopting e-business strategy, since it provides them guidance as to the necessary actions and adaptations they should undertake in order to achieve the highest possible impact of this strategy on business performance.

It should also be mentioned that previous literature (e.g. Bresnahan and Trajtenberg 1995; Melville et al. 2007) has identified the specificity of ICT assets in comparison with the ‘traditional’ non-ICT (regular) ones that firms have been using for long time, arguing that the former are ‘general purpose’ technologies, which can be adapted to

many different uses and functions, and therefore enable important innovations, while the latter do not have such characteristics. In this vein our study examines whether the above fundamental difference between ICT and non-ICT assets results in differences in their relationships with e-business, BPR and business performance.

The basic theoretical foundation for formulating the network of relations investigated in this study is, as mentioned above, the Contingency Theory of Organizations (see Donaldson 2001—it is outlined in the following Sect. 2); additionally, for the elaboration of the relations of ICT and non-ICT assets with business performance, and also for the definition of the corresponding measures, a sound theoretical foundation from the area of microeconomics has been used, the Cobb-Douglas Production Function (see Nicholson and Snyder 2008—it is outlined in 4.2). For estimating this network of relations advanced quantitative techniques of structural equation modelling (SEM) have been employed, which combine factor analysis and path analysis offering significant advantages: (a) they allow the estimation of complex multi-layer models including mediator variables that are both dependent (i.e. affected by others) and independent (i.e. affecting some others) at the same time; (b) they enable the estimation of abstract and multidimensional concepts though combination of several variables in order to achieve higher reliability levels; (c) and also allow the simultaneous testing of structural and measurement hypotheses using empirical data (Gefen et al. 2000; Byrne 2001; Kline 2005). In particular, a SEM connecting e-business, ICT assets, non-ICT assets, business process re-engineering and business performance has been estimated, using firm-level data collected through a survey of 271 Greek firms. Therefore our empirical investigation has been conducted in a single national context different from the ones of the highly economically and technologically developed countries, in which most of the previous empirical studies concerning the impact of e-business on performance have been conducted: Greece is a smaller country, with a lower level of economic development, ICT usage and innovation (OECD 2008, 2009, 2010a, b; Eurostat 2008), and previous research has concluded that the national context can influence ICT adoption and use and innovation (e.g. Leidner and Kayworth 2006; Ali and Brooks 2008; Kaasa and Vadi 2010).

This paper is structured in six sections. The next Sect. 2 presents the background of this study, outlining the basic ideas of the Contingency Theory of Organizations and reviewing previous relevant empirical literature. In Sect. 3, the research model and hypotheses are formulated, while in Sect. 4 the research design is described. Then, data analysis and results are presented and discussed in Sect. 5 and, finally, in Sect. 6 the main conclusions and limitations of the study are outlined and future research directions are proposed.

2 Background

2.1 The contingency theory of organizations

The Contingency Theory of Organizations (Burns and Stalker 1961; Chandler 1962; Child 1975; Pennings 1992; Donaldson 2001) constitutes one of the major

theoretical lenses for analyzing organizations. Earlier theories of organization posit that there is a universal 'best way' of organizing, arguing that maximum performance comes from adopting the maximum value of a particular organizational variable, such as formalization, specialization, employees participation, etc. (Taylor 1947; Brech 1957; Likert 1961). The Contingency Theory of Organizations in contrast argues that the 'best way' of organizing depends on contingencies: maximum performance comes from adopting the 'appropriate' (and not the maximum) levels of some organizational variables that fit the contingency. Various contingencies have been proposed and examined by the relevant literature, with the most important of them being environment, strategy and size. These contingency factors often change values, and then organizations experience performance decrease, because their existing characteristics are appropriate for the previous values of these contingency factors (i.e. for the previous situation), but not for the new ones. This leads organizations to make 'structural adaptations to regain fit' (SARFIT) (Donaldson 2001) and through them achieve higher performance. Successful organizations are those which can quickly diagnose changes of important contingencies and the 'misfit' they cause, and then make the required adaptations of appropriate organizational characteristics, such as structure, processes, etc.

Two main contingency theories of organizations have been presented in the literature: the 'Organic Theory' and the 'Bureaucracy Theory'. The Organic Theory considers the degree of centralization as the fundamental dimension of organizational structure (Burns and Stalker 1961). It varies among organizations in a continuum from a mechanistic structure (top management makes all decisions and prescribes in detail the activities of lower level employees) to an organic structure (decentralization of decision making lower so that employees have more autonomy in defining their activities). According to the Organic Theory, the degree of centralization in each particular organization (i.e. the appropriate point between the above two extremes) should be decided based on the contingency of 'task uncertainty' (i.e. how uncertain and unpredictable the tasks to be executed within the organization are); in particular, the mechanistic structure is appropriate for low task uncertainty, while the organic structure is appropriate for high task uncertainty. The Bureaucratic Theory considers the degree of complexity (bureaucratization) as the fundamental dimension of organizational structure (Child 1975; Mintzberg 1979), varying in a continuum from an unbureaucratic structure (simple, with a low level of formalization and specialization) to a bureaucratic structure (complex, with high level of formalization and specialization). According to the Bureaucratic Theory, the degree of complexity (bureaucratization) in each particular organization (i.e. the appropriate point between the above two extremes) should be decided based on the contingency of the size; in particular, the unbureaucratic structure is appropriate for small organizations, while the bureaucratic structure is appropriate for large organizations.

Considerable research has been conducted in order to gain an understanding of the effect of various contingencies on various organizational variables and finally on business performance (Chandler 1962; Suzuki 1980; Miller 1988; Gresov 1990; Jennings and Seaman 1994; Rhee and Mehra 2006; Pertusa-Ortega et al. 2008). However, the effects of ICT-based types of strategies, such as conducting

e-business, on some organizational characteristics which have gradually become highly important for organizations in the last 20 years, such as ICT assets and business processes, and through them on business performance, have not been researched. The empirical study described in this paper contributes to filling this research gap.

2.2 Review of empirical literature

Several empirical investigations of the impact of e-business on business performance, using mainly subjective non-financial measures have been conducted, however only few of them have dealt with identifying mediators of this relationship. Frohlich (2002) found that supplier and customer e-integration had a strong effect on e-business performance (defined as percent of procurement and sales revenues performed through the Internet) and operational performance (defined as respondents' perception of impact on delivery times, transaction costs and inventory turnover). Wu et al. (2003) found that communication (with suppliers and customers) and internal administration aspects of e-business positively affected performance outcomes (efficiency, sales performance, customer satisfaction and relationship development), while e-procurement and online order taking did not. Zhu and Kraemer (2005) reached the conclusion that use of e-business, front-end capabilities and back-end capabilities have a positive impact on e-business value; also they found that technology competence, firm size, financial commitment, competitive pressure, and regulatory support are important antecedents of e-business use. Devaraj et al. (2007) concluded that e-business technologies do not directly impact operational performance, however they support integration with customers and suppliers, which in turn impact positively operational performance (acting as mediators). The investigation of Sanders (2007) showed that the use of e-business technologies impacts on performance (measured by cost reduction, product quality, new products introduction time, delivery time) both directly and indirectly through promoting intra-organizational and inter-organizational collaboration. More recently, Soto-Acosta and Meroño-Cerdan (2008, 2009) found that while Internet resources are not directly related to e-business value, they are critical for creating internal and external e-business capabilities, which in turn are key drivers of e-business value.

A smaller number of empirical studies focus on the effect of e-business on objective measures of financial business performance. In this vein, the results of Zhu and Kraemer (2002) suggest the need for e-commerce capability and IT infrastructure alignment to obtain higher levels of firm performance. Barua et al. (2004) found significant positive relationships between information exchange capabilities and digitization of business activities for both customers and suppliers; they also found that digitization of business activities with customers results in improved financial performance, while there was not such significant relationship on the supplier side. Motiwalla et al. (2005) came to the conclusion that e-business adopters from three industries (food, beverages and tobacco, consumer products and retail) had better values in several financial performance ratios in the post-adoption period than their non-adopter counterparts. Johnson et al. (2007) reached the

conclusion that only some forms of e-business technology use (those designed to reduce coordination costs) can lead to improved financial performance.

In conclusion, previous empirical literature has produced considerable evidence that e-business has a positive impact on various measures of organizational performance, including both non-financial and financial measures. It has also revealed a number of mediating factors in the relationship between e-business and performance, such as intra-organizational and inter-organizational e-collaboration, internal and external e-business capabilities, and information exchange capabilities and digitization of business activities with customers and suppliers. However, the mediating role of ICT assets and BPR in this relationship has not been investigated, despite their high importance for modern organizations, nor that of the traditional non-ICT (regular) assets. The empirical study described in this paper contributes to filling this research gap.

Finally, although there are no empirical investigations covering the whole network of the relationships between e-business strategy, ICT assets, non-ICT assets, BPR and business performance, there is some previous empirical research focused on some of these relationships. In particular, there have been empirical investigations concerning the effect of ICT capital, non-ICT capital and BPR on business performance (e.g. Guimaraes and Bond 1996; Brynjolfsson and Hitt 1996; Stolarick 1999; Bertschek and Kaiser 2001; OECD 2003, 2004; Black and Lynch 2004; Melville et al. 2004; Arvanitis 2005; Altinkemer et al. 2007; Wan et al. 2007; Arvanitis and Loukis 2009), which have produced evidence of positive impact on various financial and non-financial measures of business performance for all these variables. There is also considerable literature supporting and analyzing, mainly through theoretical arguments, the innovative potential of ICTs as catalysts and enablers of BPR, which can result in high levels of performance improvements (e.g. Brynjolfsson and Hitt 1996, 1998, 2000; Bresnahan et al. 2002; Attaran 2004; OECD 2004). However, there are only a very small number of empirical studies that analyse the mediating effect of BPR on the relationship between ICT and business performance (Grover et al. 1998; Albadvi et al. 2007). The current empirical study contributes to filling this research gap as well.

3 Research model and hypotheses

This section presents the research model, which is shown in Fig. 1, and develops its associated hypotheses. As mentioned in the Introduction its basic theoretical foundation is the Contingency Theory of Organizations, focused on the contingency of following an e-business strategy and its impacts on ICT and non-ICT assets and business processes.

The first research hypothesis concerns the effect of following e-business strategy on business performance. E-business can provide distinct value propositions to the firm, which in turn may result in higher levels of business performance. In particular, it enables the creation of various capabilities concerning the customers, such as offering extensive information online to current and prospective customers, establishing electronic communications and online transactions, etc. (Soto-Acosta

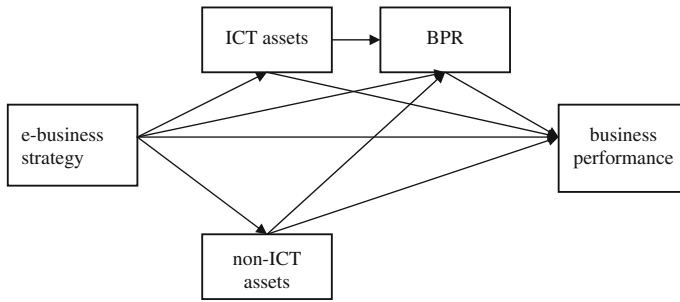


Fig. 1 The hypothesized research model

and Meroño-Cerdan 2006). With regard to offering information online, firms adopting e-business can use the Internet to provide extensive product/service information to customers, so achieving high levels of ‘reach and richness’ (Evans and Wruster 1999); ‘reach’ concerns the number of people that are reachable quickly and cheaply through these technologies, while ‘richness’ relates to the depth and detail of information that can be provided to them. E-business can also be a source of value creation to the firm by building capabilities for efficient and effective communications with customers, which are of critical importance for building and maintaining long-term customer relationships (Cannon and Homburg 2001; Heldal et al. 2004). In this line, many firms today are becoming increasingly competent in offering after-sales support through their websites. Another source of value creation in e-business identified by Amit and Zott (2001) is the transaction efficiency resulting from online transactions like e-sales and e-procurement. E-sales (or selling online) may increase the volume of sales, the number of customers and the quality of customer service; they connect firms to consumers in geographic areas that would be too costly to reach otherwise (Steinfeld et al. 1999). In addition, selling online can provide value through the automation of the sales process, which reduces staff workload and allows them to focus on more complex tasks or on exceptions instead of routine tasks. As for e-procurement (or buying online), it can contribute to improvements in business performance through the reduction of procurement and inventory costs, as well as through the establishment of strategic networks with suppliers that allow effective and efficient supply chain management (SCM). Also, Internet technologies can enhance SCM decision making by enabling the collection and analysis of real time information in order to facilitate collaboration between trading partners in a supply chain. In this sense Frohlich and Westbrook (2002) have shown the importance of linking customers and suppliers together in tightly integrated networks. At the same time, e-business facilitates and enables innovation in the way firms do business through new business models (Timmers 1998; Afuah and Tucci 2001; Tavlaki and Loukis 2005), which can result in increases of customers and sales. For the above reasons, the e-business is expected to improve business performance, so our first research hypothesis is formulated as follows:

Hypothesis 1 The extent of following e-business strategy has a positive effect on business performance

However, a firm following e-business strategy in order to exploit the abovementioned important value proposition it can offer should modify some of its business processes, make them more customer-focused and inter-departmental (horizontal) or even create new business processes, so that it can systematically offer extensive high quality and updated information online to current and prospective customers about its products and services, establish new ways of electronic communications with them and support e-sales and e-procurement. New business processes should be implemented in order to receive electronic orders and payments on a 24/7 basis, deliver products on time to geographically remote and dispersed customers as well as offer after-sales support electronically. Furthermore, new business processes, or extensive modifications of the existing ones, are required in order to support the new business models that e-business enables. In general, all the capabilities that e-business offers, which have been mentioned in the previous paragraph, need some form of BPR in order to be exploited. Previous empirical investigations, as mentioned in the literature review section, have produced considerable evidence of a positive relationship between BPR and business performance (e.g. Guimaraes and Bond 1996; Bertschek and Kaiser 2001; Black and Lynch 2004; Arvanitis 2005; Altinkemer et al. 2007; Arvanitis and Loukis 2009). E-business can generate internal efficiency and external coordination through changes in intra- or inter-organizational integrative processes, so reducing both fixed and variable costs (Kambil et al. 1999; Quan et al. 2003). Thus, e-business has a pervasive impact across the entire span of a firm's business processes, from the purchasing department and the supply-chain coordination to the field sales force (Wu et al. 2003). Consequently, organisations today frequently combine e-business redesign processes with in ways that strengthen their competitive advantages (Phan 2003). Thus, BPR is expected to play a mediating role in the relationship between e-business and business performance. So our second research hypothesis is:

Hypothesis 2 The extent of BPR mediates the relationship between the extent of following e-business strategy and business performance

which can be analyzed in the following two hypotheses:

Hypothesis 2.1 The extent of following e-business strategy has a positive effect on the extent of BPR

Hypothesis 2.2 The extent of BPR has a positive effect on business performance

Furthermore, firms following e-business strategy in order to exploit the abovementioned value proposition might acquire additional ICTs and non-ICTs assets. For instance, in order to use the Internet to offer online information about products and services to customers, establishing electronic communications with them, as well as enabling e-sales and e-procurement, it is might necessary to make acquire ICT assets, e.g. new web servers, internal information systems (IS) and applications that allow front-end and back-end integration of IS (Turban et al. 2008). The high requirements posed by e-business with respect to receiving and

delivering orders on a 24/7 basis to geographically remote and dispersed customers with short delivery times, and also the high competition that e-business gives rise to, may lead to the need for additional non-ICT assets (e.g. new production equipment, buildings, warehouses, etc.). Previous empirical investigations, as mentioned in the preceding section, have provided considerable evidence that both ICT and non-ICT assets have a positive impact on business performance (e.g. Brynjolfsson and Hitt 1996; Stolarick 1999; OECD 2003, 2004; Melville et al. 2004; Arvanitis 2005; Wan et al. 2007). Thus, both ICT and non-ICT assets are expected to mediate the relationship between e-business and business performance, so our third research hypothesis is:

Hypothesis 3 The ICT assets mediate the relationship between the extent of following e-business strategy and business performance

which can be analysed in the following two hypotheses:

Hypothesis 3.1 The extent of e-business adoption has a positive effect on firm's ICT assets

Hypothesis 3.2 The ICT assets have a positive effect on business performance

while our fourth hypothesis is:

Hypothesis 4 The non-ICT assets mediate the relationship between the extent of following e-business strategy and business performance

which can be analysed in the following two hypotheses:

Hypothesis 4.1 The extent of e-business adoption has a positive effect on firm's non-ICT assets

Hypothesis 4.2 The non-ICT assets have a positive effect on business performance

The next research hypotheses concern the relationships of ICT and non-ICT assets with BPR. As mentioned in the introduction, ICT are 'general purpose' technologies, which can be adapted to many different uses and functions and enable important innovations (Bresnahan and Trajtenberg 1995; Melville et al. 2007, etc.). There is considerable literature which, through a series of theoretical arguments, supports and analyses the innovative potential of ICT as catalysts and enablers of business process redesign (e.g. Brynjolfsson and Hitt 1996, 1998, 2000; Bresnahan et al. 2002; OECD 2004). In contrast, non-ICT assets are not characterised by such a high adaptability and multi-functionality, so they are not expected to enable process innovation. Therefore, a significant positive relationship between ICT assets and BPR is anticipated, while there may not be significant relationship between non-ICT assets and BPR. Thus, the last two research hypotheses are as follows:

Hypothesis 5 ICT assets have a positive and significant effect on the extent of BPR.

Hypothesis 6 Non-ICT assets do not have an effect on the extent of BPR.

4 Research design

4.1 Data

Data were collected through a survey of Greek companies, which was conducted in cooperation with ICAP SA (www.icap.gr), one of the largest business information and consulting companies of Greece. A first version of the survey instrument (questionnaire) was initially developed by the authors. It was pre-tested by three experienced in questionnaire design ICAP employees and their remarks were used to formulate the final version. The sample of the survey was randomly selected from the database of ICAP and included 304 Greek firms of all sizes (103 small, 103 medium and 98 large ones) from the 27 most important sectors of Greek economy. Two similar random samples were also created from ICAP database with the same proportions of small, medium and large firms, and also with the same proportions of firms from the above 27 sectors. The questionnaire was sent by mail to the managing directors of the firms of the first sample. One month later the recipients who had not responded were contacted by phone 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 if this was exhausted from the third sample. This replacement process allowed us to maintain a balanced sample in terms of company size and industry. Finally we received complete questionnaires from 271 companies (88 small, 105 medium and 78 large ones).

The dataset was examined for potential bias in terms of non-response. According to the relevant literature (Armstrong and Overton 1977; Chapman 1992) the best method for assessing non-response bias is to collect additional completed questionnaires from a significantly large and random sample of non-respondents and compare them with the ones provided by the respondents. However, this method is rarely feasible, so an acceptable alternative method, which according to the relevant literature gives reliable results, is to compare the means of the variables of the early respondents with those of the late respondents. If there are no statistically significant differences, then it is highly likely that non-response bias does not exist. Following this method, the questionnaires received were divided into two groups: those received within the first month (first group), and those received later (second group). The means of these two groups were then compared for all variables in order to test whether statistically significant differences existed. No significant differences were found, indicating that non-response bias did not exist.

Research hypotheses were tested by estimating the hypothesized research model shown in Fig. 1, based on the above data and using a covariance-based structural equations modelling (SEM) approach (Kline 2005) implemented through the AMOS 6 software (Byrne 2001).

4.2 Theoretical foundations

As mentioned in the Introduction the main theoretical foundation of this study, which was used as a basis for formulating our research model shown in Fig. 1, is the Contingency Theory of Organizations (outlined previously in 2.1), focused on the

contingency of following an e-business strategy and its impacts on ICT and non-ICT assets and business processes. Additionally, for the elaboration of the relations of ICT and non-ICT assets with business performance, and also for the definition of the corresponding measures, a sound theoretical foundation from the area of micro-economics has been used, the Cobb-Douglas Production Function (Nicholson and Snyder 2008), which connects the output of a firm with its inputs. It posits that firm output, measured by its value added (VA) during a given time period (=sales revenue minus expenses for buying materials and services), is an exponential function of the basic inputs it used in this period, capital (K) and labour (L), while it is also affected by the management of the firm that determines how efficiently these inputs have been used; by dividing capital into computer capital (CK) and non-computer capital (NCK) it takes the following form:

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

and if it is log-transformed, the following linear form it is obtained:

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

On dividing both sides by the number of firm employees (N), the equation denotes that the log-transformed value added per employee (labour productivity) is a linear function of the log-transformed non-computer capital (regular non-ICT assets) per employee, the log-transformed computer capital (ICT assets) per employee and also management-related factors (such as the business process redesign and adaptation and the adoption of e-business strategy in this research).

4.3 Measurement of variables

Based on the above theoretical foundation, the log-transformed value added per employee (labour productivity) was used as an objective measure of business performance. 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. For this reason it has been used as dependent variable in numerous previous empirical studies of the effect of ICT and/or organizational change on business performance (e.g. Bertschek and Kaiser 2001; Black and Lynch 2004; Arvanitis 2005; Arvanitis and Loukis 2009). For the same reasons, the log-transformed value of firms' ICT equipment (hardware, software and networks) per employee and the log-transformed value of firms' non-ICT assets per employee were used as objective measures of ICT and non-ICT assets respectively. Finally e-business activity was measured by the extent of following e-business strategy. The respective questions of the survey instrument are shown in the "Appendix".

On the contrary for the extent of BPR, since it constitutes a more abstract and multidimensional concept, it was decided to measure it by a reflective construct (a nine-item scale), which was developed through a comprehensive review of the BPR literature (Hammer 1990; Davenport and Short 1990; Hammer and Champy 1993; Davenport 1993; Grover et al. 1993; Davenport and Nohria 1994; Martinsons 1995; Gunasekaran and Nath 1997; O'Neill and Sohal 1999; Al Mashari and Zairi 2000;

Al Mashari et al. 2001; Champy 2002); the respective nine questions are shown in the “Appendix”.

The BPR construct was validated using the methods proposed by the relevant SEM literature (e.g. Gefen et al. 2000; Byrne 2001; Straub et al. 2004; Kline 2005). Construct validity, defined as the extent to which the selected items constitute a reasonable operationalization of it (Gefen et al. 2000; Straub et al. 2004), was initially assessed. Its main dimension, convergent validity, defined as the extent to which the selected items reflecting the construct “converge”, was assessed. For this purpose Confirmatory Factor Analysis (CFA) (Straub et al. 2004; Kline 2005) was used. In particular, the extent of BPR was hypothesized as a latent factor reflected by these nine items and the corresponding CFA model was estimated using the AMOS 6 software (Byrne 2001). Its goodness-of-fit indices and item loadings are shown in Tables 1 and 2 respectively. Table 1 shows that the values of all incremental fit indexes NFI, RFI, IFI, TLI and CFI exceed the recommended by the literature minimum level of 0.9 (Gefen et al. 2000; Straub et al. 2004), while the RMSEA value is slightly higher than the recommended maximum level of 0.08 (Browne and Cudeck 1993). Table 2 also shows that the item loadings are all statistically significant and exceed the minimum acceptable level of 0.6 (Chin 1998). Taking into account all the above results, it can be concluded that the construct is characterised by convergent validity and no purification is required.

The content validity of the construct, defined as the extent to which the selected items reflect in a representative manner the content universe to which the construct will be generalised (Gefen et al. 2000; Straub et al. 2004), was examined next. For this purpose two ICAP employees from the consulting department, who were experienced in BPR, were asked to assess this nine-item scale from this perspective. The positive opinion of these experts, and the fact that this scale has been developed through a comprehensive review of the relevant BPR literature, are positive indicators of the content validity of this construct.

Finally, the reliability of this BPR construct was assessed. Reliability is defined as the extent to which the selected items, taken together, constitute an error-prone operationalization of it (Straub et al. 2004). For this purpose the Cronbach Alpha coefficient, as recommended by the relevant literature (Gefen et al. 2000; Straub et al. 2004; Kline 2005), was calculated; its value was 0.914, exceeding the minimum acceptable level of 0.7, so the reliability of the construct is confirmed.

Table 1 Goodness-of-fit indices for the CFA BPR construct model

Chi-square	NFI	RFI	IFI	TLI	CFI	RMSEA
89.65	0.939	0.909	0.955	0.932	0.955	0.085

Table 2 Item loadings of the items of the BPR construct

BPR_1	BPR_2	BPR_3	BPR_4	BPR_5	BPR_6	BPR_7	BPR_8	BPR_9
0.722	0.698	0.783	0.694	0.706	0.781	0.751	0.729	0.676

5 Data analysis and results

The hypothesized research model shown in Fig. 1 was estimated through covariance-based SEM (Kline 2005), which allows both the measurement and the structural part of the model to be estimated at the same time using the AMOS 6 software (Byrne 2001). Initially, the fit of the whole model, as shown in Table 3, was assessed by examining the values of its basic fit indices; acceptable values, based on the recommendations of the relevant literature (Browne and Cudeck 1993; Gefen et al. 2000; Straub et al. 2004), were obtained for both the incremental fit indexes NFI, RFI, IFI, TLI and CFI (>0.9) and for the RMSEA (<0.08). Therefore, the model is characterised by acceptable fit to the data.

Following this, the measurement part of the model was examined. All item loadings in the BPR construct are statistically significant and exceed the minimum acceptable level of 0.6 (Chin 1998), confirming the conclusions of the previous section on the convergent validity of this construct.

Finally, we focused our attention on the structural model, which is shown in Fig. 2 (only the standardised coefficients of the statistically significant paths are presented).

We can see that the extent of following e-business strategy has a statistically significant positive effect on the extent of BPR (standardised coefficient 0.252), so Hypothesis 2.1 is supported. Similarly, positive, but statistically insignificant, effects of the adoption of e-business strategy on ICT and non-ICT assets per employee were found, so Hypotheses 3.1 and 4.1 are not supported. These results indicate that e-business strategy drives firms to take mainly the ‘soft action’ of redesigning their business processes (e.g. changing or even abolishing existing business processes and creating new ones), so that they can offer extensive, high quality and updated information online to current and prospective customers about their products and services, establish electronic communications with them, receive electronic orders and payments on a 24/7 basis, deliver products on time to geographically remote and dispersed customers, offer after-sales support electronically, etc. Results also show that on the contrary e-business strategy does not drive firms to take to a significant extent the ‘hard action’ of increasing their ICT or non-ICT assets per employee, probably preferring mainly to adapt and ‘align’ their ICT and non-ICT assets and investments to their e-business strategies (e.g. in a ‘strategic alignment’ sense (Henderson and Venkatraman 1999; Luftman 2000)), or even exploit the relevant capabilities of their existing IS (e.g. many ERP systems provide functionalities for creating an e-shop easily, and connecting it with some of their main modules that support internal functions, such as sales, inventory management, accounting, etc.).

Table 3 Model fit indices

Chi-square	NFI	RFI	IFI	TLI	CFI	RMSEA
81.22	.949	.925	.982	.973	.981	.044

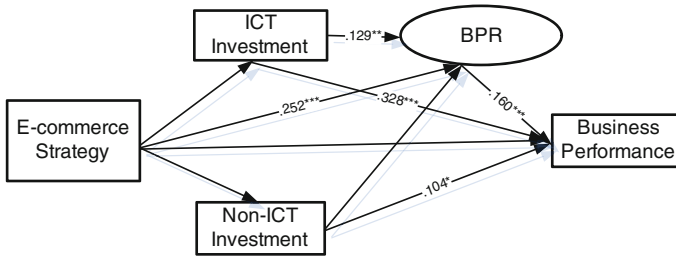


Fig. 2 The estimated structural model

In order to understand better what kind of process adaptations e-business strategy is driving the correlations of the nine BPR items (each of them measuring to what extent a particular basic BPR activity/process adaptation has been performed) were calculated with the e-business variable, and the results are shown in Table 4.

All these correlations are statistically significant, so it can be concluded that e-business strategy drives all these nine basic BPR activities/process adaptations, but to a different degree each, quantified by the magnitude of the corresponding correlation. The largest correlations of e-business strategy were with BPR_3 (Creation of new horizontal inter-departmental processes that cross more than one department—correlation 0.236) and BPR_7 (Creation of new horizontal coordination roles (process coordinators) for monitoring and coordinating the efficient and faster execution of process crossing more than one department—correlation 0.213). Both these process adaptations are associated with increasing non-hierarchical decentralised coordination of organizational units within the firm. Lower levels of correlations of e-business strategy were found with BPR_4 (Abolition of processes—correlation 0.211), BPR_2 (Improvement of processes—correlation 0.206), BPR_5 (Redesign of processes so that they become customer-focused—correlation 0.204) and BPR_1 (Simplification of processes—correlation 0.183). These four process adaptations are associated with the specific technical and operational requirements that e-business poses (the need to receive electronic orders and payments 24 h daily/7 days weekly, deliver products to geographically remote and dispersed customers in time, offer after-sales support electronically, etc. necessitates improvements/simplifications of some processes and abolition of some others). Finally the lowest (but still statistically significant) correlations of e-business strategy are with BPR_9 (Decrease of supervision and number of supervisors in some processes—correlation 0.163) and BPR_8 (Job enrichment-increase of decision making competences authorization for employees involved in some processes—correlation 0.156). Both these two process adaptations are associated with decentralization of competences to individual employees.

Table 4 Correlations of the BPR items with e-business variable

BPR_1	BPR_2	BPR_3	BPR_4	BPR_5	BPR_6	BPR_7	BPR_8	BPR_9
0.183	0.206	0.236	0.211	0.204	0.196	0.213	0.156	0.163

The above findings can be interpreted in the light of one of the main Contingency Theories of Organizations, the Organic Theory, which has been briefly described in Sect. 2.1. The adoption of e-business strategy increases the ‘unpredictable complexity’ of the tasks that the firm has to perform, since it has to serve a wider and more heterogeneous and geographically dispersed customer base, who place orders and make 24/7 payments over the Internet, and expect quick deliveries of their orders and also efficient electronic after-sales support. It is not possible to set rules for all the above, covering all possible cases that might happen, so judgemental decision making is very often necessary. Therefore e-business strategy increases ‘task uncertainty’. This results in the abovementioned two kinds of decentralization-oriented process adaptations (in addition to those necessary for responding to the specific technical and operational requirements that e-business poses, such as improvements, simplifications, redesigns increasing customer focus and abolitions of processes):

1. mainly increase of the non-hierarchical decentralised coordination of organizational units within the firm (through horizontal inter-departmental processes and horizontal coordination roles of process coordinators),
2. and to a smaller extent decentralization of competences to individual employees (more decision making competences and decrease of supervision).

Figure 2 also shows that all the three organizational characteristics investigated (ICT assets per employee, non-ICT assets per employee and BPR) have statistically significant positive effects on business performance, which is in agreement with the conclusions of the relevant literature cited in Sect. 2. Therefore Hypotheses 2.2, 3.2 and 4.2 are supported. The effect of ICT assets per employee is the highest (standardised coefficient 0.328), followed by that of BPR (standardised coefficient 0.160) and finally that of the non-ICT assets per employee (standardised coefficient 0.104). These results show that the relationship of the extent of following e-business strategy with business performance is mediated by the extent of following e-business strategy with business performance is mediated by the extent of BPR, so Hypothesis 2 is supported; In contrast, this relationship is not mediated by ICT and non-ICT assets per employee, so Hypotheses 3 and 4 are not supported. This means that e-business is a driver of business process adaptations, which in turn result in higher levels of business performance. This provides support for Hypothesis 1, since the extent of following e-business strategy does not have a significant direct effect on business performance, but has an indirect one through BPR.

Finally, concerning the relations between the three organizational characteristics investigated, ICT assets per employee have a positive significant effect on BPR (standardised coefficient 0.129), so Hypothesis 5 is supported. In contrast, non-ICT assets per employee do not have a significant effect on BPR and, therefore, Hypothesis 6 is supported. These findings are in line with the initial expectations described in Sect. 3. The above results indicate that the fundamental difference between ICT and non-ICT assets mentioned in the introduction leads to fundamental differences in their relation with BPR. In particular, since ICT assets are a ‘general purpose technology’ (Bresnahan and Trajtenberg 1995; Melville et al. 2007) with high levels of adaptability to different ways of use, it is a significant driver of BPR. In contrast, the non-ICT assets, which are not a general purpose technology and

does not have high adaptability and multi-functionality, is not a driver of BPR. From the above results it can be also concluded that the ICT assets per employee has not only a direct effect on business performance, but also an indirect one through BPR. Therefore BPR 'partially mediates' (adopting the terminology of Venkatraman (1989)) the relationship between ICT assets per employee and business performance. This conclusion is in line with the findings of two previous empirical studies that have been conducted, as mentioned in the Sect. 2.2, with regard to the mediating effect of BPR on the relationship between ICT and business performance (Grover et al. 1998; Albadvi et al. 2007).

6 Conclusions, limitations and future research

Based on the Contingency Theory of Organizations considerable research has been conducted in order to gain an understanding of the effect of various contingencies on various organizational variables and finally on performance. The empirical study described in the previous sections contributes to this body of knowledge by investigating empirically this 'old' problem for the case of the more recently emerged ICT-based strategy of e-business, and two organizational characteristics that have gradually become highly important for organizations in the last 20 years, ICT assets and business processes, and also a 'traditional' one, the non-ICT (regular) assets. For this purpose advanced quantitative techniques of structural equation modelling (SEM) have been employed, which allow the estimation of complex multi-layer models including mediator variables that are both dependent (i.e. affected by others) and independent (i.e. affecting some others) at the same time, enabling the investigation of complex networks of relationships. Initially a research model consisting of hypothesized relationships among e-business strategy, ICT assets, non-ICT assets, BPR and business performance has been developed. In order to measure the abstract and multidimensional BPR concept with high levels of reliability, a multi-item scale has been developed through an extensive review of the relevant BPR literature and then validated using the methods proposed by the SEM literature. Research hypotheses have been tested using data collected through a survey from a sample comprising 271 Greek firms from the 27 most important sectors of Greek economy, with similar representation of small, medium and large firms; these data have been used to estimate a SEM connecting the above variables.

Empirical results showed that the adoption of e-business strategy by Greek firms leads to an adaptation of their business processes (BPR). In particular, it drives process adaptations that increase the non-hierarchical decentralized coordination of firm's organizational units (through horizontal inter-departmental processes and horizontal process coordinator roles), respond to the specific technical and operational requirements that e-business poses (through improvements, simplifications, redesigns increasing customer focus and abolitions of processes) and decentralize competences to individual employees (more decision making competences and decrease of supervision). Also, positive but statistically insignificant effects of the adoption of e-business strategy by Greek firms on their ICT and non-ICT assets per employee were found. Furthermore, BPR, ICT and non-ICT assets

per employee all have positive and statistically significant effects on their financial business performance. Therefore, our results indicate that in the Greek national context the adoption of e-business strategy has positive impact on business performance mainly through the process adaptations (BPR) it drives. They highlight the importance of these 'soft actions', in comparison to the 'hard actions' of additional ICT and non-ICT investment, for the successful implementation of e-business strategy. Interesting conclusions have also been drawn concerning the relationships between the three organizational characteristics examined (ICT assets, non-ICT assets and BPR) in the Greek national context: the ICT assets per employee have a positive effect on BPR, and the relationship of the former with business performance is mediated by the latter; in contrast the non-ICT assets do not have a significant effect on BPR, indicating an important difference between these two types of assets as to their relationship with business process change.

The above conclusions cannot be indiscriminately generalised, as our study has been conducted in the national context of Greece, which is different from the ones of the highly economically and technologically developed countries, in which most of the previous empirical studies concerning the impact of e-business on performance have been conducted. Greece is a smaller country, with a lower level of economic development, ICT usage and innovation (OECD 2008, 2009, 2010a, b; Eurostat 2008). Previous research has concluded that various dimensions of the national context (e.g. economic, cultural, legal ones) can influence ICT adoption and use and also innovation (e.g. Leidner and Kayworth 2006; Ali and Brooks 2008; Kaasa and Vadi 2010). In particular, the small size of firms and internal market in Greece makes economies of scale (which are of particular importance for making decisions concerning investments in ICT and non-ICT assets) more difficult than in other bigger countries. Also, technologically Greece is characterised by lower ICT usage and investment than most European countries (e.g. see European Commission 2008), which might result in a lower correlation between e-business adoption and ICT investment. Furthermore, from a cultural viewpoint it is characterised by a disposition to uncertainty avoidance, as shown by its higher Uncertainty Avoidance Index (UAI) score in comparison with the other European countries and USA, according to the assessments of Geert Hofstede (<http://www.geert-hofstede.com/>), which might affect negatively the attitudes of firms towards BPR and ICT. For the above reasons, in order to draw more generaliseable conclusions concerning the research questions addressed in this study it is necessary to conduct similar empirical studies in other different national contexts as well and compare their findings with those presented here.

The results of this study have wider interesting implications for management. Firms following an e-business strategy should put special emphasis on making appropriate adaptations of their business processes, and also their ICT and non-ICT assets and investments to their e-business strategies. Since the adoption of e-business strategy increases task complexity and uncertainty, firms should (according to the Organic Theory) respond with process adaptations that increase decentralization in order to cope with it. Such adaptations are the establishment of non-hierarchical decentralized mechanisms for the coordination of firm's organizational units (e.g. horizontal inter-departmental processes, horizontal process

coordinator roles) and the decentralization of competences to individual employees (e.g. assignment of more decision making competences to them and a decrease in their supervision). Furthermore, firms should respond to the 'technical/operational' requirements that e-business poses with appropriate improvements, simplifications, redesigns—aimed at increasing customer focus—and even abolitions of business processes. The above process adaptations may significantly change the jobs of many employees, so increasing their competences and responsibilities, which may necessitate appropriate training and in some cases change management programmes. On the other hand, before proceeding to additional investments for new ICT or non-ICT assets, firms should learn to fully exploit the capabilities of existing ones and adapt them to the new e-business strategy. This may require extensive support from vendors or consultants. Another implication for management of this study concerns the difference between the traditional non-ICT assets (used by firms for long time) and the more recently emerged ICT assets (for which firms have much less knowledge): while the former requires limited business process adaptations, the latter, in order to maximize the benefits from it, requires significant business process adaptations. Since management is accustomed to the logic of the 'traditional' non-ICT capital, which is mainly a technological intervention, it is necessary to become aware of the new logic of the ICT capital, which is a more multidimensional and 'difficult' intervention associated with technology, processes and skills.

The findings also have interesting implications for researchers. They indicate that the existing body of knowledge related to the Contingency Theory of Organizations, which concerns the effect of various contingencies on various organizational variables (so far focusing mainly on structural ones, as mentioned in 2.1), should be enriched; new knowledge should be generated concerning the effect of both the traditional and the more recently emerged ICT-based contingencies on significant organizational variables, including both the traditional ones and the more recent ones that have gradually become highly important for organizations in the last 20 years. Furthermore, this study provides a framework for conducting such empirical investigations using the advanced quantitative techniques of multi-layer SEM, theoretically founded on the Cobb-Douglas Production Function, a sound and mature foundation from the area of microeconomics. Moreover, this study has developed (through a comprehensive review of the relevant literature) and validated a multi-item scale for measuring the abstract and multidimensional BPR concept with high levels of reliability which can be used in future empirical investigations in this domain.

A first limitation of this study, which has been mentioned and discussed above, is that it has been based on data from a single country (Greece). A second limitation is that only one business performance measure has been used, the value added per employee (labour productivity), although it is a fundamental one, as 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; also, it is supported by a sound and established theoretical foundation from the area of microeconomics (the Cobb-Douglas production function), and has been widely used in many empirical studies of the effect of ICT and organizational change on

business performance. So it would be interesting to conduct similar empirical studies using other measures of business performance as well.

Appendix: 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: Simplification of processes					
BPR_2: Improvement of processes					
BPR_3: Creation of new horizontal (inter-departmental) processes (that cross more than one departments)					
BPR_4: Abolition of processes					
BPR_5: Redesign of processes so that they become customer-focused					
BPR_6: Creation of new inter-departmental units/workgroups (e.g. customer or product-focused)					
BPR_7: 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_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 your firm follows an e-business strategy?

(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

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