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The Effects of Information and Communication Technologies on E-Business Performance: Designing a Path Analysis Framework

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Abstract

In today's fast growing digital environment, firms are keen that their strategies should take advantage of the Internet's capacity to access, organize and communicate information in fractions of cost involved before the Information and Communication Technology (ICT) revolution. Considering the vital role of strategic planning to business success, this paper proposes a path analytic framework to study the effects of ICT-driven strategies on economic performance. The theoretical framework identifies key qualitative factors for analyzing economic performance together with appropriate quantitative methods for providing useful measurements of these factors. Many of the e-business studies on gaining competitive advantage can be seen as specific instances of applying this framework-model for which this paper provides an empirical test for 202 e-firms operating in Greece. The maximum likelihood estimates of the model confirm a strong dynamic relationship between economic performance and ICT-driven strategic planning.

Keywords: ICT-driven competition, e-firm strategies, MIMIC model, Greece.

Introduction

As literature shows, business scientists have traditionally explored ways of taking advantage of existing and foreseen opportunities to translate them into specific business strategies aiming at obtaining competitive advantages. For the last twenty years or so we are witnessing such stupendous technological advances in the information and communication sphere that no human activity would allow itself to ignore. Thus, in today's increasingly expanding digital world, the ICT advances have to play a vital role in achieving efficiency (avoiding errors) and effectiveness (gaining success) of business operations. Past literature has established that business performance is positively affected by ICTs and it has concluded that the so called business/ICT alignment is both necessary and desirable. Cumps, Viaene, Dedene, and Vandenbulcke (2006) give a concise review of relevant recent literature.

The importance of strategic planning for the success of business firms has quite extensively been emphasized since the 1970s. Thus, Peter Drucker (1971) defined strategic planning as analytical thinking aiming at committing resources to business achievement. Later traditional-business researchers include Miles and Snow (1978), Porter (1980), Abell (1980), Hambrick (1983), Dess and Davis (1984), Miller and Friesen (1986), Miller (1987), Mintzberg (1988), Kim and Lim (1988), Miller (1988), McDougall and Robinson (1990), Miller and Dess (1993), Carter et al. (1994), and Kotha and Vadlamani (1995). Regarding strategy in the digital age, research is rather limited. Thus, relevant literature is almost exhausted in Miller (1991), Chang (1997), Bakos (1997 and 1998), Smith et al. (1999), Kim and Kim (2000), Kim (2000), and Kim et al. (2004). ICT/business literature including, among others, Chan et al. (1997), Luftman et al. (1999) and Benson et al. (2004), focuses on investment decisions and emphasizes the size of a superior technology installation as the main determinant of obtaining competitive advantage; however, its sustainability depends heavily on intra-firm capabilities (see among others, Clemons & Row, 1991; Kean, 1993; Tidd, Bessant, J., & Pavitt, 1997).

This paper, unlike previous work, examines e-firm strategies as ICT-driven and its arguments are positioned within the framework of a strategy-implementation process. Strategic planning has historically been implemented through business processes established within firms including the broad categories of administration, organizational structure, human resource management and intra-firm routines of "doing things" (Tidd et al., 1997). These intra-firm processes are influenced by exogenous factors, mainly the national institutional environment (Porter, 1994; Stern et al. 2000). The following figure (adapted from Georganta, 2003) shows schematically these interrelationships which intervene as a kind of implementation mechanism between strategic planning and economic performance.

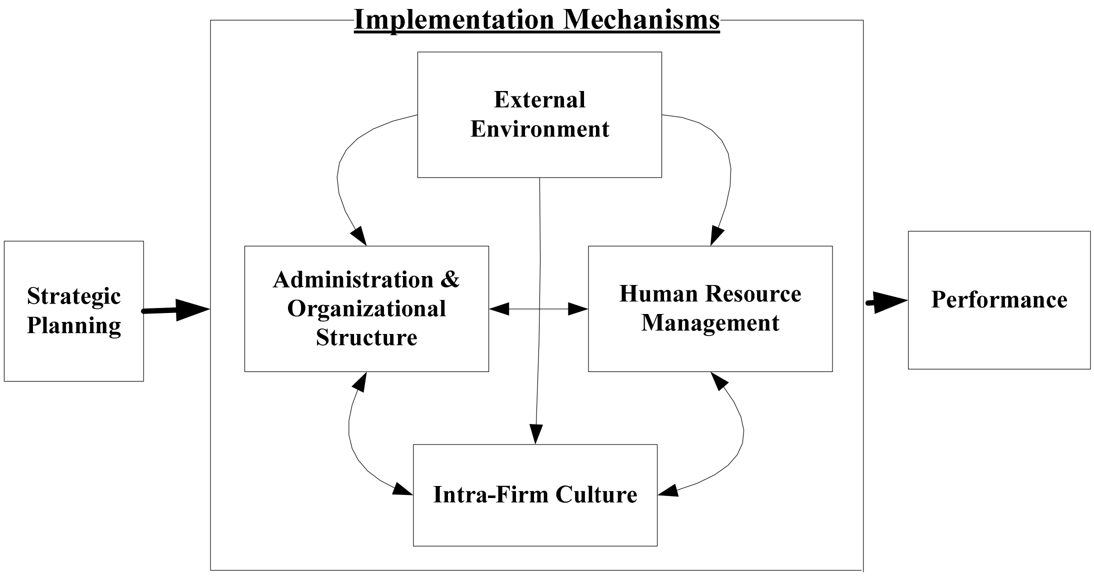

Figure 1. From Strategy Formulation to Economic Performance

If we define business success as increased turnover and profit generation, there are three main broad-spectrum approaches to successful strategic planning and implementation developed chronologically in literature: (1) The operational or rational approach – for a thorough exposition, see Nieto (2002), also Georganta (2003). (2) The competitive approach, developed by Porter (1980, 1994, 1998), and (3) the approach of dynamic capabilities, stimulated by the ideas of Nelson and Winter (1982) and developed by Teece et al. (1994, 1997).

This paper adopts the competitive approach to planning for several reasons, among which is the existence of a large volume of related past research, and also its higher susceptibility of quantification and econometric modeling in comparison with the dynamic capabilities model. The operational approach is too rigid to fit the internet economy successfully; it resembles a standardized medical therapeutic process (Tidd et al.1997):

symptoms ℘ diagnosis ℘ prescription ℘ diagnosis of therapeutic results ℘
℘ adjustment of therapy ℘ final cure

According to the competitive approach, competition in the traditional economy is determined by five competitive forces: (1) New firms entering the industry, (2) Substitutes, (3) Suppliers' power, (4) Consumers' power, and (5) Rivalry. These five forces "dictate" the adoption of one of the following three generic strategies: (1) Cost leadership, (2) Product/service differentiation, and (3) Focus on special groups of consumers/products. The five forces and the three generic strategies are interrelated, and, if properly addressed, can lead individual businesses to success: achieving a unique position in the market. Table 1 has been adapted from Porter (1980) and shows the necessary resources and capabilities required for the generic strategies to be successful.

Table 1. Capabilities Required for the Implementation of Generic Competitive Strategies

	Cost Leadership	Differentiation	Strategy Combination: Cost Focus	Strategy Combination: Differentiation Focus
Required Firm Capabilities and Implied Resources	Product design Service outline	Emphasis on labor force skills	Focus on very few characteristics	Taking advantage of a specific market opportunity
	Strict cost control	Emphasis on product/service characteristics		
	Organizational improvement	Powerful marketing		
	Learning Training	Strong coordination of the various Departments		
	Economies of scale	Strict quality control		

The competitive approach had a huge effect on business economics because it offered a theoretical foundation to the observed relationship between strategic planning and economic success (Murray 1988). Although there are more types of competitive strategies, (among others, see Chrisman, Hofer and Bolton 1988), Porter's generic strategies remain the most widely followed strategic orientations and the ones mostly researched and described in international literature (among others, see Dess, Lumpkin, & Taylor, 2004; David, 2003; Wheelen & Hunger, 2004; Thompson & Stickland, 2003, Miller & Dess, 1993, Green et al. 1993). In fact, the typology of the generic strategies has traditionally been adopted in practice by successful companies, most of which, from small and local, developed into large multinational enterprises. Such cases include Coca Cola, Unilever, Proctor and Gamble, Lenovo, Dell, Tesco, Mercedes, and Nissan.

Taking into account (a) the theory of competitive strategic planning, (b) the findings of the ICT/business alignment arguments, (c) the encouraging results from studying competition in Korea's Cyber Malls (Kim et al., 2004) and (d) Porter's (2001, p.64) statement that "…the Internet actually makes strategy more essential than ever.", this paper aspires to develop a general framework to set up future research guidelines for the study of interrelationships between ICT-driven strategies and business performance. These two phenomena constitute the two endogenously determined variables in our proposed framework-model.

To achieve its purpose, the paper develops an appropriate econometric structure to take account of the fact that the concepts of performance and ICT-driven strategy are most probably subjected to errors if we try to measure them. Thus, a general path analytic model has been utilized. More specifically, the Multiple Indicators Multiple Causes (MIMIC) approach is used. After the construction of the theoretical framework-model, its empirical validity is put to the test by fitting it to data collected by Vogiatzi (2009). This observed data base includes 202 valid responses from 6,683 e-firms operating in Greece in 2007 and 2008, and covering three types of e-business activities: B2B, B2C and e-market places. The test showed a statistically satisfactory performance of the proposed theoretical framework-model. The obtained estimates indicate a strongly significant interrelationship between ICT-driven generic strategy implementation and e-business performance.

This paper is structured in five sections. The next section discusses the theoretical structure and then it proceeds to construct its path analytic counterpart. The third section deals with the empirical exercise. The maximum likelihood estimates are discussed in the fourth section and the conclusions are presented in the final section.

Theory

Developments in ICTs have greatly increased commercial Internet. Across Europe, the percentage of e-shoppers grew by 85% between 2004 and 2009. Similar growth rates are observed in the rest of the world. Consequently, business strategy today cannot be but ICT-driven if it is to lead businesses to success. This section discusses: first, the theoretical hypotheses under investigation, and second, the Multiple Indicators Multiple Causes (MIMIC) approach to the construction of our proposed general framework of ICT-driven/business-performance model.

Hypotheses

Figure 1 shows the process through which strategy implementation leads to business performance. By introducing dynamic features and by appropriate summarization, Figure 1 can be redrafted as Figure 2.

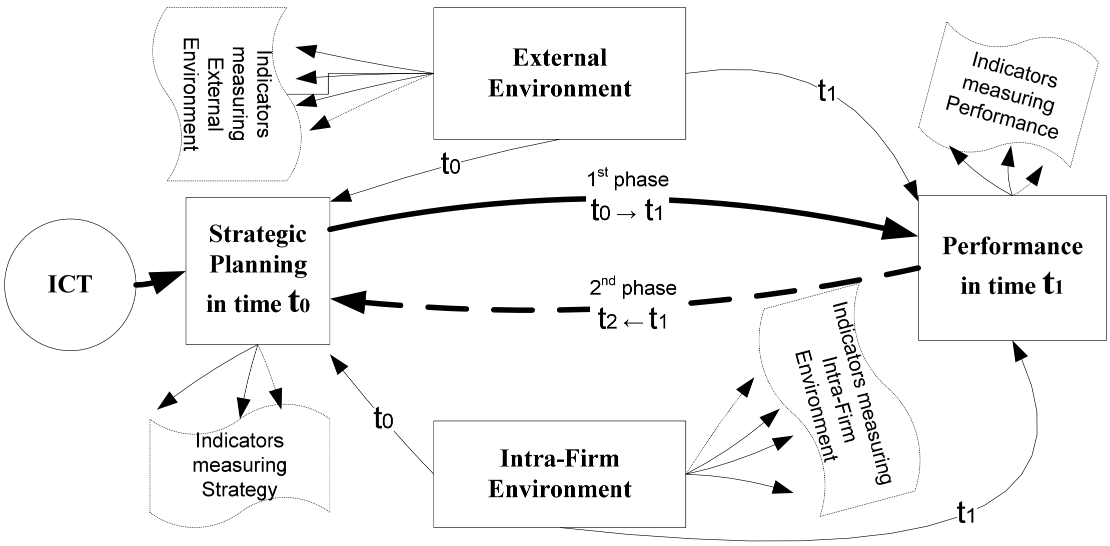

Figure 2. Introducing Dynamic Features into Figure 1

ICT's stimulate firms to pursue different business models which incorporate the three generic competitive strategies, cost leadership, product/service differentiation, and focus (Porter, 1980). In cost leadership, the firm mainly aims at becoming a low-cost producer by exploiting all sources of cost advantage. In a differentiation strategy, the firm relies more on being unique in its industry by selecting certain product/service attributes that are valued by customers. If the focus strategy is of priority to a firm, it rests on its choice of a narrow competitive scope within its industry. The focus strategy can be either cost-focus, or differentiation-focus, depending on whether the firm seeks a cost or differentiation advantage in its target segment.

Performance is measured by revenue accumulation and realized profits. In Figure 2, strategy and performance are the two endogenous variables whose interrelationships constitute a dynamic causal chain with ICT-driven strategic planning affecting economic performance in phase 1. In phase 2, performance is causing a more informed strategic planning formation for implementation in a subsequent period, bringing the whole system to another level. Figure 2 shows this dynamic specification. In other words, and as we can see in Figure 2, strategic planning is assumed to take place in period zero, t_0, during which it receives the effects of both the intra-firm and external environments. As soon as the strategy is decided upon, by the end of period zero, the implementation process starts and by the end of it we can measure the firm's performance. Let the period be t_1, during which, and by period t_2, strategy is revised in light of the achieved performance.

The intra-firm conditions as well as the external environment affect not only the formation of strategies, but the firm performance as well. Thus, in the second phase both these factors affect the strategic planning indirectly through their direct effects on firm performance. All four variables, i.e. strategy, performance, internal and external environments, are expressed by a number of indicator variables compiled on the basis of the observed data. From the discussion thus far and according to the model depicted in Figure 2, the hypotheses under examination are the following:

Hypothesis 1: There is a strong positive relationship between ICT-driven strategy and performance.
Hypothesis 2: Intra-firm environment strongly affects both strategy and performance.
Hypothesis 3: External environment strongly affects both strategy and performance.

The MIMIC Approach

The MIMIC models belong to the general class of latent-variable models (LVM). A latent variable may be defined as an unobserved variable, conceptual or “true” (without measurement error), and it may be represented by two other variables: an observable proxy or indicator variable and a measurement-error. The fundamental concepts of LVM were first introduced almost ninety years ago by the population biologist Sewell Wright (1921) at the University of Chicago, and their modern development is based on Zellner (1970) and Goldberger (1972). An early version of the LVM model was introduced and econometrically elaborated by Goldberger (1974) and Jö reskog and Goldberger (1975). Since then an important convergence in this methodology between psychometrics, socio metrics and econometrics has taken place with econometrics contributing on identification and estimation techniques within the structural errors-in-variables modeling (for example, Schennach, et al. 2007 and Lewbel, 1998). Technical overviews on LVM or SEM (Structural Equation Modeling) include Hayduk (1987), Bollen (1989), Hoyle (1995), Marcoulides and Schumacker (1996), and Cudek et al. (2001).

The application of the LVM methodology is most suitable when we study economic phenomena that we specially know that they are subjected to serious measurement errors. Of course, most of economic data are measured with error and famous econometricians, among them Goldberger (e.g. 1974), have strongly suggested the use of LVM in econometric applications. However, economists, although aware of the problem and its consequences, only recently have started “not to ignore” it (Bound et al., 2001). Especially at the micro level, where the probable smoothing-out effect of aggregation does not exist, or where polytomous variables are included, the size of the measurement error can have disastrous results if ignored or lumped together with other elements of the disturbance term (among others, see Lichtenberg & Griliches, 1989; Siegel, 1994, 97; Georganta, 2003b, 1997; Georganta & Hewitt, 2004).

The breakthrough of latent variable modeling took place with the appearance and further development of the software program LISREL (see the website www.ssicentral.com; papers by Karl G. Jö reskog, e.g. 1967, 1977, 1990; Jö reskog and Sö rbom, LISREL user’s guide, e.g. 1984). Since then, LISREL (Linear Structural Relations) has largely improved (see the relatively recent collection of research by Gudeck et al., 2001) and the relevant literature has vastly increased.

The MIMIC Model

A MIMIC model is positioned within the structural multiple-simultaneous-equation models. Let us consider the general linear form which can be described as follows: Let y, x, ξ, ε and v denote five (n x 1) vectors and let β be a scalar in the following simple bivariate linear regression model,

(1) $$y = \xi\beta + \varepsilon$$

(2) $$x = \xi + v,$$

where y and x are observable variables and ξ, ε and v are unobservable random[1] variables. The elements of ξ, ε and v are assumed to be normally i.i.d. with zero means and variances $\sigma_{\xi\xi}$, σ^2 and σ_{vv}, respectively. For the model (1)-(2) there is no way to obtain consistent estimates without additional information, which may take the form,

(3) $$\xi = W\alpha + u,$$

where W is an (n x m) matrix of observable variables, α is an (m x 1) vector of coefficients, and u is an (n x 1) vector of independent disturbances following an $N(0, \sigma_{uu}I_n)$ distribution independent of ε and v. Relation (3) may be interpreted so as the variables in W are considered to be the causes of ξ, apart from a random error term. Also, we see that the unobservable ξ depends on other exogenous variables. The model can of course be extended by the introduction of more equations.

If we consider that the latent variable ξ is represented by r indicator variables, we can replace equations (1) and (2) by the following equation,

(4) $$Z = \xi\gamma' + \Delta,$$

where Z and Δ are matrices of order (n x r) and γ is an (r x 1) vector of regression coefficients. If we assume that the variance-covariance matrix of the rows of Δ is diagonal[2], then the equations (3) and (4) constitute the MIMIC model which relates a single unobservable to a number of indicators and a number of exogenous variables.

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[1] The model (1)-(2) is a ‘structural’ (ξ is random) versus a ‘functional’ model (ξ is fixed). In fact, the term ‘structural’ has two different meanings: the first is the opposite of functional and means that the exogenous variables are considered random variables with a certain distribution. The second meaning denotes the structural form of simultaneous equation systems as opposed to the reduced form. In LVM, ‘structural’ is considered in the latter sense, although in most cases structural assumptions in the former sense are also made concerning the variables. However, for exogenous variables that are measured without error, functional assumptions may be more relevant.

[2] The diagonality of the covariance matrix of the rows of Δ means that the indicators satisfy the usual factor analysis assumption that they are correlated only via the latent variable. If we consider an unrestricted covariance matrix of the rows of Δ, we result in ideterminacy which may be solved by fixing σ^2_u at some non-negative value, e.g. zero. This means that the model is observationally equivalent to a model without an error in the cause equation.

A more general formulation of the MIMIC model, a version proposed by Robinson (1974), can be the following:

(5) $$Z = \Xi\Gamma' + \Delta + \sum_{i=1}^{m} W_i B_i$$

(6) $$\Xi = U + \sum_{j=0}^{m-1} W_j A_j$$

where Z is a matrix of indicator variables of order (n x l), Ξ is a matrix of latent exogenous variables of order (n x k), Γ is a matrix of coefficients of order (l x k), Δ and U are matrices of disturbances of order (n x l) and (n x k), respectively, each row of which is taken to be normally and independently distributed. The W's are matrices of observable exogenous variables, and the A's and B's are matrices of regression coefficients.

The model (5)-(6) accommodates causal chains between variables. The indicators Z are determined not only by the latent variables Ξ, but also by a set of exogenous variables. The latent variables in turn are determined by a set of exogenous variables, some of which may also occur in the indicator equation. This model incorporates simultaneity in the sense that the W's determine Z directly and, after a detour, via Ξ.

In fact, a MIMIC model is a special case of a simultaneous equations latent-variable model: let Z be a matrix (n x L) of observations on a vector (L x 1), where n represents the data points. We assume that Z is generated by an unobservable, but "true" or conceptuous variable set, let it be Z* of order (n x L) and a matrix U of order (n x L) which contains measurement errors. The matrix Z* is called "latent". Each row of the matrix U is independently distributed as N(0, Ω), where Ω is a matrix of order (L x L). Formally, we have,

(7) $$Z = Z^* + U$$

The latent matrix Z* is subject to R linear constraints, $R \leq L$, and

(8) $$Z^* \Gamma = 0,$$

where Γ is a matrix of coefficients to be estimated of order (L x R). It is noted that the zero restriction is only for convenience. It is apparent that for $R > 1$, equations (7) and (8) constitute a simultaneous errors-in-variables model.

Identification of a simultaneous latent variable model may not be achieved on an equation-by-equation basis. For example, if the measurement errors are correlated, or there are latent variables entering more than one equation, then identification cannot be usually achieved. If we cannot achieve identification on an equation-by-equation basis, we have to consider the structure of the whole model. In general, an identification problem may most frequently be resolved by introducing an extra indicator for an unobservable variable. This condition was discussed in Goldberger and Duncan (1973) and Goldberger (1974).

Also, an exogenous variable observed with error may be considered as an additional endogenous variable. This means that we have to expand the model by an additional equation (Hauseman, 1977). Underidentification may also be resolved by imposing overidentification through introducing appropriate restrictions. Identification of an expanded model with restrictions was studied by Wegge (1965) and Hauseman and Taylor (1983) who presented rank and order conditions for identification. It is noted that the special case of the MIMIC model can essentially be approached as an instrumental variables case (Griliches, 1986).

Using the LISREL notation, the general form of a simultaneous latent variable model includes three equations which are described as follows:

(9) $$\underset{(mx1)}{\eta} = \underset{(mxm)}{B}\,\underset{(mx1)}{\eta} + \underset{(mxn)}{\Gamma}\,\underset{(nx1)}{\xi} + \underset{(mx1)}{\zeta}$$ Structural Model

(10) $$\underset{(px1)}{y} = \underset{(pxm)}{\Lambda_y}\,\underset{(mx1)}{\eta} + \underset{(px1)}{\varepsilon}$$ Measurement Model for y

(11) $$\underset{(qx1)}{x} = \underset{(qxn)}{\Lambda_x}\,\underset{(nx1)}{\xi} + \underset{(qx1)}{\delta}$$ Measurement Model for x

where η and ξ are random vectors of latent dependent and independent variables, respectively, B and Γ are coefficient matrices, and ζ is a random vector of disturbance terms. The elements of B represent direct causal effects of η-variables on other η-variables and the elements of Γ represent direct causal effects of ξ-variables on η-variables. The vectors η and ξ are not observed, but instead vectors y and x are observed in such a way that the two measurement models (10) and (11) are valid. Λ_y and Λ_x are coefficient matrices, and ε and δ are vectors of errors of measurement in y and x, respectively.

The observed vectors y and x contain indicator variables for the unobserved or latent variables η and ξ, respectively. The latent variables correspond to theoretical constructs or variables measured correctly. For this reason, they are called "true" variables. The structural equation model (9) describes the causal relationship between the "true" or latent variables η and ξ. The measurement models (10) and (11) describe the way in which the latent variables η and ξ are measured in terms of the observed variables y and x, respectively. It is emphasized that ζ in equation (9) is a vector of classical disturbances, including all random discrepancies that emerge between the actual values of η and the values that would be obtained by the corresponding exact or, in the case of no disturbances, stable functional relationship. Such random discrepancies may be due to omitted variables from the model, or to some "intrinsic" randomness in elements of vector η which cannot be explained anyway, or to any other non-systematic influence on vector η which cannot be captured by the right-hand part of equation (9) no matter how elaborate it is. What ζ does not include is measurement errors, which are instead incorporated in the vectors ε and δ of equations (10) and (11).

For the system of equations (9)-(11) the following assumptions are made:

(a) The error terms ζ, ε, and δ have zero mean values. ζ is uncorrelated with the vectors ξ and η. ε and δ are uncorrelated with the corresponding vectors η and ξ, respectively.
(b) The matrix B has zeroes in the diagonal, and
(c) The matrix (I-B) is non-singular.

Assumptions (a) ensure that equations (9)-(11) are well specified including all the important determinants of the dependent variables. Regarding assumption (b), the elements of matrix B are assumed not to depend on themselves. Assumption (c) is required for estimation purposes, i.e. the inverse of matrix (I-B) or $(I-B)^{-1}$ must exist.

The complete specification of the system of equations (9)-(11) requires the following additional four matrices: the variance-covariance matrix of the exogenous variables ξ, Φ, the variance-covariance matrix of the vector ζ, Ψ, and the variance-covariance matrices of the elements of vectors ε an δ, Θε and Θδ respectively. The identification problem of the system of equations (9)-(11) may be expressed as the existence of a unique set of parameter values consistent with the data. A given structure, or in other words, a given set of parameter values in matrices Λ_x, Λ_y, Β, Γ, Φ, Ψ, Θε and Θδ generates one and only one variance-covariance matrix, Σ, of the observed variables z=(y', x'), which is calculated as follows:

$$(12) \qquad \underset{\{(p+q)x(p+q)\}}{\Sigma} = \begin{pmatrix} \Lambda_y \left\{ B^{-1}(\Gamma\Phi\Gamma' + \Psi)(B')^{-1} \right\} \Lambda'_y + \Theta_\varepsilon & \Lambda_y B^{-1}\Gamma\Phi\Lambda'_x \\ \Lambda_x \Phi\Gamma'(B')^{-1}\Lambda'_y & \Lambda_x\Phi\Lambda'_x + \Theta_\delta \end{pmatrix}$$

The parameters of Σ are estimated on the basis of the matrix $S_{\{(p+q)x(p+q)\}}$ of second sample moments of x and y. For the model to be identified we have to introduce restrictions on the parameters, e.g. equality of certain parameters. Given these restrictions and the structure (12), LISREL computes FIML estimates by minimizing the fit function,

$$(13) \qquad F = \log|\Sigma| + tr(S\Sigma^{-1}) - \log|S| - (p+q)$$

The identification of the parameters is checked numerically by the LISREL software. The necessary condition for identification of all parameters is that the total number of unknown parameters, let it be s, in the system is less than or equal to the number of equations, or more formally,

$$(14) \qquad s \le \frac{(p+q)(p+q+1)}{2}$$

The sufficient condition for identification requires the information matrix[3] to be positive definite. LISREL evaluates the information matrix and when it is not positive definite, this is an indication of underidentification.

Evaluation of the system of equations (9)-(11) is obtained on the basis of four criteria: standard errors, multiple determination coefficients, multiple correlation coefficients and the chi-square distribution. The chi-square is equal to n-1 times the minimum value of the ML fit function. If the model is good and the sample size large, the chi-square coincides with the

[3] The information matrix is defined as the inverse of the covariance matrix of the maximum likelihood estimators, multiplied by the number of observations.

likelihood ratio test. It is noted that the chi-square is a good test only when the distribution of the observed variables is multivariate normal and the sample size is large. Other measures for the overall fit of a LISREL model include the goodness of fit index, GFI, the Adjusted GFI, AGFI, and the root mean square error, RMR (for a full list, see the manual of LISREL 8.8).

The Proposed Framework-Model

"Performance" and "Strategy" are the two endogenous latent variables. Each endogenous variable is directly represented and linked to n indicator variables and the corresponding measurement errors. There are two exogenously determined latent variables, the intra-firm and external business environments. Both exogenous variables affect both the endogenous variables and, like them, they are represented and linked to indicator variables and corresponding measurement errors.

Thus, the structural model (9) can be written as:

$$\underset{(2x1)}{\eta} = \underset{(2x2)}{B}\ \underset{(2x1)}{\eta} + \underset{(2x2)}{\Gamma}\ \underset{(2x1)}{\xi} + \underset{(2x1)}{\zeta} \qquad (15)$$

The vector η includes the two endogenous variables, performance and strategy, and the vector ξ includes the two exogenous variables, intra-firm and external environments. Matrices B and Γ include the structural coefficients and express the endogenous latent variables as linear combinations of the other latent variables.

In particular, matrix B shows the direct causal effects of the η variables on all other η variables, and matrix Γ shows the direct causal effects of variables ξ on η. Vector ζ is the random disturbance term . Thus, equation (15) includes all the direct effects of latent variables on all the other latent variables.

The measurement models (10) and (11) can be written as follows:

$$\underset{(px1)}{y} = \underset{(px2)}{\Lambda}\ \underset{(px1)}{\eta} + \underset{(px1)}{\varepsilon} \qquad (16)$$

$$\underset{(qx1)}{x} = \underset{(qx2)}{M}\ \underset{(2x1)}{\xi} + \underset{(qx1)}{\delta} \qquad (17)$$

The following Figure 3 presents model (15)-(17) as a path diagram. This model is the proposed general framework-model depicting the interrelationships among and between all variables. Thus, ICT-driven strategies and performance may exhibit a mutual interrelationship according to Figure 2 depending on the empirical cases examined. Similarly, i.e. depending on the particular empirical conditions, the exogenous variables, Intra-firm and external environments may affect both the endogenous variables. The arrows represent econometrically evaluated quantitative effects, direct and/or indirect.

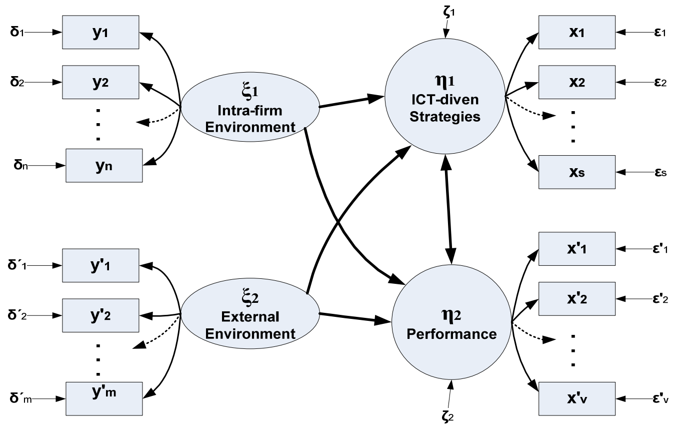

Figure 3. The Framework-Model of ICT-Driven Strategies/Performance: A Path Analytic Form

Methodology

The Empirical Model – Data Description

Following the general theoretical framework of Figure 3, the model for the empirical exercise of e-businesses operating in Greece in the year 2007 is presented in Figure 4. It is noted that the effects of endogenous variables on other endogenous variables are symbolized by β, the effects of exogenous variables on endogenous variables are symbolized by γ, the strength of the indicator variables as approximations of the endogenous variables are symbolized by λ, and the strength of the indicator variables as approximations of the exogenous variables are symbolized by μ.

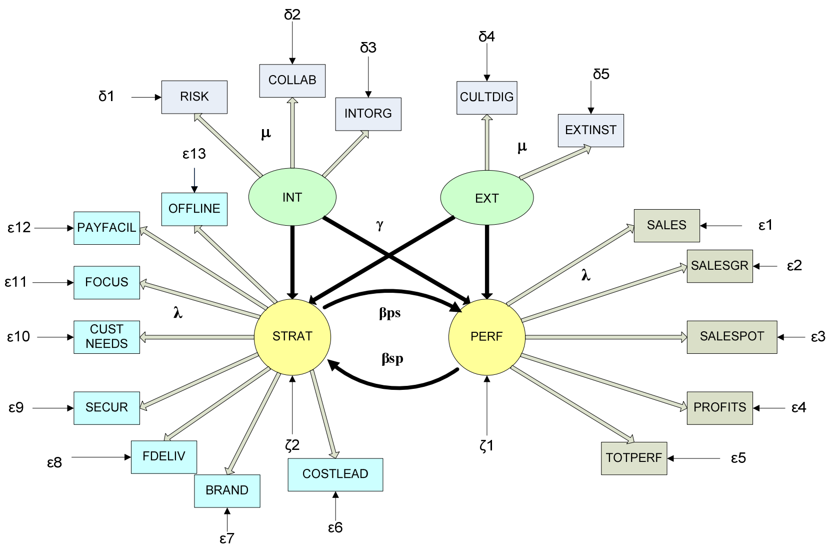

Figure 4. The Path Diagram of the Empirical Model

Table 2 presents the indicators for our endogenous and exogenous variables.

Table 2. Indicator Variables

	Notation	Description
Strategies (STRAT)		ICT-driven competitive strategies
Cost leadership	COSTLEAD	Low cost/Low price
		Brand development
Differentiation	BRAND	Sale of a brand product/service
	FDELIV	Immediate delivery of product/service
	CUSTNEED	Satisfaction of customer needs
	SECUR	Security of exchange
	PAYFACIL	Payment facilities
Focus	FOCUS	Focus on special groups of consumers/products/services
Performance (PERF)		
	SALES	Revenue from sales
	SALESGR	Growth of sales
	SALESPOT	Potential sales
	PROFITS	Profits
	TOTPERF	Index of total performance
	OFFLINE	Probable off-line activity
External Environment (EXT)		
	EXTINST	National institutional arrangements
	CULTDIG	Attitude towards Internet transactions
Intra-firm Environment (INT)		
	COLLAB	Cooperative culture
	INTORG	Type of organizational structure
	RISK	Predisposition to reasonable risk

The data come from a questionnaire survey which was the result of a pilot research and 50 semi-structured interviews. The questionnaire survey was materialized during 2007-2008. The delineation of the statistical population was based on the following four electronic catalogues: (1) europe.bloombiz.com which is a European catalogue of B2B electronic businesses. In 2008 this catalogue included 1134 e-businesses operating in Greece. (2) tradekey.com which is an international catalogue with 2,500,000 registered e-businesses. (3) dir.forthnet.gr with 4,749 B2C e-businesses operating in Greece. (4) The catalogue scroutz with 250 e-businesses operating in Greece.

In total, the statistical population included 6,683 e-businesses: 1,134 from bloombiz, 550 (those found with a purchase basket) from tradekey, 4,749 from forthnet and 250 (those found with a purchase basket) from scroutz. We sent an email to all 6,683 e-businesses explaining the purpose of our project and asking them whether they would participate. We received 2,500 responses, or 37% of the total. We finally obtained 202 valid answers.

Statistical Analysis

The necessary condition for the model's identification is (p+q)(p+q+1)/2(=153) > s (total parameters to be estimated). In its full form, the empirical model includes 200 free parameters to be estimated: 24 coefficients of matrices Β, Γ, Λ, Μ, 18 variances of the error terms, 152 covariances of the error terms, 3 variances-covariances of ζ, and 3 variances-covariances of the exogenous latent variables. Consequently, we had to impose restrictions on the parameters. The structural model is the following:

$$\begin{aligned} &\text{STRAT*} = \beta_{ps}\text{PERF*} + \gamma_{ins}\text{INT*} + \gamma_{exs}\text{EXT*} + \zeta_1 \\ (18)\quad &\text{PERF*} = \beta_{sp}\text{STRAT*} + \gamma_{exp}\text{EXT*} + \gamma_{inp}\text{INT*} + \zeta_2 \end{aligned}$$

The star denotes a latent variable. It is noted that all latent variables are approximated by corresponding indicator variables. The coefficients γ in model (18) include more detailed ones according to the number of corresponding indicator variables. These more detailed coefficients appear in Table 3 which presents the maximum likelihood estimates of the model in Figure 4.

Discussion

Table 3 presents six estimated versions of our model. All parameter estimates are statistically significant at the 5% level. There is a strong positive interrelationship between ICT-driven strategy and performance for model versions 1 and 4. The rest four versions of the model show a one-way strong effect of strategy on performance. These effects express the influence of four strong ICT-driven strategies: cost leadership, λ_c, fast delivery of products/services, λ_d, satisfaction of customer needs, λ_{cn}, and focus on special groups of customers and/or products/services, λ_f.

Table 3. Estimates of the Empirical Model, Part I. (Numbers in parentheses are t-values at 5%)

Parameter	Effects of	Estimate Model 1	Estimate Model 2	Estimate Model 3	Estimate Model 4	Estimate Model 5	Estimate Model 6
β_{sp}	STRAT on PERF	0.6284 (2.64)	0.9930 (15.65)	1.0575 (15.28)	0.1290 (4.54)	1.0410 (15.19)	0.9137 (11.66)
β_{ps}	PERF on STRAT	1.0867 (12.46)			0.4942 (10.26)		
γ_{cs}	COLLAB on STRAT				0.5355 (9.66)	0.7660 (10.14)	0.8765 (13.10)
γ_{rp}	RISK on PERF				0.8891 (17.07)		
γ_{is}	EXTINST on STRAT		-0.4544 (-14.43)	-0.4512 (-14.75)		-0.1467 (-3.94)	
γ_{ip}	EXTINST on PERF	-0.2358 (-1.16)		0.0301 (1.11)		0.0223 (0.84)	
γ_{os}	INTORG on STRAT	0.0194 (0.90)	0.0900 (1.30)	0.0543 (0.79)			
γ_{dp}	CULTDIG on PERF						0.1136 (2.85)
	Indicators of STRAT						
λ_{c}	COSTLEAD	0.7376 (16.03)	0.7578 (17.03)		0.7824 (16.99)		0.7666 (16.67)
λ_{d}	FDELIV			0.9760 (21.07)		0.9702 (21.11)	
λ_{cn}	CUSTNEED			1.0983 (21.07)		1.1034 (21.77)	
λ_{f}	FOCUS		0.7296 (18.73)		0.7034 (16.22)		0.7218 (17.39)
	Indicators of PERF						
λ_{p}	PROFITS	0.8703 (13.37)	0.8631 (16.20)	0.8593 (17.44)	0.7060 (14.83)	0.8653 (17.26)	0.8575 (13.19)
λ_{t}	TOTPERF	0.8770 (13.75)	0.8814 (17.32)	0.8580 (18.03)	0.7454 (17.44)	0.8618 (17.72)	0.8609 (13.52)
	Indicators of INT and EXT						
μ_{r}	RISK				1.0279 (20.05)		
μ_{in}	EXTINST	1.7146 (20.05)					
μ_{cd}	CULTDIG						0.7630 (20.05)
μ_{c}	COLLAB				0.8583 (20.05)		0.8583 (20.05)
μ_{io}	INTORG	0.6705 (20.05)					

Table 3. ML Estimates of the Empirical Model, Part II

Parameter	Estimate Model 1	Estimate Model 2	Estimate Model 3	Estimate Model 4	Estimate Model 5	Estimate Model 6
$\sigma^2_{\varepsilon_{COSTLEAD}}$	0.2456 (8.58)	0.2160 (8.75)		0.1780 (8.04)		0.2025 (8.47)
$\sigma^2_{\varepsilon_{FDELIV}}$			0.2218 (8.56)		0.2332 (8.70)	
$\sigma^2_{\varepsilon_{CUSTNEED}}$			0.2809 (8.56)	0.0453 (4.83)	0.2697 (8.52)	
$\sigma^2_{\varepsilon_{FOCUS}}$		0.1385 (8.13)		0.1760 (8.44)		0.1498 (8.15)
$\sigma^2_{\varepsilon_{PROFITS}}$	0.1791 (7.59)	0.1922 (8.14)	0.1986 (8.69)	0.4386 (10.02)	0.1883 (8.55)	0.1766 (7.78)
$\sigma^2_{\varepsilon_{TOTPERF}}$	0.1344 (6.65)	0.1270 (6.88)	0.1677 (8.36)	0.3482 (9.99)	0.1612 (8.24)	0.1373 (6.99)
$R^2_{COSTLEAD}$	0.6890	0.7266		0.7747		0.7424
R^2_{FDELIV}			0.8111		0.8014	
$R^2_{CUSTNEEDS}$			0.8111		0.8186	
R^2_{FOCUS}		0.7935		0.7376		0.7809
$R^2_{PROFITS}$	0.7808	0.7949	0.7880	0.5319	0.7990	0.7181
$R^2_{TOTPERF}$	0.8512	0.8594	0.8144	0.6147	0.8216	0.7718
GFI	0.8996	0.8919	0.9005	0.7115	0.8673	0.7391

On the other hand, performance is influenced positively by increased profits, indicated by the coefficient λ_p , as well as by the indicator TOTPERF, which has been constructed as a weighted average of realized sales and potential sales. This effect is positive and significant. It is symbolized by λ_t. The effects of the intra-firm and external environments on strategy and performance are given by the coefficients γ. They are all significant at the 5% level apart from the effects γ_{ip} and γ_{os}, which are not significant. Thus, strategy is affected positively and significantly by prevailing collaborative cultural features, γ_{cs}, and negatively by national institutional arrangements, γ_{is}, which means that Greece's institutional framework (laws and procedures) need modernization. Also, performance is positively influenced by reasonably risky entrepreneurial attitudes and a positive stance towards Internet. The coefficients μ are all statistically significant which means that the selected indicators for the exogenous variables are satisfactory approximations.

All six versions of the estimated model have a satisfactory fit as we can see on the second part of Table 3: the estimates of variances, the coefficients of determination and the index GFI all are statistically satisfactory.

Conclusions

This paper has constructed a general framework-model to explain the interrelationships between the ICT-driven competitive strategies and business performance by following the competitive approach and a path analytic model. By using a set of valid information from 202 e-businesses operating in Greece during 2007-2008, we have put to the test Porter's generic strategies. The maximum likelihood estimates of the model have shown the following:

1. There is a positive interrelationship between strategy and performance in the Internet economy. This confirms our hypothesis 1.
2. Intra-firm environment as expressed by: (1) collaborative attitude has a significant positive effect on strategy, and (2) logical risk undertaking has a significant positive effect on performance. These findings confirm our hypothesis 2.
3. External environment as expressed by: (1) the national institutional framework has a significant negative effect on strategy, and (2) the customers' favorable attitude towards the use of Internet has a significant positive effect on performance. These findings confirm our hypothesis 3.

This paper is a contribution to literature regarding the interrelationships between competitive strategic planning and economic performance in the digital age. It is useful in providing a general framework of analysis for policy purposes. For example, taking into consideration Katos (2009), the findings of this paper can be used to improve Greece's global competitiveness by improving the national institutional framework regarding e-business entrepreneurship. Another example could be the promotion of collaboration in work by designing appropriate policies in the secondary and tertiary online education along the lines proposed by Blumenthal (2009).

Further research is of course needed. As Porter (2001, p.64, 66) said, "The key question is not whether to deploy Internet technology – companies have no choice if they want to stay competitive – but how to deploy it." And, "The great paradox of the Internet is that its very benefits – making information widely available; reducing the difficulty of purchasing, marketing, and distribution; allowing buyers and sellers to find and transact business with one another more easily – also make it more difficult for companies to capture those benefits as profits."

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