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Electronic business adoption by European firms: a cross-country assessment of the facilitators and inhibitors

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Abstract

In this study, we developed a conceptual model for studying the adoption of electronic business (e-business or EB) at the firm level, incorporating six adoption facilitators and inhibitors, based on the technology–organization–environment theoretical framework. Survey data from 3100 businesses and 7500 consumers in eight European countries were used to test the proposed adoption model. We conducted confirmatory factor analysis to assess the reliability and validity of constructs. To examine whether adoption patterns differ across different e-business environments, we divided the full sample into high EB-intensity and low EB-intensity countries. After controlling for variations of industry and country effects, the fitted logit models demonstrated four findings: (1) *Technology competence*, *firm scope and size*, *consumer readiness*, and *competitive pressure* are significant adoption drivers, while *lack of trading partner readiness* is a significant adoption inhibitor. (2) As EB-intensity increases, two environmental factors – consumer readiness and lack of trading partner readiness – become less important, while competitive pressure remains significant. (3) In high EB-intensity countries, e-business is no longer a phenomenon dominated by large firms; as more and more firms engage in e-business, network effect works to the advantage of small firms. (4) Firms are more cautious in adopting e-business in high EB-intensity countries – it seems to suggest that the more informed firms are less aggressive in adopting e-business, a somehow surprising result. Explanations and implications are offered.

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Introduction

Europe's online business and consumer trade is predicted to reach 1.6 trillion by 2004 (Forrester Research, 1999). This estimated growth is accompanied by the increasing adoption of electronic business (e-business or EB) – business activities conducted over the Internet – by European companies. Another survey shows that about 90% of European firms expect to use e-business in sales and marketing and 83% in procurement by 2004 (Anderson Consulting, 1999). Yet, companies face a series of obstacles in adopting e-business, particularly their ability to transcend significant technical, managerial, and cultural issues (IBM, 2001). Hence, understanding the drivers and barriers of e-business adoption becomes increasingly important (Zhu & Kraemer, 2002). However, such issues have

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not been well studied in the academic literature. Especially, what is missing from the existing literature are: (1) a theoretical framework specific to e-business adoption, (2) the conceptualization and measurement of factors affecting e-business adoption, and (3) empirical assessment based on large sample data (Zhu *et al*., 2002). Our study seeks to reduce these gaps. The objective of this study is to identify factors affecting e-business adoption, and to test those factors using data from a large sample survey. Key research questions that motivate our work are: (1) What framework can be used as a theoretical basis for studying e-business adoption? (2) What facilitators and inhibitors can be identified within the theoretical framework? (3) How would the adoption patterns change across different national environments?

To better understand these issues, we developed a conceptual model for e-business adoption based on the technology–organization–environment framework from the technology innovation and information systems (IS) literature (Tornatzky & Fleischer, 1990). Six adoption predictors were identified and six corresponding hypotheses were developed. Then, we tested them using survey data from 3100 businesses and 7500 consumers in eight European countries. Data analysis identified significant adoption facilitators and inhibitors in general, but demonstrated differing adoption behaviors across different e-business environments.

The following section reviews the relevant literature, on which the technology–organization–environment framework was developed. Within this framework, a conceptual model and associated research hypotheses are then presented, followed by research method, analysis, and results. The paper concludes with a discussion of research findings, limitations, and contributions from both research and managerial perspectives.

Theoretical background: the technology–organization–environment framework

To study adoption of general technological innovations, Tornatzky & Fleischer (1990) developed the *technology–organization–environment* (TOE) framework, which identified three aspects of a firm's context that influence the process by which it adopts and implements technological innovations: technological context, organizational context, and environmental context. *Technological context* describes both the internal and external technologies relevant to the firm. This includes existing technologies inside the firm, as well as the pool of available technologies in the market. *Organizational context* is typically defined in terms of several descriptive measures: firm size and scope; the centralization, formalization, and complexity of its managerial structure; the quality of its human resource; and the amount of slack resources available internally. *Environment context* is the arena in which a firm conducts its business – its industry, competitors, access to resources supplied by others, and dealings with government (Tornatzky & Fleischer, 1990, pp 152–154).

The TOE framework is consistent with Rogers' (1983) theory of innovation diffusion in organizations. Rogers identified three groups of adoption predictors: *leader characteristics* (leader's attitude toward change), *internal characteristics of the organization* (centralization, complexity, formalization, interconnectedness, organizational slack, and size), and *external characteristics of the organization* (system openness). In addition, he emphasized the impact of *technological characteristics* (innovation attributes) on potential adopters. Since leader characteristics can be viewed as specific internal organization properties, Rogers' theoretical analysis (technological characteristics, internal and external characteristics of the organization) is consistent with the TOE framework.

As a generic theory of technology diffusion, the TOE framework can be used for studying the adoption of IS innovations. However, IS innovations can be of various types – some only support technical tasks; some others are deployed in a strategic way and may affect the overall organization. Swanson (1994) classified IS innovations into three types: Type I innovations are confined to the technical tasks; Type II innovations support business administration; and Type III innovations are embedded in the core of the business. According to this typology, e-business should be deemed as a Type III innovation, in the sense that e-business is often embedded in a firm's core business processes – (e.g., making use of the open standard of the Internet protocol to streamline information sharing among various functional departments); e-business can extend basic business products and services (e.g., leveraging Internet-enabled two-way connectivity to offer real-time customer service); and e-business can streamline the integration with suppliers and customers (e.g., using XML-based communication to increase the ability of exchanging invoice and payment documents online between companies).

Swanson (1994) further examined the adoption contexts of the TOE framework for each innovation type, and contended that it is typical of Type III innovators to have facilitating technology portfolio, certain organizational attributes such as diversity and sufficient slack resources, and great concerns on the strategic environment. This theoretical argument can be extended to the Internet domain: e-business is being enabled by technology development (Kauffman & Walden, 2001), requires organizational enablers and entails necessary business and organization reconfiguration (Chatterjee *et al.*, 2002), and may shape (and be shaped by) the industry environments (Kauffman & Walden, 2001; Kowtha & Choon, 2001). Thus, upon theoretically examining adoption contexts, IS innovation types, and e-business features, we believe that the three contexts in the TOE framework are well suited for studying e-business adoption. The rest of this section reviews empirical support from the IS literature for this theoretical framework.

The TOE framework has been examined by a number of empirical studies on various IS domains. In particular, the adoption of Electronic Data Interchange (EDI), an antecedent of e-business, has been studied extensively in the last decade. An examination of this literature by Iacovou *et al*. (1995) reveals many factors that were demonstrated as significant adoption facilitators and inhibitors in previous studies. Following Tornatzky & Fleischer (1990), Iacovou *et al*. developed a model formulating three aspects of EDI adoption – *technological* factor, *organizational* factor, and *environmental* factor as the main reasons for EDI adoption, and examined the model by seven case studies. Their model was further tested by other researchers using large samples. For example, Kuan & Chau (2001) developed a perception-based TOE framework incorporating six factors (direct benefits, indirect benefits, cost, technical competence, industry pressure, and government pressure) as EDI adoption predictors, which was empirically evaluated using data collected from 575 Hong Kong firms. Their study 'confirms the usefulness of the technology-organization–environment framework for studying adoption of technological innovations' (Kuan & Chau, 2001). Studies on other IS domains also provided empirical support for this theoretical framework. For example, Thong (1999) studied IS adoption in small businesses. Data from 166 Singaporean businesses demonstrated significant relationships of IS adoption with technological and organizational characteristics. Although the insignificant association between environmental characteristics and IS adoption called for further examination, Thong (1999) claimed that, 'in general, the results provide support for the model,' and 'future research can build on and extend the proposed integrated model.' Another application is the exploratory study on open system adoption by Chau & Tam (1997). They adopted this framework and developed an adoption model for open systems. In-depth interviews with senior executives responsible for managing corporate IS functions from 89 organizations were conducted. Their analysis demonstrated the value of using the TOE framework to understand the adoption of a complex IS innovation; furthermore, Chau and Tam argued that 'one future line of research is to extend the proposed [TOE] framework to other innovation domains.'

Table 1 summarizes relevant studies that were based on the TOE framework. Although specific factors identified within the three contexts may vary across different studies, the TOE framework has consistent empirical support. Drawing upon these empirical evidences combined with literature review and theoretical perspectives discussed earlier, we believe that the TOE framework is appropriate for studying e-business adoption, because e-business is enabled by technological development of the Internet, driven by organizational factors such as firm scope and size, and influenced by environmental factors related to consumers, business partners, as well as competitors (Zhu et al., 2002). Hence, we adopted this theoretical framework and extended it to the e-business domain, which has not been done in the literature. The next section discusses the conceptualization and operationalization of this e-business adoption model.

Conceptual model and hypotheses

Based on the TOE framework discussed above, we proposed a conceptual model for e-business adoption, as illustrated in Figure 1. This conceptual model posited six adoption predictors for e-business adoption within the TOE framework, and controlled for country and industry effects.

The dependent variable in the conceptual model is the *intent to adopt e-business*. According to ECaTT (2000), e-business refers to 'the electronic preprocessing, performance, and postprocessing of business transactions between commercial subjects over the Internet.' By this definition, e-business facilitates major business processes along the value chain. This leads to the common constituents of e-business – Web marketing, online selling, online procurement, as well as service and support. A firm is deemed as having intent to adopt e-business if it plans to implement such e-business constituents within 2 years.

Technological context

On the basis of a thorough literature review, Kwon & Zmud (1987) asserted the importance of the *internal technology resource* (infrastructure, technical skills, developer, and user time) for successful IS adoption. Their theoretical assertions were supported by a number of empirical studies (for example, Cragg & King, 1993; Grover, 1993; Crook & Kumar, 1998; Kuan & Chau, 2001). Consistent with the literature, *technology competence* was conceptualized in our study to be a second-order construct, capturing three sub-constructs – IT infrastructure, Internet skills, and e-business know-how.

In our study, *IT infrastructure* refers to technologies that enable Internet-related businesses; *Internet skills* are defined as employees' skills of using the Intern*et a*nd related technologies; and *e-business know-how* refers to executives' knowledge of managing e-business (e.g., online selling and procurement). By these definitions, technology competence constitutes not only physical assets, but also intangible resources, which are more likely to generate competitive advantages for innovators since skills and know-how are complementary to physical assets (Mata *et al*., 1995; Helfat, 1997), and are more difficult to imitate by competitors (Teece, 1980; Powell & Dent-Micallef, 1997). IT infrastructure provides a platform on which e-business can be built; Internet skills provide the technical skills to develop e-business applications; and e-business know-how provides the business and managerial skill to use e-business effectively (Zhu & Kraemer, 2002). Therefore, one would expect that firms with higher levels of technology competence would be more likely to adopt e-business. This leads to the following hypothesis:

> **H1**: *Firms with higher levels of technology competence are more likely to adopt e-business.*

Organizational context

The adoption literature proposed that scope and size are important organizational factors for technology adoption

Table 1 Previous studies using the *TOE* framework

Study	*Model*	*Theoretical framework*		
		Technology	*Organization*	*Environment*
Iacovou et al. (1995), EDI adoption	Technological context (perceived benefits)	✓		✓
	Organizational context (organizational readiness)		✓	
	Interorganizational context (external pressure)			✓
Kuan & Chau (2001), EDI adoption	Technological context (perceived direct benefits)	✓		
	Organizational context (perceived financial cost, perceived technical competence)	✓	✓	
	Environmental context (perceived industry pressure, perceived government pressure)			✓
Thong (1999), IS adoption	CEO characteristics (CEO's innovativeness and IS knowledge)		✓	
	IS characteristics (relative advantage/compatibility, complexity)	✓		
	Organizational characteristics (business size, employee's IS knowledge)		✓	
	Environmental characteristics			✓
Chau & Tam (1997), open system adoption	Characteristics of the innovation (perceived barriers, perceived importance of compliance)	✓		
	Organization (satisfaction with existing systems)		✓	
	External environment			✓
Premkumar & Ramamurthy (1995), EDI adoption	Organizational factor (internal need, top management support)	✓	✓	
	Interorganizational factor (competitive pressure, exercised power)			✓
Cooper & Zmud (1990), MRP adoption	User		✓	
	Organization		✓	
	Task (compatibility)	✓		
	Technology (technology complexity)	✓		
	Environment			✓

Note: Check marks indicate the intersection of the theoretical framework with previous studies. Only factors that were statistically significant are listed in this table.

(Rogers, 1983; Tornatzky & Fleischer, 1990). This was also confirmed in the IS literature. For example, Dewan *et al*. (1998) and Hitt (1999) found that the greater the scope, the greater the demand for IT investment. Brynjolfsson *et al*. (1994) found that firm size is strongly associated with IT investment.

Firm scope

Firm scope is defined as the horizontal extent of a firm's operations. The role of scope as an adoption predictor can be explained from three perspectives. First, *internal coordination costs* increase with business scope due to the increased administrative complexity and information processing (Gurbaxani & Whang, 1991), while business digitalization can help reduce internal coordination costs (Shapiro & Varian, 1999). Second, although the general relationship between scope and *external coordination costs* is ambiguous, *search costs* and *inventory holding costs* (two elements of external coordination costs) increase with firm scope (Gurbaxani & Whang, 1991). For example,

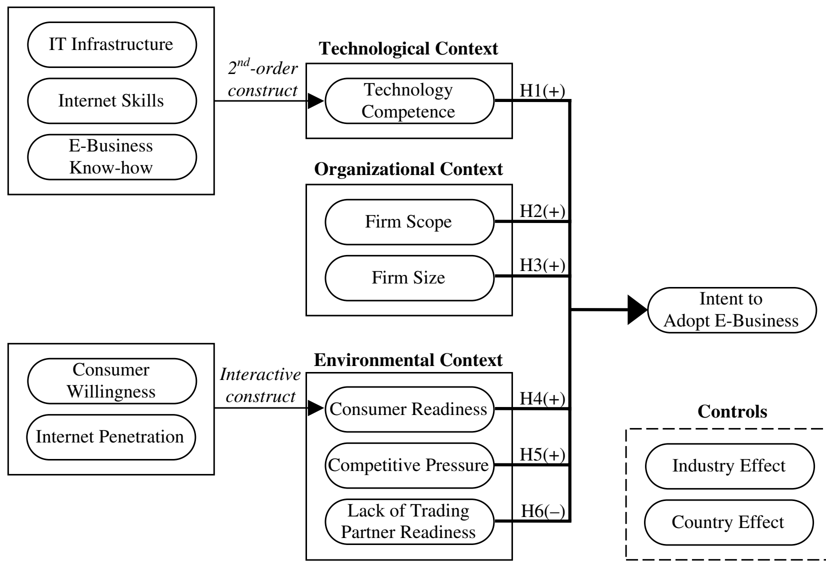

Figure 1 Conceptual model for e-business adoption.

firms operating in different geographic regions need to locate the target markets and form channels in every region, resulting in higher search costs (search of consumers, trading partners, and distributors), especially when firms expand globally into heterogeneous market segments. Firms conducting business in more than one market segment have to control demand uncertainty in every segment simultaneously, which causes higher inventory holding costs (Chopra & Meindl, 2001). Since the use of e-business can reduce search costs for both *sellers* and *buyers* (Bakos, 1998), achieve demand aggregation, and improve inventory management (Chopra & Meindl, 2001), firms with greater scopes are more motivated to adopt e-business. Third, synergy of e-business with traditional businesses is another important consideration (Steinfield *et al.*, 2002). Firms with greater scopes have more potential to benefit from synergy. The connectivity and open-standard data exchange of the Internet may help remove incompatibility of traditional legacy information systems. Typical examples are using Web-based search to help consumers locate physical stores, establishing more diversified customer community, using Web-based, graphical interfaces to improve the user-friendliness of ERP systems, and linking various legacy databases by common Internet protocols and open standards. These perspectives lead to the following hypothesis:

H2: *Firms with greater scope are more likely to adopt e-business.*

Firm size

Firm size has been consistently recognized as a factor influencing technology adoption in the existing literature (e.g., Aiken & Hage, 1971; Damanpour, 1992). For example, the proportion of EDI adoption is about 95% in Fortune 1000 firms, and only 2% in small companies (Densmore, 1998). With regard to e-business adoption, larger firms have several advantages over small firms. Large firms (1) tend to have more slack resources to facilitate adoption, (2) are more likely to achieve economies of scale, an important concern due to the substantial investment required for e-business projects, (3) are more capable of bearing the high risk associated with early stage investment in e-business, and (4) possess more power to urge trading partners to adopt technology with network externalities. Therefore, it is reasonable to hypothesize:

H3: *Larger firms are more likely to adopt e-business.*

Environmental context

Consumer readiness

Consumer readiness is an important factor for decision makers of e-business adoption because it reflects the potential market volume, and thereby determines the extent to which innovations can be translated into profits. This study defined consumer readiness as a combination of *consumer willingness* and *Internet penetration*. Consumer willingness reflects the extent to which consumers engage in online shopping; Internet penetration measures the diffusion of PCs and the Internet in the population. Therefore, the combination of the two factors represents consumers' readiness for online purchasing. This readiness may encourage firms to adopt e-business.

H4: *Firms facing higher levels of consumer readiness are more likely to adopt e-business.*

Competitive pressure

Competitive pressure has long been recognized as an adoption driver in the innovation adoption literature (e.g., Grover, 1993; Iacovou *et al.*, 1995; Premkumar *et al.*, 1997; Crook & Kumar, 1998). Porter and Millar (1985) analyzed the strategic rationale underlying competitive pressure as an IS adoption driver. They suggested that, by adopting IS, firms might be able to alter rules of competition, affect the industry structure, and leverage new ways to outperform rivals, thus changing the competitive environment. This analysis of the relationship between competitive pressure and IS adoption can be extended to the e-business domain. As documented in the existing literature, e-business may induce changes of industry structure such as disintermediation and reintermediation (Bailey & Bakos, 1997), offer new means of competing and alter competition rules through lock in (Shapiro & Varian, 1999), electronic integration (Venkatraman & Zaheer, 1990), and brick-and-click synergy (Steinfield *et al.*, 2002). Thus, we hypothesize a positive association between competitive pressure and e-business adoption, as follows:

> **H5**: *Firms facing higher levels of competitive pressure are more likely to adopt e-business.*

Lack of trading partner readiness

E-business may necessitate more tight integration with customers and suppliers, up and down the supply chain, which goes well beyond the walls of an individual organization. A firm's decision to adopt e-business may be influenced by the adoption status of its trading partners along the value chain, since for an electronic trade to take place, it is necessary that all trading partners adopt compatible electronic trading systems and provide Internet-enabled services for each other (Premkumar *et al.*, 1997; Ramamurthy *et al.*, 1999). The benefits of e-business initiatives of a firm depends not only on its own efforts to digitize its value chain, but also on the readiness of its business partners, suppliers, and customers to engage in electronic interactions and transactions simultaneously. Conversely, a lack of trading partner readiness would be a significant inhibitor for e-business adoption. This is precisely what we have learned from field studies and interviews of e-business managers: lack of trading partner readiness is frequently cited as an inhibitor. Hence, we propose to formulate this as a formal hypothesis and test it by using broader data:

> **H6**: *A lack of trading partner readiness is negatively associated with intent to adopt e-business.*

Controls

Some of the cross-sectional variations in adoption can be explained only if controls are appropriately applied. In our study, we need to control for industry and country effects. It is common for IS researchers to use dummy variables to control for effects of various sample characteristics, such as industry and geographic scope (e.g., Hitt & Brynjolfsson, 1996; Dewan & Min, 1997; Bresnahan *et al.*, 2002; Mendelson, 2000). Taking this convention, our study used eight country dummies and 13 industry dummies (listed in Table 2) to control for data variations that would not have been captured by the explanatory variables discussed above.

Research methodology

Data

Our data source is ECaTT, a database developed by Empirica, a research institution based in Bonn, Germany. ECaTT includes two major surveys conducted in 1999: General Population Survey (GPS) and Decision Maker Survey (DMS). GPS is a survey of 7500 European consumers in 10 European Union (EU) countries, covering attitudes toward electronic commerce, which was based on a representative random sample of the population in each country, and carried out by using computer-aided telephone interviewing techniques (ECaTT, 2000). DMS is a survey of about 4000 European businesses in the same set of EU countries, covering current practices and plans to introduce electronic commerce. DMS was based on a random sample of establishments in these countries, stratified by establishment size (number of employees) and industry. Numbers of establishments were weighted by size to ensure that the results would properly reflect the balance of large and small business units.

To check for data consistency and reliability, we compared the ECaTT data with statistics published by Organization for Economic Cooperation and Development – OECD (2001a, b). The data from these two sources matched well for most countries, with only one exception – Sweden – which therefore was excluded from the analysis. The Netherlands had some missing GPS data necessary for the analysis, so the Netherlands was also excluded. Our final sample includes eight European countries (Germany, UK, Denmark, Ireland, France, Spain, Italy, and Finland) and 13 industries covering manufacturing, distribution, and service sectors. Characteristics of the final sample, including country, industry, and respondent's position, are summarized in Table 2, which shows that 74% of the data was collected from owners, managing directors, heads of establishments, or heads of IT departments, suggesting the high quality of the data source.

Operationalization of constructs

We adopted the paradigm for validating measurement models suggested by Straub (1989), which includes successive stages of theoretical modeling, statistical test, and refinement. We developed measurement items on the basis of comprehensive literature review and interviews of managers and expert opinion. We then tested multi-indicator constructs using confirmatory factor analysis (CFA). Based on the assessment of CFA, the measurement model was further refined and then fitted

Table 2 Sample characteristics

	Obs.	(%)		Obs.	(%)
Country			*Industry*		
Germany	501	14.1	Agriculture	74	2.1
UK	501	14.1	Mining, energy	45	1.3
Denmark	361	10.2	Manufacturing	884	24.9
reland	374	10.5	Construction	335	9.4
France	501	14.1	Distribution	611	17.2
Spain	500	14.1	Hotels, restaurants	112	3.2
Italy	506	14.2	Transport, communication	196	5.5
Finland	308	8.7	Banking, insurance	122	3.4
Total	3552	100	Business services	333	9.4
Respondent's position			Public administration	178	5.0
Owner/Proprietor	603	17.0	Education	120	3.4
Managing director/Board member	528	14.9	Health and social work	151	4.3
Head of establishment/site	337	9.5	Other services	327	9.2
Head of IT/DP department	1148	32.3	Missing	64	1.8
Other member of IT/DP department	427	12.0	Total	3552	100
Other	500	14.1			
Missing	9	0.3			
Total	3552	100			

again. The rest of this subsection discusses the resultant measurement model.

Several constructs are directly operationalized by observed variables. First, *intent to adopt e-business* is measured as a binary variable. A firm is classified as an adopter if it intends to implement e-business within 2 years. Second, the number of establishments is used as a proxy for *firm scope*. By this operationalization, firm scope, in our study, mainly measures the geographic scope. Third, consistent with the existing literature (Raymond, 1985; Cragg & King, 1993; Brynjolfsson *et al.,* 1994), we use the number of employees to measure firm *size*, and take a logarithm transformation to reduce the data variance (Bharadwaj *et al.,* 1999; Thong, 1999). Fourth, *lack of trading partner readiness* is coded based on whether the firms reported that their trading partners were not ready for conducting businesses on the Internet.

Other variables were operationalized as multi-item constructs. Appendix A lists definitions of all indicators for each construct. Three constructs deserve further explanation. First, indicators for *competitive pressure* are percentages of firms in each industry that had already adopted e-business at the time of the survey. These adoption rates were calculated based on the adoption *status* in 1999 from DMS survey. It is important to note that these indicators are different from the dependent variable, adoption *intent* by 2001. This difference reflects the underlying rationale in our model that a firm's observation on the adoption behaviors of its competitors influences its own adoption decision.

Second, as mentioned earlier, technology competence is modeled as a second-order construct (for examples of using second-order construct, see Venkatraman, 1990; Sethi & King, 1994; Segars & Grover, 1998; Steward & Segars, 2002). This second-order construct is conceptualized as an overall trait of technological advantage, manifesting in three related dimensions: IT infrastructure; Internet skills; and e-business know-how. The three dimensions of technology competence should not be considered in isolation from each other, but should be treated in a collective and mutually reinforcing manner. Hence, the technology competence construct represents an integrative measure of the level of technology capability along these three dimensions (Zhu & Kraemer, 2002). A second-order factor modeling approach can capture the correlations among the three first-order factors and explain them using a higher-order construct that is an integrative latent representation of technology competence. Previous research notes that this operational approach represents a theoretically strong basis for capturing complex measures (Segars & Grover, 1998). In addition, the empirical reason for building a second-order construct is to avoid the adverse effect of possibly high correlations among sub-constructs on regression estimates.

Third, the interactive effect, *consumer readiness*, is modeled using the Kenny & Judd (1984) method, in which the interactive effect between two constructs, say X and Y, is computed by multiplying each of X's indicators by all of Y's indicators; all of the resulting cross-products are used as indicators for the interactive construct XY (Schumacker & Marcoulides, 1998). Using this method, we modeled *consumer readiness* as an interactive construct since each of its two sub-constructs – *consumer willingness* and *Internet penetration* – serves as a necessary condition for the other to evolve into real online-purchasing readiness.

Instrument validation

To empirically assess the constructs theorized above, we conducted the confirmatory factor analysis in AMOS 4.0. We checked construct reliability, convergent validity, discriminant validity, and validity of the second-order construct. The measurement properties are reported in Tables 3 and 4.

Validity of the second-order construct

Figure 2 shows the estimates of the measurement model, where all exogenous constructs are set to be correlated with one another. All estimates are significant at $P \leq 0.001$ level. R^2 for the three (endogenous) sub-constructs with values of 0.805, 0.932, and 0.398 are satisfactory. The paths from the second-order construct to the three first-order constructs are significant and of high magnitude, providing empirical support to our conceptualization that *technology competence* is the overarching trait of *IT infrastructure*, *Internet skills*, and *e-business know-how*. Note that the second-order construct explains variance among first-order constructs in a parsimonious way. Marsh & Hocevar (1985) suggested that the efficacy of the second-order model be assessed by the target coefficient (*T* ratio) with an upper bound of 1.0. Our model had a satisfactory $T = 0.88$, implying that the relationship among first-order constructs is sufficiently captured by the second-order construct (Steward & Segars, 2002). Therefore, on both theoretical and empirical grounds, the conceptualization of technology competence as a higher-order, multi-dimensional construct seems justified.

Reliability

Reliability measures the degree to which items are free from random error, and therefore yield consistent results. Cronbach's α is the most widely used measure for assessing reliability (Chau, 1999). The α values in Table 4 range from 0.764 to 0.947, indicating adequate reliability. We also calculated composite reliability, which ranged from 0.783 to 0.985, all above the cutoff value of 0.70 (Straub, 1989).

Convergent validity and discriminant validity

Convergent validity assesses the consistency across multiple operationalizations. In Table 3, all estimated standard loadings are significant at $P \leq 0.001$ level, suggesting good convergent validity. To assess the discriminant validity – the extent to which different constructs diverge from one another – we used the Fornell & Larcker (1981) criteria: average variance extracted (AVE) for each construct should be greater than the squared correlation between constructs. Such results suggest that the items share more common variance with their respective constructs than with other constructs. The correlation matrix on the right-hand side of Table 4 shows that our measurement model meets this condition.

In summary, our measurement model satisfies various reliability and validity criteria. Moreover, for the purpose

Table 3 Measurement model: loadings and t-statistics (convergent validity)

Indicator	*Loading*	*t-stat*	*Indicator*	*Loading*	*t-stat*
	Consumer readiness			*Technology competence*	
CR1	0.903	—	IT infrastructure	0.897	—
CR2	0.980***	119.972	Internet skills	0.965***	88.237
CR3	0.974***	116.904	E-business know-how	0.631***	41.636
CR4	0.983***	121.179			
CR5	0.907***	93.430		*Competitive pressure*	
CR6	0.977***	118.606	CP1	0.784	—
CR7	0.978***	118.832	CP2	0.935***	49.074
CR8	0.991***	125.448	CP3	0.457***	27.647
CR9	0.557***	39.609	CP4	0.527***	32.289
CR10	0.714***	56.941		*IT infrastructure*	
CR11	0.599***	43.661	ITI1	0.988	—
CR12	0.822***	73.806	ITI2	0.906***	117.051
CR13	0.600***	43.758	ITI3	0.550***	39.825
CR14	0.787***	67.622	ITI4	0.651***	51.422
CR15	0.697***	54.665	ITI5	0.490***	33.867
CR16	0.892***	89.154	ITI6	0.299***	19.173
CR17	0.986***	122.288		*Internet skills*	
CR18	0.992***	125.529	ITE1	0.956	—
CR19	0.998***	129.130	ITE2	0.981***	158.822
CR20	0.994***	126.919	ITE3	0.874***	96.088
	E-Business know-how		ITE4	0.570***	41.429
EKH1	0.950	—	ITE5	0.304***	19.442
EKH2	0.947***	79.929			

***$P \leq 0.001$.

Table 4 Measurement model: construct reliability and discriminant validity

Construct	*Cronbach's α*	*Composite reliability*	*CR*	*CP*	*TC*
Exogenous constructs				*Correlation matrix*[a]	
Consumer readiness (CR)	0.922	0.985	*0.879*		
Competitive pressure (CP)	0.764	0.783	0.398	*0.703*	
Technology competence (TC)	NA[b]	0.878	0.177	*0.268*	*0.843*
Endogenous constructs					
IT infrastructure	0.828	0.815			
Internet skills	0.870	0.875			
E-business know-how	0.947	0.947			

[a]Diagonal elements in the correlation matrix are the square roots of AVEs, which, for discriminant validity, should be greater than the interconstruct correlations (off-diagonal elements).
[b]Since *technology competence* does not have observed items, we did not calculate α for it.

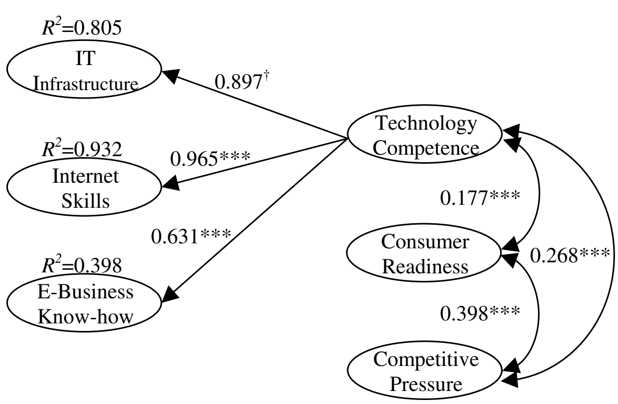

Figure 2 Estimates of multi-item constructs. *Note.* This graph shows estimates of the three multi-item constructs — technology competence, consumer readiness, and competitive pressure. Among them, technology competence is a second-order construct. For clarity, indicators and error terms are omitted. ***$P \leq 0.0001$. †To make the model identified, the loading on the path from *technology competence* to *IT infrastructure* is set to be fixed before estimation.

to test the robustness of our measurement model, we ran exploratory factor analysis on all indicators. Principal component analysis with equamax rotation yielded a consistent grouping with CFA. Thus, factor scores based on this measurement model can be used as independent variables in the logit regression discussed below.

Analysis

Logit regression

Model specification Since the dependent variable is dichotomous, a binary logit model is developed. Similar models have been used in the IS literature to study EDI adoption (Kuan & Chau, 2001) and open system adoption (Chau & Tam, 1997). Based on the conceptual framework for e-business adoption in Figure 1, the logit regression model is specified as follows:

$$\Pr(ADOPTION = 1) = \Lambda(\gamma' x)$$
$$= \Lambda(\alpha + \beta_1 \cdot TC + \beta_2 \cdot S + \beta_3 \cdot FS + \beta_4 \cdot CR + \beta_5 \cdot CP \quad (1)$$
$$+ \beta_6 \cdot LTPR + \sum \delta_i \cdot C_i + \sum \lambda_j \cdot I_j),$$

where $\Lambda(\cdot)$ denotes the probability density function of the logistic distribution. Variables used in (1) are defined in Table 5. This model incorporates the six hypotheses defined earlier. Testing the six hypotheses is equivalent to testing whether coefficients β_1 to β_6 are non-zero; significant and positive coefficients imply adoption facilitators, while significant and negative coefficients imply inhibitors. However, note that 'the parameters of the logit model, like those of any nonlinear regression model, are not necessarily the marginal effects we are accustomed to analyzing' (Greene, 2000, p 815). Actually, the marginal effect – incremental change of the adoption probability due to unit increase of the regressor – is a function of *all* coefficients and regressors:

$$\frac{\partial \Pr(ADOPTION = 1)}{\partial x} = \Lambda(\gamma' x)[1 - \Lambda(\gamma' x)]\gamma. \quad (2)$$

In interpreting the estimated model, it will be useful to calculate this value at the means of the regressors, which is labeled as *slope* by Greene (2000, p 816). In short, to test hypotheses, we check the significance of coefficients in (1), while we rely on slopes in (2) for economic interpretation.

Goodness-of-fit Goodness-of-fit is assessed in three ways. First, a likelihood ratio (LR) test, analogous to the F-test in multiple linear regressions, was conducted to examine the joint explanation power of independent variables. Second, the Hosmer – Lemeshow (1980) test was used to compare the proposed model with a perfect model that can classify respondents into their respective groups correctly, by comparing fitted expected values to the actual values. A small (insignificant) Hosmer–Lemeshow statistic, $\hat{C}$ with a χ^2 distribution conditional on a correct model specification, implies good model fit. Third, we calculated two pseudo-R^2's to measure the proportion of data variation explained: Nagelkerke's (1991), R^2_N, and the Veall and Zimmermanns' (1992), R^2_{VZ}.

Robustness We test the assumption of logistic disturbance by running the Kolmogorov–Smirnov (K–S) test (Charkavarti *et al.*, 1967, pp 392–394), which refers to the biggest gap between the empirical distribution function of the residuals and the hypothesized (i.e., logistic) cumulative distribution function to K–S table. If the gap is small enough, the logistic assumption retains; otherwise, it is suggested we estimate the model again by applying White's (1982) 'sandwich' variance–covariance matrix estimator, which is robust to certain misspecifications of the underlying distribution (EViews, 1994).

Discriminating power The logit model was also assessed in terms of the discriminating power (Hosmer & Lemeshow, 2000). Based on the observation–prediction table, the rate of correct prediction by the logit model and by random guess may be computed. If the former is greater, we conclude that the logit model has a better discriminating power.

Analysis of the full sample

The full sample contains $N=3103$ observations after the listwise deletion of missing values. Summary statistics are shown in Table 6. Independent variables except dummies were standardized before estimation. Then we tested whether the distribution of the residuals was logistic and got a significant ($P \leq 0.001$) K–S statistic, implying a violation of the distribution assumption. Hence, we performed logit regression based on the model in (1) with White's robust variance–covariance estimator applied. Table 7 shows the estimated logit model on the full sample. The significantly positive coefficients of technology competence, firm scope, size, consumer readiness, and competitive pressure confirm their roles as adoption facilitators (firm scope being the most significant); while its significantly negative coefficient ($\beta=-0.345$, P-value$=0.030$) shows that the lack of trading partner readiness inhibits e-business adoption.

The significant likelihood ratio test ($LR=654.868$, $P \leq 0.001$) implies a strong relationship between the dependent variable and regressors. Hosmer-Lemeshow $\hat{C}$

Table 5 Variables used in the logit regression

Variable	*Content*	*Description*
Dependent variable		
ADOPTION	Intent to adopt e-business	Dummy variable. 1 – adopter; 0 – non-adopter
Independent variables		
TC	Technology competence	Factor score of the second-order construct formed in CFA
S	Firm scope	Number of establishments
FS	Firm size	Log (number of employees)
CR	Consumer readiness	Factor score of the interactive effect between *Internet penetration* and *consumer willingness* formed in CFA
CP	Competitive pressure	Factor score formed in CFA
LTPR	Lack of trading partner readiness	Whether the firm reports that their trading partners are not ready for conducting businesses on the Internet
C_1–C_8	Country dummies	Eight dummies for eight countries
I_1–I_{13}	Industry dummies	Thirteen dummies for 13 industries

Table 6 Summary statistics

Variable	*Full sample (N=3103)*		*Low EB-intensity countries (N=2069)*		*High EB-intensity countries (N=1034)*	
	Mean	SD	Mean	SD	Mean	SD
Intent to adopt e-business	0.616	—	0.563	—	0.722	—
Technology competence	0.649	0.641	0.562	0.629	0.823	0.630
Firm scope	0.415	—	0.398	—	0.450	—
Firm size	3.406	1.866	3.327	1.918	3.565	1.749
Consumer readiness	649.1	572.8	297.8	143.7	1352.2	449.3
Competitive pressure	0.174	0.083	0.148	0.070	0.225	0.084
Lack of trading partner readiness	0.0740	—	0.0744	—	0.0735	—

Table 7 Logit model – full sample

Estimates	*Coefficient*	*SE*[a]	*P-value*
Constant	0.366*	0.165	0.027
Technology competence	0.485***	0.066	0.000
Firm scope	0.606***	0.093	0.000
Firm size	0.452***	0.052	0.000
Consumer readiness	0.269***	0.082	0.001
Competitive pressure	0.375***	0.078	0.000
Lack of trading partner readiness	−0.345*	0.159	0.030
Industry dummies	Included		
Country dummies	Included		

Goodness-of-fit

LR statistic: 654.868	Probability: 0.000
Hosmer–Lemeshow $\hat{C}$: 43.742	Probability: 0.786
R^2_N: 0.258	R^2_{VZ}: 0.307

Discriminating power

		Predicted		% Correct
		Non-adopters	Adopters	
Observed	Non-adopters	656	537	54.99
	Adopters	353	1557	81.52
Overall				71.32

[a]White's robust variance–covariance estimator is used.
$^{***}P\leqslant 0.001$; $^{**}P\leqslant 0.01$; $^{*}P\leqslant 0.05$.

($\hat{C}=43.742$, $P=0.786$) indicates that the proposed model is not significantly different from a perfect one that can correctly classify observations into their respective groups (Chau & Tam, 1997). Two pseudo-R^2's reflect that about 28.3% ((25.8+30.7%)/2 = 28.3%) of the data variation is explained by the logit model. The classification table shows an overall prediction accuracy of 71.32% by the logit model. As there are 1193 non-adopters and 1910 adopters, the classification accuracy by random guess would be $(1193/3103)^2+(1910/3103)^2=52.67\%$. Thus, we conclude that the logit model has much higher discriminating power.

In summary, estimated on the full sample, the logit model shows strong support for all six hypotheses, substantive model fit, and satisfactory discriminating power.

Analysis of the sample split

Related to the environment context in our theoretical framework, we wish to understand differences of e-business adoption across countries as each country has its unique environment for e-business. It is frequently reported that certain countries are leaders and others are followers, but there is a lack of understanding on how different national environments shape e-business adoption. We used three indices to measure e-business intensity in each country: (1) annual online consumer spending per capita; (2) e-business adoption rate by firms based on 1999 actual adoption status; and (3) the ratio of e-business volume over GDP. The three indices (Cronbach's $\alpha=0.932$) measured e-business intensity at three levels – consumers, firms, and the economy – and were used as clustering variables in a non-hierarchical cluster analysis of eight countries. It turned out that Finland, Denmark, and UK were grouped together ($N=1034$), while the remaining five were clustered into the other group ($N=2069$). Since ANOVA showed that each of the three indices in the first group had significantly higher value, we labeled the first group as 'high EB-intensity countries' and the second group 'low EB-intensity countries.' Summary statistics for two sub-samples are shown in Table 6.

Our sample split result shown in Table 8 reflects a country-level imbalance of e-business development in Europe, which might have resulted from many factors affecting e-business adoption and diffusion such as technology infrastructure, economic development and national public policies. At the time of the ECaTT survey, high EB-intensity countries (Denmark, Finland, and UK) enjoyed higher levels of diffusion of information and telecommunication technologies including PC, mobile phone, and the Internet than low EB-intensity countries (OECD, 2000, 2001a). In addition to technology infrastructure, government policies may also play a role in stimulating e-business diffusion. For instance, the Danish government centered its e-business strategy on rapid adoption, implementation, and exploitation of e-business in all sectors of the economy, rather than a production-led strategy (Anderson & Bjørn-Anderson, 2001). It is somewhat surprising that France and

Germany are not grouped into the high EB-intensity subsample. This could be partly explained by the late adoption of the Internet technology in France due to its early development of the Minitel – a user-friendly, low-cost, and low-digital network designed for text-based information exchanges implemented on the telephone network. This could also be related to the unfavorable economic status – both countries, in the period of 1995–1999, had a GDP growth rate less than the average EU level and an unemployment rate as high as 10% (Brousseau, 2001; Koenig *et al.,* 2001). Given that our sample split result based on three quantitative indices is consistent with other qualitative e-business studies at the country level (e.g., Kraemer & Dedrick, 2000), we proceeded to fit the proposed logit model on two subsamples.

Table 9 shows the estimated logit model on low EB-intensity countries. All coefficients are significant and the LR test is significant as well ($P \leq 0.001$). About 25.9% ((23.7+28.1%)/2 = 25.9%) of the data variation is explained. Although $\hat{C}$ has a marginal significance level ($P = 0.103$), the overall model fit is deemed good. The classification accuracy by the logit model is 68.92%, higher than the 50.78% by random guess $((905/2069)^2 + (1164/2069)^2 = 50.78\%)$.

Table 10 shows the estimated logit model on high EB-intensity countries. Two differences should be noted: the coefficient of consumer readiness shows marginal

Table 8 Sample split

Country	*E-business adoption rate*[a] *(%)*	*E-business expenditure per capita (in EURO p.a.)*[a]	*E-business volume*[a] *GDP (‰)*
High EB-intensity countries			
Finland	58.4	200	8.0
Denmark	50.4	160	4.9
UK	49.3	110	4.6
Low EB-intensity countries			
Ireland	43.3	40	1.6
Germany	42.7	50	1.9
Spain	38.6	10	0.7
France	25.9	70	2.0
Italy	22.1	20	1.0

[a]The three clustering variables are calculated based on statistics shown in ECaTT 2000.

Table 9 Logit model — low EB-intensity countries

Estimates	*Coefficient*	*SE*[a]	*P-value*
Constant	−0.325	0.273	0.234
Technology competence	0.447***	0.061	0.000
Firm scope	0.592***	0.111	0.000
Firm size	0.457***	0.061	0.000
Consumer readiness	0.266*	0.128	0.038
Competitive pressure	0.312***	0.094	0.001
Lack of trading partner readiness	−0.423*	0.192	0.028
Industry dummies	Included		
Country dummies	Included		

Goodness-of-fit

LR statistic: 401.856	Probability: 0.000
Hosmer–Lemeshow $\hat{C}$: 44.716	Probability: 0.103
R^2_N: 0.237	R^2_{VZ} : 0.281

Discriminating power

		Predicted		% Correct
		Non-adopters	Adopters	
Observed	Non-adopters	567	338	62.65
	Adopters	305	859	73.80
Overall				68.92

[a]See footnote in Table 7.

significance ($P = 0.082$), and the lack of trading partner readiness has an insignificant coefficient ($P = 0.589$). The LR test is significant ($P \leq 0.001$) while the $\hat{C}$ is highly insignificant ($P = 0.946$), suggesting a good overall model fit. The logit model explains about 27.1% ((24.8+29.3%)/2 = 27.1%) of the data variation, and has a prediction accuracy of 76.31%, higher than the 59.81% by random guess. However, it is surprising to see that the classification accuracy for non-adopters is as low as 36.81%, which seems to imply that the proposed model tends to be overly optimistic in high EB-intensity countries (more on this point later).

As discussed earlier, we should rely on slopes when interpreting results and comparing across sub-samples. By plugging sample means into formula (2), we obtained slopes as shown in Table 11. Take the slope on technology competence as an example. The value 0.110 in the full sample means that a unit increase in the standardized value of technology competence may increase the adoption probability by 11%. To test whether the two sub-samples had the same slopes, we applied the method suggested by Greene (2000, pp 824–825). First, the delta method was used to find standard errors of slopes; then, a normal pivotal was calculated to compare slopes. It turned out that the two-tailed test was significant only for firm size, implying that *firm size* has different impacts on e-business adoption across two different e-business environments. The following section discusses findings based on these statistical results.

Table 10 Logit model – high EB-intensity countries

Estimates	*Coefficient*	*SE*[a]	*P-value*
Constant	1.467***	0.444	0.001
Technology competence	0.588***	0.121	0.000
Firm scope	0.678***	0.173	0.000
Firm size	0.438***	0.102	0.000
Consumer readiness	0.197	0.113	0.082
Competitive pressure	0.395**	0.139	0.004
Lack of trading partner readiness	−0.167	0.309	0.589
Industry dummies	Included		
Country dummies	Included		

Goodness-of-fit

LR statistic: 195.4089	Probability: 0.000
Hosmer–Lemeshow $\hat{C}$: 8.097	Probability: 0.946
R^2_N: 0.248	R^2_{VZ}: 0.293

Discriminating power

		Predicted		*% Correct*
		Non-adopters	Adopters	
Observed	Non-adopters	106	182	36.81
	Adopters	63	683	91.55
Overall				76.31

[a]See footnote in Table 7.

Table 11 Marginal effects (slopes) of the logit model

Variables	*Slopes*			*High EB-intensity vs low EB-intensity*	
	Full sample	*Low EB-intensity countries*	*High EB-intensity countries*	*Two-tailed test*	*P-value*
Technology competence	0.110	0.109	0.104	0.254	0.799
Firm scope	0.138	0.144	0.120	0.870	0.384
Firm size	0.103	0.111	0.077	**2.226***	**0.026**
Consumer readiness	0.061	0.065	–[a]	–[a]	–[a]
Competitive pressure	0.085	0.076	0.070	0.259	0.795
Lack of trading partner readiness	−0.079	−0.103	–[a]	–[a]	–[a]

[a]Slopes and tests are not reported, since the associated coefficients are insignificant in the high EB-intensity sub-sample.
*$P \leqslant 0.05$.

Discussions

Major findings and interpretations

Finding 1: Technology competence, firm scope and size, consumer readiness, and competitive pressure are significant adoption facilitators. Among them, firm scope appears to be the strongest driver. The lack of trading partner readiness is a significant adoption inhibitor.

This finding is based on the estimated logit model on the full sample (Table 7). Significant regression coefficients provide strong support for the six hypotheses. Moreover, the good model fit and satisfactory discriminating power, measured by various statistics, suggest the comprehensiveness of the TOE framework, within which the six adoption predictors were derived, and its ability to predict e-business adoption. As indicated by the significant regression coefficients, firms with higher levels of technology competence, greater scope, and larger size are more likely to adopt e-business; higher levels of consumer readiness and competitive pressure are environmental stimulators; while the lack of trading partner readiness drags e-business adoption. The significantly positive coefficient of country-level consumer readiness implies that, although EU is evolving into one unified market, country-level environmental differences among EU countries still affect e-business adoption by firms in each country, at least at the time of this study.

In addition, the structure of the second-order construct of technology competence sheds light on the composition of the technological capability. In Figure 2, significant paths between the higher-order and first-order constructs imply that both physical infrastructure and intangible knowledge (i.e., Internet skills and e-business know-how) are important constituents. These results are consistent with our theoretical arguments based on the TOE framework.

Finding 2: As EB-intensity increases, two environmental factors – consumer readiness and lack of trading partner readiness – become less important, while competitive pressure is the only significant environmental factor.

Estimated logit models on both the high EB-intensity and low EB-intensity subsamples (Tables 9 and 10) demonstrate strong model fit and satisfactory discrimination power; yet, in high EB-intensity countries, consumer readiness becomes a marginal factor ($P=0.082$), and the lack of trading partner readiness becomes insignificant ($P=0.589$). First, this is surprising, given that consumer readiness is much higher in high EB-intensity countries (see Table 6). A plausible explanation is that, as more customers and competitors adopt e-business, and e-business becomes more prevalent in the value chain, firms in the high EB-intensity countries tend to regard it as a *long-run* strategic necessity, while consumer readiness, which reflects the potential return in the *short-run*, becomes a less important factor. Accordingly, firms tend to choose adoption to avoid competitive declines, which is consistent with the fact that, in the high EB-intensity environment, competitive pressure is the only significant ($P=0.004$) environmental adoption facilitator. Second, the lack of trading partner readiness becomes an insignificant factor, possibly because in high EB-intensity countries it is much easier to find online partners as more firms have adopted e-business, which leads decision makers to down-grade this factor in the decision-making process.

Finding 3: In high EB-intensity countries, e-business is no longer a phenomenon dominated by large firms; as more and more firms engage in e-business, network effect works to the advantage of small firms.

For reasons discussed above, we resort to the marginal effects (slopes, see Table 11) to compare two sub-samples: low EB-intensity countries and high EB-intensity countries. The comparison suggests that the impact of firm size on adoption is significantly lower in high EB-intensity countries than in low EB-intensity countries. This implies that in high EB-intensity countries, e-business is no longer a phenomenon dominated by large firms. Consequently, there are more opportunities for small- and medium-sized enterprises (SMEs) to participate in the e-business arena. A possible explanation is that the disadvantages of SMEs such as less power in the market and more resource constraints in technological and financial resources, tend to be leveled out as EB-intensity increases. That is, as more and more firms engage in e-business, network effect works to the special advantage of small firms. In addition, in high EB-intensity countries, there commonly exist more available technology providers and service providers, which may help SMEs adopt new technology; executives accumulate more managerial experience, which helps lower the adoption risk; and as e-business diffuses from low intensity to high intensity, the government also gradually improves its regulation policies. Accumulated experiences and norms increase adoption of firms, which in turn attracts more other firms, especially SMEs to adopt. Hence, network effects facilitate broader e-business adoption by SMEs.

Finding 4: Firms are more cautious in adopting e-business in high EB-intensity countries – it seems to suggest that the more informed firms are less aggressive in adopting e-business.

Examining the prediction accuracy (in Tables 9 and 10) might shed some light on how adoption behaviors change across two sub-samples. Table 9 shows that in low EB-intensity countries, the logit model predicts well for both adopters and non-adopters; however, Table 10 shows that in high EB-intensity countries the logit model predicts well for adopters, but poorly for non-adopters. This implies that our logit model is overly optimistic when applying to the high EB-intensity countries, in the sense that our model 'optimistically' predicted many firms ($N=182$) as adopters, which actually turned out to be non-adopters. In other words, firms in high EB-intensity countries tend to be more cautious than predicted by our model. A possible explanation is that in high EB-intensity countries, managers tend to have a more balanced understanding about e-business in terms of its benefits, costs, and risks. Accordingly, they tend to consider more factors when assessing e-business projects and make more cautious adoption decisions, rather than quickly jumping onto the e-business bandwagon.

Limitations

We believe that the key limitations of this study are as follows. First, our study only investigated adoption decisions. To gain a holistic understanding of e-business, implementation processes and the impacts of e-business on firm performance should be examined. Second, all countries in our dataset are industrialized countries. We do not know whether these results would apply to developing countries or newly industrialized countries. Third, the operationalization of several constructs in this study (technology competence and consumer readiness) has no precedence in the IS literature, which to some extent limits our ability to cross-check the external validity of the results, although reliability, convergent validity, and discriminant validity were empirically tested in our data set.

Implications

Our study has several important implications for managers. First, from a managerial standpoint, our empirical findings suggest that firms must pay great attention to their capability to adopt e-business, and keep in mind that technology competence constitutes both physical infrastructure and intangible knowledge, such as Internet skills and e-business know-how. As Internet technologies diffuse and become necessities, technical and managerial knowledge for e-business management becomes even more significant, an implication consistent with recent e-business case studies (e.g., Mehrtens *et al.,* 2001). This urges top managers to foster managerial skills and human resource that possesses knowledge of e-business, and reminds e-business vendors to put more effort into assisting firms to develop their own capabilities to assimilate e-business into the organization's functionalities through training programs.

In addition to technology capability, managers need to assess the appropriateness of e-business to certain organizational characteristics (e.g., firm size and firm scope) as suggested by our empirical findings. This implies that potential value of e-business investment could be determined by complementary structural differences. Therefore, managers in firms with wider scope should pursue more proactively e-business adoption, given the greater potential to achieve benefits from e-business. This implication should be of special significance for firms seeking global expansion and diversification that face great coordination tasks and possess heterogeneous resources. Those firms could leverage e-business initiatives discussed earlier to facilitate coordination and achieve resource complementarities.

Third, as shown by the empirical analysis, firms' attitude toward e-business and the relative importance of various factors – consumer readiness, trading partner readiness, and firm size – in the decision-making process should be adjusted as e-business environment changes. This implies that managers should re-evaluate the potential adoption benefits and costs as the environment changes. Another important message for managers is to realize that, as e-business intensity increases and more value chain partners have adopted e-business, SMEs have more opportunities to compete in the e-business domain.

Our study also offers implications for policy makers. The consumer readiness factor provides evidence that affordable Internet access and consumers' willingness to buy online can greatly pull firms to adopt e-business. Governments, therefore, should regulate the Internet to make it a trustworthy commerce platform (e.g., dealing with fraud and credit card misuse), and promote the diffusion of the Internet among end-users. Furthermore, our empirical findings suggest positive network effect – firms are more likely to adopt as more peers and business partners have adopted. Thus, governments, at early stages of e-business development in an economy, could accelerate its diffusion by establishing supportive business and tax laws to stimulate firms' adoption. This is particularly important at the early stage of e-business adoption. Once the diffusion reaches a certain level of critical mass, network effect would kick in to speed up e-business diffusion.

Conclusions

We have proposed a conceptual model based on the TOE theoretical framework, and developed a measurement model satisfying various reliability and validity conditions. Upon examining the model using data from surveys on 3100 European businesses and 7500 European consumers, five adoption facilitators and one adoption inhibitor have been identified. Moreover, our results demonstrated properties of the adoption behaviors as the e-business environment changes, and highlighted key areas that may require further research and managerial attention.

This study was conducted on a broad empirical base with large sample data ($N = 3103$) obtained from a multi-country survey. As the sample was not limited to data from a single country, this helps to strengthen the generalizability of the model and findings.

More broadly, this study offered several contributions relevant to future research. First, we demonstrated the solid theoretical basis of the TOE framework and showed the usefulness of this framework for identifying facilitators and inhibitors of e-business adoption. This framework could be applied by other researchers for further studies on e-business or other IS adoptions in different settings. Second, our empirical analysis identified six e-business adoption predictors and revealed differing adoption patterns across different e-business environments. These results might be useful to serve as a starting point for others to derive their research models. Finally, instruments used in this study passed various reliability and validity tests, so they could be used in future studies.

In terms of further research, it would be interesting to study the e-business implementation process and how e-business affects firm performance. Combining these with e-business adoption, we could gain a deeper and more holistic understanding of the consequences and management of e-business. Another interesting direction for future research would be to compare e-business adoption in industrialized countries with developing countries, using the framework and methodology proposed in this study. These countries have different e-business environments, and firms tend to have different levels of technology competence. Hence, such comparisons could reveal distinct adoption behaviors.

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Appendix A: Measurement items

Indicators	*Description*
Consumer willingness	
CW1	% of the population using online shopping in each country
CW2	% of the population using online banking in each country
CW3	% of the population willing to use credit card payment for online shopping in each country
CW4	% of the population willing to use e-cash payment for online shopping in each country
CW5	Average annual online spending per capita in each country
Internet penetration	
IP1	% of the population using the Internet in each country
IP2	% of the population using email in each country
IP3	% of households with PCs in each country
IP4	% of households with Internet access in each country
Consumer readiness	
CR1 ~ CR20	20 cross-products of the five indicators for *consumer willingness* and the four indicators for *Internet penetration*
Competitive pressure	
CP1	% of domestic establishments adopting Web marketing or online selling in each industry and each country
CP2	% of domestic establishments adopting online procurement in each industry and each country
CP3	% of European establishments adopting Web marketing or online selling in each industry
CP4	% of European establishments adopting online procurement in each industry
IT infrastructure	
ITI1	If the establishment uses EDI (Yes or No)
ITI2	If the establishment has access to the Internet (Yes or No)
ITI3	If the establishment has an Intranet (Yes or No)
ITI4	If the establishment uses e-mail (Yes or No)
ITI5	If the establishment uses groupware tools (Yes or No)
ITI6	If the establishment has video-conferencing (Yes or No)
Internet skills	
ITE1	% of employees who can send emails to internal addresses (three-point scale: majority–some–no one)
ITE2	% of employees who can send emails to external addresses (three-point scale: majority–some–no one)
ITE3	% of employees who can browse Internet sites (three-point scale: majority–some–no one)
ITE4	% of employees who can browse Intranet sites (three-point scale: majority–some–no one)
ITE5	% of employees who can communicate via video-conferencing (three-point scale: majority–some–no one)
E-business know-how	
EKH1	Do the executives in this establishment have sufficient know-how for implementing online procurement?
EKH2	Do the executives in this establishment have sufficient know-how for implementing online selling?

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