A Cross-Country Study of Electronic Business Adoption Using the Technology-Organization-Environment Framework

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A CROSS-COUNTRY STUDY OF ELECTRONIC BUSINESS ADOPTION USING THE TECHNOLOGY-ORGANIZATION-ENVIRONMENT FRAMEWORK

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Abstract

In this study, we developed a conceptual model for electronic business (e-business or EB) adoption incorporating six adoption facilitators and inhibitors, based on the technology-organization-environment framework. Survey data from 3,100 businesses and 7,500 consumers in eight European countries were used to test the model. We conducted confirmatory factor analysis to assess the reliability and validity of constructs. To examine whether adoption behaviors differ across different e-business environments, we divided the full sample into high EB-intensity and low EB-intensity countries. 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. (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 into adopting e-business in high EB-intensity countries, which seems to suggest that the more informed firms are less aggressive into adopting e-business.*

Keywords: Electronic business, adoption, Europe, empirical study, cross-country analysis, technology competence, readiness, firm scope, technology-organization-environment framework

1 INTRODUCTION

Internet-based electronic business (e-business or EB) has been predicted to experience significant growth across Europe. Yet, in adopting e-business, companies face a broad range of obstacles, particularly their missing ability to transcend significant technical, managerial, and cultural issues (Anderson Consulting 1999; Forrester Research 1999). Hence, understanding adoption drivers and barriers becomes increasingly important. However, such issues have not been well studied in the literature. In particular, what is missing from the existing literature is (1) a theoretical framework specific to e-business adoption, (2) measurement of factors affecting e-business adoption, and (3) empirical assessment based on large sample datasets. Our study seeks to reduce these gaps. 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) What different adoption behaviors can be found across different e-business 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. Then we tested this framework using survey data from 3,100 businesses and 7,500 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 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.

2 THEORETICAL BACKGROUND: THE TECHNOLOGY-ORGANIZATION-ENVIRONMENT FRAMEWORK

To study adoption of general technological innovation, Tornatzky and Fleischer (1990) developed the technology-organization-environment framework, which identified three aspects of a firm's context that influence the process by which it adopts and implements technological innovation: organizational context, technological context, and environmental context. *Organizational context* is typically defined in terms of several descriptive measures: firm size; the centralization, formalization, and complexity of its managerial structure; the quality of its human resource; and the amount of slack resources available internally. *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. *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 and Fleischer 1990, pp. 152-154).

This framework has been examined by a number of 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 (Mukhopadhyay et al. 1995). An examination of this literature by Iacovou et al. (1995) reveals many factors that were demonstrated as significant adoption drivers and barriers in previous studies. Following Tornatzky and Fleischer, Iacovou et al. developed a model formulating three aspects of EDI adoption influences—*technological* factor (perceived benefits), *organizational* factor (organizational readiness), and *environmental* factor (external pressure)—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 and Chau (2001) developed a perception-based technology-organization-environment framework incorporating six factors as EDI adoption predictors, and confirmed the usefulness of the technology-organization-environment framework for studying adoption of technological innovations.

Although specific factors identified within the three contexts may vary across different studies, the *technology-organization-environment* framework has a solid theoretical basis, consistent empirical support, and promise of applying to other IS innovation domains. Thus, we adopted this theoretical framework and extended it to the e-business domain, which has not been done in the literature. The next two sections discuss its conceptualization and operationalization in the e-business context.

3 CONCEPTUAL MODEL AND HYPOTHESES

Based on the technology-organization-environment framework, we proposed a conceptual model for e-business adoption, shown in Figure 1. This conceptual model posited six predictors for e-business adoption within the three-context framework, and controlled for country and industry effects.

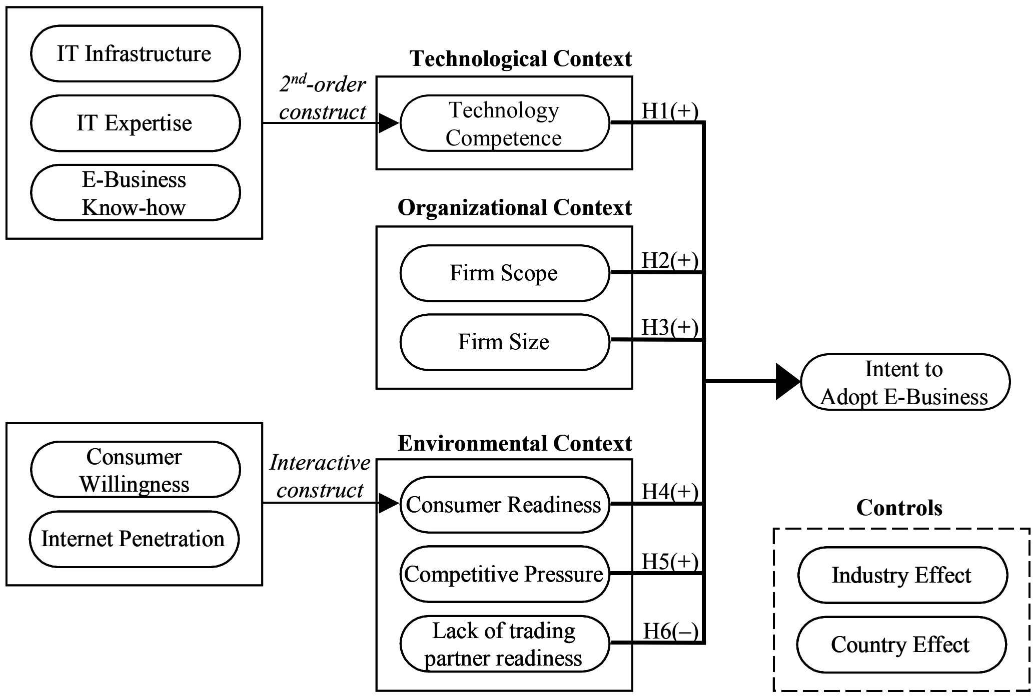


Figure 1. Conceptual Model for E-Business Adoption

3.1 Dependent Variable

The dependent variable in the conceptual model is *intent to adopt e-business*. E-business was defined as "the electronic preprocessing, negotiation, performance and postprocessing of business transactions between commercial subjects over the Internet" (ECaTT 2000). According to this definition, e-business facilitates major business processes along the value chain. A business' *intent* of adoption refers to its "concrete plan" to implement Web-marketing, online selling, or online procurement (ECaTT 2000).

3.2 Technological Context

In the existing literature, technology resource has been consistently demonstrated as an important factor for successful IS adoption (e.g., Crook and Kumar 1998; Grover 1993; Kuan and Chau 2001). Hence, our study posited *technology competence* as an adoption driver, which, as conceptualized to be a second-order construct, encapsulates three sub-constructs: (1) *IT infrastructure*—technologies that enable Internet-related businesses; (2) *IT expertise*—employees' knowledge of using these technologies; and (3) *e-business know-how*—executives' knowledge of managing online selling and procurement. By these definitions, technology competence constitutes not only physical assets, but also intangible resources since expertise and know-how are complementary to physical assets (Helfat 1997). The above viewpoints lead to the following hypothesis:

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

3.3 Organizational Context

3.3.1 Firm Scope

The existing literature has proposed that the larger the scope, the greater the demand for IT investment (Dewan et al. 1998; Hitt 1999; Teece 1980), which suggested us to posit scope as a facilitator for e-business adoption. The role of scope as an adoption predictor can be explained from two perspectives. First, greater scopes lead to higher *internal coordination costs* (Gurbaxani and

Whang 1991), and higher *search costs* and *inventory holding costs* (Chopra and Meindl 2001). Since business digitalization can reduce internal coordination costs (Hitt 1999), and since e-business can lower search costs for both *sellers* and *buyers* (Bakos 1998), achieve demand aggregation and improve inventory management (Zhu and Kraemer 2002), firms with greater scopes are more motivated to adopt e-business. Second, firms with greater scopes have more potential to benefit from synergy between e-business and traditional business processes. 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.*

3.3.2 Firm Size

Firm size has been consistently recognized as an adoption facilitator (for a meta-analysis, see Damanpour 1992). With regard to e-business adoption, larger firms have several advantages over small firms. Larger 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.*

3.4 Environmental Context

3.4.1 Consumer Readiness

Consumer readiness is an important factor for decision makers because it reflects the potential market volume, and thereby determines the extent to which innovations can be translated into profitability. This study defined consumer readiness as a combination of consumer willingness and Internet penetration. Consumer willingness reflects the extent to which consumers accept 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.*

3.4.2 Competitive Pressure

Many empirical studies recognized competitive pressure as an adoption driver (e.g., Crook and Kumar 1998; Grover 1993; Iacovou et al. 1995; Premkumar et al. 1997). Competitive pressure refers to the degree of pressure from competitors, which is an external power pressing a firm to adopt new technology in order to avoid competitive decline. Based on this, the following hypothesis is posited:

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

3.4.3 Lack of Trading Partner Readiness

A firm's e-business adoption decision 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. Furthermore, the Internet is fundamentally about connectivity. E-business may necessitate more tight integration with customers and business partners, which goes beyond the walls of an individual organization (Zhu and Kraemer 2002). Accordingly, a lack of trading partner readiness may hinder e-business adoption.

> ***H6**: Firms facing a lack of trading partner readiness are less likely to adopt e-business.*

3.5 Controls

To control data variation that would not have been captured by the explanatory variables discussed above, we included country dummies and industry dummies as independent variables.

4 RESEARCH METHOD

4.1 Data

Our data source is ECaTT, a database developed by Empirica, Society for Communication and Technology Research Ltd., based in Bonn, Germany. ECaTT includes two major surveys: General Population Survey (GPS) and Decision Maker Survey (DMS). GPS is a survey of about 7,500 European consumers, covering attitudes toward electronic commerce. DMS is a survey of about 4,000 European businesses at the establishment/division level, covering current practices and plans to introduce the various forms of electronic business. To check for data consistency and reliability, we compared the ECaTT data with OECD statistics. They matched well for most countries, with only one exception—Sweden—which therefore was excluded from the analysis. Data from the Netherlands were removed due to considerations of missing data. The final sample includes eight European countries (Germany, the United Kingdom, Denmark, Ireland, France, Spain, Italy, and Finland) and 13 industries covering manufacturing, distribution and service sectors.

4.2 Operationalization of Constructs

Several constructs are operationalized as observed variables. First, *intent to adopt e-business* was measured as a dichotomy. A firm was classified as an adopter if it had made concrete plans to implement e-business by 2001. Second, we used the number of establishments as a proxy for *scope*. Third, we used the number of employees (in logarithm transformation) to measure firm *size*. Fourth, *competitive pressure* was the percentage of firms in each industry that had already adopted e-business at the time of the survey in 1999. Other variables were operationalized as multi-item constructs. First, *technology competence* was modeled as a second-order construct.[1] The theoretical interpretation of this second-order construct is an overall trait of technological advantage, manifesting in three related dimensions. Taken together, they measure an overarching, second-order construct of technology competence. Second, the interactive effect, *consumer readiness*, is of the Kenny and Judd (1984) type. We modeled this 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 actual online-purchasing readiness.

4.3 Instrument Validation

We conducted a confirmatory factor analysis in AMOS 4.0 to assess the constructs theorized above. We checked construct reliability, convergent validity, discriminant validity, and validity of the second-order construct. The measurement properties are reported in Table 1.

4.3.1 Validity of the Second-Order Construct

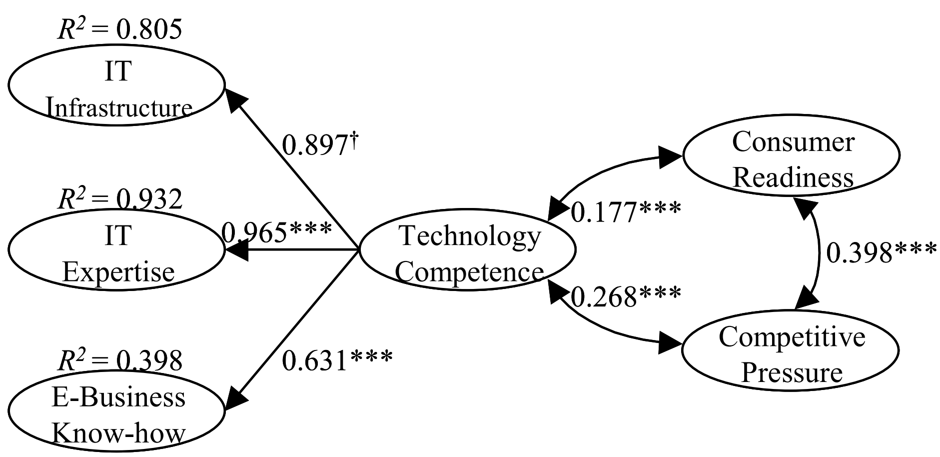
Figure 2 shows the estimates of the measurement model, where exogenous constructs are set to be correlated with one another. Satisfactory R^2s of three first-order (endogenous) constructs and significant paths ($p \leq 0.001$) provided empirical support to our conceptualization that *technology competence* was the overarching trait of *IT infrastructure*, *IT expertise*, and *e-business know-how*. We also checked Marsh and Hocevar's (1985) target coefficient (*T* ratio) to examine the efficacy of the higher-order structure. It had a satisfactory $T = 0.88$, implying that the relationship among first-order constructs was sufficiently captured by the second-order construct (Segars and Grover 1998).

[1] For examples of using second-order constructs, see Segars and Grover (1998) and Sethi and King (1994).

Table 1. 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	IT expertise	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	ITI7	0.332 ***	21.484
CR18	0.992 ***	125.529	***IT Expertise***		
CR19	0.998 ***	129.130	ITE1	0.956 ***	--
CR20	0.994 ***	126.919	ITE2	0.981 ***	158.822
E-Business Know-How			ITE3	0.874 ***	96.088
EKH1	0.950	--	ITE4	0.570 ***	41.429
EKH2	0.947 ***	79.929	ITE5	0.304 ***	19.442

*** $p \leq 0.001$



***$p \leq 0.001$

†To make the model identified, the loading was set to be fixed before extimation.

Figure 2. Estimates of Measurement Model

4.3.2 Construct Reliability

Construct reliability measures the degree to which indicators are free from random error and, therefore, yield consistent results. The values of Cronbach's alpha in Table 2 ranged 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).

4.3.3 Convergent Validity and Discriminant Validity

Convergent validity assesses the consistency across multiple operationalizations. All estimated standard loading were significant at $p \leq 0.001$ level (Table 1), suggesting good convergent validity. To assess the discriminant validity—the extent to which different constructs diverge from one another—we used Fornell and Larcker's (1981) criteria: average variance extracted (AVE) for each construct should be greater than the squared correlation between constructs. The correlation matrix on the right-hand side of Table 2 shows that our measurement model met this condition.

In summary, our measurement model satisfied various reliability and validity criteria. Moreover, for the purpose of testing the robustness of our measurement model, we also 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 in subsequent analyses.

Table 2. Measurement Model: Construct Reliability and Discriminant Validity

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

† Since *technology competence* does not have observed items, we did not calculate alpha for it.

5 ANALYSIS

5.1 Logit Regression

Since the dependent variable is dichotomous, a binary logit model was developed. Based on the conceptual model for e-business adoption in Figure 1, the logit regression model is specified as follows:

$$\begin{aligned} &\Pr(Adoption = 1) = \Lambda(\gamma' x) \\ &= \Lambda(\alpha + \beta_1 \cdot TC + \beta_2 \cdot S + \beta_3 \cdot FS + \beta_4 \cdot CR + \beta_5 \cdot CP + \beta_6 \cdot LTPR + \sum_i \delta_i C_i + \sum_j \lambda_j I_j \end{aligned} \quad (1)$$

where *TC* stands for *technology competence*, *S* for *scope*, *FS* for *firm size*, *CR* for *consumer readiness*, *CP* for *competitive pressure*, *LTPR* for *lack of trading partner readiness*, C_i's (i = 1,…,8) for *country dummies*, and I_j's (j = 1,…,13) for *industry dummies*. $\Lambda(\cdot)$ denotes the probability density function of the logistic distribution. This model is consistent with our conceptual framework in Figure 1 and 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:

$$\frac{\partial \Pr(Adoption=1)}{\partial x} = \Lambda(\gamma' x)[1-\Lambda(\gamma' x)]\gamma \tag{2}$$

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

5.2 Analysis of the Full Sample

The full sample contains N = 3103 observations after the listwise deletion of missing values. Independent variables except dummies were standardized before estimation. Table 3 shows the estimated logit model, with White's robust variance-covariance estimator applied. The significantly positive coefficients of technology competence, scope, size, consumer readiness, and competitive pressure confirm their roles as adoption facilitators; while the significantly negative coefficient (β = -0.345, p-value = 0.030) of lack of trading partner readiness implies that it is an adoption inhibitor.

Table 3. Logit Model — Full Sample (N = 3103)

Estimates				
	Variable	*Coefficient*	*Std. Error*†	*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

†White's robust variance-covariance estimator is used.
***$p \le 0.001$; ** $p \le 0.01$; * $p \le 0.05$.

Goodness-of-fit of the model was assessed in three ways. First, a likelihood ratio (LR) test was conducted to examine the joint explanation power of independent variables. Second, the Hosmer-Lemeshow (2000, p. 147) test was used to compare the proposed model with a perfect model that can classify respondents into their respective groups correctly (Chau and Tam 1997). An insignificant Hosmer-Lemeshow index $\hat{C}$ implies good model fit. Third, we calculated two pseudo-R^2s to measure the proportion of data variation explained: R^2_N (Nagelkerke 1991) and R^2_{VZ} (Veall and Zimmermann 1992). The estimated logit model on the full sample had significant LR test (LR = 654.868, $p \leq 0.001$), insignificant Hosmer-Lemeshow test ($\hat{C} = 43.742$, $p = 0.786$), and satisfactory R^2s (25.8% and 30.7%), all suggesting a good model fit.

The logit model was also assessed in terms of the discriminating power (Hosmer and Lemeshow 2000). Based on the observation-prediction table, the rate of correct predictions by the logit model and that by random guess was computed. The logit model had an overall prediction accuracy of 71.32 percent. As there are 1,193 adopters and 1,910 non-adopters, the classification accuracy by random guess would be $(1193/3103)^2 + (1910/3102)^2 = 52.67\%$. Thus, we concluded that the logit model had much higher discriminating power.

5.3 Analysis of the Sample Split

Related to the environment context in our theoretical framework, we wanted to understand differences across countries as each country may have its unique environment for e-business adoption. Hence, we split our full sample into two subsamples on the basis of e-business intensity. We used three indices to measure e-business intensity in each country: (1) annual e-business expenditure per capita; (2) e-business adoption rate by firms based on 1999 adoption status; and (3) the ratio of business-to-consumer market 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 nonhierarchical cluster analysis of eight countries. It turned out that Finland, Denmark, and the United Kingdom were grouped together ($N = 1034$), while the other 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." Logit model was then fitted on the two subsamples.

In high EB-intensity countries, only four factors—technology competence, scope, size, and competitive pressure—remained significant at the $p \leq 0.05$ level; and the other two factors became *insignificant* ($p = 0.082$ for consumer readiness, $p = 0.589$ for lack of trading partner readiness). All coefficients were significant at the $p \leq 0.05$ level in low EB-intensity countries, similar to the full sample.

In each subsample, logit model had good model fit as suggested by a significant LR test ($p \leq 0.001$), satisfactory R^2 (above 25%), and insignificant Hosmer-Lemeshow $\hat{C}$ ($p > 0.1$). However, in low EB-intensity countries the logit model predicted well for both

Table 4. 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**	**2-tail 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	--†	--†	--†
Competitive pressure	0.085	0.076	0.070	0.259	0.795
Lack of trading partner readiness	-0.079	-0.103	--†	--†	--†

† Slopes and tests are not reported, since the associated coefficients in high intensity countries are insignificant ($p > 0.05$).

adopters (prediction accuracy = 73.8%) and non-adopters (prediction accuracy = 62.7%), but in high EB-intensity countries the logit model predicted well only for adopters (prediction accuracy = 91.6%), but poorly for non-adopters (prediction accuracy = 36.8%). The implication of this distinction is discussed later.

We calculated slopes by plugging sample means into (2). Values of slopes are shown in Table 4. We conducted a two-tail test to examine whether the two subsamples had the same slopes; it turned out that the two-tail test was significant only for firm size, which meant that firm size had different impacts on e-business adoption across two different e-business environments.

6 DISCUSSION

6.1 Major Findings and Interpretation

Finding 1: Technology competence, firm scope and size, consumer readiness, and competitive pressure are significant adoption facilitators; while lack of trading partner readiness is a significant adoption inhibitor.

This result is suggested by the significant coefficients of the logit regression (Table 3). The good model fit and satisfactory discriminating power demonstrated the comprehensiveness of the technology-organization-environment framework. Significant regression coefficients provided strong support for the six hypotheses. These results were consistent with our theoretical arguments based on the technology-organization-environment framework.

Finding 2: As EB-intensity increases, two environmental factors—consumer readiness and lack of trading partner readiness—become less important.

All six factors were significant in low EB-intensity countries; yet, in high EB-intensity countries, consumer readiness became marginal (p = 0.082), and lack of trading partner readiness became insignificant (p = 0.589). This is surprising, given that consumer readiness was higher in high EB-intensity countries (mean = 1352) than in low EB-intensity countries (mean = 298). A plausible explanation is that, as more customers and competitors adopt e-business and as 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. The lack of trading partner readiness became 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 causes decision makers to downgrade 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.

We resorted to slopes to compare two subsamples (Table 4). The comparison suggested 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, and 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. All of these improved situations might facilitate e-business adoption by SMEs.

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

As discussed above, in low EB-intensity countries, the logit model predicted well for both adopters and non-adopters; however, in high EB-intensity countries, the logit model predicted well for adopters, but poorly for non-adopters. This implies that our logit model is *overoptimistic* when applying to high EB-intensity countries, in the sense that our model *optimistically* predicted many firms (182 out of 288 non-adopters in the high EB-intensity subsample) as adopters, which actually were non-adopters. In other words, firms in high EB-intensity countries behaved more cautiously than predicted by our model. In comparison, firms in low EB-intensity countries behaved more aggressively. 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.

6.2 Limitations and Future Research

The research design of this study has incorporated multiple rounds of theory building through literature review and expert opinion. The empirical part also instituted a series of validating procedures and controls. Still, our methodology required tradeoffs that may limit the use of the data and interpretation of the results. First, our study only investigated adoption decisions. To gain a holistic understanding of e-business, implementation processes and the impacts of e-business on business 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. Accordingly, one future research direction is to design a longitudinal study examining implementation and impacts on firm performance. Another direction is to compare e-business adoption in industrialized countries with developing and newly industrialized countries.

6.3 Implications and Concluding Remarks

Our research model was tested on a broad empirical base with a large dataset that was not limited to a single country. This helps to strengthen the generalizability of the findings. Drawing up the data and results, our study offered several contributions. First, we demonstrated the usefulness of the technology-organization-environment framework for identifying facilitators and inhibitors of e-business adoption. This framework could be applied by researchers to study other IS adoptions in different settings. Second, our empirical analysis identified six significant e-business adoption predictors and revealed differing adoption behaviors across different e-business environments. These results might be useful to serve as a basis for others to derive their research models. Another technical message is to develop second-order constructs and interactive constructs to operationalize complex concepts. Finally, instruments used in this study passed various reliability and validity tests, so they could be used in other studies.

This study also has managerial implications as well. First, it is important for firms to build up their technology competence to adopt e-business, including both physical infrastructure and intangible properties (e.g., e-business know-how). Second, managers need to re-evaluate the benefits and costs of e-business adoption as the environment changes. Another important message for managers is to realize that, as e-business intensity increases, SMEs have more opportunities to compete in the e-business domain.

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8 REFERENCES

Anderson Consulting. "eEurope Takes Off," 1999 (available online at http://www.ac.com/ecommerce/ecom_efuture1.html).

Bakos, Y. "The Emerging Role of Electronic Marketplaces on the Internet," *Communications of the ACM* (41:8), 1998, pp. 35-42.

Chau, P. Y. K., and Tam, K. Y. "Factors Affecting the Adoption of Open Systems: An Exploratory Study," *MIS Quarterly* (21:1), 1997, pp. 1-21.

Chopra, S., and Meindl, P. *Supply Chain Management*. Upper Saddle River, NJ: Prentice-Hall, Inc., 2001.

Crook, C. W., and Kumar, R. L. "Electronic Data Interchange: A Multi-Industry Investigation Using Grounded Theory," *Information & Management* (34), 1998, pp. 75–89.

Damanpour, F. "Organizational Size and Innovation," *Organization Studies* (13:3), 1992, pp. 375-402.

Dewan, S., Michael, S., and Min, C. "Firm Characteristics and Investments in Information Technology: Scale and Scope Effects," *Information Systems Research* (9:3), 1998, pp. 219- 232.

ECaTT. "Benchmarking Progress on New Ways of Working and New Forms of Business Across Europe," 2000 (available online at http://www.ecatt.com/).

Fornell, C., and Larcker, D. F. "Structural Equation Models with Unobserved Variables and Measurement Errors," *Journal of Marketing Research* (18:1), 1981, pp. 39-50.

Forrester Research. "Europe: The Sleeping Giant Awakens," 1999 (available online at http://www.forrester.com/ER/Research/Report/Summary/0,1338,8706,00.html).

Greene, W. H. *Econometric Analysis* (4th ed.). Upper Saddle River, NJ: Prentice-Hall, Inc., 2000.

Grover, V. "An Empirically Derived Model for the Adoption of Customer-Based Interorganizational Systems," *Decision Science* (24:3), 1993, pp. 603–640.

Gurbaxani, V., and Whang, S. "The Impact of Information Systems on Organizations and Markets," *Communications of the ACM* (34:1), 1991, pp. 59-73.

Helfat, C. E. "Know-How and Asset Complementarity and Dynamic Capability Accumulation: The Case of R&D," *Strategic Management Journal* (18:5), 1997, pp. 339-360.

Hitt, L. "Information Technology and Firm Boundaries: Evidence from Panel Data," *Information Systems Research* (10:2), 1999, pp. 134-149.

Hosmer, D. W., and Lemeshow, S. *Applied Logistic Regression* (2nd ed.). New York: John Wiley & Sons, Inc., 2000.

Iacovou, C. L., Benbasat, I., and Dexter, A. S. "Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology," *MIS Quarterly* (19:4), 1995, pp. 465–485.

Kenny, D. A., and Judd, C. M. "Estimating the Nonlinear and Interactive Effects of Latent Variables," *Psychological Bulletin* (96), 1984, pp. 201-210.

Kuan, K. K. Y., and Chau, P. Y. K. "A Perception-Based Model for EDI Adoption in Small Business Using a Technology-Organization-Environment Framework," *Information and Management* (38), 2001, pp. 507-512.

Marsh, H. W., and Hocevar, D. "A New, More Powerful Approach to Multitrait-Multimethod Analyses: Application of Second-Order Confirmatory Factor Analysis," *Journal of Applied Psychology* (73:1), 1985, pp. 107-117.

Mukhopadhyay, T., Kekre, S., and Kalathur, S. "Business Value of Information Technology: A Study of Electronic Data Interchange," *MIS Quarterly* (19:2), 1995, pp. 137-156.

Nagelkerke, N. J. D. "A Note on a General Definition of the Coefficient of Determination," *Biometrika* (78:3), 1991, pp. 691-693.

Premkumar, G., Ramamurthy, K., and Crum, M. R. "Determinants of EDI Adoption in the Transportation Industry," *European Journal of Information Systems* (6:2), 1997, pp. 107-121.

Segars, A. H., and Grover, V. "Strategic Information Systems Planning Success: An Investigation of the Construct and its Measurement," *MIS Quarterly* (22:2), 1998, pp. 139–163.

Sethi, V., and King, W. R. "Development of Measures to Assess the Extent to which an Information Technology Application Provides Competitive Advantage," *Management Science* (40:12), 1994, pp. 1601-1627.

Straub, D. W. "Validating Instruments in MIS Research," *MIS Quarterly* (13:2), 1989, pp. 147-169.

Teece, D. J. "Economics of Scope and the Scope of the Enterprise," *Journal of Economic Behavior and Organization* (1:2), 1980, pp. 223-247.

Tornatzky, L. G., and Fleischer, M. *The Process of Technology Innovation*. Lexington, MA: Lexington Books, 1990.

Veall, M. R., and Zimmermann, K. F. "Pseudo-R^2s in the Ordinal Probit Model," *Journal of Mathematical Sociology* (16:4), 1992, pp. 333-342.

White, H. "A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity," *Econometrica* (48:4), 1980, pp. 817-838.

Zhu, K., and Kraemer, K. L. "E-Commerce Metrics for Net-Enhanced Organizations: Assessing the Value of E-Commerce to Firm Performance in the Manufacturing Sector," *Information Systems Research* (13:3), 2002, pp. 275-295.