DETERMINANTS OF INFORMATION TECHNOLOGY ADOPTION IN PORTUGAL

Tiago Oliveira and Maria F. O. Martins
Instituto Superior de Estatística e Gestão Informação, Universidade Nova de Lisboa
Campus de Campolide, 1070-312 Lisboa, Portugal

Keywords: Web site adoption, e-Commerce adoption, Technology-organization-environment, Binary decision.

Abstract: There is an absence of empirical studies on information technology (IT) adoption decision in Portugal. This paper is based on a representative sample of 2626 Portuguese firms and it analyzes the determinants of web site and e-commerce adoption decisions using a technology-organization-environment (TOE) framework. The proposed statistical methodology advocates that the IT adoption decisions are taken sequentially, stage by stage. Findings also suggest that the relevant drivers of web site and e-commerce adoption are not necessarily the same. For web site adoption we found 8 drivers. For e-commerce we found 5 drivers. Explanations and implications are offered.

1 INTRODUCTION

Literature on information technology (IT) adoption and diffusion at firm level (Hong and Zhu, 2006) suggests that when analyzing this topic, one should consider the nature of the IT. For simple technologies, like the internet or Web site, the adoption process is expected to be inexpensive and easy and probably will not bring about fundamental changes to the firm. However, for advanced technologies, especially those related to online transactions, the adoption process may be complicated and costly. That is perhaps why, in 2006, even though most firms in Portugal are internet adopters (83%), only 35% owned a web site and a limited part of them, 7%, have adopted e-commerce. These national figures are clearly below the EU-15 mean level, where 94% of firms are internet users, 66% own a web site and 16% have adopted e-commerce practices.

The two main purposes of this study are the following:

- To examine the importance of technology-organization-environment (TOE) related factors as fundamental determinants of web site and e-commerce adoption;
- To analyze the extent to which there are significant differences in the factors driving these two types of IT.

To achieve these research objectives, we used a rich data set of 2626 firms that are representative of Portuguese firms with more than 10 employees in 2006, (excluding the financial service sector).

In this study, as suggested by Hong and Zhu (2006), we defined e-commerce as any application of web technologies that enables revenue generating business activities over the internet.

2 THEORICAL FRAMEWORK AND CONCEPTUAL MODEL

The TOE model (Tornatsky and Fleischer, 1990) identifies three aspects that may possibly influence web site and e-commerce adoption: technological context (technology readiness, technology integration and security applications); organizational context (firm size, perceived benefits of electronic correspondence, IT training programs, access to the IT system of the firm, internet and e-mail norms and main perceived obstacle); and environmental context (competitive pressure). In accordance with the TOE theory, we developed in the next subsection a conceptual framework for web site and e-commerce adoption (see Figure 1).

Oliveira T. and O. Martins M. (2009).
DETERMINANTS OF INFORMATION TECHNOLOGY ADOPTION IN PORTUGAL.
In *Proceedings of the International Conference on e-Business*, pages 264-270
DOI: 10.5220/0002261502640270

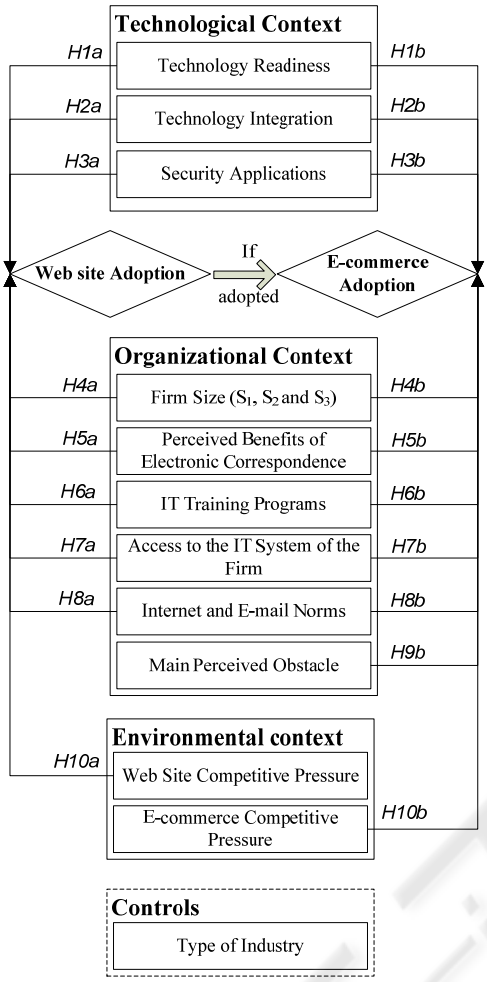

Figure 1: Conceptual framework for web site and e-commerce adoption.

2.1 Technology Context

Technology readiness can be defined as technology infrastructure and IT human resources. Technology infrastructure establishes a platform on which internet technologies can be built; IT human resources provide the knowledge and skills to develop web applications (Zhu and Kraemer, 2005). Theoretical assertions are supported by several empirical studies (Hong and Zhu, 2006, Iacovou et al., 1995, Kwon and Zmud, 1987, Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006, Zhu et al., 2004)

H1a and H1b. The level of technology readiness is positively associated with web site and e-commerce adoption

Evidence from the literature suggests that integrated technologies help improve firm performance by reduced cycle time, improved customer service, and lowered procurement costs (Barua et al., 2004). As a complex technology, e-commerce demands close coordination of various components along the value chain. Correspondingly, a greater integration of existing applications and the internet platform represent a greater capacity of conducting business over the internet (Al-Qirim, 2007, Mirchandani and Motwani, 2001, Premkumar, 2003).

H2a and H2b. The level of technology integration is positively associated with web site and e-commerce adoption.

The lack of security may slow down technological progress. For example, for Portugal in 2002 this was the greatest barrier to internet use (Martins and Oliveira, 2005) and in China it is one of the most important barriers to the adoption of e-commerce (Tan and Ouyang, 2004).

H3a and H3b. Security applications is positively associated with web site and e-commerce adoption

2.2 Organization Context

Firm size is one of the most commonly studied determinants of IT adoption (Lee and Xia, 2006). Several empirical studies indicate that there is a positive relationship between the two variables (Pan and Jang, 2008, Premkumar et al., 1997, Thong, 1999, Zhu et al., 2003)

H4a and H4b. Firm size is positively associated with web site and e-commerce adoption

Empirical studies consistently found that perceived benefits have a significant impact in IT adoption
(Beatty et al., 2001, Gibbs and Kraemer, 2004, Iacovou et al., 1995).

H5a and H5b. Perceived benefits of electronic correspondence is positively related with web site and e-commerce adoption

We used IT training programs as a proxy of employees' education level, because in our survey we do not have this variable. The presence of skilled labor in a firm increases its ability to absorb and make use of an IT innovation, and therefore it is an important determinant of IT diffusion (Caselli and Coleman, 2001, Hollenstein, 2004, Kiiski and Pohjola, 2002).

H6a and H6b. IT training programs are positively associated with web site and e-commerce adoption

The fact that workers can have access to the IT

system from outside of the firm reveals that the organization is prepared to integrate its technologies (Mirchandani and Motwani, 2001).

H7a and H7b. The level of access to the IT system from outside of the firm is positively associated with web site and e-commerce adoption

Regulatory environment has been acknowledged as a critical factor influencing innovation diffusion (Zhu et al., 2003, Zhu and Kraemer, 2005, Zhu et al., 2006, Zhu et al., 2004). Firms often refer inadequate legal protection for online business activities, unclear business laws, and security and privacy as concerns in using web technologies (Kraemer et al., 2006).

H8a and h8b. The presence of internet and e-mail norms is positively associated with web site and e-commerce adoption

Research into IT adoption and implementation suggests that when the technology is complex, as is the case for e-commerce, the main perceived obstacles are particularly relevant because in this case, the adoption process may be complicated and costly (Hong and Zhu, 2006).

H9b. Main perceived obstacle is negatively associated with e-commerce adoption

2.3 Environmental Context

Competitive pressure refers to the degree of pressure felt by the firm from competitors within the industry. Porter and Millar (1985) analyzed the strategic rationale underlying competitive pressure as an innovation-diffusion driver. They suggested that, by using a new innovation, firms might be able to alter the rules of competition, affect the industry structure, and leverage new ways to outperform rivals, thus changing the competitive landscape. This analysis can be extended to IT adoption. Empirical evidence suggests that competitive pressure is a powerful driver of IT adoption and diffusion (Al-Qirim, 2007, Gibbs and Kraemer, 2004, Hollenstein, 2004, Iacovou et al., 1995, Mehrtens et al., 2001, Zhu et al., 2003).

H10a. The level of web site competitive pressure is positively associated with web site adoption

H10b. The level of e-commerce competitive pressure is positively associated with e-commerce adoption.

3 DATA AND METHODOLOGY

3.1 Data

The data used in this study were provided by National Institute of Statistics (INE) and result from the survey on the use of communication and information technologies in firms (iutice) in 2006. We used a sample of 2626 firms with more than 9 employees that is statistically representative of the whole private business sector in Portugal at January 2006, excluding the financial sector.

3.2 Methodology

In our model we examine the influence of several TOE factors on the adoption decision at two adoption stages (see Figure 2).

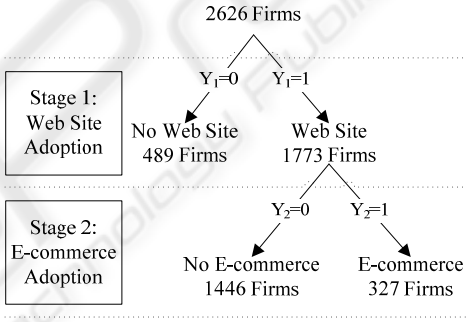

Figure 2: Stage of adoption by firms.

We estimated the following probit model, for stage adoption *i*:

$$P(y_i=1/\mathbf{x_i})=\Phi(\mathbf{x_i}\boldsymbol{\beta_i}) \quad \text{for i=1,2} \qquad (1)$$

Where $y_1=1$ is web site adoption, $y_2=1$ is e-commerce adoption, $\mathbf{x_i}$ is the vector of the explanatory variables, $\boldsymbol{\beta_i}$ the vector of unknown parameters to be estimated, and $\Phi(.)$ is the normal cumulative distribution.

Within our context, the e-commerce adoption decision (stage 2) should be modeled jointly with the decision on web site adoption (stage 1), taking into account the fact that e-commerce adoption decision is observed only for those firms who own a web site. As it is usual in statistical analysis, we use a bivariate probit model with sample selectivity that estimates simultaneously the system of two nonlinear equations, in our case, two probit models taking into account sample selection. If the hypothesis of uncorrelated errors ($\rho=0$) is not rejected then we can proceed as usual by specifying two sequential models (Greene, 2008). This means

that we can compute, without the existence of selectivity bias, one binary model (probit or logit) for web site adoption with all firms and another binary model (probit or logit) for e-commerce only with firms that had adopted web site.

The probit or logit model has been used in the IT literature to study the following adoptions: computer-mediated communication technologies (Premkumar, 2003), internet (Martins and Oliveira, 2007), web site (Oliveira and Martins, 2008) and e-business (Pan and Jang, 2008, Zhu et al., 2003).

Definition of explanatory variables

A technology readiness index was built by aggregating 8 items on technologies used by the firm (on a yes/no scale): computers, e-mail, intranet, extranet, own networks that are not the internet (own exclusive networks), wired local area network (LAN), wireless LAN, wide area network (WAN), and one item standing for the existence of IT specific skills in the firm (on a yes/no scale) (Zhu et al., 2004). The first 8 items represent the penetration of traditional information technologies, which formed the technological infrastructure (Kwon and Zmud, 1987). The last item represents IT human resources (Mata et al., 1995). To aggregate these 9 items measured in yes/no scale, we used multiple correspondence analyses (MCA). The MCA is a method of "multidimensional exploratory statistic" that is used to reduce the dimension when the variables are binary (Johnson and Wichern, 1998). The first dimension explains 38% of inertia. In the negative side of the first axis we have variables that represent firms that do not use IT infrastructures and do not have workers with IT skills. On the positive side we have the variables that represent the use of infrastructures and workers with IT skills. This resulting variable reflects the technology readiness. Technology integration (TI) was measured by the number of IT systems for managing orders that are automatically linked with other IT systems of the firm. The variable ranges from 0 to 5. This variable reflects how well the IT systems are connected on a common platform. Security applications (SA) was measured by the number of existing security applications in the firms. The variable ranges from 0 to 6. Firm size was measured by three binary variables: small firms (S_1) (10 up to 49 employees); medium-size firms (S_2) (50 up to 249 employees); large firms (S_3) (more than 249 employees). Perceived benefits of electronic correspondence (PBEC) was measured by the shift from traditional postal mail to electronic correspondence as the main standard for business communication, in the last 5 years (on a yes/no scale). IT training (ITTP) programs is also binary variable (yes/no) related to the existence of professional training in computer/informatics, available to workers in the firm. Access to the IT system of the firm (AITSF) was measured by the number of places from which workers access the firms information system. The variable ranges from 0 to 4. Internet and e-mail norms (IEN) was measured by whether firms have defined norms about internet and e-mail (on a yes/no scale). Main perceived obstacles was measured by five dummy variables reflecting the main problems faced in the implementation of e-commerce solution. Web site competitive pressure (WEBP) and e-commerce competitive pressure (ECOMP) are computed as the percentage of firms in each of the 9 industries that had already adopted a web site/e-commerce two years before the time of the survey, i.e. in 2004. As in Zhu et al. (Zhu et al., 2003) the rationale underlying our model is that an observation of the firm on the adoption behavior of its competitors influences its own adoption decision. To control for type of industry we used a binary variable (yes/no), representing the service sector (SER).

We made an analysis of reliability for variables that were obtained by multi-item indicators. We used the standardized Kuder-Richardson Formula 20 (KR-20) estimated, which is a special form of coefficient alpha that is applicable when items are dichotomous (Kuder and Richardson, 1937). The KR-20 obtained are: for technology readiness (KR-20 = 0.78), technology integration (KR-20 = 0.92), security applications (KR-20 = 0.71) and access to the IT system of the firm (KR-20 = 0.73). All of KR-20 are higher than the generally accepted level of adequacy of 0.60 (Nunnally and Bernstein, 1994). These results suggest that all of the factors are considered to be satisfactory for the reliability of multi-item scale.

4 ESTIMATION RESULTS

Initially we estimated a bivariate probit model with sample selectivity. No support was found to the existence of selectivity in our sample, at the usual 5% significance level (p-value=0.12). Since the two adoption decisions are uncorrelated, we can estimate our model with two single probit models. Table 1 reports the estimation results. We also estimated two logit models. As expected, the results are analogous.

Table 1: Estimated results.

Explanatory variables	Probit (sequential equations)	
	Web site (y_1)	E-commerce (y_2)
	Coef.	Coef.
Technology context		
TR	0.699***	-0.055
TI	0.008	0.087***
SA	0.087***	0.040
Organization context		
Firm size (S_1 is reference variable):		
-S_2	0.064	-0.056
-S_3	0.263***	0.158
PBEC	0.166**	0.168**
ITTP	0.274***	0.112
AITSF	0.170***	0.099**
IEN	0.152**	0.024
Main perceived obstacle [+]:		
-Goods and services are not susceptible of being sold through the internet	nc	-0.707***
Competitive pressure		
WEBP	0.021***	nc
ECOMP	nc	0.029***
Controls		
SER	-0.122*	0.299***
Constant	-1.367***	-1.792***
Sample size	n_1=2626	n_2=1773

Note: nc means that the variable is not considerated; * p-value<0.10; ** p-value<0.05; *** p-value<0.01; [+]the other main perceived obstacles are not statistically significant in the model.

Goodness-of-fit is assessed in three ways. First, to analyze the joint statistical significance of the explanatory variables we computed the likelihood ratio test. Secondly, we use the Hosmer-Lemeshow test (Hosmer and Lemeshow, 2000), which compares the fitted expected values of the model to the actual values. For web site adoption and for e-commerce adoption, there is no support to reject both models. Finally, the discrimination power of the model is evaluated using the area under the ROC curve, which is equal to 83% and 75% for web site and e-commerce adoption, respectively. This reveals an excellent discrimination for both models (Hosmer and Lemeshow, 2000). The three statistical procedures reveal a substantive model fit, a satisfactory discriminating power and there is evidence to accept an overall significance of the model.

Hypotheses H1a-H10a and H1b-H10b were tested analyzing the sign and the statistical significance of the coefficients of the two adoption decision models. As can be seen from Table 1, for the web site adoption decision model all the coefficients have the expected signs and the only explanatory variable that is not statistically significant is technology integration. We can identify eight relevant drivers of web site adoption; technology readiness and security application reflecting the technological context; firm size, perceived benefits of electronic correspondence, IT training programs, access to the IT system of the firm and internet and e-mail norms, representing the organization context; web site competitive pressure characterizing the environmental context. We can conclude that hypothesis H1a, H3a, H4a, H5a, H6a, H7a, H8a and H10a are confirmed and no support was found for H2a. For the e-commerce adoption model, the estimated coefficients also have the anticipated signs: technology integration has a positive effect on the e-commerce adoption probability; perceived benefits of electronic correspondence, access to the IT system of the firm and e-commerce competitive pressure are also important drivers of e-commerce adoption. Moreover, our results indicate that goods and/or services provided by the company that are not susceptible of being sold through the internet is the most important obstacle of e-commerce adoption. As a whole, the results substantiate all hypotheses formulated for the e-commerce adoption model except H1b, H3b, H4b, H6b and H8b.

5 CONCLUSIONS

In this study we have proposed a conceptual model based on TOE theoretical framework to analyze the determinants of two different adoption decisions. At the basic level, we considered the adoption of a simple information technology, the web site and at the more advanced level, a complex technology is contemplated: e-commerce. While IT adoption models have been widely discussed and studied in theory and practice, few empirical publications exist for southern European countries like Portugal.

We examined 2626 firms representative of the Portuguese private economic sectors (except the financial one) and the major findings are the following: (1) from our empirical results, by statistical tests, we conclude that the two adoption decisions are taken at different stages; (2) the relevant facilitators and inhibitors of web site and e-commerce adoption decision found in our study for Portuguese firms are, in general, similar to those obtained in other IT adoption studies (Al-Qirim, 2007, Hong and Zhu, 2006, Zhu et al., 2006); (3) in particular, our results suggest that organizational factors like perceived benefits and access to firms IT system contribute to both adoption decision process. Similarly, competitive pressure, an environmental

factor, significantly influences both adoption decisions, meaning that competitive pressure is an important innovation-diffusion driver in these two stages of adoption; (4) other variables have limited influence: technology readiness as a component of technological factors, firm size, IT training programs and internet and e-mails norms as organizational factors, had a significant effect on web site adoption decision but had no effect on e-commerce adoption. This indicates that once a firm decides to own a web site, these variables become less important for e-commerce purpose. On the other hand, technology integration has a relevant impact on e-commerce adoption decision but is not important within the web site adoption model, meaning that for e-commerce adoption technologies that help improve firm performance by reduced cycle time, improved customer service, and lowered procurement costs are needed (Barua et al., 2004).

In terms of policy implications, the above findings suggest that a key factor is the improvement of IT skills at the basic and higher levels. This can be achieved by lowering, through different types of policy instruments, the IT training cost, and by promoting a closer relationship between firms, associations and education institutions. With the cost of infrastructure technology decreasing, the lack of qualified IT human resources is probably one of the major constraints for Portuguese firms' technology readiness improvement.

Our study also has important implications for managers who are involved in processes of introducing simple and complex IT innovations into their organizations. First, managers should be aware that technology readiness constitutes both physical infrastructure and intangible knowledge such as IT skills. This urges top leaders to foster managerial skills and human resources that possess knowledge of these new information technologies. Secondly, our study sought to help firms become more effective in moving from a traditional channel to the internet by identifying the profile of early web site and e-commerce adopters. For non-adopters, it provides a mechanism for self-evaluation. For firms that are already web site adopters, in the development of strategies for e-commerce adoption, it is fundamental to recognize that e-commerce requires enhanced technology integration between the existing applications and the internet platform.

The cross-sectional nature of this study does not allow knowing how this relationship will change over time. To solve this limitation the future research should involve panel data.

ACKNOWLEDGEMENTS

We would like to acknowledge the National Institute of Statistics (INE) for providing us with the data.

REFERENCES

Al-Qirim, N. (2007) The adoption of eCommerce communications and applications technologies in small businesses in New Zealand. *Electron. Commer. Rec. Appl.*, 6**,** 462-473.

Barua, A., Konana, P., Whinston, A. B. & Yin, F. (2004) Assessing internet enabled business value: An exploratory investigation. *MIS Quart*, 28**,** 585-620.

Beatty, R. C., Shim, J. P. & Jones, M. C. (2001) Factors influencing corporate web site adoption: a time-based assessment. *Information & Management*, 38**,** 337-354.

Caselli, F. & Coleman, W. J. (2001) Cross-country technology diffusion: The case of computers. *American Economic Review*, 91**,** 328-335.

Gibbs, L. J. & Kraemer, K. L. (2004) A Cross-Country Investigation of the Determinants of Scope of E-commerce Use: An Institutional Approach. *Electronic Markets*, 14**,** 124-137.

Greene, W. H. (2008) *Econometric Analysis*, New Jersey, Prentince-Hall, Inc.

Hollenstein, H. (2004) Determinants of the adoption of Information and Communication Technologies (ICT). An empirical analysis based on firm-level data for the Swiss business sector. *Structural Change and Economic Dynamics*, 15**,** 315-342.

Hong, W. Y. & Zhu, K. (2006) Migrating to internet-based e-commerce: Factors affecting e-commerce adoption and migration at the firm level. *Information & Management*, 43**,** 204-221.

Hosmer, D. W. & Lemeshow, S. (2000) *Applied Logistic Regression* Willey.

Iacovou, C. L., Benbasat, I. & Dexter, A. S. (1995) Electronic data interchange and small organizations: Adoption and impact of technology. *Mis Quarterly*, 19**,** 465-485.

Johnson, R. & Wichern, D. (1998) *Applied Multivariate Data Statistical Analysis*, New Jersey, Prentice Hall.

Kiiski, S. & Pohjola, M. (2002) Cross-country diffusion of the Internet. *Information Economics and Policy*, 14**,** 297-310.

Kraemer, K. L., Dedrick, J., Melville, N. & Zhu, K. (2006) *Global E-Commerce: Impacts of National Environments and Policy*, Cambridge, UK.

Kuder, G. F. & Richardson, M. W. (1937) The theory of estimation of test reliability. *Psychometrika*, 28**,** 221-238.

Kwon, T. H. & Zmud, R. W. (1987) Unifying the fragmented models of information systems implementation. In critical *issues in Information Systems Research* (Boland RJ and Hirschheim RA, Eds). IN WILEY, J. (Ed.) New York.

Lee, G. & Xia, W. D. (2006) Organizational size and IT innovation adoption: A meta-analysis. *Information & Management,* 43**,** 975-985.

Martins, M. & Oliveira, T. (2007) Determinants of information technology diffusion: A study at the firm level for Portugal. IN REMENYI, D. (Ed.) *Proceedings of the European Conference on Information Management and Evaluation.* Nr Reading, Academic Conferences Ltd.

Martins, M. R. O. F. & Oliveira, T. (2005) Characterisation of Portuguese Organizations regarding Investment in Information and Communication Technologies – Application of Multivariate Data Analysis Techniques. IN REMENYI, D. (Ed.) *The 12th European Conference on Information Technology Evaluation.* Turku, Finland, Academic Conferences Limited.

Mata, F., Fuerst, W. & Barney, J. (1995) Information technology and sustained competitive advantage: A resource-based analysis. *MIS Quart,* 19**,** 487–505.

Mehrtens, J., Cragg, P. B. & Mills, A. M. (2001) A model of Internet adoption by SMEs. *INFORMATION & MANAGEMENT,* 39**,** 165-176.

Mirchandani, D. A. & Motwani, J. (2001) Understanding small business electronic commerce adoption: An empirical analysis. *Journal of Computer Information Systems,* 41**,** 70-73.

Nunnally, J. & Bernstein, I. (1994) *Psychometric Theory,* New York, McGraw-Hill.

Oliveira, T. & Martins, M. F. O. (2008) A comparison of web site adoption in small and large Portuguese firms. *Ice-B 2008: Proceedings of the International Conference on E-Business***,** 370-377.

Pan, M. J. & Jang, W. Y. (2008) Determinants of the adoption of enterprise resource planning within the technology-organization-environment framework: Taiwan's communications. *Journal of Computer Information Systems,* 48**,** 94-102.

Porter, M. E. & Millar, V. E. (1985) How Information Gives You Competitive Advantage. *Harvard Business Review,* 63**,** 149-160.

Premkumar, G. (2003) A meta-analysis of research on information technology implementation in small business. *Journal of Organizational Computing and Electronic Commerce,* 13**,** 91-121.

Premkumar, G., RAMAMURTHY, K. & CRUM, M. (1997) Determinants of EDI adoption in the transportation industry. *European Journal of Information Systems,* 6**,** 107-121.

Tan, Z. & Ouyang, W. (2004) Diffusion and Impacts of the Internet and E-commerce in China. *Electronic Markets,* 14**,** 25-35.

Thong, J. Y. L. (1999) An Integrated Model of Information Systems Adoption in Small Businesses. *Journal of Management Information Systems* 15**,** 187-214.

Tornatsky, L. & Fleischer, M. (1990) *The Process of Technology Innovation,* Lexington, MA, Lexington Books.

Zhu, K., Kramer, K. & Xu, S. (2003) Electronic business adoption by European firms: a cross-country assessment of the facilitators and inhibitors. *European Journal of Information Systems,* 12**,** 251-268.

Zhu, K. & Kramer, K. L. (2005) Post-adoption variations in usage and value of e-business by organizations: Cross-country evidence from the retail industry. *Information Systems Research,* 16**,** 61-84.

Zhu, K., Kraemer, K. L. & Xu, S. (2006) The process of innovation assimilation by firms in different countries: A technology diffusion perspective on e-business. *Management Science,* 52**,** 1557-1576.

Zhu, K., Kraemer, K. L., Xu, S. & Dedrick, J. (2004) Information technology payoff in e-business environments: An international perspective on value creation of e-business in the financial services industry. *Journal of Management Information Systems,* 21**,** 17-54.