A MULTI-LEVEL MODEL OF ENTERPRISE SYSTEMS ADOPTION

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Abstract

During past decades, enterprise systems (ES) are becoming increasingly popular and numerous IS researchers have investigated the adoption of ES. Most of them investigated ERP adoption at the firm level. Few papers investigate ES adoption at multi-level. On the basis of TOE model, this paper propose a multi-level framework that specifies the country-level, the firm-level, and the cross-level effects, examining the effects of two country-level variables and three firm-level factors on ES adoption. We found that a country's uncertainty avoidance orientation has a positive impact on ES adoption. In addition, the positive impacts of firm size and technology competence on ES adoption become stronger with the increase in a country's maturity of IT-related law. The study extends the TOE framework by using a multi-level perspective to understand ES adoption. The authors conclude the paper with a discussion of the study's implications for practice and future research.

Keywords: Enterprise systems adoption, TOE, Multi-level.
1 INTRODUCTION

Enterprise systems (ES) are becoming increasingly popular for their potential to form competitive advantages (Powell & Dent-Micalef 1997). Majority of researchers suggest that ES can improve firm performance (Davenport 1998; Poston & Grabski 2000; Hendricks et al. 2007). Enterprise systems are software packages that enable the integration of transactions-oriented information and business processes throughout an organization (and perhaps eventually throughout the entire inter-organizational supply chain) (Markus & Tanis 2000). Hendricks et al. (2007) suggested that ES include one or more of the following applications: Enterprise Resource Planning (ERP), Supply Chain Management (SCM) systems, and/or Customer Relationship Management (CRM) systems. Thus ES are always large systems involving different end users and complex functions (Hwang 2005).

Prior studies show that there are lots of factors affecting ES adoption. Numerous researchers have investigated ES adoption at the firm level (Law & Ngai 2007; Laukkani et al. 2005; Buonanno et al. 2005). For example, Buonanno et al. (2005) focused on organizational factors that influence ERP adoption and found that firm size and organizational changes influence ERP adoption while membership of an industrial group, market area and presence of branch offices have no effect on ERP adoption. Law and Ngai (2007) concentrated on factors related to strategic management: senior management support, CEO-IT distance, and strategic intent. Furthermore, some scholars study ES adoption under globalization with samples from Europe (Van Everdingen et al. 2000; Hanseth et al. 2001) or Asia (Rajapakse & Seddon 2005; Liang et al. 2004; Martinsons 2004). The complexity in ES adoption has become a significant issue for both practitioners and academic researchers.

Despite these advocates, no research to date theorizes the effects of cross-level factors on ES adoption and tests these effects using large scale data from countries with a wide span of cultural and institutional characteristics. Erumban and De Jong (2006) confirmed the differences in IT adoption rates across countries by using Hofstede’s cultural framework. Thus we conjectured cross-country factors may also affect ES adoption, which is one kind of IT. In addition, Rosenberg (1972) claimed that variables—social, legal and institutional as well as economic and technological—which might retard the diffusion process is virtually limitless. Therefore, country-level factors should conclude not only culture but also legal or economic factors. Our study develops a multi-level framework of ES adoption that specifies the country-level, the firm-level, and the cross-level effects. At the country level, the study describes the impact of a country's cultural, legal, and economic factors on firm ES adoption. At the firm level, the study examines the effects of firm size, technology competence, and competition pressure on firm ES adoption. Investigating ES adoption at country-level and firm-level simultaneously has important policy and managerial implications.

2 LITERATURE REVIEW

Based on literature on IS adoption, we found that the TOE framework (Tornatzky et al. 1990) is widely used for investigating IS adoption, such as EDI adoption (Kuan & Chau 2001), e-business adoption (Zhu et al. 2003) and other IS adoption (Chau & Tam 1997). The TOE framework identifies three kinds of contexts that influence the process by which an organization adopts, implements, and uses technological innovations: (a) technological context relates to the technologies available to an organization; (b) organizational context refers to descriptive measures about the organization such as scope, size, and the amount of slack resources available internally, and (c) environmental context is the area in which a firm conducts its business—its competitors, government policy and country. Therefore, we adopt the TOE framework to summarize the literature on ES adoption (see Table 1 for related studies).

Firstly, in terms of technological context, scholars deemed that the scalability, friendliness, complexity, and compatibility of enterprise systems are all important determinants in ERP adoption (Van Everdingen et al. 2000; Van Everdingen & Waarts 2003; Buonanno et al. 2005; Hung et al. 2010).
Scalability, friendliness, and compatibility facilitate ES adoption while complexity impedes ES adoption. Markus and Tanis (2000) listed many technical reasons for adopting enterprise systems, such as solving Y2K and similar problems, integrating applications cross-functionally, replacing hard-to-maintain interfaces, consolidating multiple different systems of the same type and so on. In addition, they considered that technical issues are also reasons for non-adoption as enterprise systems are technically challenging and not every firm can deal with them.

Secondly, in terms of organizational context, the literature suggests that there are mainly three factors affecting ES adoption: CEOs’ characteristics/support, firm size, and the fit between ES and business. (a) Some scholars (Law & Ngai 2007; Shiau et al. 2009; Ko et al. 2008; Hung et al. 2010; Kotzab et al. 2011) claim that CEOs’ characteristic/support and the status of IT function/CIO are critical to the ERP adoption. They emphasize that the association between CEOs’ characteristic and ERP adoption cannot be totally ignored as it was marginally significant. (b) The majority of researchers agree that firm size affects the adoption of ERP systems (Laukkonen et al. 2005; Buonanno et al. 2005; Shiau et al. 2009; Ko et al. 2008; Hung et al. 2010). In general, the rate of ERP system adoption is quite low among both micro and small firms because enterprise systems adoption and implementation require large investment, related resources, and professionals. (c) A few scholars suggest that the better fit between ES and business, the higher rate of ES adoption will be (Law & Ngai 2007; Van Everdingen et al. 2000; Karakostas et al. 2005). Karakostas et al. (2005) surveyed 46 financial sector companies and showed that 95% of the survey respondents agreed strongly or moderately that they adopted CRM because of CRM fitting with the growth of e-business and improving customer satisfaction.

Finally, for the environmental context, prior researchers have investigated two types of factors that affect ES adoption: competitive press and national culture. Enterprises in the same industry always tend to adopt the same technology for the pressure of competition (Chang et al. 2010; Karakostas et al. 2005). Through affecting the belief and participation of executives, competitive pressure influences ES adoption indirectly. Furthermore, scholars find that ES vendors hardly dominate other country’s ES market due to cultural differences (Liang et al. 2004; Soh et al. 2000; Martinsons 2004; Davison 2002). National culture is an important factor affecting ES adoption (Hwang 2005; Rajapakse & Seddon 2005; Van Everdingen et al. 2000). In Van Everdingen et al.’s (2000) case study, they used two cultural dimensions from Hofstede, namely Power Distance and Individualism/Collectivism, to explore potential cultural misfit between western-style ERP systems and Sri Lankan organizations. The results show that cultural factors do matter, which, to some degree, can explain the relatively low adoption of ERP systems in developing countries in Asia. Van Everdingen and Waarts (2003) expanded their study by investigating seven cultural dimensions, including the well-known Hofstede dimensions and the national cultural dimensions of Hall (low- versus high-context cultures and monochronic versus polychronic cultures) The study is the first large-scale empirical study in a business setting, including 10 European countries and investigating the role of national culture in explaining cross-country differences in ERP adoption rate. Consequently, they showed that most of the cultural dimensions have significant impact on ERP adoption.

The TOE framework provides a comprehensive framework to understand the factors that affect ES adoption. However, except a few scholars have investigated the effect of national culture on ES adoption, few researchers have investigated the effect of country-level environmental factors on ES adoption. In addition, national culture is only one dimension of country-level factors, there are also other dimensions such as law systems, government policies, and economic development (Hargittai 1999; Oxley & Yeung 2001) that may affect ES adoption. Therefore, more research on the role of country-level environmental factors in ES adoption is needed.

More importantly, the environment of a country is the context for ES adoption. Therefore, as contextual factors, country-level elements may influence how technological/organizational factors affect firm decision on IT adoption (Qu & Pinsonneault 2011). However, extant research on ES adoption usually treats technological, organizational, and environmental factors independently. No study to date has investigated how the interactions between high-level factors and low-level factors affect ES adoption. We conjecture that the country-level factors may moderate the effect of technological/organizational factors on ES adoption, in the sense that national context may affect managers’ perceptions on technological/organizational factors.
Therefore, in order to really understand ES adoption, in this paper we propose a multi-level framework that specifies how country-level factors and other TOE factors affect ES adoption, as well as how country factors moderate the influence of technological/organizational factors on ES adoption.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Reference</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Scalability, friendliness</td>
<td>(Van Everdingen et al. 2000) (Buonanno et al. 2005)</td>
</tr>
<tr>
<td>Complexity, compatibility</td>
<td>(Chang et al. 2010) (Alshawi et al. 2011)</td>
<td>CRM</td>
</tr>
<tr>
<td>Integration, consolidation, and so on</td>
<td>(Markus &amp; Tanis 2000)</td>
<td>ES</td>
</tr>
<tr>
<td>Organization</td>
<td>CEOs’ characteristic /Management support</td>
<td>(Law &amp; Ngai 2007) (Shiau et al. 2009) (Chang et al. 2010)</td>
</tr>
<tr>
<td></td>
<td>(Ko et al. 2008)</td>
<td>CRM</td>
</tr>
<tr>
<td></td>
<td>(Hung et al. 2010)</td>
<td>SCM</td>
</tr>
<tr>
<td></td>
<td>(Kotzab et al. 2011)</td>
<td></td>
</tr>
<tr>
<td>Firm size</td>
<td>(Buonanno et al. 2005)</td>
<td>ERP</td>
</tr>
<tr>
<td></td>
<td>(Laukkanen et al. 2007)</td>
<td>ERP</td>
</tr>
<tr>
<td></td>
<td>(Shiau et al. 2009)</td>
<td>ERP</td>
</tr>
<tr>
<td></td>
<td>(Ko et al. 2008)</td>
<td>CRM</td>
</tr>
<tr>
<td></td>
<td>(Hung et al. 2010)</td>
<td>CRM</td>
</tr>
<tr>
<td></td>
<td>(Van Everdingen et al. 2000)</td>
<td>ERP</td>
</tr>
<tr>
<td></td>
<td>(Law &amp; Ngai 2007)</td>
<td>ERP</td>
</tr>
<tr>
<td></td>
<td>(Karakostas et al. 2005)</td>
<td>CRM</td>
</tr>
<tr>
<td>Environment</td>
<td>Competitive press</td>
<td>(Chang et al. 2010) (Benders et al. 2006)</td>
</tr>
<tr>
<td></td>
<td>(Karakostas et al. 2005)</td>
<td>CRM</td>
</tr>
<tr>
<td>National culture</td>
<td>(Van Everdingen &amp; Waarts 2003)</td>
<td>ERP</td>
</tr>
<tr>
<td></td>
<td>(Rajapakse &amp; Seddon 2005)</td>
<td>ERP</td>
</tr>
<tr>
<td></td>
<td>(Hwang 2005)</td>
<td>ERP</td>
</tr>
</tbody>
</table>

*Table 1: Prior research on Enterprise systems adoption*

### 3 RESEARCH FRAMEWORK AND HYPOTHESES

Based on the TOE framework, we developed a multi-level model to examine ES adoption. The multi-level model includes three traditional TOE factors (i.e., firm size, technology competence, and competitive pressure) from Zhu and Kraemer (2005) and two country-level environmental factors (uncertainty avoidance and IT-related legal system). The model also investigates how the interaction between country-level factors and technological/organizational factors affect ES adoption (see Fig.1). As traditional TOE factors (i.e., firm size, technology competence, and competitive pressure) are measured at the firm level, for simplicity we call them as firm-level factors in this study.

#### 3.1 Country-level Hypotheses

**3.1.1 Effect of Uncertainty Avoidance on ES Adoption**

Uncertainty avoidance refers to the extent to which the members of a culture feel threatened in new, unknown, and uncertain situations and trying to avoid it (Hofstede et al. 1991). People in countries with high uncertainty avoidance feel high stress and anxiety when facing uncertain situations. Organizations in countries with high uncertainty avoidance generally show characteristics such as highly formalized management and preferring strict laws and rules (Hofstede 2001).
We conjecture that uncertainty avoidance has a positive effect on ES adoption. It is because that the integrated information sharing in ES can reduce uncertainty. ES can be used as tools to reduce uncertainty among users with structured business process and operations based on the behavioral control, and with reduced order cycle times and improved customer response times and delivery speeds (Hwang 2005; Cotteleer & Bendoly 2002; McAfee 2002). Lee et al. (2000) considered that integrated information sharing between manufacturers and retailers in SCM systems can reduce uncertainty. The integrated information in SCM systems is beneficial to manufacturers’ capability to react to the retailer’s needs in time because the knowledge of the retailer’s inventory levels can help reduce uncertainties in the demand process faced by the manufacturer. As for CRM systems, firms can acquire customer information and orders in time, which reduce uncertainty in customers’ demands and deal. Hence we hypothesize the following:

**H1:** The uncertainty avoidance orientation of a country associates positively with a firm’s ES adoption.

### 3.1.2 Effect of The Maturity of The IT-related Legal System on ES Adoption

National legal policies can enhance or hold back diffusion of an innovation adoption, depending on their approach to regulating mechanisms and execution degree (Hargittai 1999). Oxley and Yeung (2001) argued that the strength of law affects IS adoption in three ways. First, a strong rule of law reduces transactions’ uncertainty about what legal protection they can expect. Second, effective punishment of transgressors lowers the risk of exchange. Third, a strong rule of law increases the level of trust between both parties of transaction and contracting. Therefore, only in such an environment can buyers in IS transactions have confidence of satisfactory performance or adequate legal recourse should the transaction break down.

The maturity of IT-related legal systems is defined as the extent the law or rules exist relates to information technologies and information systems. In countries without mature and effectively enforced IT-related laws and rules, despite having the necessary conditions such as sufficient funds and professionals, firms may still be unwilling to adopt ES. This is because firms may be hesitant to make a deal with unfamiliar vendors when there is lack of legal protection of their contract and legal recourse if they are dissatisfied with the exchange (Shih et al. 2005). However, in countries with mature IT-related law, firms face less risk because they can seek remediation or compensation through legal means if they have some problems after buying the ES. As a result, firms in such countries are more willing to adopt ES.
In addition, information systems facilitate information sharing between buyers and suppliers, which transform the way we conduct trade and deliver service. As a result, the information security has become more difficult than solving many technical problems that might arise (Dhillon & Backhouse 2000). It is generally agreed that information security is of crucial importance, especially for the big data age nowadays (Pfleeger & Pfleeger 2006; Hoecht & Trott 2006). As Oxley and Yeung (2001) suggested, effective punishment of transgressors lowers the risk of exchange. That is to say, if a country has strong IT-related law systems, people in this country may not leak information for fear of high sanctions, which lower firms’ risk of information security. Hence we suggest the following hypothesis:

**H2:** The maturity of IT-related legal system in a country is positively associated with ES adoption.

### 3.2 Firm-level Hypotheses

#### 3.2.1 Effect of Firm Size on ES Adoption

Enterprise systems promise the seamless integration of all the information flowing through an organization, and vendors alleged benefits of ES adoption are numerous. They include, for example, cost reductions, productivity improvement, quality improvement, customer service improvement, better resource management and increased profits (Laukkanen et al. 2007; Ko et al. 2008). Majority of large firms have already adopted one or more enterprise systems and smaller firms have started to adopt as well (Van Everdingen et al. 2000; Gable & Stewart 1999). However, as ES adoption is typically companied with long-term commitment and costly investments in terms of time, money and effort, adopting an enterprise system has important effects for organizations. In general, large companies are inclined to adopt ES more easily than small ones because they have good management abilities, abundant available resources, related talent, and strong infrastructures. Smaller companies, in contrast, suffer from high competition, lack of resources, financial difficulty, and the lack of professionals, which results in difficulty in adopting ES (Laukkanen et al. 2005; Chang et al. 2010; Thong 1999). In addition, Lind et al. (1989) indicated that large organizations have more advantages than small ones in the use of ES because of economies of scale. Therefore, we propose:

**H3:** Firm size is positively associated with ES adoption.

#### 3.2.2 Effect of Technology Competence on ES Adoption

Prior technology diffusion literature suggests that IS diffusion should consider technology resources or technology characteristics (Cooper & Zmud 1990). Furthermore, some scholars assert the importance of technology resources (e.g. infrastructure, technical skills and IT human resources) for successful IS adoption based on empirical evidence (Kwon & Zmud 1987; Mata et al. 1995).

Technology competence in Zhu and Kraemer’s (2005) study consists of technology infrastructure and IT human resource, where technology infrastructure refers to technologies that support IS adoption (e.g., EDI, LAN and intranet) and IT human resources refer to IT professionals possessing skills to enable implement IS. Thus technology competence reflects not only the physical foundation, but also human resources to support physical foundation (Slaughter & Ang 1995). IT infrastructure provides enterprise systems a great foundation and platform and IT human resource provide firms the necessary knowledge and skills to use the enterprise systems well. Firms with greater technology competence will be more willing to adopt ES and believe they have great capability to implement ES well and to acquire competitive advantage. This leads to the following hypothesis.

**H4:** Technology competence is positively associated with ES adoption.

#### 3.2.3 Effect of Competitive Pressure on ES Adoption

Competitive pressure refers the degree of pressure that a company feels from competitors within the same industry. It is generally believed that competition increase the possibility of innovation adoption (Thong 1999; Zhu & Kraemer 2005; Kuan & Chau 2001), especially when competitors in the same industry have adopted certain technology and acquired competitive advantage. As prior scholars
suggested, a new technology innovation adoption may give business new ways, alter industry structure, and change the rule of competition (Thong 1999; Zhu & Kraemer 2005). A firm may feel pressure when it sees more and more competitors adopting the technology and therefore feels the need to adopt in order to remain competitive (Kuan & Chau 2001; Bradford & Florin 2003). This analysis can be extended to ES adoption. In order to catch up with and even outperform rivals, firms have great pressure to adopt ES and expect to achieve the same advantage.

Many researchers have illustrated this point by empirical evidence. For example, Karakostas et al (2005) surveyed 46 financial sector companies to investigate CRM adoption and the results showed that more than half of survey respondents agreed that they adopted CRM because their competitors have done so. When a competitor embarks upon an enterprise system, firms feel a pressure to eliminate their competitor's advantage as soon as possible. Therefore, competitive pressure plays a significant role in pushing firms to adopt ES.

\[ H5: \text{Competitive pressure is positively associated with ES adoption.} \]

### 3.3 Cross-level Hypotheses

In addition to the main effects, country-level factors are also likely to moderate the effects of firm-level factors. The study here focuses on IT-related law systems to examine the cross-level interactions because legal systems is a critical factor that provide legal protection and thus increase trust in contract and transaction, which may affect decision-making of organizations (Shih et al. 2005; López de Silanes et al. 1998). In particular, we conjecture that a country's maturity of IT-related law system may moderate the effect of firm size and technology competence on ES adoption.

In a country with high maturity of IT-related law systems, firms face lower uncertainty about what legal protection they can expect, what legal recourses they would acquire when the transaction break down and feel trust to the vendors (Oxley & Yeung 2001). Only in this environment, firms feel trustful and protected to adopt ES. Larger firms with the capabilities of ES adoption will be more willing to adopt ES and implement them well in the environment of high maturity of IT-related law systems.

However, in countries with low maturity of IT-related law systems, organizations grant little legitimacy to legal contracts, relying on more informal approaches when dealing with ES contract. Even the larger firms, who have enough funds, human resources and other necessary conditions, may hesitate to adopt ES for fear of the potential risk leded by lack of relative law systems protection. Furthermore, in the countries with low maturity of IT-related law systems, the risk of information leakage will be higher. Firms are unwilling to face this kind of risk as it's difficult to solve and remedy (Dhillon & Backhouse 2000), especially for larger firms. Hence we hypothesize the following:

\[ H6: \text{The positive effect of firm size on ES adoption becomes stronger when the maturity of IT-related law systems of a country is high rather than low.} \]

Similarly, in countries without mature and effectively enforced IT-related laws and rules, despite having great technology competence, firms may still be unwilling to adopt ES. For example, a firm possesses perfect IT infrastructure and IT talents and be ready to invest in ERP system. However, there’s no clear law to protect their contract of buying ERP system in their country. The firm may feel unsafe to adopt ERP and worry about legal recourse if they are dissatisfied with the deal or some problems after the deal. Based on above consideration, firms who originally intend to purchase ERP system may eventually quit this plan and continues to use traditional but safe practice. Accordingly, we have the following hypothesis.

\[ H7: \text{The positive effect of technology competence on ES adoption becomes stronger when the maturity of IT-related law systems of a country is high rather than low.} \]
4 METHOD

4.1 Data and Variables

The data are from four sources, namely, e-Business Watch (ebusiness-watch.org), the Global Competitiveness Report from the World Economic Forum (weforum.org), Hofstede's scores of national culture (geerthofstede.com), and the World Bank (worldbank.org). Many country-level studies have used multiple data sources, which have the advantage of avoiding common method bias. E-business Watch collected data from decision makers of 14,065 enterprises in 10 sectors across 29 European countries through computer-aided telephone interviews (N=11,072 at the firm level and N=22 at the country level in the final sample due to missing data). E-business Watch conducted the survey in March and April 2006 and randomly selected companies to ensure that those in the sample were representative of the respective industry in terms of firm size and age.

4.1.1 Dependent Variable

Enterprise systems include one or more of the following applications: Enterprise Resource Planning (ERP), Supply Chain Management (SCM), and/or Customer Relationship Management (CRM) systems (Hendricks et al. 2007). In our research, enterprise systems adoption, the dependent variable, was measured with these three items that reflect the company’s adoption extent of enterprise systems, which is from the 2006 e-Business Watch data. We gave value 1 to one item (e.g., ERP, SCM, and CRM) if a firm has adopted corresponding application.

4.1.2 Independent Variables at the Country Level

Following prior research (Van Everdingen & Waarts 2003; Hwang 2005; Erumban & De Jong 2006), uncertainty avoidance is from Hofstede's website. The maturity of the IT-related legal system is drawn from the Global Competitiveness Report. This study used the index of “laws relating to ICT” from the 2006 report to measure the variable “the maturity of the IT-related legal system.” The survey question asked in determining this index was “To what extent laws relating to information and communication technologies are well developed and enforced?” Respondents can choose from a scale of 1 to 7. This measure is consistent with previous research (Boyer-Wright & Kottemann 2008; Yap et al. 2006; Qu & Pinsoneault 2011).

4.1.3 Independent Variables at the Firm Level

Firm size was measured by the number of employees, and was divided into four types: small size (10-49 employees), medium size (50-249 employees), large size (250-999 employees), and very large size (1000+). We gave value 1 to small size, 2 to medium size, 3 to large size and 4 to very large size. It is similar to other studies that have investigated the effect of firm size on IS adoption (Buonanno et al. 2005; Laukkanen et al. 2005; Ko et al. 2008).

Technology competence in our study consists of technology infrastructure, IT human resource, and IT investment. Technology infrastructure refers to technologies that support enterprise systems (e.g., EDI, Lan and intranet), IT human resources refer to IT professionals possessing skills to enable implement enterprise systems, and IT vestment is the premise of above two factors, following prior studies (Zhu & Kraemer 2005).

Competitive pressure refers to the degree of pressure that the company feels from competitors. It is measured based on two questions:

1. Did your company engage in e-business because your company believes that e-business will help to get an edge over your competitors?
2. Did you engage in e-business because your competitors also engage in e-business?

E-business is characterized by firms activities conducted through IT. A tighter integration of business and IT systems is already a distinct feature of e-business (Gordijn et al. 2001). Many scholars claimed
the strong relationship between e-business and ERP (Norris et al. 2000), CRM (Tiwana & Williams 2000; Weill & Vitale 2002), and SCM (Gordijn et al. 2001). Thus we use above two questions to measure the competitive pressure because that ES are main technologies supporting e-business. Respondents choose “yes” (1) or “no” (0) or “don’t know” according their own situation. This measure is consistent with previous research on CRM adoption (Karakostas et al. 2005).

4.1.4 Control Variables

As scholars suggested, economic development has significant effect on IS diffusion (Karakostas et al. 2005; Oxley & Yeung 2001). A richer country will have access to the necessary resources and capital required for adoption and upgrade of enterprise systems. Therefore, we should control its effect on ES adoption. The measurement of economic development of a country derived from the World Bank, which is the GDP at purchasing power parity (PPP) per capita in 2006. Prior studies have widely used GDP to represent a country's economic development level (Oxley & Yeung 2001; Franke & Nadler 2008; Spencer & Gomez 2004).

We also used dummy variables to control the effect of industry sectors as industry factors may influence results. Take CRM for example, the CA magazine 2012 CRM Survey (www.camagazine.com) suggested CRM is popular in industries such as manufacturing and wholesale trade, while few CRM vendors provide CRM to public administration. We use nine dummy variables represent 10 industries and data is from e-Business Watch.

4.1.5 Factor Analysis

Following prior research (Ward & Zhou 2006; Straub et al. 2004), factor analysis was conducted to evaluate the construct validity. Measurement items for enterprise systems adoption, technology competence, and competitive pressure were used as input for factor analysis. We used the polychoric correlation matrix as the input for factor analysis because the Pearson correlation matrix is often distorted for ordinal and dichotomous variables (Zumbo et al. 2007). The result indicates that there are four factors (eigenvalues larger than one). Table 2 shows the factor loadings from the analysis based on a varimax rotation. All measurement items load heavily on their corresponding factors with loadings higher than 0.7, which indicates a good convergent validity (Hair et al. 1998). At the same time, measurement items correlates weakly with all other factors, which indicates the discriminant validity of our measures (Gefen & Straub 2005).

<table>
<thead>
<tr>
<th>Measurement items</th>
<th>Factor1</th>
<th>Factor2</th>
<th>Factor3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise Resource Planning (ERP)</td>
<td>0.797</td>
<td>0.225</td>
<td>-0.044</td>
</tr>
<tr>
<td>Supply Chain Management (SCM)</td>
<td>0.880</td>
<td>-0.086</td>
<td>0.058</td>
</tr>
<tr>
<td>Customer Relationship Mgmt (CRM)</td>
<td>0.732</td>
<td>0.291</td>
<td>0.071</td>
</tr>
<tr>
<td>Technology infrastructure</td>
<td>0.372</td>
<td>0.756</td>
<td>0.062</td>
</tr>
<tr>
<td>IT human resource</td>
<td>0.227</td>
<td>0.807</td>
<td>0.040</td>
</tr>
<tr>
<td>IT investment</td>
<td>-0.080</td>
<td>0.849</td>
<td>0.009</td>
</tr>
<tr>
<td>Competitors actions</td>
<td>-0.250</td>
<td>-0.026</td>
<td>0.815</td>
</tr>
<tr>
<td>Competitors acquired advantage</td>
<td>0.089</td>
<td>0.101</td>
<td>0.780</td>
</tr>
</tbody>
</table>

Table 2: Factor analysis based on polychoric correlation matrix

To simplify the data analysis, we adopted summated scales for all key constructs. That is, the value of enterprise systems adoption was calculated as the number of enterprise systems (i.e., ERP, SCM, and CRM) that a company has adopted, with a range from 0 to 3. The value of technology competence was set as the sum of its three measurement items, with a range from 0 to 3. Similarly, the value of competitive pressure was also set as the sum of their corresponding measurement items, with a range
from 0 to 2. The mean statistics and correlation matrix of the main country-level variables are presented in Table 3.

<table>
<thead>
<tr>
<th>Measurement items</th>
<th>Mean</th>
<th>ES adoption</th>
<th>Uncertainty avoidance</th>
<th>Maturity of IT law systems</th>
<th>GDP per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES adoption</td>
<td>0.524</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncertainty avoidance</td>
<td>70.480</td>
<td>0.208</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maturity of IT law systems</td>
<td>5.127</td>
<td>0.121</td>
<td>-0.572**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>GDP per capita</td>
<td>21287.097</td>
<td>0.025</td>
<td>-0.430*</td>
<td>0.795**</td>
<td>1</td>
</tr>
</tbody>
</table>

* p<0.05; ** p<0.01

Table 3: Means and correlation matrix in country-level

4.2 Analytical Approach

The data of the study have a hierarchical structure, with firms nested within countries. To test the hypotheses, this study uses a multi-level model to simultaneously estimate both firm- and country-level effects. The level-1 (firm level) model for ES adoption is:

\[ ES \text{ adoption} = \beta_0 + \beta_1 \text{ Firm size} + \beta_2 \text{ Technology competence} + \beta_3 \text{ Competitive pressure} + \beta_x \text{ Dummy_Industries} + r \]

where \( \beta_0 \) is the intercept, \( \beta_1, \ldots, \beta_x \) are regression coefficients for \( \text{Firm size}, \text{Technology competence}, \text{Competitive pressure} \) and control variable. And \( r \) is the firm-level error term.

The level-2 (country-level) model is as follows:

\[
\beta_0 = \gamma_{00} + \gamma_{01} \text{ Law} + \gamma_{02} \text{ GDP} + \gamma_{03} \text{ UAI} + u_0 \\
\beta_1 = \gamma_{10} + \gamma_{11} \text{ Law} + \gamma_{12} \text{ UAI} + u_1 \\
\beta_2 = \gamma_{20} + \gamma_{21} \text{ Law} + \gamma_{22} \text{ UAI} + u_2 \\
\beta_3 = \gamma_{30} + \gamma_{31} \text{ Law} + \gamma_{32} \text{ UAI} + u_3 \\
\ldots \\
\beta_x = \gamma_{x0} + u_x
\]

where \( \beta_0 \) is the intercept of the level-1 model, which relates to a country's uncertainty avoidance (UAI), maturity of IT-related law systems (Law) and economic development(GDP). \( \beta_1 \) and \( \beta_2 \) are the coefficients of Firm size and Technology competence in the level-1 model, which associate with a country's uncertainty avoidance (UAI) and maturity of IT-related law systems (Law). \( u_0, u_1, \) and \( u_2 \) represent the level-2 error terms. However, we subsequently constrained \( \beta_x \) of dummy variables (industries) to be constant across countries (i.e., \( u_x = 0 \)) in order to solve the under-identification problem in the initial model.

4.3 Results

The statistical package HLM6 was used to analyze the multi-level model in our study. All country-level independent variables and all non-dummy firm-level independent variables were standardized
before the multi-level analysis in order to simplify the interpretation of the results (Raudenbush 2002). The analysis result is shown in Fig.2.

At the country-level, we find that uncertainty avoidance is positively related to ES adoption ($\beta=0.129$, $p<0.05$). Therefore, H1 is supported because the result shows that ES are more popular in higher uncertainty avoidance orientation countries. However, we didn’t find positive association between maturity of IT-related law systems and ES adoption ($\beta=0.082$, $p>0.1$). This is possibly because of the relative small sample size at the country level.

At the firm-level, H3 predicts that firm size associates positively with ES adoption. Consistent with H3, the results show a positive relationship between firm size and firm ES adoption ($\beta=0.113$, $p<0.01$). H4 is also supported as the relationship between technology competence and ES adoption is positive ($\beta=0.206$; $p<0.01$). This result indicates that firms will be more willing to adopt ES if they have high technology competence. Furthermore, we find that the relationship between competitive pressure and ES adoption is positive ($\beta=0.046$; $p<0.1$). Thus H5 is supported as well. The result indicates that if a firm observes its competitors in the industry have adopted ES, it will catch up with competitors and adopt ES too.

For the cross-level, H6 predicts the positive effect of firm size on ES adoption becomes stronger when the maturity of IT-related law systems of a country is high rather than low. Consistent with H6, the results confirm it ($\beta=0.038$; $p<0.1$), but with weak significance. H7 proposes that the maturity of IT-related law systems moderates the effects of technology competence on ES adoption at the firm level, in a way that the effect of firm size becomes stronger with the increase of the maturity. Supporting H7, maturity of IT-related law systems affects the relationship between firm size and ES adoption positively ($\beta=0.021$, $p<0.05$).

In terms of control variables, we find a positive but not significant relationship between GDP and ES adoption ($\beta=0.020$, $p>0.1$). And industry sectors also have an influence on ES adoption. Firms in the telecommunications industry and ICT manufacturing industry are the most likely to adopt ES, while those in the food and beverages industry are among the least likely to adopt OSS.

**Firm level**

\[
\begin{align*}
\text{Firm size} & \rightarrow 0.113^{**} \\
\text{Technology competence} & \rightarrow 0.206^{**} \\
\text{Competitive pressure} & \rightarrow 0.046^{†} \\
\text{ES adoption} &
\end{align*}
\]

\begin{align*}
\text{Country level} & \\
\text{Uncertainty avoidance} & \rightarrow 0.038^{†} \\
\text{IT-related legal system} & \rightarrow 0.021^{*} \\
\end{align*}

$\dagger p<0.10; \; * p<0.05; \; ** p<0.01$(two-tail)

*Figure 2. The multi-level model of ES adoption and analysis results*
5 DISCUSSION

5.1 Main Findings

With a multi-level framework, this study examines how two country-level factors, three firm-level variables, and the interactions between them affect firm ES adoption. Our work offers several important contributions.

Firstly, country-level factors do play an important role in ES adoption. As expected, the uncertainty avoidance is positively associated with ES adoption, which seems inconsistent with prior research (Van Everdingen & Waarts 2003). We believe that this is because integrated information sharing in ES can reduce uncertainty. In addition, enterprise systems are becoming more and more mature and their value has been proven in the market. Therefore, the adoption of ES may not be considered as a risky activity any more.

Secondly, the results show that all the firm-level factors (firm size, technology competence and competitive pressure) have significantly positive effects on ES adoption, which is consistent with extant literature (Laukkanen et al. 2005; Buonanno et al. 2005; Chang et al. 2010). However, only focusing firm-level factors are inadequate to understand why firms adopt ES. Thus we develop this multi-level framework.

Finally, the maturity of IT-related law systems moderate the positive effects of firm size and technology competence on ES adoption in a way that the impact of firm size becomes bigger and technology competence becomes stronger with the increase of the maturity. The findings suggest that, even larger firms with strong technology competence, in a country with immature IT-related law systems, may hesitate to adopt ES for fear of the potential risk leaded by the lack of law protection.

5.2 Implications for Research and Practice

Our study contributes to the literature by investigating the antecedents of ES adoption at different levels. Although several studies have researched this issue, these studies usually focus on only firm level (Laukkanen et al. 2005; Buonanno et al. 2005; Chang et al. 2010; Law & Ngai 2007; Ko et al. 2008; Hung et al. 2010) or national culture (Van Everdingen & Waarts 2003; Hwang 2005; Rajapakse & Seddon 2005). Little attention has been paid to other country-level factors. To fulfill this research gap, our study first attempts to explore the effect of country-level factors (including culture and law) on ES adoption and develops a multi-level framework. Further, the present research is the pioneer to explore the interplay of the maturity of IT-related law systems at the country level and two factors at the firm level. The results show that the effect of firm size and technology competence on ES adoption becomes stronger with the increase of maturity of IT-related law systems. These cross-level interactions are novel and important, and point out new research avenues for future researchers to integrate firm- and country-level effects in studying technology innovation in general and ES adoption in particular.

The results also offer implications to practitioners. On the one hand, our study provides important implications for governments. The result shows that a country's uncertainty avoidance positively affects firms ES adoption. Thus countries with high uncertainty avoidance may highlight the benefits of reliability and security when promoting ES adoption. Moreover, to promote ES adoption, governments should enact and improve IT-related law. On the other hand, we offer implications for ES vendors as well. Another finding of this study is that firms in a country with high maturity of IT-related law systems are more likely to adopt ES. Furthermore, the maturity of IT-related law systems moderate the positive effects of firm size and technology competence on ES adoption in a way that the impact of firm size becomes bigger and technology competence becomes stronger with the increase of law maturity. Therefore, ES vendors should consider the country's law systems before entering in a new country as firms in low maturity of IT-related law systems will be unwilling to adopt ES. In addition, ES vendors may enter high uncertainty avoidance countries. Our results suggests that firms in countries with high uncertainty avoidance are more likely to adopt ES, probably because
firms use ES as tools to reduce uncertainties involved in information asymmetry and information delay.

5.3 Limitation and Future Research Directions

Despite the above implications, the study still has three limitations and can be extended by future research. Firstly, as Rosenberg (1972) claimed, variables—social, legal and institutional as well as economic and technological—which might retard the diffusion process is virtually limitless. Our study only includes legal and cultural factors. Future research may further investigate more country-level factors, such as social trust and other institutional factors. Secondly, this study only focuses on the moderation of maturity of IT-related law systems. However, other country-level factors are also likely to moderate the effects of firm-level factors. Future research needs to expand this study by investigating moderation effect of other country-level factors. Finally, the sample of this study, mainly from European countries, may have some cultural similarities and other similarities. Future study should identify different culture, including both western countries and eastern countries.

6 CONCLUSION

This study finds that country-level factors may significantly affect a firm's adoption of ES. In addition, country-level factors may also play moderating roles in the adoption of ES. These findings expand existing studies that mainly focus on the effects of firm-level factors or national culture on ES adoption. And the results in our study deepen the understanding of the role of country contexts in ES adoption, which offer significant implications for both governments and ES vendors. When government promoting ES adoption or ES vendors entering a new country, they should not simply copy successful practice in other countries, but consider country-specific contexts.

Reference


Weill P. and Vitale M. (2002). What IT infrastructure capabilities are needed to implement e-business models. MIS Quarterly Executive, 1(1), 17-34.


