



Impact of experience on open inter-organizational systems adoption

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Abstract

Purpose – Little research to date has investigated how firm experience and industry experience in related inter-organizational systems (IOS) affect the adoption of open IOS. The purpose of this paper is to address this issue.

Design/methodology/approach – Based on large-scale archival data from European countries, logistic regression was used to test the research model.

Findings – It was found that firm experience in EDI and experience in proprietary IOS positively affect the adoption of open IOS; industry experience in EDI and experience in proprietary IOS have a negative effect on the adoption of open IOS; and industry experience in open IOS has a positive effect on the adoption of open IOS.

Research limitations/implications – One main limitation is that the measures of the variables are based on single-item and dichotomous scales. Also, this study only focused on the industry level and alternative explanations for the results have not been ruled out. The main implication is that IOS experience at firm and industry levels should be distinguished, as they can have different effects on the adoption of open IOS.

Originality/value – This paper is among the first that examines how the experience in prior generations of IOS affects the adoption of open IOS. Furthermore, the authors expand the literature by distinguishing IOS experience at two levels – firm level and industry level and show that it is necessary to recognize the different roles of different types of experience.

Keywords Supply chain management, Systems analysis, Open systems, Systems software, Europe

Paper type Research paper

1. Introduction

Supply chains are increasingly replacing individual firms as the competitive unit in many industries (Cheng *et al.*, 2010; Swaminathan and Tayur, 2003). The IT underlying supply chains is inter-organizational systems (IOS), which connect the business processes of two or more organizations in a supply chain by providing a common IT platform (Robey *et al.*, 2008). The key role of IOS in improving supply chains by dramatically facilitating inter-firm collaboration has been emphasized by research (Kess *et al.*, 2010; Rai *et al.*, 2006). It is suggested that IOS-enabled supply chain collaboration such as information sharing and collaborative forecasting can be a source of competitive advantage (Subramani, 2004; Swaminathan and Tayur, 2003).

The authors thank the National Natural Science Foundation of China (No. 70732001) and the Humanities and Social Sciences Youth Grant of China Ministry of Education (10YJC630195) for financial support and E-Business Watch for providing research data.



Three generations of IOS have been identified – proprietary, EDI-based, and open IOS (Zhu *et al.*, 2006). With the recent development of open standards such as RosettaNet and CIDX, firms are increasingly deploying open IOS due to their advantages such as flexibility, real-time, wide message coverage, and cost-saving (Bala and Venkatesh, 2007; Chong and Ooi, 2008). Research has reported that firms can benefit from the implementation of open IOS via the improvement in flexibility, knowledge creation, operational performance as well as strategic performance (Gosain *et al.*, 2004; Malhotra *et al.*, 2007).

Several studies have investigated factors that either facilitate or inhibit firm adoption of open IOS. For instance, Zhu *et al.* (2006) showed that firms are more likely to adopt open IOS when the network effects of open IOS are present and when there is a high level of expected benefits. Bala and Venkatesh (2007) reported that firm ability and willingness to overcome resource rigidities can promote the adoption of open IOS. However, little research to date has examined how firm experience and industry experience in prior generations of IOS influence a firm's adoption of open IOS. Does the experience in prior generations of IOS facilitate the adoption of open IOS? Is there a difference between EDI and proprietary IOS regarding their effects on the adoption of open IOS? Will the adoption of open IOS be affected by both firm and industry experience in related IOS? All of these are unanswered questions.

Our study addresses above issues by investigating the impact of firm and industry experience in related IOS on the adoption of open IOS. Our research contributes to the literature in two important ways. First, three generations of IOS have been identified in the literature. However, our understanding on how the experience in prior generations of IOS affects the adoption of the latest open IOS is still limited. Research has suggested that history in related technologies matters in the adoption of a new technology due to path dependency (Arthur, 1989; Cohen and Levinthal, 1990). Therefore, it is important to investigate how history matters in the adoption of open IOS. Second, we posit that there are different types of history that matter in different ways in influencing open IOS adoption. More specifically, we distinguish IOS experience at two levels – firm level and industry level. While it is well known that history matters in new technology adoption, we posit that it is necessary to recognize the different roles of different types of history.

2. Research background

Recently, information systems (IS) scholars have adopted the IT-enabled organizational capabilities perspective to understand the business impact of IT (Benitez-Amado *et al.*, 2010; Melville *et al.*, 2004). The basic tenet of this view posits that the main role of IT is to create or enhance higher order organizational capabilities, which are the central aspects of firm performance. Many IT-enabled organizational capabilities have been documented such as capabilities in intrapreneurship (Benitez-Amado *et al.*, 2010), new product development (Pavlou and El Sawy, 2006), and green management (Benitez-Amado *et al.*, 2011). With the increasing importance of knowledge in today's business, the role of IT in developing knowledge management capabilities has also been noticed (Chen *et al.*, 2010; Li and Tsai, 2009). In the area of supply chain management, the key role of IOS in shaping supply chain collaboration has been particularly emphasized in the literature (Rai *et al.*, 2006; Swaminathan and Tayur, 2003).

In this paper, IOS refer to IS employed in inter-organizational contexts to mediate buyer-supplier transaction and collaboration. They are usually shared by two or more

organizations, and designed to link business processes between trading partners in a supply chain (Robey *et al.*, 2008). With the aid of common databases, communication networks, and common applications provided by IOS, firms can transact and collaborate with their supply chain partners by exchanging both structured (e.g. billing and CAD/CASE) data and unstructured (e.g. discussion and customer feedback) data stored in repositories. While early forms of IOS primarily support the automation of manual processes such as ordering and settling accounts, a range of new features for information sharing, communication, and collaboration have subsequently enhanced these systems (Shi *et al.*, 2010; Subramani, 2004).

The standards of IOS have gone through three generations: proprietary, EDI and open standards (Markus *et al.*, 2006; Zhu *et al.*, 2006). Proprietary standards are developed by and available only to a closed set of firms, and require a private communication platform (e.g. the ASAP system of American Hospital Supply Corporation) (Venkatraman and Short, 1992). In contrast, open standards are usually developed by a non-profit organization (e.g. an industry consortium) and use public communication platforms and software (e.g. RosettaNet in the electronics industry) (Gosain *et al.*, 2004; Markus *et al.*, 2006). EDI standards are the intermediate generation between proprietary and open standards. Although the two widely used EDI standards (i.e. ANSI X12 and EDIFACT) are developed by non-profit organizations and available to the public, the implementation of EDI-based IOS often involves relationship-specific customization and uses privately owned value-added network. As a result, EDI standards have more openness than proprietary standards, but have less openness than open standards (Zhu *et al.*, 2006).

With the fast development of open standards such as RosettaNet (electronics industry), CIDX (chemical industry) and ebXML (cross-industries), firms are increasingly deploying open standards-based IOS (Bala and Venkatesh, 2007; Zhu *et al.*, 2006). Studies typically posit that open IOS are the next generation of IOS and superior to the traditional proprietary IOS or EDI. Four advantages of open IOS over prior IOS have been documented in the literature. First, open IOS are often less costly than proprietary IOS and EDI because the latter two usually use the expensive privately owned networks as deliver platforms while open IOS rely on public networks such as the internet (Zhu *et al.*, 2006). Second, the technical features of open IOS such as event driven make the flow of messages more real-time than that of prior IOS, which facilitates firms to implement advanced supply chain practices such as just-in-time program (Kauremaa *et al.*, 2010; Malhotra *et al.*, 2007). Third, open IOS generally have a wider coverage of messages for transaction and collaboration activities than there are within EDI standards as the update of messages is usually much faster with open IOS than with EDI (Chong and Ooi, 2008; Kauremaa *et al.*, 2010). A wide coverage of messages, in turn, can facilitate firms to engage in supply chain collaboration such as information sharing and collaborative forecasting. Finally, and most importantly, open IOS are more likely to facilitate many-to-many inter-organizational coordination due to their more flexible and easy-to-learn formats and less partner-specific customization (Gosain *et al.*, 2004; Zhu *et al.*, 2006). Unlike proprietary or EDI-based IOS that usually involve customized one-to-one connection, firms have implemented open IOS can easily connect to other trading partners via open standards without the occurrence of additional high costs.

3. Hypotheses

In this paper, we propose that firm- and industry-levels experience in prior IOS will have significant impacts on the adoption of open IOS (Figure 1).

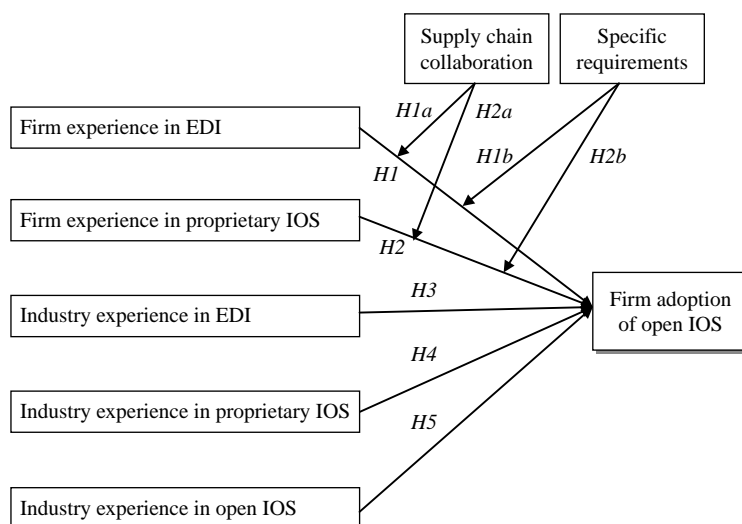


Figure 1.
Research model

3.1 The effect of firm experience

A firm's experience in prior technologies may increase its absorptive capacity for a new technology and thus facilitate the firm to adopt the new technology. Absorptive capacity refers to a firm's ability to value, assimilate, and apply new knowledge or technology, and it can be influenced by a firm's development path (Cohen and Levinthal, 1990; Zahra and George, 2002). In using a prior technology, firms may cultivate knowledge and skills for deploying and using a new generation of technology. Acquired primarily through learning-by-doing, such knowledge and skills can be viewed as the primary components of absorptive capacity and are often transferable from one generation of technology to the next (Cohen and Levinthal, 1990; Wheeler, 2002). Thus, the adoption of a new technology should be facilitated by the availability of related knowledge and skills of prospective users. For instance, Fichman and Kemerer (1997) showed that a firm's prior knowledge in activities such as C language programming and client-server application development have a positive effect on its adoption of object-oriented programming languages.

IT is one type of "complex organizational technologies," i.e. technologies that, if introduced, impose a substantial burden on would-be adopters in terms of the knowledge needed to use them effectively (Attewell, 1992). As a result, sufficient knowledge and skills are required to implement and operate such complex technologies successfully. When firms have accumulated knowledge and skills on related technologies, however, the implementation and operation of such complex technologies become much easier. Research on IT adoption has shown that prior knowledge in IT can be an important facilitator for adopting new IT (Attewell, 1992; Fichman and Kemerer, 1997). Zhu *et al.* (2006), for instance, found that EDI users, with prior experience of using electronic IOS, tend to have lower adoption costs for open IOS than EDI nonuser.

The idea that the experience in prior technologies develops a firm's absorptive capacity is also consistent with the theory of net-enabled business innovation cycle (NEBIC) (Wheeler, 2002). The NEBIC suggests that, in order to generate customer

value from the business use of emerging IT, firms should develop four types of dynamic capabilities: choosing emerging/enabling IT, matching with economic opportunities, executing business innovation for growth, and assessing customer value. In this view, these four dynamic capabilities are applicable to different types of IT applications and are primary components of absorptive capacity for adopting and exploiting emerging new IT applications (Wheeler, 2002). The theory of NEBIC can be viewed as an extension of the IT-enabled organizational capabilities perspective in turbulent environments where organizational capabilities need continuous renewal by applying NEBIC-related dynamic capabilities to emerging IT (Benitez-Amado *et al.*, 2010; Pavlou and El Sawy, 2006). If these dynamic capabilities have been developed by firms in the past during the utilization of prior IT, they can facilitate firms to adopt and exploit new IT applications in the future. In short, research has suggested that the experience in prior technologies will facilitate firms to adopt new technologies, an idea that is also applicable in the case of IOS. Since there are two generations of IOS prior to open IOS (i.e. proprietary IOS and EDI), we propose the following two hypotheses:

- H1. A firm's adoption of open IOS will be positively affected by its experience in EDI.
- H2. A firm's adoption of open IOS will be positively affected by its experience in proprietary IOS.

3.2 The influence of moderating effects

Furthermore, the effect of firm experience in prior IOS on open IOS adoption may be moderated by contextual factors. In this paper, we consider two of such factors – supply chain collaboration and specific requirements in transaction. As stated previously, one of advantages of open IOS over prior IOS is the easiness to connect to new trading partners. When the supply chain collaboration between trading partners is intensive, the two parties in transaction are supposed to have a cooperative relationship with each other (Klein *et al.*, 2007). With this cooperative relationship, it is less likely for firms in the relation to change their trading partners. Accordingly, even if open IOS make the switch of trading partners easier, this feature is not attractive to firms with cooperative relationship with trading partners. Without this motivation, firms may not be willing to adopt open IOS even though they have gained enough knowledge and skills during the use of proprietary IOS and EDI. That is to say, the effect of proprietary IOS and EDI experience on open IOS adoption may be negatively moderated by the level of supply chain collaboration between trading partners.

In addition, another advantage of open IOS over prior IOS is the wide coverage of messages related to transaction and collaboration activities. Again, this feature of open IOS may not be that attractive to firms that already have intensive collaboration with trading partners. Recall that the main benefit that firms can get from the wide coverage of messages is that they can develop new collaboration practices with trading partners based on these messages. If a firm has already engaged in intensive supply chain collaboration, this feature of open IOS will not offer much additional value to the firm. Therefore, the firm may not be willing to adopt open IOS in this case even if it has the capability to do so. As a result, again, the effect of proprietary IOS and EDI experience on open IOS adoption may be negatively moderated by the level of supply chain collaboration:

H1a. The effect of firm EDI experience on open IOS adoption will be negatively moderated by the level of supply chain collaboration between trading partners.

H2a. The effect of firm proprietary IOS experience on open IOS adoption will be negatively moderated by the level of supply chain collaboration between trading partners.

The level of specific requirements in transaction may also moderate the effect of proprietary IOS and EDI experience on open IOS adoption. In order to promote wide diffusion, open IOS are often designed to incorporate the common goal of various stakeholders instead of individual specific needs (Markus *et al.*, 2006). However, different industries and different firms usually have different requirements in transaction. As a result, some specific requirements of firms in certain industries may not be fulfilled by open IOS. In this case, firms may not choose to adopt open IOS; instead, they may choose to develop customized proprietary IOS or EDI-based IOS that can meet their specific requirements. In other words, even if firms have obtained enough knowledge and skills for adopting open IOS from the experience of prior IOS, they may not choose to do so if there is a high level of specific requirements in their transactions. Accordingly, the effect of firm proprietary IOS and EDI experience on open IOS adoption may be negatively moderated by the level of specific requirements in transaction:

H1b. The effect of firm EDI experience on open IOS adoption will be negatively moderated by the level of specific requirements in transaction.

H2b. The effect of firm proprietary IOS experience on open IOS adoption will be negatively moderated by the level of specific requirements in transaction.

3.3 The effect of industry experience

Besides, a firm's own experience, other firms' experience in related IOS may also matter in the adoption of open IOS. Research suggests that a firm may be trapped into an old technology even though a newer, superior, but incompatible technology is available, if other firms are still using the old technology (Arthur, 1989). A classic example of this lock-in phenomenon is the QWERTY keyboard. Although there are better standards for keyboard layout available, the QWERTY layout persist, evolving from typewriter keyboard more than one century ago to computer keyboard nowadays (David, 1985). A main reason for this lock-in is the network effects of the old technology (Arthur, 1989). Many technologies have the characteristic of network effects – the more users of a technology, the higher value of the technology to prospective users. Take telephones as an example. The more people use telephones, the more value a telephone can offer to its owner as he/she can reach more people via telephones. Although the positive value of network effects is attractive, it may lock a firm into an old, inferior technology. While an old inferior technology with network effects gets a large user base, prospective users may gain more value by adopting the old technology than by adopting a new superior technology. In this case, firms may stick with the old, inferior technology, instead of migrate to the new technology.

The economic benefit deriving from network effects is not the only reason that a firm adopts the technology that other firms currently use. Institutional pressures, particularly mimetic pressures, can be another driving force. Institutional theory

posits that firms may mimic other firms' actions when facing ambiguous and uncertain problems as imitation can be an efficient solution to solve such problems (DiMaggio and Powell, 1983). This imitative behavior also has a ritual aspect; firms adopt the same technology to enhance their legitimacy and to demonstrate that they are at least making an effort to advance their technologies or management. Taken together, under network effects and mimetic pressures, a firm is more likely to adopt a technology that is widely used by other firms.

Many IT applications have network effects, especially those with networking and communication features such as internet, B2B e-commerce, electronic payment systems and videoconferencing technology (Forman and Goldfarb, 2006). The network effects of IOS have also been noticed in the literature. For instance, Zhu *et al.* (2006) found that firms are more likely to adopt internet-based IOS when many firms in its trading community (e.g. customers, suppliers, and peers companies) are also using internet-based IOS. The degree of IOS network effects depends on the popularity and interoperability of IOS standards. Usually, the more popular an IOS standard, the higher value a user can gain from the network effects of IOS (Arthur, 1989). But the interoperability of IOS standards also matters. The more interoperability an IOS standard has, the more likely firms will be willing to adopt this standard. Research has suggested that open IOS are the most interoperable and have the highest potential popularity, followed by EDI and proprietary IOS in order (Zhu *et al.*, 2006). As a result, open IOS have the highest network effects, followed by EDI and proprietary IOS.

The two most widely used EDI data standards are EDIFACT and ANSI X12. Both data standards are developed by public consortia, and thus are considered more open than earlier proprietary standards that are owned by only one or a few firms (David and Greenstein, 1990; Venkatraman and Short, 1992). The use of public data standards lowers the asset specificity of EDI compared with proprietary IOS like ASAP, since the content platform supports communications with a larger number of firms in the trading partner base (Zhu *et al.*, 2006). Owing to the moderately high interoperability and popularity of EDI, EDI can involve substantial network effects. Further, the popularity of EDI may also give firms mimetic pressures when adopting IOS. Because of the network effects and mimetic pressure associated with EDI, firms may be inhibited from adopting open IOS when other firms are using EDI. It should be noted, however, above proposition is based on insights from network effects research and institutional theory. Counter-arguments may be developed based on other theories such as the resource-based view (Barney, 1991) and institutional entrepreneurship (Garud *et al.*, 2002). For instance, entrepreneurial firms may foresee the value potential of open IOS and choose to differentiate themselves from their competitors by implementing open IOS. In this paper, however, we stick to the first proposition because entrepreneurial firms are supposed to be rare.

Network effects and mimetic pressures can be examined at different levels. In this paper, we limit our focus at the industry level. That is, we are interested in whether a firm's adoption of open IOS will be either facilitated or inhibited by industry experience in related IOS (defined as other firms' use of related IOS in the same industry). As the intensity of network effects and mimetic pressures increases with the popularity of EDI in an industry, a firm will be less likely to migrate to open IOS when EDI is widely used in its industry:

H3. A firm's adoption of open IOS will be negatively affected by industry experience in EDI.

Unlike EDI which is used by many firms, proprietary IOS are available only to a closed set of firms (Venkatraman and Short, 1992) and involve low network effects. This may limit their impact on open IOS adoption. On the other hand, as suggested above, firms may mimic other firms' actions when facing ambiguous and uncertain problems (DiMaggio and Powell, 1983). IT management often faces such type of ambiguous and uncertain problems because IT management has been made particularly complex by the uncertainties surrounding the proliferation of competing standards, the introduction of new applications, and the risk of technological obsolescence. As a result, mimic behaviors often occur in IT management. In the case of IOS adoption decision, firms may also mimic other firms' actions (Teo *et al.*, 2003). While there are a lot of firms using proprietary IOS in an industry, it may give the focal firm an institutional pressure to copy the same action. As a result, the adoption of open IOS may be hampered by the utilization of proprietary IOS in an industry. As a result, other firms' experience in proprietary IOS in the same industry (i.e. industry experience in proprietary IOS) may also have a negative influence on firm adoption of open IOS:

H4. A firm's adoption of open IOS will be negatively affected by industry experience in proprietary IOS.

Finally, industry experience in open IOS (i.e. other firms' experience in open IOS in the same industry) may affect firm adoption of open IOS as well. As suggested above, open IOS have the strongest network effects among the three generations of IOS. The network effects may attract firms to adopt open IOS as they provide additional value to firms. In addition, as suggested by the institutional theory, firms may also follow other firms in adopting open IOS due to mimetic pressures. Because the networks effects and mimetic pressures are associated with the popularity of open IOS, we posit industry experience in open IOS should have a positive effect on firm adoption of open IOS:

H5. A firm's adoption of open IOS will be positively affected by industry experience in open IOS.

4. Method

4.1 Data and variables

Our analysis is based on data from E-Business Watch (available at: ebusiness-watch.org), an organization developed and managed by the European commission. E-Business Watch collects data relating to the use of ICT and e-business in European enterprises by means of representative surveys. In 2006, E-Business Watch interviewed decision makers of 14,065 enterprises in ten industries across 29 European countries about their uses of e-business and related issues. Owing to missing data, our final sample includes 8,490 enterprises in ten industries across 26 countries. Interviews were carried out in March and April 2006, using computer-aided telephone interview technology. The sample drawn was a random sample of companies from the respective sector population with the objective of fulfilling strata with respect to business size. It should be noted that E-Business Watch has also conducted surveys more recently in 2007 and 2009. However, these surveys only cover a few industries, which are not enough to test our hypotheses. Therefore, this study uses data from the 2006 survey. Data from E-Business Watch have been used in previous research (e.g. Koellinger, 2008). Our study relies on a subset of data that is different from previous research.

The dependent variable – firm adoption of open IOS (Open) was derived from participating firms' response to one question in the E-Business Watch survey: "Does your company use XML-based standards such as ebXML, RosettaNet, UBL?" ("yes" – 1; "no" – 0). For independent variables, we measured firm experience in prior IOS by whether a firm has experience in EDI/Proprietary IOS. In the E-Business Watch survey, there is a question asking: "Please tell us which of the following technical standards your company uses". EDI and proprietary IOS are two non-exclusive options that firms can choose. We gave value 1 to the variable firm experience in EDI (EDI) if a firm has used EDI-based standards (e.g. EDIFACT, EANCOM, ANSI X12 or TRADACOM) and gave the value 0 if it has not. Similarly, firm experience in proprietary IOS (Proprietary) was set to be 1 if a firm has used proprietary standards agreed between itself and business partners, and to be 0 otherwise.

As the same industry in different countries will have different levels of network effects, we need to treat them as different units. As a result, totally we have 180 industries across 26 countries. In order to obtain value for industry experience in EDI (IndEDI) and industry experience in proprietary IOS (IndProprietary), we calculated the ratio of firms that have used EDI and proprietary IOS in an industry, respectively, (the focal firm is excluded). A high value of industry experience in EDI/proprietary IOS indicates a wide usage of EDI/proprietary IOS in an industry. Finally, we measured industry experience in open IOS (IndOpen) using the ratio of firms that have adopted open IOS in an industry (the focal firm is excluded).

For moderating variables, supply chain collaboration (Collab) between trading partners was measured based on two questions:

- (1) Do you use online applications other than e-mail to collaborate with business partners to forecast product or service demand?
- (2) Do you use online applications other than e-mail to collaborate with business partners in the design of new products or services?

Responders can choose yes (1) or no (0). We combined the value of these two items to get the score for supply chain collaboration. The variable of specific requirements in transaction (specific) was measured based on another question in the survey: "Does your company take into account industry specific standards when making decisions on what technology and data standards to use?" The value was set to be 1 if the answer is "yes" and 0 for "no".

We controlled the effect of firm IT expertise on the adoption of open IOS as IT expertise is likely to facilitate firms to adopt IOS (Chwelos *et al.*, 2001). IT expertise was measured based on participating a firm's response to four questions asking whether a firm uses intranet, ERP, knowledge management systems and supply chain management systems (intranet, ERP, KM, SCM). Firms using these IT applications should have better IT expertise than firms that do not use them. We also controlled the effect of firm sizes by dividing firms into four categories: micro (one to 9 employees), small (ten to 49 employees), middle (50-249 employees), and large size (250 + employees) and using three dummy variables. In addition, we used dummy variables to control the effect of industry- and country-specific characteristics (nine dummies for industry effect and 25 for country effect) as research has suggested that industry- and country-level factors may influence the adoption of IOS (Chwelos *et al.*, 2001). Because our dependent variable is a dichotomous variable, we used logistic regression for the data analysis. Accordingly, we get the following model:

$$\begin{aligned} \text{Log} \left[\frac{P}{(1-P)} \right] = & \beta_0 + \beta_1 \text{EDI} + \beta_2 \text{Proprietary} + \beta_3 \text{EDI} * \text{Collab} \\ & + \beta_4 \text{Proprietary} * \text{Collab} + \beta_5 \text{EDI} * \text{Specific} \\ & + \beta_6 \text{Proprietary} * \text{Specific} + \beta_7 \text{IndEDI} + \beta_8 \text{IndProprietary} \\ & + \beta_9 \text{IndOpen} + \beta_{10} \text{Collab} + \beta_{11} \text{Specific} + \beta_{12} \text{Intranet} \\ & + \beta_{13} \text{ERP} + \beta_{14} \text{KM} + \beta_{15} \text{SCM} \\ & + \beta_x \text{Dummy Variables (firm size, industry, \& country)} + e \end{aligned}$$

where P is the probability that a firm has adopted open IOS. Regressors and control variables have been discussed above.

4.2 Results

The mean statistics and correlation matrix for the main variables are presented in Table I. The overall adoption level of open IOS is 0.116 (i.e. 11.6 percent of firms have adopted open IOS). For prior generations of IOS, the adoption level of proprietary IOS (18 percent of all the firms) is higher than that of EDI (8.8 percent). These numbers indicate that all three categories of IOS have a relatively low adoption level. As expected, open IOS adoption has positive correlations with firm experience in EDI, firm experience in proprietary IOS, and industry experience in open IOS.

The analysis result of logistic regression shows that the likelihood ratio χ^2 test is significant ($\chi^2 = 1600.5, p < 0.001$), implying a strong relationship between the dependent variable and regressors. Cox and Snell, R^2 and Nagelkerke, R^2 are 17.2 percent and 33.6 percent, respectively, (Nagelkerke, 1991). The classification table shows an overall prediction accuracy of 89.6 percent by the model. As there are 7,509 non-adopters and 981 adopters, the classification accuracy by random guess would be $(7509/8490)^2 + (981/8490)^2 = 79.6$ percent (Zhu *et al.*, 2003). Thus, our model has higher discriminating power.

The analysis result is shown in Figure 2. As expected, we find the adoption of open IOS is positively associated with both firm experience in EDI ($\beta = 1.71; p < 0.01$) and firm experience in proprietary IOS ($\beta = 1.12; p < 0.01$). Therefore, $H1$ and $H2$ are supported because firm experience in EDI and experience in proprietary IOS both facilitate firms to adopt open IOS. In terms of moderating effects, we find that the positive impact of firm EDI experience on open IOS adoption is weakened when the level of supply chain collaboration is high than low ($\beta = -0.29; p < 0.05$), supporting $H1a$. However, $H2a$ is not supported because the moderating effect is not significant

| | Mean | 1 | 2 | 3 | 4 | 5 | 6 |
|---|-------|--------|--------|--------|--------|--------|---|
| 1. Open IOS adoption | 0.116 | 1 | | | | | |
| 2. Firm experience in EDI | 0.088 | 0.246* | 1 | | | | |
| 3. Firm experience in proprietary IOS | 0.180 | 0.222* | 0.141* | 1 | | | |
| 4. Industry experience in EDI | 0.085 | 0.075* | 0.296* | 0.045* | 1 | | |
| 5. Industry experience in proprietary IOS | 0.177 | 0.122* | 0.064* | 0.247* | 0.208* | 1 | |
| 6. Industry experience in open IOS | 0.112 | 0.286* | 0.080* | 0.103* | 0.280* | 0.451* | 1 |

Note: * $p < 0.01$

Table I.
Means and
correlation matrix

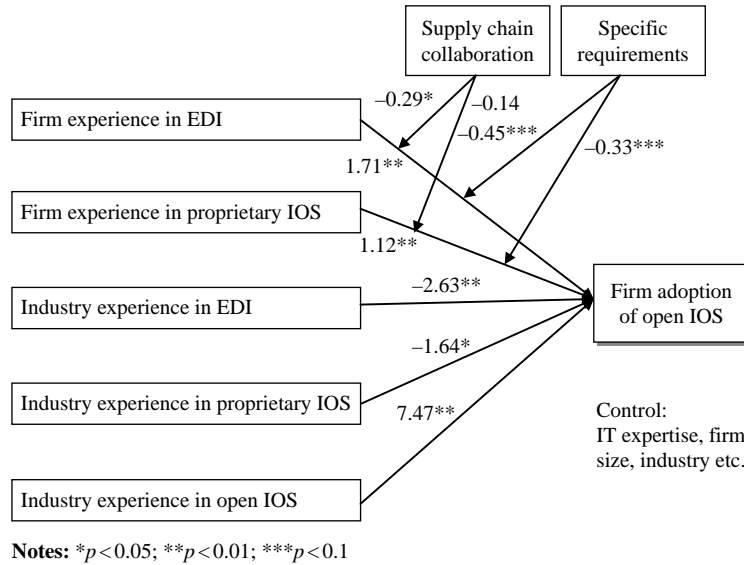


Figure 2. Analysis results

in the case of proprietary IOS experience ($\beta = -0.14$; $p > 0.10$). The results also show that the positive impacts of both firm EDI experience and proprietary IOS experience on open IOS adoption are weakened when firms have specific requirements in transaction ($\beta = -0.45$ and $\beta = -0.33$, respectively). However, these moderating effects are not significant at the 0.05 level, though they are close ($p < 0.1$). As a result, *H1b* and *2b* are only weakly supported.

The analysis result also supports *H3* as there is a negative relationship between industry experience in EDI and open IOS adoption ($\beta = -2.63$; $p < 0.01$), indicating that industry experience in EDI will impede firms from adopting open IOS. The association between open IOS adoption and industry experience in proprietary IOS is also negative ($\beta = -1.64$; $p < 0.05$), which is consistent with *H4*. Finally, *H5* is supported as there is a positive relationship ($\beta = 7.47$; $p < 0.01$) between industry experience in open IOS and the adoption of open IOS, implying industry experience in open IOS may increase the likelihood of open IOS adoption among potential adopters.

5. Discussion

Owing to their relative advantages such as cost-saving, real-time, and flexibility, open IOS have gained increasing attention in the business world (Malhotra *et al.*, 2007; Markus *et al.*, 2006). Prior to open IOS, two generations of IOS have been used in industry – proprietary IOS and EDI. Although research has long suggested that history matters in the adoption of new technologies, little research has investigated how prior generations of IOS affect the adoption of open IOS. As a result, our knowledge about how history matters in the case of open IOS adoption is still limited.

Our analysis results suggest that both firm experience and industry experience in related IOS have significant impacts on the adoption of open IOS. First, we find that firm experience in EDI and in proprietary IOS both facilitate firms to adopt open IOS. This is consistent with previous research that posits the experience in an old technology

can increase firms' absorptive capacity for a new technology and thus facilitate firms to adopt the new technology (Cohen and Levinthal, 1990; Zahra and George, 2002). By accumulating knowledge and skills on an old technology, firms may become more capable to overcome the knowledge barriers for adopting a new technology (Attewell, 1992). Our results suggest that firms can gain absorptive capacity for open IOS by accumulating knowledge and skills on prior generations. At the same time, we also find that the positive impact of firm experience on open IOS adoption is moderated by contextual factors such as the supply chain collaboration between trading partners. The results also suggest that the specific requirements in transaction might have similar, but weaker, moderating effect as well. One explanation for this weakened moderating effect is that some open IOS may be flexible enough to incorporate the specific requirements in transaction (Gosain *et al.*, 2004; Zhu *et al.*, 2006), which should mitigate the influence of specific requirements. In short, our findings suggest that the impact of firm experience on open IOS adoption can be complicated and contextual factors may need to be taken into account to understand this issue.

Second, we find that industry experience in EDI inhibits a firm from adopting open IOS. This result is consistent with prior research that find firms may be trapped into an old technology with network effects even though a newer, superior, but incompatible technology is available (Arthur, 1989; David, 1985). For a technology with network effects, the larger user base of the technology, the higher value a user can gain from that technology. Thus, it is possible that prospective users can gain more value from an old inferior technology with network effects than from a new superior technology when the old technology gets a large user base. As a result, firms may choose to adopt or stick with the old technology, instead of migrate to the new technology. Our results indicate that this idea is also applicable in the case of migration from EDI to open IOS. When EDI gains a large user base in an industry, many firms in that industry may choose to refuse open IOS.

Finally, the results also show that industry experience in proprietary IOS has a negative impact on the adoption of open IOS. Mimetic pressures may be the driving force underlying this finding (DiMaggio and Powell, 1983). Institutional theory posits that firms may mimic other firms' behaviors when facing ambiguity and uncertainty, an insight also applicable in IOS adoption decisions (Teo *et al.*, 2003). While proprietary IOS are widely used in an industry, it may give the focal firm a mimetic pressure to adopt proprietary IOS, instead of open IOS. Along the same vein, however, the large user base of open IOS in an industry may promote more firms to adopt open IOS due to network effects and mimetic pressures. And without surprise, our results show that there is a positive relationship between industry experience in open IOS and the adoption of open IOS.

6. Conclusions

6.1 Contributions to research

Our study contributes to the literature by investigating the effect of experience in prior IOS on the adoption of open IOS. Although several studies have examined factors that influence a firm's decision on open IOS adoption (Bala and Venkatesh, 2007; Chong and Ooi, 2008; Zhu *et al.*, 2006), these studies usually focus on factors related to user firms (e.g. perceived benefits and costs, inter-organizational relationship, and internal resources) and factors related to environments (e.g. government influence, institutional pressures, and legal system). Little attention has been paid to factors related to IOS themselves. In particular, no research to date has investigated how experience

in prior IOS affects firm adoption of open IOS, although research implies that technological history plays an important role in the adoption of new technologies (Arthur, 1989; Cohen and Levinthal, 1990).

To fulfill this research gap, our study investigates how the experience in prior IOS affects open IOS adoption. More importantly, we distinguish IOS experience between two levels – firm level and industry level and posit that these two types of experience have totally different effects on the adoption of open IOS. While firm experience in prior IOS facilitates firms to adopt open IOS, industry experience in prior IOS can do the opposite. By distinguishing between two types of IOS experience, we suggest that history (experience in prior IOS) does not only matter, but also matter in different ways. Future research on IOS adoption may need to take technological history as well as the different roles of history into account besides organizational and environmental influence.

6.2 Implications for IT executives

Our study also offers implications to IT executives. As supply chains become increasingly important for today's companies, more and more companies adopt IOS to support their collaboration with supply chain partners (Subramani, 2004; Swaminathan and Tayur, 2003). Nowadays, open IOS are gaining increasing attention because they are the new generation of IOS that is superior to traditional proprietary IOS or EDI and with advantages such as cost savings, connectivity and flexibility (Malhotra *et al.*, 2007; Markus *et al.*, 2006). Our study suggests that migration to open IOS from prior generations of IOS such as EDI involves a paradox. On the one hand, the adoption of open IOS can be facilitated by firm experience in EDI. On the other hand, when many firms adopt EDI, it becomes very difficult for a firm to migrate to open IOS because open IOS is usually not compatible with EDI, and firms cannot gain network effects from the adoption of open IOS. Although the experience in EDI may increase a firm's absorptive capacity for open IOS, it may eventually inhibit firms from adopting open IOS due to the network effects of EDI. In other words, while a high level of absorptive capacity enables firms to adopt open IOS, firms may still refuse to adopt open IOS due to the low network effects of open IOS. Managers should notice this paradox when they make decisions on EDI adoption. The experience in proprietary IOS has a similar story. While firm experience in proprietary IOS facilitates the adoption of open IOS, industry experience in proprietary IOS hampers the diffusion of open IOS. But the negative impact of industry experience in proprietary IOS on open IOS adoption is probably due to institutional forces, not network effects.

6.3 Limitations and future research directions

This study has three limitations that may be expanded by future research. First, our variables are measured by single-item questions. Although it is not uncommon to use single-item scales to measure observed variables in the literature (Agarwal *et al.*, 2009; Zhu *et al.*, 2003), it would be better to use more comprehensive scales. Also, it is better to measure firm experience in related IOS as a degree since different firms may have different levels of usage. However, due to the limitation in the data, dichotomic variables were used for the measure. Future research may retest our model by using better measures. Second, we used network effects theory and institutional theory as the theoretical perspective to understand the influence of other firms' behaviors on a focal firm's decisions on open IOS adoption. However, these theories may not be the only

explanations for this influence. Future research may use different theoretical angles to study this issue. Finally, network effects exist at different levels. This paper only focused on the industry level as we lack data for other levels. Future research may expand our study by investigating network effects at different levels, such as at the community, industry group, or region level.

6.4 Concluding remarks

Our study suggests that firm experience and industry experience in related IOS have important effects on the adoption of open IOS. Although previous studies have examined factors that either facilitate or inhibit the adoption of open IOS, no research has focused on the role of prior technologies. In this paper, we identify IOS experience at two levels and posit that IOS experience at the firm and industry levels can have different effects on open IOS adoption. Particularly, we find that firm experience in EDI and in proprietary IOS facilitate firms to adopt open IOS, whereas industry experience in EDI and in proprietary IOS impede firms from migrating to open IOS. We contribute to the IS literature by showing that prior IOS do matter in the process of migration to open IOS. And most importantly, different types of IOS experience should be distinguished as they can have different effects on the adoption of open IOS.

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