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On network externalities, e-business adoption and information asymmetry

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Abstract

Purpose – This paper seeks to investigate and provide empirical evidence of the interrelationships among network externalities, e-business adoption and information asymmetry.

Design/methodology/approach – A conceptual model was proposed and tested using 307 completed interview cases selected from a database of 2,075 Chinese international trading companies published by the Beijing Municipal Bureau of Commerce for this study.

Findings – The results indicated that network externalities significantly influenced e-business adoption and information asymmetry, and e-business adoption influenced information asymmetry through information sharing and collection. A split sample analysis showed that cultural contexts significantly moderated the interrelationships among network externalities, e-business adoption, and information asymmetry.

Research limitations/implications – Data for this study were collected only from mainland China, therefore, non-Chinese companies (foreign-owned) operating in China may have been influenced by Chinese cultures and some of them have been localizing their operations in China. The influences of network externalities on business performance and decision making remain unclear. In addition, data were collected from self-reported questionnaires, and thus may be subject to self-reporting bias. Future studies should use more objective measurements to reduce the potential for self-reporting bias.

Practical implications – This study contributes significantly to the literature by providing empirical evidence on interrelationships among network externalities, e-business adoption, and information asymmetry. The findings in this study also provide valuable insights for managers to better understand the influence of network externalities on e-business adoption.

Originality/value – This study contributes significantly to the literature by providing empirical evidence of the interrelationships among network externalities, e-business adoption, and information asymmetry. The findings also provide managers with valuable insight into better understanding of the nature of these interrelationships.

Keywords Computer networks, Electronic commerce, Information management, China

Paper type Research paper

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Introduction

Described as a demand-side economy of scale (Besen and Farrell, 1994), network externalities refer to the value of a network created as a by-product of an existing installed base (Kauffman and Wang, 2002) from which the user benefits are associated with the size of the network (Katz and Shapiro, 1985, 1986). Network externalities pervasively exist in telephones/faxes, ATM's, hardware, software, computers, and the internet (Liebowitz and Margolis, 1994; Church and Gandal, 1993).

Technological, organizational, managerial, and environmental factors all have important influences on e-business adoption (Tornatzky and Fleischer, 1990; Wang and Cheung, 2004). However, there remains a limited understanding of the influence of network externalities on e-business adoption (Zhu *et al.*, 2006). The concept of network externalities has been used in a number of analytical models to improve the understanding of e-business adoption (Riggins *et al.*, 1994; Wang and Seidmann, 1995; Bhargava and Choudhary, 2004; Asvanund *et al.*, 2004; Ahsan and Herath, 2006). However, so far, only limited empirical testing of these models has ever been attempted (Kauffman *et al.*, 2000; Zhu *et al.*, 2006).

Information related to exchanges or transactions is not evenly distributed among participants (Anthony and Gales, 2002). When one participant in these exchanges or transactions has an information advantage over the other participants, this represents "Information Asymmetry" a topic widely studied in the economics literature (Stigler, 1961; Akerlof, 1970). A company's decision making and operations may be significantly influenced by information asymmetry (Daft and Lengel, 1986). Although factors such as information sharing and price discounting have been suggested to reduce information asymmetry (Filia, 2005; Lee *et al.*, 2004; Klastorin *et al.*, 2002), very little empirical evidences on the influence of network externalities on information asymmetry has ever been provided.

The purpose of this study is to investigate the interrelationships between network externalities and information asymmetry as well as between e-business adoption and information asymmetry. It is proposed that network externalities would significantly influence e-business adoption, and that e-business adoption and network externalities would reduce information asymmetry. It is also proposed that cultural contexts would have a significant influence on the interrelationships among network externalities, e-business adoption, and information asymmetry.

Theoretical background and relevant studies will be presented in the following section followed by the development of the proposed conceptual model and hypotheses. Methodologies developed to empirically test the above-mentioned proposals will be described in the section followed. The conceptual model will then be tested using survey data from 307 international trading companies in China. Data analyses will be conducted and the results interpreted. A brief summary of major findings in this study and a discussion on directions for future studies will conclude this report.

Theoretical background

Network externalities

Network externalities may be classified as positive or negative. Positive externalities exist when a user's utility for a product or service increases with an increase in users of identical or compatible products or services (Srinivasan *et al.*, 2004). Conversely, negative network externalities exist when a user's utility decreases with an increase in

other agents who consume the same products or services. For example, a telephone user's utility increases as the number of telephone users increases, thus exhibiting positive network externalities. However, when the telephone network becomes overloaded, the effect on an individual subscriber will be negative, thus exhibiting negative network externalities (Liebowitz and Margolis, 1994). Positive network externalities are supported by Metcalfe's Metcalfe (1995) law, which suggests that the utility of a network equals the square of the number of users. In this study, only positive network externalities were considered, since most of the network externalities were positive in the context of this study. This was consistent with conclusions derived by Zhu *et al.* (2006), in which only positive network externalities of open-standard interorganizational systems were considered.

Network externalities may also be classified as direct or indirect (Katz and Shapiro, 1994). Direct network externalities exist when the benefits derived from network technologies are dependent on the number of users, or the size of the network (Liebowitz and Margolis, 1995; Katz and Shapiro, 1986). An example of direct network externalities is the positive effect of the number of internet adopters on the benefits that an individual adopter can achieve. Indirect or complementary network externalities are market-mediated effects, which arise when there is a link between utility of a customer and the number of other complementary products (Katz and Shapiro, 1986; Srinivasan *et al.*, 2004). An increase in the number of users of a product or service increases the availability of other complementary products, which further increases the utility that customers derive from the focal product (Church and Gandal, 1993). An example of indirect network externalities is toner cartridges, which as complementary goods are more readily available at lower prices as the number of users of the focal product (printers) increases.

Information asymmetry

Marketing relationships between buyers and sellers are characterized by information asymmetry (Mishra *et al.*, 1998) when sellers have informational advantages over their customers (Barney and Ouchi, 1986) because they know more about their product or service attributes (prices and quality) than their customers (Akerlof, 1970; Ba and Pavlou, 2002). Although customers may search for information on product or service attributes before purchasing a product, the true attributes of the products or services are only revealed after the customers use the product (Nelson, 1970).

Information asymmetry is a source of inefficiency in a supply chain (Filia, 2005). For example, information asymmetry is a powerful source of the bullwhip effect, which occurs when information distortion increases as information moves upstream along the supply chain (Lee *et al.*, 2004).

Relevant studies

Zhu *et al.* (2006) investigated the influence of network externalities on the adoption of open-standard inter-organizational systems, and noted that few other empirical studies had addressed network externalities. The most closely related studies have focused on the diffusion of automated teller machine (ATM) networks. Saloner and Shepard (1995) suggested that the number of ATM locations and the number ATM users were significantly and positively associated with the benefits of adopting an ATM network. Kauffman *et al.* (2000) found that companies with more shared networks

are more likely to adopt an ATM network. However, these ATM studies were business-to-consumer (B2C), which implies that the adoption of ATM networks required minimal investments by customers. In contrast, business-to-business (B2B) requires all trading partners to invest in compatible systems to operate internet-based services with each other (Zhu *et al.*, 2006). Therefore, developing an e-business platform requires joint efforts across firm boundaries. The benefits of adopting e-business are contingent on the status of network adoption by other firms in the trading community (Zhu, 2004, Zhu *et al.*, 2006).

Asvanund *et al.* (2004) examined network externalities of peer-to-peer (P2P) file sharing over the internet. Bhargava and Choudhary (2004) found that buyers valued an intermediary's service more if it provided access to more sellers, while sellers value an intermediary's service more if it provided access to more buyers and when they compete with fewer sellers. They also found that an intermediary's profits were larger with positive, rather than negative, network externalities.

To alleviate information asymmetry disadvantages, a company may have to search for information. Although this search may be costly (Stigler, 1961), recent advances in information technology (IT) have significantly reduced the costs of information dissemination, acquisition, and processing for both firms and customers (Stewart, 1995). Alba *et al.* (1997) suggested that IT has significant influences on the way information is disseminated and acquired, and how products are sold. Kulkarni (2000) examined how IT influences the costs of information dissemination and acquisition, and the information asymmetry between a firm and its customers.

Several models and theories have investigated factors that affect e-business adoption, such as innovation diffusion theory, institutional theory, the theory of planning behavior, the technology-organization-environment framework, the technology acceptance model, and the perceived e-readiness model (Molla and Licker, 2005). Factors investigated in these models and theories may be categorized into four domains: innovation attribution (e.g. relative advantage, complexity, and compatibility), management characteristics (e.g. top management beliefs and risk propensity), organizational characteristics (e.g. centralization, formalization, specialization, and technological readiness), and environmental contexts (e.g. infrastructure maturity and competition intensity). However, no study has addressed the influences of network externalities on e-business adoption. The only related study is that of Zhu *et al.* (2006), which examined network externalities and open-standard interorganizational systems adoption. Therefore, further research is warranted on the influences of network externalities on e-business adoption.

Conceptual model

To test above-mentioned proposals, a conceptual model is developed as the foundation for investigating the interrelationships among network externalities, e-business adoption and information asymmetry. The model is shown in Figure 1.

Network externalities

Since, positive network externalities enhance the value of e-business as the size of the e-business network increases, there is an incentive for companies to adopt e-business. Zhu *et al.* (2006) and Teo *et al.* (2003) suggested that network externalities consist of two parts: vertical partners and horizontal peers. To increase network externalities

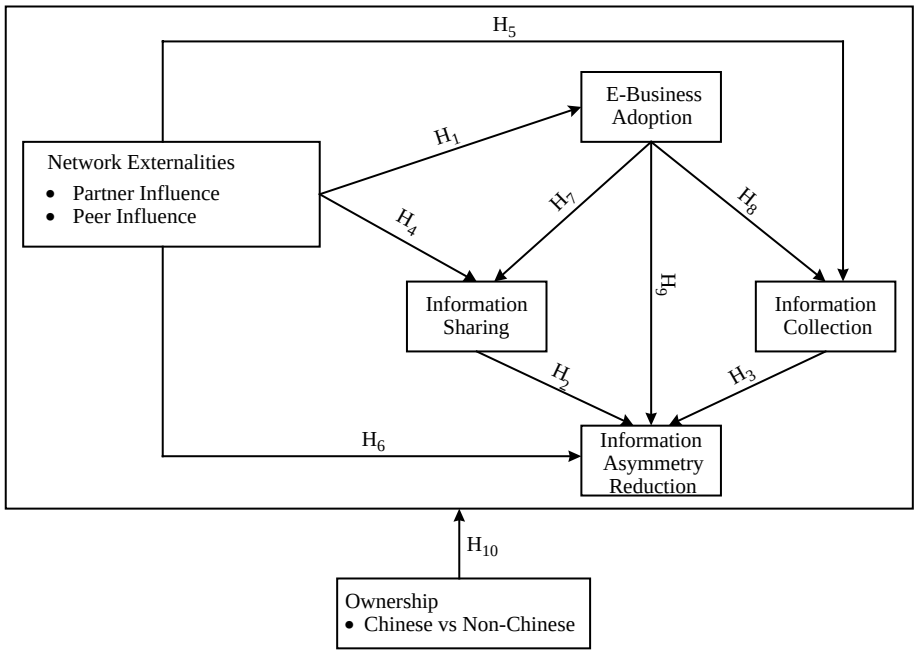

Figure 1.
The conceptual model

of e-business, firms need to increase the participation of vertical partners in the supply chain, such as their suppliers and customers. According to Shapiro and Varian (1999), building an alliance with vertical partners to support one technology over another may be the single most important tactic a firm can use to increase network externalities.

E-business diffusion among horizontal peers also may enhance network externalities (Teo *et al.*, 2003). As more peers adopt e-business, a larger market for complementary goods, such as hardware, software, and e-business related professional services (e.g. payment, logistics, and network security) will emerge. This will further accelerate e-business adoption, as the larger market may result in intensified competition and force product and service price reductions.

Similar to Zhu *et al.* (2006), operationalized network externalities may be treated as a second order factor with two first-order dimensions: vertical partners and horizontal peers. The discussion above indicated that these two dimensions have significant influences on e-business adoption. It is, thus, expected that the overall network externalities will have significant influences on e-business adoption. This leads to the first hypothesis:

H1. Higher network externalities significantly accelerate e-business adoption.

Information asymmetry

Advances in IT reduce searching costs. As a result, information sharing and collection become potential solutions for information asymmetry. Information sharing in the supply chain, which is often considered to be a generic cure for the bullwhip effect, may optimize supply chain-wide performance (Lee *et al.*, 2004; Chen *et al.*, 2000). The importance of internal sharing of information within organizations has been

emphasized in management and organizational theories, such as total quality management (TQM), business process re-engineering (BPR), and virtual teams (Marchand *et al.*, 2001). TQM suggests that to improve product or process quality, team members must identify and share information about the sources of defects, failures, and mistakes. Continuous improvement (CI) and BPR suggest that information sharing simplifies and streamlines processes across the value chains of companies (Marchand *et al.*, 2001).

In this study, a distinction between information sharing and information collection is defined as follows. Information sharing refers to the sharing of information among employees and with supply chain members, while information collection refers to the collection of information from organizations outside of the firm's supply chain. The distinction between sharing and collection is that sharing implies a mutuality (Wareham *et al.*, 2005), while collection is only one method of gathering information outside an organization. Therefore, two additional hypotheses are proposed:

H2. Information sharing significantly reduces information asymmetry.

H3. Information collection significantly reduces information asymmetry.

Wareham *et al.* (2005) showed that network externalities lead to more efficient information flow because they standardize communication protocols, business interfaces, and operational processes. This standardization may facilitate information sharing and collection through the use of compatible technologies and platforms, such as TCP/IP and XML. These arguments lead to two more hypotheses:

H4. Higher network externalities significantly enhance information sharing.

H5. Higher network externalities significantly enhance information collection.

In today's competitive environment of global and digital economies, supply chains, rather than individual companies, compete with each other (Fynes *et al.*, 2005). The growing size of e-business adoption facilitates information exchanges among vertical supply chain members and horizontal peers and entities outside the supply chain. Accelerated information flow and information exchanges allow companies to be more knowledgeable about their products, pricing, and markets. This should result in a reduction in information asymmetry, which leads to the hypothesis:

H6. Higher network externalities significantly reduce information asymmetry.

E-business adoption

Stewart (1995) suggested that IT advances may facilitate information sharing across virtual teams and processes among suppliers, customers, and partners operating in a virtual network. E-business adoption fosters information sharing by facilitating a firm's communication and collaboration with supply chain members, while enhancing internal communications among employees (Tsang and Tse, 2005). For example, e-business technologies may create real-time collaborative planning, forecasting, and replenishment (CPFR) among supply chain members in reality, since e-business technologies, such as TCP/IP and XML, are universally compatible. Shih and Wen (2005) and Helo and Szekely (2005) cited that e-business technologies may enable many

organizations to form an electronic-enterprise for effective communication and information sharing.

E-business-based internet technologies may redefine how companies communicate with their partners and customers (Yang *et al.*, 2007; Koh and Nam, 2005). For example, internet technologies may be leveraged to redefine marketing channels and customer communication, resulting in improved interaction with partners and customers (Burn and Ash, 2005) and thus valuable information from partners and customers (Lunce *et al.*, 2006). Communication via internet technologies also may help companies radically transform their trading processes and the roles of their traditional intermediaries (Kambil, 1997). This allows a company to skip their traditional intermediaries between the company and its customers and directly collect information about their markets and customers (EI Sawy and Bowles, 1997). The following two hypotheses will be tested:

H7. E-business adoption significantly improves information sharing.

H8. E-business adoption significantly improves information collection.

As previously discussed, e-business adoption may improve information sharing and information collection, which in turn may reduce information asymmetry. E-business-based internet technologies accelerate information flow to help reduce information asymmetry. To build a broader view, it is expected that e-business adoption will directly influence information asymmetry:

H9. E-business adoption significantly reduces information asymmetry.

Ownership

The effects of ownership on network externalities are important to the current study. Successful leverage of IT requires that systems work "right" technically and fit with the company's environment (Gallivan and Srite, 2005). Different ownerships, especially the Chinese-owned and non-Chinese-owned, may demonstrate different cultures. In current China's context, non-Chinese-owned often means "foreign"-managed. Most of non-Chinese-owned companies' senior managers and top management team members are foreigners and/or Chinese oversea returnees who have oversea working experience and/or foreign education background. They often adopt western management tools, techniques and values (Punnett, 2004), thus cultivating western cultures in these companies, thus non-Chinese-owned companies may exhibit different national and organizational cultures from Chinese-owned companies. Therefore, ownership may have significant influence on the relations among constructs that have been examined in this study.

In the present study, ownership types are grouped into two categories: Chinese-owned and non-Chinese-owned. The Chinese-owned companies were classified as state-owned, Chinese-private-owned, and Chinese-collective-owned. The non-Chinese-owned companies were represented by firms with foreign investments.

In this study, it is anticipated that ownership would have a moderating effect on network externalities. Modeling the type of business ownership as a moderator is consistent with previous studies (Mascarenhas, 1989; Peng, 2003) and helps reveal the

influence of cultural contexts on both the dependent and independent variables. Therefore, the following hypothesis is added to the list:

H10. Ownership has a significant impact on the influences on the interrelationships among network externalities, e-business adoption, and information asymmetry.

Methodology

Measures

Measurement items were developed based on a comprehensive review of the literature and expert opinions, which reflect the three successive stages of theoretical specification, statistical testing, and refinement (Straub, 1989). Detailed definitions of all measurement items as presented in the Appendix, are discussed in the following paragraphs.

As suggested by Zhu *et al.* (2006), the operationalization of partner and peer influences on network externalities can be modeled as a second-order construct formed by these two first-order factors. Within the context of interorganizational open-standard systems, Zhu *et al.* (2006) defined partner influence as the extent to which a firm's customers, suppliers, and other vertical partners in its trading community used the technology. Peer influence has been defined as the extent of technology diffusion among horizontal peers in the same industry (Teo *et al.*, 2003). These two variables were posited to form the second-order construct of network externalities, consistent with the network externalities literature (Zhu *et al.*, 2006; Katz and Shapiro, 1985).

E-business adoption was measured as the extent to which e-business was diffused into routine business activities and processes (Chatterjee *et al.*, 2002; Cooper and Zmud, 1990) for enabling customer-facing activities, such as product or service sales, distribution, after-sales support, product testing, and market research (Chatterjee *et al.*, 2002).

Information sharing was operationalized as the degree to which a firm had enabled both intra-organizational and inter-organizational information sharing. Marchand *et al.* (2001) argued that managers view intra-organizational and inter-organizational information sharing differently, and that internal and external information sharing are two different dimensions. Information collection measurement was developed from expert opinions, and operationalized as to the extent that responding companies collected 14 different types of international business information (i.e., exchange rates, markets, raw material supply, etc.). Information asymmetry was measured as the degree to which the company was able to access needed information to reduce information asymmetry and solve uncertainty problems. This item was developed by converting the construct definition into a questionnaire format (Bock *et al.*, 2005).

Sample

A sample was selected from a database of 2,075 Chinese international trading companies published by the Beijing Municipal Bureau of Commerce for this study. These 2,075 companies were represented by 810 foreign companies, 337 branch offices of foreign companies, and 928 domestic companies.

To help respondents better understand the questionnaire instrument and to improve the survey response rate, data were collected by personally-administered on-site surveys, rather than mail surveys. All of the 2,075 registered trading companies were first contacted by phone call, and then subsequently made follow-up phone calls to companies which were unreachable during the first attempt. After 812 companies

agreed to participate in the survey, follow-up phone calls were made to schedule interview appointments with IT managers or operations managers of 500 companies randomly selected from those 812 companies. Appointments with 54 of the 500 selected companies could not be arranged, so formal interviews were conducted with senior IT managers or operations managers from the remaining 446 companies. A total of 307 interviews were successfully completed, representing a response rate of 68.8 percent. As shown in Table I, 58 percent of these respondents were pure trading companies, (provide trading services only), 72 percent were over five years old, and 54 percent had less than 200 employees.

Data analysis and results

PLS-Graph 3.00, a partial least squares (PLS) tool, was used in this study to assess the measurement model and structural model. PLS is a powerful SEM technique that has been used extensively in information system research (Gefen and Straub, 2005). There are several advantages of using PLS over other tools. First, since PLS is more concerned with relationships among constructs, it is preferred for theory development (Chin, 1998). Second, because PLS does not place a high requirement on sample size or normal distribution of source data (Chin, 1998; Gefen and Straub, 2005), it is suitable for manipulated constructs (Fornell and Bookstein, 1982). Finally, PLS can handle formative and single-item scales (Chin, 1998; Fornell and Larcker, 1981).

Characteristic	*N*	Percent
Company type		
Pure trading	177	58
Manufacturing	68	22
Service	32	10
Comprehensive	30	10
Age		
Less than five years	56	18
Between 5 and 15 years	139	45
More than 15 years	112	37
Number of employees		
≤ 49	88	29
Between 50 and 199	77	25
Between 200 and 999	84	27
≥ 1000	58	19
Trading products		
Machinery and electronic	86	28
Chemical, oil, petrochemical, pharmacy, coal, mining, and steel	61	20
Light industrial product, craftwork, and construction material	51	17
Software and IT	40	13
Textile and garment	31	10
Food, grain, and stock	19	6
Service, finance, and infrastructure	11	4
Other	8	3

Table I.
Characteristics of participating firms

PLS was used in this study because the proposed model had formative and single-item constructs, which could not be handled by other SEM methods. In addition, PLS is more appropriate when the research model is in an early stage of development and has not been tested extensively (Fornell and Bookstein, 1982; Keil *et al.*, 2000; Teo *et al.*, 2003). There have been few empirical tests of network externalities (Zhu *et al.*, 2006). Therefore, PLS was the most appropriate technique for this study.

After considering the relationships of the measurement items and their respective constructs, all first-order constructs as formative constructs are specified (Chin, 1998; Zhu *et al.*, 2006). A bootstrapping estimation procedure is used to assess the significance of the factor weights of the scales in the measurement model and the path coefficients in the structural model (Gefen and Straub, 2005). As shown in the Appendix, all measurement items had significant ($p < 0.001$) weights and acceptable magnitudes (Chin, 1998), suggesting acceptable measure reliability and validity. Descriptive statistics and the correlation matrix are shown in Table II.

Assessment of the structural model involves estimating the path loadings and the R^2 values. Path loadings indicate the strengths of the relationships between independent variables and dependent variable, while R^2 values measure the predictive power of the structural models. Interpreted like multiple regression results, R^2 values indicate the amount of variance explained by the exogenous variables. Path loading and *t*-statistics for hypothesized relationships were calculated using a bootstrapping technique. Results of hypothesis testing are presented in the following paragraphs.

Full sample

To test the hypotheses, the structural model is fitted with full sample ($N = 307$). Results are shown in Figure 2 and Table III. As indicated by path loadings, network externalities had significant influences e-business adoption, information sharing, information collection, and information asymmetry ($b = 0.360, 0.378, 0.375$, and 0.268; $p < 0.001$). This result confirmed above-discussed theoretical expectation and provided support for *H1*, *H4*, *H5* and *H6*. The significant loadings from information sharing and information collection to information asymmetry ($b = 0.203$ and 0.318; $p < 0.05$ and 0.001) provided support for *H2* and *H3*. It implied that information sharing and information collection had a mediation effect on the relationship between network externalities and information asymmetry.

E-business adoption had significant influences on information sharing ($b = 0.345$, $p < 0.0001$), suggesting support for *H7*, but the influence of e-business adoption on information collection was not significant ($b = 0.158$, ns), suggesting rejection of *H8*.

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Partner	1.000					
(2) Peer	0.507	1.000				
(3) E-business adoption	0.270	0.384	1.000			
(4) Information sharing	0.275	0.496	0.252	1.000		
(5) Information collection	0.339	0.411	0.361	0.293	1.000	
(6) Information asymmetry reduction	0.333	0.266	0.369	0.367	0.432	1.000

Table II.
Construct correlation matrix

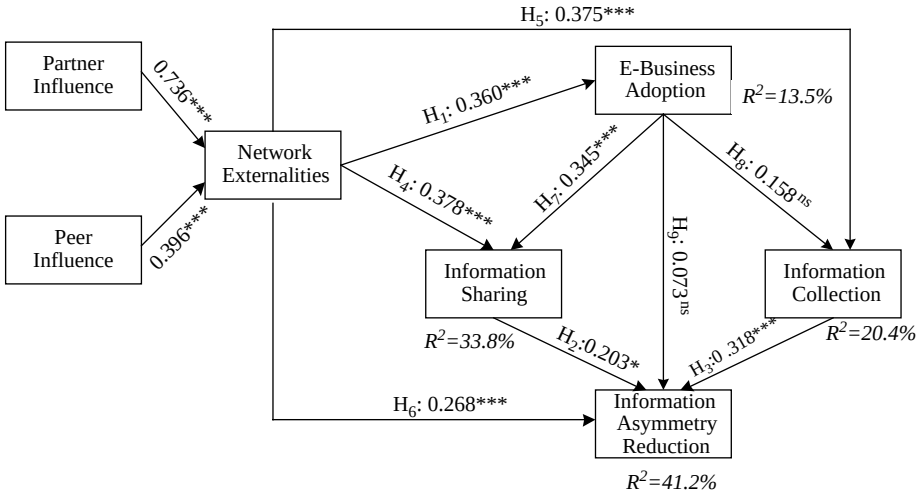

Figure 2.
Results of data analysis (full sample)

Notes: *p<0.05; **p<0.01; ***p<0.001; ns: not significant

	Full sample	Split-sample: Chinese	Split-sample: Non-Chinese	Difference[a] (*H10*)
Hypothesis				
H1	0.360***	0.320***	0.469***	0.149***
H2	0.203**	0.031ns	0.333**	0.302***
H3	0.318***	0.374***	0.262***	−0.112***
H4	0.378***	0.318***	0.598***	0.280***
H5	0.375***	0.280**	0.594***	0.314***
H6	0.268***	0.235**	0.193ns	−0.042***
H7	0.345***	0.353***	0.241*	−0.112***
Variance explained (R^2)				
H8	0.158[b]	0.227*	0.146[b]	−0.081***
H9	0.073[b]	0.047[b]	0.074[b]	0.027[b]
E-business adoption (percent)	13.5	10.3	22.3	12.0
Information sharing (percent)	33.8	29.8	50.7	20.9
Information collection (percent)	20.4	17.1	43.7	26.6
Information asymmetry (percent)	41.2	29.0	53.6	24.6

Table III.
Summary of hypothesis testing

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; a – Difference (non-Chinese − Chinese); b: not significant

The small path loading ($b = 0.073$, ns) indicated that the influence of e-business adoption on information asymmetry was not significant, suggesting rejection of *H9*. Therefore, it seems that information sharing mediates the relationship between e-business adoption and information asymmetry.

As shown in Figure 2, model in this study explained 13.5 percent of the variance in e-business adoption, 33.8 percent in information sharing, 20.4 percent in information collection, and 41.2 percent in information asymmetry reduction.

The sub-dimensions of network externalities, a second-order construct were also examined. As evident from the path loadings of vertical and horizontal peer influences, each of these two dimensions of network externalities was significant and of high magnitude ($b = 0.736$ and 0.396; $p < 0.001$), supporting the conceptualization of network externalities as a second-order structure. Consistent with Zhu *et al.* (2006), it was found that vertical partner influence ($b = 0.736$, $p < 0.001$) is a stronger determinant of network externalities than horizontal peer influence ($b = 0.396$, $p < 0.001$), though both were significant determinants of network externalities.

Sample split: Chinese vs non-Chinese sample

To further examine the influences of ownership on the interrelationships specified in the proposed model, the full sample was split into two subsamples: Chinese-owned companies ($N = 228$) and non-Chinese-owned companies ($N = 73$). There were 6 respondents not indicating their ownership. The structural model was tested using each of these two sub-samples. The results shown in Figure 3 and Table III demonstrated significant differences between Chinese-owned companies and non-Chinese-owned companies. For example, the influences of network externalities and information sharing on information asymmetry was significant only for non-Chinese-owned companies, while the influence on e-business adoption on information collection was significant only for Chinese-owned companies.

To test the differences between two subsamples, each path loading in the structural model for non-Chinese-owned companies was compared with the corresponding path loading for Chinese-owned companies. Significance differences were examined by t-tests, following the procedure documented in Keil *et al.* (2000). The results, as shown in Table III, indicated that, except the influence of e-business adoption

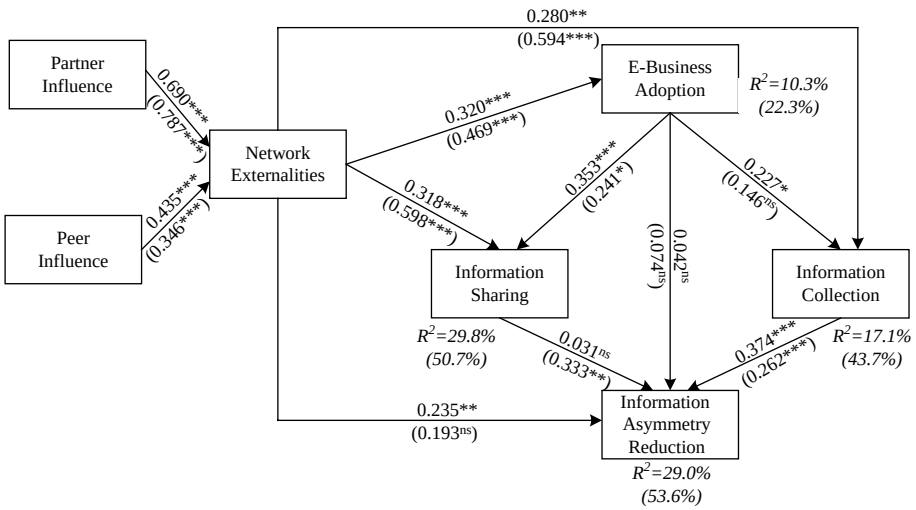

Figure 3.
Results of data analysis (split samples – Chinese vs non-Chinese)

Notes: Numbers in parentheses are for non-Chinese; *p<0.05; **p<0.01; ***p<0.001; ns: not significant

on information asymmetry, all other paths differed significantly between non-Chinese-owned companies and Chinese-owned companies, suggesting support for *H10*. The explained variances also differed, ranging from 12.0 percent to 26.6 percent, which means that the conceptual model had greater predictive power for non-Chinese-owned companies than for Chinese-owned companies.

Discussion

Network externalities and e-business adoption

The results revealed that e-business adoption was influenced by network externalities. Companies were more likely to benefit from e-business adoption when their peer and partner companies have adopted e-business. Thus, companies were more likely to adopt e-business when greater network externalities existed. These results are consistent with resource dependency theory, which posits that organizations are interdependent with other organizations and that their external environment exerts essential influences on their actions (Miner, 2006; Pfeffer and Salancick, 1978). In today's economies, inter-organizational dependency results in organizational interconnectedness (Miner, 2006). According to this perspective, a company can obtain the resources and benefits of interconnectedness when more companies adopt e-business. These results are also consistent with neoinstitutional theories, which argue that there are widespread social conceptions of appropriate organizational forms and behaviors (Weber, 1946; Teo *et al.*, 2003), thus organizations face pressures to become isomorphic by conforming to these forms and behaviors (Burt, 1987). Otherwise, they may lost legitimate and become abnormal (DiMaggio and Powell, 1983).

Finding regarding the influence of network externalities on e-business adoption as discussed in previous section also has empirical support in the literature. For example, Granovetter (1978) and Krassa (1988) suggested that decisions to engage in a particular behavior depended on the perceived number of similar others in the environment that had done likewise (Iacovou *et al.*, 1995). Teo *et al.* (2003) found that the greater the interorganizational technology adoption among competitors, suppliers, and customers, the greater the likelihood that organizations would adopt this technology. Wang and Cheung (2004) found that pressure from other organizations was positively related to travel agencies' adoption of e-business.

Information asymmetry

With respect to hypotheses *H4*, *H5*, and *H6*, it was found that network externalities had a significant influence on information sharing, information collection, and information asymmetry. The influence of network externalities on information asymmetry was partially mediated by information sharing and collection. This suggested that the companies were more likely to share and collect information to reduce information asymmetry if more partner and peer companies had adopted e-business. Since, e-business adoption by partner and peer companies builds an expanded base for information sharing and collection, a company may obtain more benefit from this information sharing and collection.

Influence of ownership

Split sample comparisons revealed that ownership had a significant influence on the interrelationships among network externalities, e-business adoption, and

information asymmetry. Comparing the Chinese subsample with the non-Chinese subsample, network externalities had a stronger influence on e-business adoption among non-Chinese companies, with a significant path loading difference of 0.149 ($p < 0.001$).

The direct effects of network externalities on information sharing and collection were much stronger for non-Chinese companies than for Chinese companies (0.598 vs 0.318, $p < 0.001$ and 0.594 vs 0.280, $p < 0.001$, respectively). The direct influence of network externalities on information asymmetry among Chinese companies was significant and partially mediated by information collection, but not by information sharing. In contrast, the impact of information sharing on information asymmetry was significant only for non-Chinese companies. The direct influence of network externalities on information asymmetry among non-Chinese companies was not significant. Instead, the influence was indirect and mediated by both information sharing and information collection.

In terms of the influence of e-business adoption on information asymmetry, the direct effect was not significant, regardless of ownership. E-business adoption may have improved information sharing among both Chinese and non-Chinese companies, but this effect was significantly stronger among Chinese companies ($p < 0.0001$). Further, the effect of e-business adoption on information collection was significant only for Chinese companies.

Conclusion

This study examined the interrelationships among network externalities, e-business adoption, and information asymmetry. The results from 307 survey respondents revealed that network externalities had significant influences on e-business adoption and information asymmetry reduction. Specifically, a higher level of network externalities increased the likelihood of e-business adoption, while reducing information asymmetry through information sharing and collection. In addition, ownership moderated the influences of network externalities on e-business adoption and information asymmetry reduction.

This study contributed significantly to the literature by providing empirical evidence on interrelationships among network externalities, e-business adoption, and information asymmetry. The findings in this study also provide valuable insights for managers to better understand the influence of network externalities on e-business adoption.

While this study made a significant contribution, there were some limitations. First, although this study examined ownership's influences on network externalities, the data was collected only from mainland China. Therefore, non-Chinese companies (foreign-owned) operating in China may have been influenced by Chinese cultures and some of them have been localizing their operations in China. Second, although the influences of network externalities on e-business adoption and information asymmetry was supported by this study, the influences of network externalities on business performance and decision making remain unclear. Third, the data were collected from self-reported questionnaires, and thus may be subject to self-reporting bias. Future studies should use more objective measurements to reduce the potential for self-reporting bias.

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Appendix. Survey instrument

Partner influences (5-point Likert: very disagree ~ very agree):

- Your foreign customers, suppliers, and trading partners use internet technologies ($W = 0.3664$; $T = 5.0036$).
- Your domestic customers, suppliers, and trading partners use internet technologies ($W = 0.7689$; $T = 11.7801$).

Peer influences (5-point Likert: very disagree ~ very agree):

- The whole industry is very interested in the application of internet technologies ($W = 0.4774$; $T = 12.5648$).
- In your industry, internet technologies provide support for various services, such as payment, logistics, and credit reporting, and the technology platform is very mature ($W = 0.3228$; $T = 5.3569$).
- In your industry, computer networks are everywhere, and there is no network infrastructure barrier to the adoption of internet technologies. ($W = 0.3982$; $T = 7.7328$).
- In your industry, a few professional services provide services to develop trading business, such as marketing trend analysis, searching for trading opportunities, and even transaction deals ($W = 4{,}188$; $T = 10.2109$).

E-business adoption. In what business activities does your firm use web technologies? Please check all of the following that apply (Yes/No):

- Information sharing within the firm ($W = 0.3392$; $T = 3.0238$).
- Information sharing with customers and partners ($W = 5{,}524$; $T = 5.2888$).
- Online transactions ($W = 0.7656$; $T = 7.5903$).
- Online marketing and advertising ($W = 0.4372$; $T = 3.0264$).
- Enterprise resources planning ($W = 0.4054$; $T = 3.2977$).
- Customer relationship management ($W = 0.7202$; $T = 7.1594$).

Information sharing (5-point Likert: very disagree ~ very agree):

- Your firm has enabled information sharing among different employees and units ($W = 0.8266$; $T = 19.3890$).
- Your firm has enabled information sharing between your firm and existing and potential customers ($W = 0.8688$; $T = 32.4897$).

Information asymmetry (5-point Likert: very disagree ~ very agree):

- Your firm was able to access needed information about international businesses, which helped alleviate information asymmetry and information uncertainty ($W = 1.000$; $T = 0.0000$)

Information collection. Your firm has collected following international market information (Yes/No):

- Potential dealers for your products ($W = 0.5303$; $T = 9.6932$)
- Potential buyers of your products ($W = 0.5501$; $T = 10.1815$)
- Potential suppliers of raw materials ($W = 0.5445$; $T = 9.1288$)
- Information about competitive products ($W = 0.6936$; $T = 20.9506$)
- Competitors ($W = 0.6371$; $T = 15.5941$)
- Market scale ($W = 0.6989$; $T = 14.7213$)
- Market growth ($W = 0.7014$; $T = 16.8388$)
- Price trends ($W = 0.6246$; $T = 14.0012$)
- Exchange rates ($W = 0.5547$; $T = 10.7428$)
- Legal requirements of market entry ($W = 0.6665$; $T = 16.1897$)
- Hidden hurdles of market entry ($W = 0.6601$; $T = 16.5054$)
- Social and political backgrounds ($W = 0.5305$; $T = 9.1545$)
- Economical backgrounds ($W = 0.5450$; $T = 9.0258$)
- Transportation infrastructure ($W = 0.5916$; $T = 11.8746$)

Note: †Item weight; ‡T-statistics, all $p < 0.01$

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