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EXPLORING THE ROLE OF GOVERNMENT IN INFORMATION TECHNOLOGY DIFFUSION: An Empirical Study of IT Usage in Shanghai Firms

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Abstract

By analyzing survey data from 1,211 firms across 14 industries in Shanghai, this study examines factors that influence information technology usage in Chinese firms applying a technology–organization–environment framework and institutional theory. This study provides an in-depth examination of governmental impact on Chinese firms' IT adoption. Although government cannot directly influence firms' IT adoption, it does so indirectly by influencing firms' IT infrastructure construction and management. Firms' IT infrastructure development and IT management decisions act as a mediator between government policies and firms' IT adoption. Furthermore, firms adapt to governmental impact in distinct ways. The findings suggest that e-government approaches and government promotion policies have a significant impact on IT usage in manufacturing firms, in local firms, and in national-background firms.

Keywords

IT adoption, TOE framework, institutional theory, government

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1 INTRODUCTION

With the development of information technology, more and more Chinese firms have investing heavily in IT in order to catch up with the “age of the information economy.” A recent report puts China’s total IT investment in 2004 at 286.5 billion RMB, 13.7 percent higher than in 2003 (CCW 2004b). The rate of increase reached 15.2 percent in 2005 and will be around 20 percent for 2006 (CCIDNet 2006). Shanghai, as one of the biggest and most modern cities in China, ranks at the top in IT adoption (ISIC 2004).

However, as a developing country, China is still in transition to a market economy and is in the initial phase of IT usage. Compared with firms in developed countries, information technology usage in Chinese firms is far from mature and is uneven across different types and scales of enterprises. A report from ChinaLabs (2004) shows that, out of 1,000 surveyed firms, only 3.7 percent achieved mature IT usage. A survey by the Chinese National Informatization Evaluation Center (NIEC 2004) also shows that the top 500 informatization¹ enterprises in China are mostly large manufacturing enterprises with revenue above 500 million RMB. Large SOEs (state-owned enterprises) tend to be leaders in the national informatization process (NIEC 2004), while only 5 percent of SMEs (small- and medium-sized enterprises) have IT application systems (CCW 2004a).

In the information systems field, factors that affect IT adoption, usage, and valuation have long constituted an active research area (Straub et al. 2002). Many researchers and practitioners have sought theoretical models and empirical evidence to explain these factors and to give suggestions regarding firms’ IT decisions. Most of the research to date has focused on developed countries. However, since developing countries have different markets, legal systems, and cultural factors, models from developed countries may not be adaptable to developing countries’ environments (Shenkar and Glinow 1994) and such factors may have different effects. It seems clear that government and culture factors have a greater impact on firms’ IT usage in developing countries than they do in developed countries (Thatcher and Foster 2003). Research also points out that government regulation plays a more important role than culture in Chinese firms’ decisions and IT usage (Xu et al. 2004).

To better understand factors that influence IT adoption in Chinese firms, we developed a research model based on the technology–organization–environment (TOE) framework (Tornatzky and Fleischer 1990) and focused more on government-related factors. With survey data from 1,211 firms across 14 industrial fields, the study provides insightful managerial implications for Chinese firms and valuable practical suggestions to the Chinese government. We explored the following research issues:

- (1) The importance of technological, organizational, and environmental factors for firms deploying IT.
- (2) The influence of different industry types, investment property types, and ownership types on IT adoption by firms in developed Chinese cities such as Shanghai.

¹*Informatization* refers to IT usage and adoption in organizations and is a widely accepted concept in China.

Focusing on measuring Shanghai's government initiatives can largely reduce the potential interference of different influences on policy execution by various local governments and enhance our observation of the government's role. To make the results generalizable, firms with either headquarters or branches registered in Shanghai were included in the sample.

2 LITERATURE REVIEW

Many studies have explored the factors that drive the business value of IT. The research relevant to this study can be divided into two streams. One is the technology–organization–environment framework (Tornatzky and Fleischer 1990), which is used to identify technological, organizational, and environmental factors that affect IT diffusion in organizations. Here, we concentrate more on external institutional elements as a unique environmental factor. The second research stream is institutional theory perspective, which is used to explore the effects of path dependency, governmental intervention, and historical context on the evolution of organizational rules (Zucker 1987). These streams provide evidence of environment constructs, especially government related factors in the model.

2.1 The Technology–Organization–Environment Framework

The technology–organization–environment (TOE) framework (Tornatzky and Fleischer 1990) was developed to study the adoption of general technological innovations in organizations. The framework features three aspects that influence the process of technology diffusion in organizations: technological context, organizational context, and environmental context. Technological context refers to technologies that are relevant to firms. Organizational context generally refers to organizational characteristics, such as size, scope, and resources available within a firm. Environmental context involves the macro-circumstances in which a firm conducts its business. Environmental factors include industry, competitors, government relations, etc. The framework is suitable to identify factors shaping innovation adoption (Xu et al. 2004) and provides a reliable theoretical basis for this study.

The impact of technological factors on information system adoption and business values may be enhanced in the Chinese context. Because the overall IT usage in Chinese firms is immature (ChinaLabs 2004), better IT resources are comparatively rare and probably exert greater influence on firms' IT adoption. A report from National Informatization Evaluation Center (NIEC 2005) also showed that high IT adoption has successfully helped some large firms gain a competitive advantage and support their core value realization.

Organizational and management factors also play an important role in firms' IT usage. Research shows that SMEs are more likely to focus on the alignment between IT and business strategy (Levy and Powell 2003; Tsao et al. 2004), but tend to lack management support (such as technical consultation), IT management knowledge, and business transformation guidelines (Yeung et al. 2003). In China, those obstacles seem to be common. Suffering from an immature IT service market and poor IT management

knowledge, most Chinese enterprises have low performance in IT usage and value creation (NIEC 2004). Therefore, effective IT management has become one of the most critical and urgent problems Chinese enterprises face.

External environmental factors, such as trading partners, competitors, government, and socio-political conditions, may play an important role in firms' IS/IT adoption and business value generation (Melville et al. 2004). Due to an immature market, different culture, and other reasons, China has environmental characteristics distinct from Western countries (Boisot and Child 1999). For example, studies find that culture and philosophy have impacts on firms' IT adoption (Davison 2002; Martinsons and Westwood 1997). Tan and Ouyang (2004) examined the diffusion of e-commerce in China and found that the current e-commerce barriers include legal, cultural, and governmental issues. Xu et al. (2004) further confirmed that government regulation plays a more important role in China than in the United States. As a new method of delivering public services, e-government initiatives and activities, differing from traditional incentive policies such as legislation and promotion, became a new way through which government could potentially participate in e-business affairs and affect IT diffusion. Government influence can be particularly significant in a government-directed economy or where the private sector is not yet fully developed (Blakeley and Matsuura 2004).

Overall, the TOE framework provides a theoretical basis for understanding factors that affect firms' IS/IT adoption. In this study, IT infrastructure, IT management, and government factors are all investigated.

2.2 Institutional Theory Perspective

From an institutional perspective, organizations can be influenced by varied pressures arising from either external environment or internal organizational factors. Firms become more similar due to isomorphic pressures and pressures for legitimacy by three important legitimization processes: coercive, imitative, and normative (DiMaggio and Powell 1983).

The institutional factors provide a useful research view on an IT adoption study. The institutional environment in which the organization is embedded exerts an influence on the adoption process exhibited by individual organizations. In IT diffusion, firms tend to be induced to adopt and use certain information systems by external isomorphic pressures from competitors, trading partners, customers, and government. Recent studies have taken an institutional approach to e-commerce diffusion (Gibbs and Kraemer 2004; Teo et al. 2003), which reveals the importance of external pressures, government promotion, and legislation in e-commerce adoption and use. Regulatory agencies, such as the government or industrial consortiums, may create incentives or barriers to adoption and use. On the other hand, firms tend to learn and copy successful IT practices from industry leaders and accept a normalized best practice on IT adoption in a fast-changing environment.

From an institutional view, firms with strong ties to the public sector are likely to adopt innovations required or supported by government policy (Hinings and Greenwood 1987; Zucker 1987). In China, the government has determined informatization-driven industrialization as part of its national policy. The Ministry of Information Industry (MII) of China indicates that, in the future, China will persist in promoting a national

plan of enterprise informatization, led by large-scale backbone enterprises. Given different investment property and ownership, firms' IT adoption may be influenced differently by government policies and actions. Studies also found that firms' ownership strongly influences their IT implementation (see Reimers 2002), and government regulation plays a more important role in Chinese firms' IT decisions and usage than in the United States (Xu et al. 2004). These environmental factors may play a crucial role in firms' IT adoption in China.

3 RESEARCH MODEL AND HYPOTHESES

With theoretical support by the TOE and institutional theory, we developed the research model shown in Figure 1. Our framework is inspired by the TOE, while environmental factors here are examined by institutional factors of government: e-government, promotion, and regulation. Three major factors—IT infrastructure, IT management, and government factors (Melville et al. 2004; Tan and Ouyang 2004; Wade and Hulland 2004; Xu et al. 2004)—are proposed in the model to analyze their impact on IT usage. We also consider the possible relationships between different government factors, firms' IT factors, and organizational factors and explore how different government policies may influence firms' IT infrastructure and management decisions, respectively. Furthermore, we sought to determine whether government impacts are diverse across multiple industries, investment properties, and ownerships.

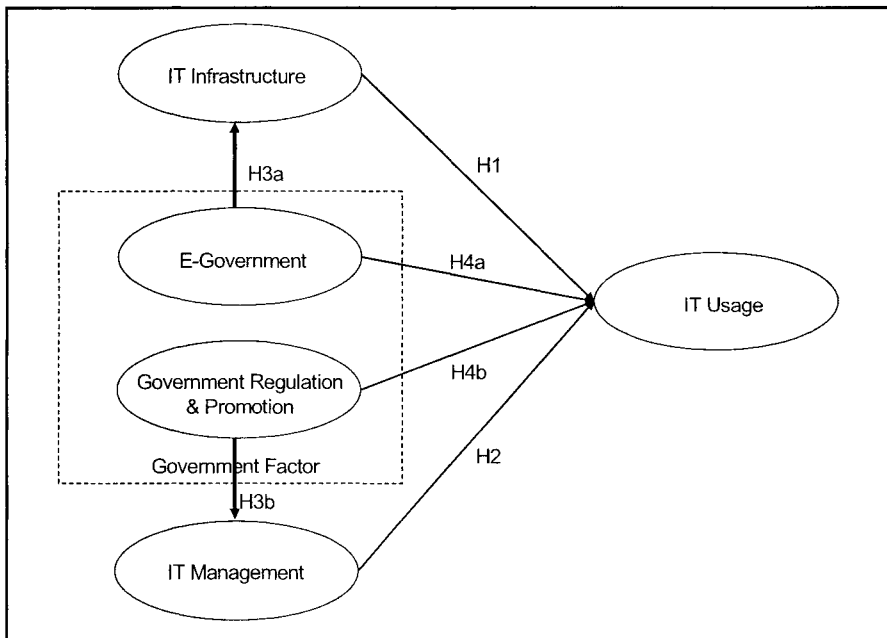


Figure 1. The Research Model

IT infrastructure is a collection of physical technology resources, including shared technology and technology services across the organization (Melville et al. 2004), which facilitate firms' connectivity and operations. Depending on its use, IT infrastructure can be an important source to influence firms' business value (Kumar 2004). Firms can develop unique capabilities and business value by using their IT infrastructure (Zhu 2004). Research shows that IT factors, including infrastructure and expertise, play a significant role in IT usage (Zhu et al. 2002). Therefore, we propose

H1: The more developed a firm's IT infrastructure, the greater the firm's IT usage.

Another type of factor is IT management capability (ITMC) in organizations, which denotes firms' technical and managerial knowledge (Byrd and Turner 2000; Melville et al. 2004) of IT. Compared with physical IT infrastructure, IT management is a set of soft abilities that help firms to deploy IT in an effective manner (Lee et al. 1995; Swanson 1994). In order to utilize IT physical assets economically, firms need to pursue a good fit between IT functionalities and business strategies (Grabowski and Lee 1993; McLaren et al. 2004) and manage IT infrastructures to improve organization performance (Markus and Soh 1993). Therefore, we propose

H2: The greater a firm's IT management capability, the greater the firm's IT usage.

Considering the relatively immature markets and information asymmetry in China, government regulations or promotion policies are likely to have broader impact on Chinese local firms' behavior, including their IT decisions, management, and usage. The government influence is more direct and visible than other environmental factors, such as culture or philosophy. Furthermore, Chinese firms are accustomed to adapting to government policies, given the history of frequent government interventions in China. Therefore, government regulation affects firms' IT configuration and management.

According to prior research (Anderson et al. 2003; Blakeley and Matsuura 2004), governance activities in IT diffusion can have different influences. One category of government promotion activities involves the e-government initiatives to directly influence firms' IT configurations and thus usage (GDRP), such as transactions with firms in e-government systems, online tax payment, and so on. In order to be consistent with these e-government activities, firms are coerced to establish accordant IT infrastructure and IT configuration. In this way, e-government will affect firms' IT plans, especially their IT infrastructure. The other category deals with their regulations and promotion policies (GIRP). These are intended to improve firms' IT-related knowledge and to provide a standardized environment by establishing IT application standards, evaluation frameworks, regulation standards, and so on. The government regulations or promotion policies cannot influence firms' IT decisions directly, but may shorten firms' learning curves, reduce information asymmetry, and improve and accelerate the IT knowledge-diffusion process in the entire market. Firms are motivated to imitate other organizations' IT practices and normalize their IT usage behavior. Therefore, these regulations or policies can affect firms' IT knowledge and, consequently, their IT management quality. Accordingly, we propose

H3: Government IT promotion policies have positive impact on firms' IT infrastructure and IT management.

H3a: E-government initiatives positively affect firms' IT infrastructure construction.

H3b: Government regulation and IT promotion policies help firms improve their IT management.

Prior research shows that nontechnical environmental factors affect innovation adoption (Kraemer et al. 2002; Tornatzky and Fleischer 1990). While firms in e-commerce surveys frequently cite environment issues like security, credibility of the system, and legal matters as their major concerns, they also point out that incentives provided by the government are key drivers for their new IT and e-commerce usage (Tan and Ouyang 2004; Xu et al. 2004). The results denote that government regulation (GRDP) and IT-related promotion policies can affect firms' IT configuration and improve their IT usage. Thus, we propose

H4: Government IT-related policies positively affect firms' IT usage.

H4a: E-government initiatives help firms improve their IT usage.

H4b: Government regulation and IT promotion policies help firms improve their IT usage.

Firms with strong ties to the public sector are likely to adopt IT innovations supported by government policy (Hinings and Greenwood 1987; Zucker 1987) and to follow up government IT-usage actions. The extent of environmental effect can be defined by firms' ownership, investment property, and industry type. Firms with a national background are more easily influenced by government actions and regulations. Government may influence firms' IT adoption in diverse ways. With e-government implementation, firms are coerced to adopt their technology infrastructure to align with the government's system. With government promotion and regulation of IT standards and practices, firms can imitate other organizations' IT practices and normalize their IT usage behavior. In order to examine whether government effects are the same across different firm types, we will divide the full sample into subsample sets according to firm type and run *post hoc* analysis to further explore government's role in firms' IT adoption.

4 METHODOLOGY

4.1 Data and Method

A questionnaire survey method was adopted for the study. The sample frame includes enterprises in Shanghai from 14 industries: machinery manufacturing; transportation services; retail business/wholesale trade; food, beverage, and tourism services; food processing; textile; oil and coking processing; pharmaceutical manufacturing; chemical fiber/rubber/plastic products; metal smelt and mangle processing; transport manufacturing; electronic and telecommunication equipment manufacturing; sporting, cultural, and educational goods manufacturing; and real estate. Overall, 1,912 random firms received questionnaires, resulting in 1,211 valid returned questionnaires. We used the

partial least squares (PLS) approach, a structural equation modeling (SEM) technique, to examine the model and hypotheses. The software used to apply PLS to the model is PLS-Graph (Chin 2001).

4.2 Measures and Validity

Three items (i.e., firms' IT hardware, software, and network status) were used to measure IT infrastructure; these items were also used in prior work (Byrd and Turner 2000; Duncan 1995). To measure the IT management factor, we studied the practice of IT-related planning, evaluation, and management activities in firms (Byrd and Turner 2000). To measure the regulatory environment, questions about how government actions, including online procurement requirement, incentives, laws, and legal protection, would affect firms' IT adoption were adapted from prior research (Tan and Ouyang 2004, Xu et al. 2004). Other new items, including funding, e-government service, establishing application standards, and establishing evaluation framework were added after careful discussion among professionals and were validated in the pretest. Among these, adopting web-based online e-government services is categorized as e-government, and others are attributed to government regulations and promotion policies. Finally, IT usage included measures on firms' computer usage and application usage.²

To validate the instruments, we examined internal consistency, convergent validity, and discriminant validity. The result shows that the composite reliability values for the constructs in the model were all above the suggested threshold of 0.7 (Chin 1998; Straub 1989). All items had a loading above 0.55 as suggested by Falk and Miller (1992) while average variance extracted (AVEs) of the construct were above the limit of 0.50 advised by Fornell and Larcker (1981). The squared root of average variance extracted for each construct was higher than the correlation coefficient between two constructs.

5 DATA ANALYSIS

5.1 Full Sample Analysis

All hypothesized paths, except the link between government factors and IT usage, are found to be significant ($p < 0.01$). The path coefficient from infrastructure to usage is 0.453, and from IT management to usage is 0.147, which suggests significant impacts of IT infrastructure and management issues on appropriate IT usage in firms. Furthermore, the paths from e-government to the infrastructure and from government regulation and promotion to IT management are also significant. The path coefficients are 0.189 and 0.246, respectively. The results suggest a clear influence of government on firms' IT configuration and management. However, the impact of government factors on firms' IT usage is not significant. This result suggests that government affects firms' IT usage in an indirect manner. The mediating factors are firms' IT infrastructure and IT manage-

²Details of the questionnaire are available upon request from the second author (cuilili@fudan.edu.cn).

ment. The important dependent construct (i.e., IT usage) has R^2 of 0.331, suggesting a reasonable explanation of data variation in the TOE framework. In summary, H1, H2, H3a, and H3b are supported, while H4a and H4b are not supported.

To verify the mediating effect of IT management and IT infrastructure on government factors and IT usage, we removed the paths between government factors and IT infrastructure and IT management and the model was rerun. Result shows that the paths from government factors to IT usage are not significant, while other paths are still significant. The test demonstrates that government factors affect firms' IT usage indirectly, with IT infrastructure and IT management as mediators.

5.2 Subsample Analysis

5.2.1 Industry Difference Analysis

To test for industry differences in the model, we split the full sample set into two subsamples, one including 988 survey responses from the manufacturing industry (MI) and the other 223 responses from the service industry (SI). According to China's national standard of statistics, the service industry includes retail business/wholesale trade, as well as food, beverage, and tourism services and real estate. The remaining industries belong to the manufacturing category. After examining the internal consistency, convergent validity, and discriminant validity of the model with each subsample set, we ran a PLS analysis.

The path coefficient from infrastructure to usage and from management to usage, respectively, is of the same significance as those in the full-data mode. The result suggests that the model applies across industries. However, the effect of government on firms' IT infrastructure and IT management is only significant in manufacturing, suggesting a distinct government impact on firms' IT decision from different industries. Therefore, the process of IT adoption proves to be similar across industries, while government actions and policies influence only the manufacturing industry significantly.

5.2.2 Investment Property and Ownership Difference Analysis

To further explore whether different types of firms have different IT adoption behavior, we divided firms into several groups according to their investment property and ownership types. With respect to investment property, firms were divided into three groups: local invested, joint invested, and foreign invested. In terms of ownership, firms were divided into three groups: state owned, private owned, and semi-national (private) owned.

The impacts of technological and organizational factors on firms' IT adoption are significant across firms investment property. However, the government influence on firms' IT infrastructure and IT management is only significant in local firms, suggesting a distinct government impact on firms' IT decision from different investment property. Furthermore, IT management plays a more important role in foreign-invested firms than in local- and joint-invested firms, which may suggest a different focus on IT strategy among local, joint, and foreign firms. Therefore, government's actions and policies influence local firms' IT adoption only.

The impacts of technological and organizational factors on firms' IT adoption are significant across firms' ownership. However, government influence on firms' IT infrastructure and IT management is not significant in private firms. The result suggests a distinct government impact on firms of different ownership. Government's actions and policies influence national-background firms significantly.

6 DISCUSSION AND CONCLUSIONS

To study IT adoption in the context of China's governmental regulation, we developed a research model and examined the model with empirical data from 14 selected vertical industries in Shanghai. The empirical analysis provides several major findings.

Finding 1: Government actions affect firms' IT adoption via different paths. Firms' IT infrastructure development and IT management decisions act as mediators between government actions and firms' IT adoption

China, with its booming economy and large population, has been gaining increasing interest from both the business world and the academy. Considering the relatively immature markets, information asymmetry, and relatively strong cultural tradition of subservience to government authority in China, government regulation may have broad impacts on local firms. Although prior research often concluded that government regulation, as an important environmental factor, would significantly influence firms' operation and decisions, exactly how government factors work is not as clear. Few studies have empirically examined the role of government in driving IT adoption in Chinese firms.

In this study, government actions are initially classified into two categories: e-government approach and regulation approach. The data suggests that different government actions affect firms' IT adoption in different ways. Although the government cannot directly influence firms' IT adoption, it does so by influencing firms' IT infrastructure construction and management. Further examination of mediating effects proves that IT infrastructure and management are mediators between government factors and IT usage. In other words, firms' IT infrastructure development and IT management decisions act as mediators between different government actions and firms' IT adoption.

By exploring the government's intervention power over firms' IT infrastructure construction and IT application usage, we find that e-government can affect firms' IT adoption by affecting their IT infrastructure construction. The finding seems reasonable. For example, when adopting online tax-payment systems, firms have to configure proper hardware, network connections, and software to pay the taxes online. Similarly, if firms want to evolve into government e-procedure, they have to be accordant with the e-government systems. Since government regulation and promotion policies can improve firms' IT-related knowledge, the promotion policies interactively act on firms' IT management.

The results also suggest that government regulation and promotion policies affect firms' IT adoption by influencing their IT management decisions. The finding seems reasonable and practical. Because IT adoption is emergent as a technological innovation for most Chinese firms in recent years, firms lack knowledge and experience on how to adopt IT to support their management and business practices. Without theoretical advancement or empirical examination in the context of China, firms cannot receive useful suggestions from the academy, either. Given these reasons, government actions (such

as establishing case studies and an IT adoption evaluation framework, promoting IT learning and firms' IT practice, and adopting web-based tax reporting, inspection, and government e-procurement transaction) give firms a greater opportunity to learn and act. For example, case studies and IT research can help firms know more about IT, providing an IT adoption evaluation framework that can help firms clarify their direction of IT adoption, while promoting IT practices and e-government systems can directly motivate firms to initialize their IT adoption process.

However, since China is gradually transforming to a market economy, the government's impact on firms is decreasing. Although the government's promotion gives firms useful information to configure IT infrastructure and set up management rules, firms are likely to determine their own usage of IT according to their specific conditions and purposes, rather than following exactly what the government has provided. Also, because IT usage is a complex process of fitting IT assets with business operations and strategies, government promotion policies cannot influence manufacturing firms' IT usage directly, but do so indirectly by affecting firms' IT infrastructure and management. This observation will help the government assess its IT policies. For example, when considering new regulations, the government may find it more effective to help firms improve their IT management knowledge, rather than to intervene on their IT usage or direct investment.

Finding 2: Firms adapt to governmental impact in distinct ways. Government impacts on firms' IT adoption are most obvious in the manufacturing industry and are different among firms of different investment property and ownership types

The manufacturing industry is one of the most vital industries in China. With fast globalization and industrialization, China is playing an important role in the global production network (Ernst 2003), and facing more pressure from global competition. Since China has determined informatization-driven industrialization to be its national development strategy, the government has directed more attention to manufacturing firms' IT usage than usage by service firms. Comparing the manufacturing industry with the service industry provides clear evidence of how local government can influence firms' IT usage.

Firms' investment property types and ownership types indicate different degrees of control by government and probably different IT usage and management style in firms. From the empirical data, it seems clear that government policies show differing impacts on local-, joint-, and foreign-invested firms. It is clear that both e-government approaches and promotion policies play a significant role on local firms' IT adoption. In other words, local firms' IT usage is more influenced by government than in the case of firms with foreign investment. Compared to firms with foreign investment, local firms usually have less experience with how Western firms operate and less mature ways of using IT. As a result, local firms are willing to receive support from government when making IT-related decisions. Besides, government influence on local firms is historically strong in a government-directed economy. As market economics in China matures, government influence is weakening, but the empirical data in the study still suggest a stronger influence on local firms, compared with foreign-invested firms. The result also suggests that government policies and actions in China are critically important factors influencing firms' IT usage.

Government policies show distinct impacts on national, semi-national, and private firms. It is clear that firms with a national background are more significantly influenced by government policies. The reason is straightforward: national firms are more used to

following government policies than other ownership type firms. On the other hand, national firms constitute the major focus of government regulation in China. Government usually targets national firms when making decisions and policies. Therefore, it is not surprising to see a more significant role of government in such firms' operation and management activities in China.

Overall, e-government approaches and government promotion policies have shown a significant impact on manufacturing firms, on local firms, and on national-background firms. The results suggest that environmental factors, such as government policies, may have varying impacts on different types of firms. Future studies should pay more attention to industry type, investment property type, and ownership type in examining firms' IT adoption, particularly in developing countries like China.

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