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ASSIMILATION OF ENTERPRISE SYSTEMS: THE EFFECT OF INSTITUTIONAL PRESSURES AND THE MEDIATING ROLE OF TOP MANAGEMENT¹

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Abstract

We develop and test a theoretical model to investigate the assimilation of enterprise systems in the post-implementation stage within organizations. Specifically, this model explains how top management mediates the impact of external institutional pressures on the degree of usage of enterprise resource planning (ERP) systems. The hypotheses were tested using survey data from companies that have already implemented ERP systems. Results from partial least squares analyses suggest that mimetic pressures positively affect top management beliefs, which then positively affects top management participation in the ERP assimilation process. In turn, top management participation is confirmed to positively affect the degree of ERP usage. Results also suggest that coercive pressures positively affect top management participation without the mediation of top management beliefs. Surprisingly, we do not find support for our hypothesis that top management participation mediates the effect of normative pressures on ERP usage, but instead we find that normative pressures directly affect ERP usage. Our findings highlight the important role of top management in mediating the effect of institutional pressures on IT assimilation. We confirm that institutional pressures, which are known to be important for IT adoption and implementation, also contribute to post-implementation assimilation when the integration processes are prolonged and outcomes are dynamic and uncertain.

Keywords: Enterprise resource planning, technology assimilation, innovation diffusion, top management, institutional theory

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Introduction

With the promise of greatly improving operational efficiency and enhancing organizational performance, enterprise resource planning (ERP) systems have been embraced by most of the large and medium organizations worldwide. A survey of 500 mid- to large-size companies shows that ERP penetration was 67 percent and another 21 percent of the companies were evaluating the systems; 74 percent of manufacturers and 59 percent of service companies were either using or implementing ERP (Sirkisoon and Shepherd 2002). However, many ERP projects have failed and led companies to financial difficulties (Miller 2000; Xue et al. 2005). According to one estimate, the percentage of ERP implementations that can be classified as “failures” range from 40 percent to 60 percent (Langenwalter 2000).

The high failure rate of ERP projects can be largely ascribed to the complexity of ERP systems. ERP systems’ impacts on organizational processes, structures, and even cultures are much broader and more profound (Robey et al. 2002; Soh et al. 2000) than less complicated technologies. Implementation of an ERP system involves unpacking the “best practices” embedded in the design of the software, possibly through various customizable configurations. The challenge of aligning the embedded business processes with the existing organizational processes puts ERP projects at considerable risk. As a consequence, the outcome of an ERP project is highly dynamic and often a moving target: an early success could become a later failure and an early failure could turn into a later success (Larsen and Myers 1999). Since the potential business value of IT applications cannot be fully realized until they are extensively assimilated in an organization (Armstrong and Sambamurthy 1999; Purvis et al. 2001; Zmud and Apple 1992), success cannot be claimed until ERP assimilation is ultimately achieved by the organization.

While there is a rich body of literature on ERP adoption and implementation (Holland and Light 1999; Markus and Tanis 2000), research on ERP assimilation is scant (Gattiker and Goodhue 2005). Existing post-implementation studies mainly focus on ascertaining their organizational impact of ERP systems and consequently their business value (e.g., Gattiker and Goodhue 2005; Hitt et al. 2002). Few studies utilize a theory focused approach to understand the role of key factors in influencing post-implementation assimilation. Drawing on the literature on institutional theory (Powell and DiMaggio 1991; Zucker 1977, 1987) and top management (Chatterjee et al. 2002a; Jarvenpaa and Ives 1991; Purvis et al. 2001), we develop a theoretical model to explain how ERP assimilation within an organization is influenced by the external institutional forces and the internal human agency. Extending

the findings of Teo et al. (2003b) that isomorphic processes drive the adoption of electronic data interchange (EDI) by organizations, we submit that institutional forces retain their influence into the post-implementation stages of complex IT innovations. Due to the persistent uncertainties and complexities surrounding an ERP project even during the post-implementation phase, the implementing organization remains acquiescent to the mimetic, coercive, and normative pressures arising from its organizational field consisting of the community of suppliers, customers, competitors, professional networks, and governmental agencies. In addition, we extend Teo et al.’s (2003b) argument in another direction by contending that the impact of institutional forces on ERP assimilation is mediated by top management, who serves as an organization’s primary human interface to the external environment.

While it is reasonable to assume that institutional forces and top management, critical to successful adoption and implementation of ERP systems, might still be influential in the assimilation stage, we submit that a theoretical explanation regarding the effects of these factors on ERP assimilation during actual usage is still underdeveloped. Theory-based empirical studies with a focus on the post-implementation assimilation of ERP systems, and IT innovations in general, are clearly called for. By empirically validating a theoretically derived ERP assimilation model, this study offers three major contributions to the literature on IT innovation. First, as a novel contribution, we investigate to what extent top management mediates the effect of institutional forces on ERP assimilation. Second, recognizing the inherent multidimensionality of the concept of top management, we conceptualize the construct at a refined level by discriminating between top management beliefs and actions. In the literature, these two constructs are often treated as a single construct, top management championship. Our third contribution is that we extend prior research on IT adoption and implementation to the post-implementation assimilation phase. Our findings enrich the theory on IT innovation by confirming that institutional forces remain significant in the context of post-implementation assimilation. The relevance of studying the external institutional forces becomes clearer as we describe next the difficulties that arise in assimilating ERP systems in organizational work processes.

In this study, we adopt the definition of assimilation by Purvis et al. (2001) as “the extent to which the use of technology diffuses across the organizational projects or work processes and becomes routinized in the activities of those projects and processes.” This definition corresponds to the “shakedown” and “onward and upward” stages of the ERP life cycle model proposed by Markus and Tanis (2000). The key objective

during the post-implementation stage is to assimilate the technical features of an ERP system into the business routines so that the expected benefits of ERP can be actually realized. At this stage, the involvement of the vendors is significantly lowered and the system is considered officially “rolled out” for routine usage by the operational-level users. Most of the radical customizations such as process conversion and re-engineering are complete at this stage (Luo and Strong 2004). As the initial implementation ends, organizations typically try to ensure that a sufficient amount of knowledge about the ERP system has been transferred from the vendors and consultants to the end users. Power users (users who are technically savvy about the ERP system) are identified to help their peers adapt, and sufficient training resources are committed to reinforce the changes (Somers and Nelson 2004).

However, a number of obstacles could slow down or even stop the assimilation of the ERP after the implementation. For instance, users may not understand the ERP system completely. Instead they may create and reenact workarounds (Markus and Tanis 2000). These workarounds can then persist indefinitely (Tyre and Orlikowski 1994) even though they are recognized as inefficient. For example, Boudreau and Robey (2001) described how users in a state university continued to maintain the *shadow* systems and how power users found it difficult to unlearn their legacy systems after the implementation of an ERP system. Further, unless users are motivated to adapt, they may continue to informally rely (sometimes exclusively) on consultants or power users for solving bottlenecks (Hirt and Swanson 2001). It is also possible that the top executives publicize an ERP project for the purpose of satisfying shareholder expectations without being fully committed to assimilating the ERP system within the organization² (Chatterjee et al. 2002b). At worst, it is even possible that an ERP system is terminated in the post-implementation stage if not appropriately assimilated (Davenport 1998). In summary, ERP assimilation in the post-implementation stage is fraught with uncertainties under which organizations are inclined to seek solutions from their institutional environments. Hence, institutional theory affords us a lens through which organizational behavior in assimilating ERP systems can be reasonably explained.

The rest of the paper is organized as follows. In the next section, we develop our theoretical framework, which integrates institutional theory with the top management perspective. Subsequent sections consecutively develop a research model based on this framework, describe the construct

operationalization and data collection method, present the data analysis procedure and the results of the model testing, and discuss the findings and their theoretical and managerial implications. This paper concludes with a discussion about our findings and directions for future research.

Theoretical Framework

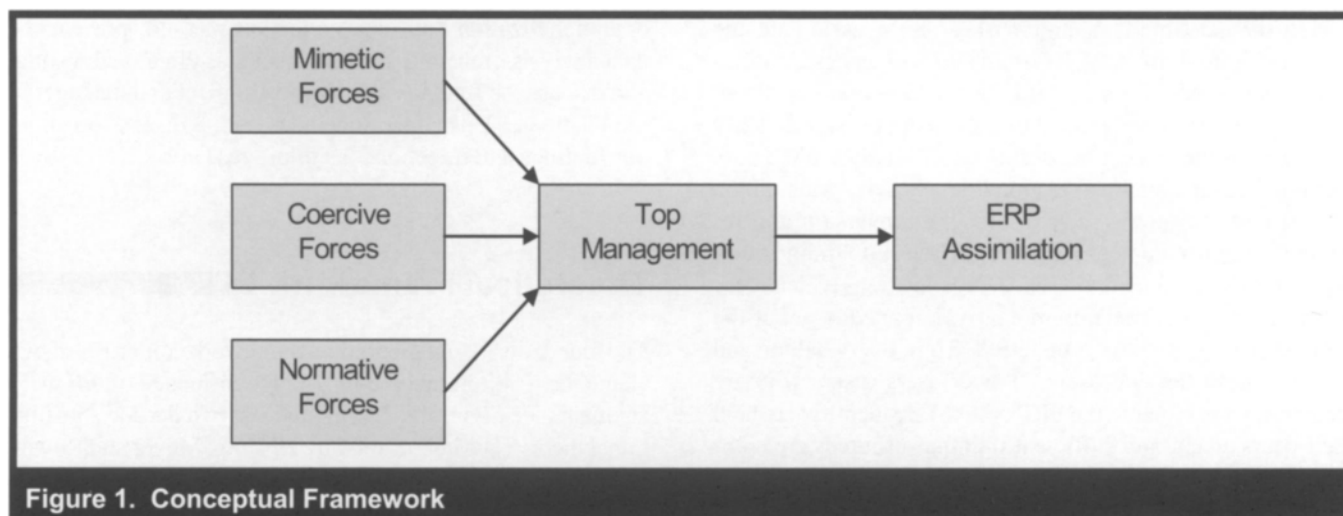
The foundation of our theoretical framework comprises of two elements: institutional theory and the influence of top management (see Figure 1). During the last two decades, institutional theory (DiMaggio and Powell 1983; Meyer and Rowan 1977) has emerged as a powerful explanation to account for the influence of external institutions on organizational decision making and outcomes (Mizruchi and Fein 1999). We argue that institutional forces retain their influence throughout the life cycle of complex enterprise systems as they are adopted and then evolve continuously (Gosain 2004; Swanson and Ramiller 1997). However, external forces, no matter how strong they are, will have no effect on the behavior of an organization without first affecting the behavior of human agents within the organization. Thus, we further argue that external institutional forces affect the assimilation of ERP systems through the agency of key organizational members (top management). Our theoretical framework is grounded in the proposition that institutional forces affect organizational behavior after being mediated by the top management.

Institutional Isomorphism and IT Assimilation

When considering the influence of external social, technical, and political environments on organizational behavior such as assimilation of innovations, institutional theory is especially salient. In contrast to transaction cost economics (Williamson 1975, 1981) and resource dependence theory (Pfeffer and Salancik 1978), institutional theory posits that structural and behavioral changes in organizations are driven less by competition and the desire for efficiency, but more by the need for organizational legitimacy. It is this drive for legitimacy that fosters the processes of institutionalization which eventually makes organizations more similar without necessarily making them more efficient, giving rise to institutional isomorphism (DiMaggio and Powell 1983).

DiMaggio and Powell (1983) identify three basic types of institutional isomorphism, *coercive*, *mimetic*, and *normative*, which reflect three analytically distinct processes of institutionalization. Coercive isomorphism results when organiza-

²This also emerged during an exploratory interview with a project manager of a large outsourcing vendor operating in the United States.



tions acquiesce to “the formal and external pressures exerted upon them by other organizations upon which they are dependent, and the cultural expectations in the society within which the organizations function” (DiMaggio and Powell 1983, p. 150). *Coercive* pressures can also arise from government regulations and policies and from industry and professional networks and associations, or in the form of competitive necessity within an industry or market segment (Gular et al. 2002; Mezas 1990; Tolbert and Zucker 1983). *Mimetic* isomorphism results as organizations respond to uncertainty by mimicking actions of other organizations. When technologies are poorly understood, when goals are ambiguous, or when the environment creates uncertainty, organizations may model themselves after other organizations perceived to be legitimate or successful (DiMaggio and Powell 1983). Therefore, mimicry is often associated with the bandwagon effect (Staw and Epstein 2000). Several empirical studies observe mimetic isomorphism in the decision making processes (Haveman 1993; Staw and Epstein 2000). *Normative* isomorphism occurs primarily as a result of professionalization defined as “the collective struggle of members of an occupation to define the conditions and methods of their work, to control the production of the future member professionals, and to establish a cognitive base and legitimization for their occupational autonomy” (DiMaggio and Powell 1983, p. 152). For a particular industry, it is argued that a pool of almost interchangeable employees is created through formal education and professional networks. By occupying similar positions across a range of organizations, these individuals possess similar orientation and disposition that override the variations in traditions and control mechanisms otherwise shaping distinctive organizational behavior.

Institutional theory has been widely used in the social science and management literature (Mizruchi and Fein 1999) and has recently begun to be applied in IS research. For example, empirical evidence of mimetic behavior has been found in various contexts such as website adoption (Flanagin 2000), EDI adoption (Teo et al. 2003b), IT product choice (Tingling and Parent 2002), and in IT budgeting decisions (Hu and Quan 2006). Coercive and normative isomorphic mechanisms are found to occur in organizational information security practices and policies (Hu et al. 2006). In particular, ERP systems have been described as both the objects and carriers of external institutional forces. Gosain (2004) theorizes how institutional forces may not only lead to the adoption of enterprise systems, such as ERP, but may also have a powerful influence on how these systems are configured during implementation.

To our knowledge, institutional theory has not been applied in the context of ERP assimilation. Research literature commonly conveys the notion that innovation assimilation is determined primarily by factors *internal* to the organization (Armstrong and Sambamurthy 1999; Purvis et al. 2001). However, there are significant indications in qualitative studies that *external* factors are also significant. For example, Hirt and Swanson (2001) describe the increasingly important role of consultants, vendors, and industry conferences in the post-implementation context. Although Somers and Nelson (2004) do not explicitly note this, their findings also indicate the important role of external entities during the “infusion” stage. Similarly, Damanpour (1991) suggests that communications with external entities may be just as important during the early as in the later stages of an innovation’s life cycle. Hence, institutional theory is highly relevant in understanding the assimilation stage.

Top Management and IT Assimilation

While institutional theory predicts institutional isomorphism, in reality, organizations have exhibited diversity with respect to the degree of ERP assimilation under a similar institutional environment. To account for this diversity, we apply a human agency perspective and posit that the top management members are the primary human agency that translates external influences into managerial actions such as changing organizational structures and establishing policies based on their perceptions and beliefs of institutional practices. Top management's boundary spanning role has been found to significantly affect IT project performance by importing external knowledge and integrating internal knowledge (Mitchell 2006). In the institutional environment, top managers are not only influenced by others' choices of IT products or services or of influential consultants, they may also benchmark the business benefits they derive from their ERP usage against those derived by other organizations. Thus, we propose that institutional forces may not directly affect ERP assimilation in organizations; rather, their effect on ERP assimilation is realized by the actions of top management. That is, we theorize that institutional forces' influence on ERP assimilation is mediated by top management. To fully explain the extent of ERP assimilation, we must consider the interaction between institutional forces and top management. It may be argued that it is the operational level employees who need to adapt their work processes to assimilate a new IT artifact. However, past research suggests that top management needs to recognize and assume the responsibility for both the technical and organizational changes (Leonard-Barton 1988). Indeed, literature on innovation assimilation largely views top management as the agency responsible for changing the norms, values, and culture within an organization, and in turn, this enables other organizational members to adapt to the new technology artifact. The norms, values, and culture engendered by the top management permeate to the individual level in the form of procedures, rules, regulations, and routines, which serve as powerful templates that guide individual behavior (Purvis et al. 2001).

In contrast to the relative lack of theorizing about the role of external institutions in IT assimilation, a broad base of literature provides theoretical support for the role of top management in driving IT usage within organizations (Reich and Benbasat 1990). For example, prior studies demonstrate that formal monitoring of progress (Garritty 1963) and incentives (Bhattacharjee 1996) result in increased usage of IT. For large scale systems, top management is especially critical for forging partnerships among functional area executives (Doll and Vonderembse 1987). Prior studies also find that top management affects progressive usage of IT in

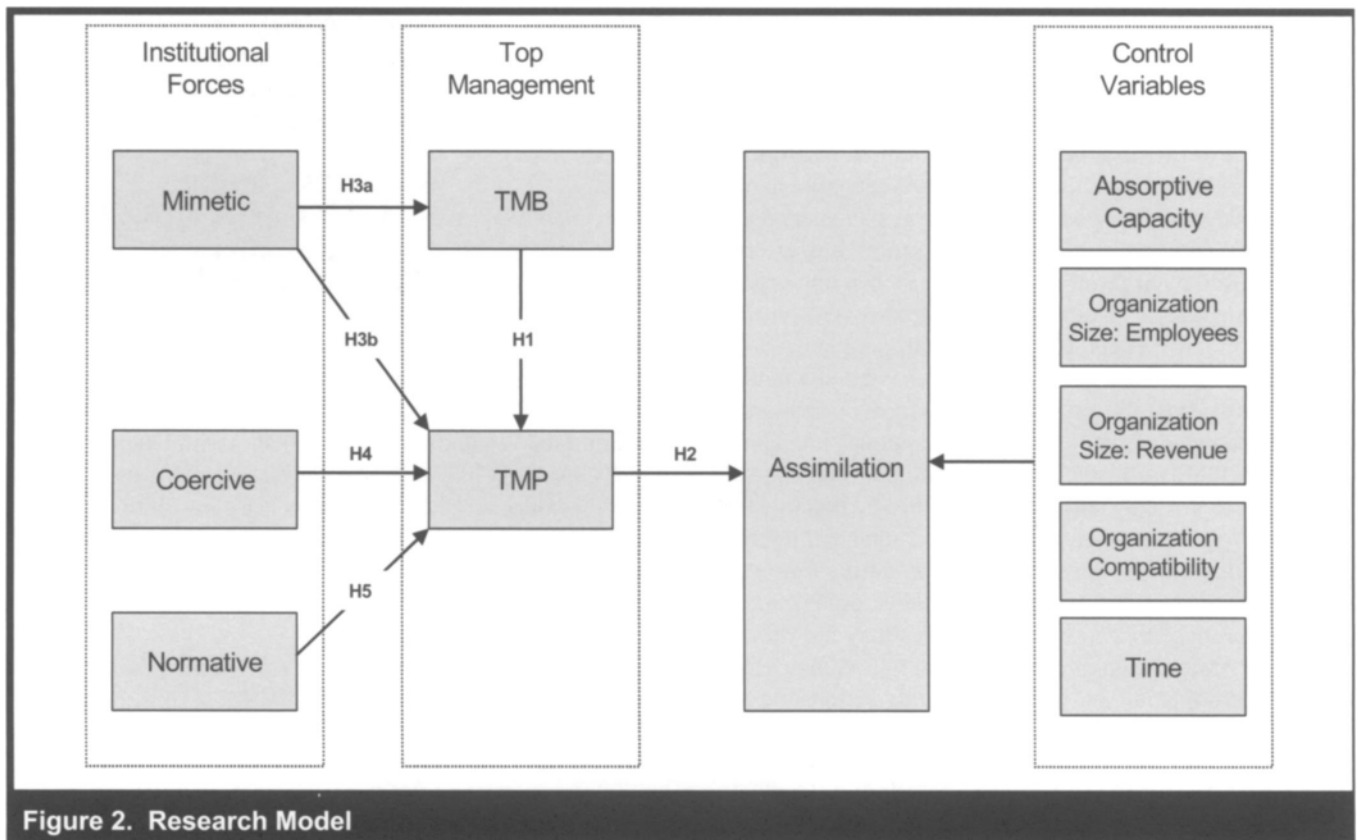
companies (Jarvenpaa and Ives 1991), contributes to assimilation of CASE tools (Purvis et al. 2001), increases the assimilation of web technologies (Chatterjee et al. 2002a), and can reverse failing implementations (Akkermans and van Helden 2002).

Research Model and Hypotheses

Based on our theoretical proposition that top management mediates the effect of institutional pressures on assimilation, we develop a research model (Figure 2) and propose six hypotheses grounded in the ERP assimilation context. However, these hypotheses do not exclude the possibility that other factors may mediate the influence of institutional forces, a possibility that will be considered during our model testing and subsequent discussion.

Top Management Beliefs and Participation in Assimilation

To develop a refined understanding of the role of top management, we elaborate on two conceptual stages in the process by which top management supports an organizational initiative, namely, belief and participation. Following Jarvenpaa and Ives (1991), we use top management beliefs (TMB) and participation (TMP) to represent these two stages and treat them as two distinct constructs. TMB refers to a subjective psychological state regarding the potential of ERP, while TMP refers to the behavior and actions performed to facilitate ERP assimilation. First, past research shows how the external environment affects the beliefs of top management. For example, top managers develop "belief structures" to manage concepts and stimuli from the environment and use these beliefs as a basis for inferences (Walsh 1988). Second, literature suggests that top managers' beliefs guide their administrative behaviors. Srivastava (1983) asserts that organizational strategies, decisions, and behavior are guided by top managers' mental image of a desired future organizational state. Hambrick and Mason (1984) suggest that organizational choices are a reflection of the top management's values and cognitive bases. Thus, the positive beliefs of top managers about the usefulness of information systems result in certain managerial actions intended to assimilate such systems. For instance, Chatterjee et al. (2002a) state that "through their beliefs, top management can offer visions and guidelines to managers and business units about the opportunities and risks in assimilating the Web technologies" (pp. 70-71). Lefebvre et al. (1997) also find that top management's



participation in organizational IT management activities is largely based upon their beliefs, rather than objective reality. Based on substantial evidence from the management and IS literature, we propose that

Hypothesis 1: Stronger top management beliefs about the benefits of ERP lead to higher levels of top management participation in the ERP assimilation process.

Drawing from the prior research on IT implementation (Armstrong and Sambamurthy 1999; Orlikowski 1992; Orlikowski and Gash 1994; Purvis et al. 2001; Sharma and Yetton 2003), we argue that TMP is accomplished by the creation of organizational structures that facilitate ERP assimilation in different ways. First, top management publicly championing the new systems lends legitimacy to assimilating the ERP system and to the changes imposed by managers in the work routines. Legitimacy is especially important since ERP systems are high impact systems that could encounter strong resistance from organizational elements such as functional departments, regional cliques, unions, employee asso-

ciations, etc. Second, employees view internal policies and rules relevant to the ERP initiative as cognitive guides. For example, in one organization, top management was reported to actively direct ERP users within the company to interact with external parties and encourage participation in industry-wide ERP user forums or conferences (Hirt and Swanson 2001). Finally, due to the broad impact of an ERP implementation on organizational structure and processes, organizational diktats (rules and sanctions) could either facilitate or hinder the adaptation by employees. As an example, it is recommended that top management pay particular attention to designing appropriate performance control systems that align individual incentives to use IT with the benefits accruing from adoption (Ba et al. 2001). These mechanisms have a meta-structuring effect by providing a vision as to what the IT innovation is supposed to achieve and by encouraging organizational members to adapt a new IT artifact toward specific goals. Therefore,

Hypothesis 2: Higher levels of top management participation in the ERP assimilation process lead to a higher extent of ERP assimilation within the organization.

The Role of Institutional Pressures in Assimilation

Mimetic Pressures

We argue that top management mediates the effect of mimetic pressures on ERP assimilation when it copies the choices other firms have made in their efforts to assimilate the system. Given the inherent uncertainty of the outcomes of ERP initiatives, top managers succumb to mimicking the actions of their successful peers or competitors since it shields them against potential loss of face and helps to maintain the legitimacy of their decisions.³ For example, in their effort to achieve organization–ERP alignment, top managers may experience ambivalence about the manner in which they undertake business process redesign: they may either follow a radical approach (Hammer and Champy 1993) or a gradual approach (Davenport and Stoddard 1994). The decision to follow either approach presents uncertainties in performance outcomes of ERP. Hence, top management exhibits the tendency to imitate the action taken by other structurally equivalent organizations perceived as successful (Teo et al. 2003b). For example, Liang and Xue (2004) find that many Chinese companies follow a mild organizational transformation strategy to improve, optimize, and reengineer business processes during ERP assimilation, primarily because of the perceived success of this approach.

Extant literature is not clear about how top management mediates the impact of mimetic forces on ERP assimilation. On the one hand, the institutional theory posits that mimetic forces should directly affect TMP, since the practices of successful competitors may be taken for granted. On the other hand, based on vicarious learning, top management may choose to imitate certain organizational practices according to their perceived impact or outcomes (Haunschild and Miner 1997), implying that TMP is indirectly affected through TMB. Swanson and Ramiller (2004) suggest that the majority of firms may “borrow” mindfulness from a few successful peers by observing what they are doing and what they have to say about an innovation’s benefits. As a rational response to uncertainty, top management tends to develop beliefs about an innovation’s benefits and then translate their beliefs into actions. Hence, we propose that both TMB and TMP are influenced by mimetic forces.

³Top management is also able to learn coping strategies from watching the actions and failures of unsuccessful peers or competitors. This avenue warrants taking a learning theory perspective, which is beyond the scope of this research. Besides, it would be difficult for top management to learn from unsuccessful firms because implementation and assimilation failures are often covered up. In this study, we will focus on the imitative tendencies of top management.

Hypothesis 3a: Higher levels of mimetic pressures lead to stronger top management beliefs about the benefits of ERP assimilation.

Hypothesis 3b: Higher levels of mimetic pressures lead to higher levels of top management participation in the ERP assimilation process.

Coercive Pressures

Coercive pressures have been shown to be significant in the adoption of innovations (Hart and Saunders 1998; Hu et al. 2006; Mezas 1990). We predict that such pressures remain significant in the assimilation stage. In Teo et al.’s (2003b) EDI study, coercive pressures mainly stem from dominant suppliers and customers because of the nature of EDI as a dyadic technology linking business partners. In the ERP assimilation context of this study, we believe that coercive pressures arise primarily from regulatory agencies and industry associations. In developing countries where government agencies still exert significant influences on business policies and practices in addition to the emerging market forces (Park and Luo 2001), coercive pressures are more likely to arise from governments and collective industry associations, and could be especially pronounced in countries like China where the legacy of a central-planning economy still manipulates the emerging free market economy (Rawski 1994). The Chinese government has been coercing firms to use ERP systems both directly and indirectly. The direct pressures arise from government agencies that require specific report formats or standard procedures supported by certain ERP modules. The State Food and Drug Administration, for instance, requires Chinese pharmaceutical distributors and wholesalers to conduct good supply practice (GSP) supported by the quality management modules of ERP (Liang and Xue 2004); and the Ministry of Finance mandates specific accounting report formats supported by the accounting modules of ERP (Xue et al. 2005). Thus, firms that have implemented ERP systems are obligated to assimilate the functionalities of various ERP modules into their work routines to meet government regulations. The indirect pressures⁴ arise from government-based agencies such as the Ministry of Science and Technology and State Economic and Trade Commission, which reward companies that successfully assimilate IT into their business routines. Local governments and industry associations (usually affiliated with the government) also recognize local companies as “model” IT users, which increases their

⁴This information was obtained by personal communications with the senior marketing manager at UFIDA.

reputation and access to business opportunities. In addition, some local governments also allow companies to get tax credits for their capital investments in ERP systems.

Top management team members are the focal point of these coercive pressures and they are forced to participate in meta-structuring activities to support ERP assimilation. Under these circumstances, top management does not have to cognitively believe in the benefits of ERP assimilation. Thus, we argue that coercive pressures directly stimulate TMP aimed at assimilating ERP system without affecting TMB.

Hypothesis 4: Higher levels of coercive pressures lead to higher levels of top management participation in the ERP assimilation process.

Normative Pressures

The role of normative pressures in ERP assimilation processes is closely related to the key characteristic of ERP systems that they contain commoditized knowledge. Once an ERP package is available for the industry, members of an organizational field such as suppliers, customers, consultants, and governments collectively evaluate and promote various features of the product (Swanson and Ramiller 1997), thus shaping institutional norms regarding implementation and consequent assimilation of ERP systems. Given that the so-called “best practices” embedded in an ERP system cannot provide a generic solution to all users (Newell et al. 2000; Swan et al. 1999), institutional norms about ERP systems may guide top managers in making decisions to mitigate outcome uncertainties, such as decisions about when and how to modify existing business processes vis-à-vis to alter the ERP system itself. These decisions are made not only during implementation but also during the assimilation stage where incremental adjustments to the system and processes are equally important (Markus and Tanis 2000). With their knowledge of the institutional norms and understanding of the enterprise-wide business processes, the top managers can facilitate the “unpacking” of these products and their integration with existing organizational knowledge (Davenport 1998; Mitchell 2006).

Although normative pressures usually permeate through the channels of professional affiliations as well as the increasingly popular ERP user conferences hosted by vendors⁵

⁵However, while the literature identifies the role of interlocking directorates as another source of normative influence, we do not see much influence arising from the board of directors in the context of this study—except perhaps when they transmit such influence to the top management.

we believe that the networking of top managers along the value chain comprising a group of closely related suppliers and customers is a more important route through which normative influences permeate in the context of this study. This is especially true in developing countries where the governance of interfirm relationships is pervasively achieved through *guanxi*, interpersonal relationships between senior managers (Lee and Dawes 2005). By developing *guanxi* with managers of other organizations and officials of various government agencies, top management creates an interorganizational network within which greater resources, knowledge, and management expertise can be accessed (Park and Luo 2001). Hence, top managers tend to be the boundary spanners who collectively shape and are inevitably influenced by the institutional norms in this network. In the context of ERP assimilation, these norms guide them about the extent to which they should adapt their business processes and work routines to the ERP system and conversely what features of the ERP system can be modified to suit their processes and routines. We contend that top management is likely to take for granted institutional norms that are prevalent in their inter-organizational networks. Hence,

Hypothesis 5: Higher levels of normative pressures lead to higher levels of top management participation in the ERP assimilation process.

Control Variables

To fully account for the differences among organizations, we also include five control variables that characterize our unit of analysis, a firm that has completed the initial implementation of an ERP system. These variables are absorptive capacity of the implementing organization toward the ERP system; number of employees; revenue; organizational compatibility; and time since implementation is completed. We select these particular variables because of their potential impact on ERP assimilation as suggested by the extant literature.

Absorptive Capacity

The learning perspective suggests that assimilation can be greatly improved if organizations have prior knowledge that facilitates assimilation of external information and its application to commercial ends (Cohen and Levinthal 1990). This ability is termed *absorptive capacity* and is widely understood to enhance an organization's innovative capabilities. The intuition of absorptive capacity has been applied to explain IT usage in large organizations. For example, Teo et al. (2003a) show how absorptive capacity can influence the intention to

adopt an EDI system. To account for the variances attributable to organizational knowledge on ERP systems, we control for the differences among organizations in terms of their absorptive capacity for assimilating the ERP system.

Organization Size

We use number of employees and revenue as two measures of organizational size. Just as organizational size connotes slack resources required for purchasing expensive innovations and withstanding adoption failures (Rogers 1983), bigger size permits organizations to foster adaptation mechanisms such as maintaining shadow systems and slow phasing out of legacy systems. Whereas larger organizations can withstand such implementation hurdles by virtue of their size, for smaller organizations survival is the more immediate concern and therefore any ERP implementation hurdle has immediate repercussions on their business commitments to customers and suppliers. Organizational size is an important control variable for another reason. ERP system vendors have more at stake by being attentive to their larger clients compared to their smaller ones.

Organizational Compatibility

Even though managers of an organization may have assessed the compatibility of an ERP system with various dimensions of the organization such as its business values, work practices, and culture (Jones and Beatty 1998), such assessment might often be inaccurate or incomplete. Since the ERP life cycle is often protracted,⁶ it is possible that organizational criteria for assessment might have changed or the organization itself evolved in some way so as to invalidate the initial assessment. It is likely that after the completion of the initial implementation, new incompatibilities are discovered during the actual use of the ERP system that could hinder assimilation of the ERP system. This control variable takes into account the variance as a result of organizational compatibility issues.

Time since Implementation

Finally, we include the time since the completion of ERP implementation as a control variable for the reason that adaptation is a time-sensitive process and misalignments that might have existed initially may have been resolved by users

and managers to various degrees at the time the survey was taken. Thus, this variable takes into account the accumulated organizational learning and experience that facilitates assimilation (Fichman 2001). Chatterjee et al. (2002a) used a similar control variable in a recent study on IT assimilation.

Research Method and Data

Construct Operationalization

We used the survey method to test our model. A survey instrument was developed by identifying appropriate measurements from a comprehensive literature review. Some modifications were made to the existing scale to make those more suitable in the context of ERP assimilation. Since the target organizations are the companies that have implemented ERP systems in China, the questionnaire was translated into Chinese and a panel of experts in the Chinese ERP industry examined the face validity of the items. A few changes to the scales were made in order to match the Chinese context. All of the exogenous constructs in the model are operationalized as reflective constructs. The dependent construct, ERP assimilation, was operationalized as a formative construct as discussed next.

Assimilation

We reviewed existing literature as a basis for developing this scale (Hart and Saunders 1998; Iacovou and Benbasat 1995; Massetti and Zmud 1996) and in particular, the four dimensions of EDI usage as identified by Massetti and Zmud (1996) were used as a guide to construct a three-item formative scale. However, all four scale items in Massetti and Zmud could not be replicated because of the differing contexts of ERP versus EDI. Whereas in an EDI context, usage *volume* can be measured by specifying the extent to which a firm's particular types of transactions are conducted with its suppliers/customers through EDI, the same scheme could not be used for ERP systems because different respondents had implemented a different set of modules. In the interest of maintaining the conciseness of the questionnaire (and thus the response rate), the volume dimension was measured by asking respondents to indicate the percentage of a subset of business processes that were conducted using ERP. *Diversity* represents the number of a firm's business functional areas automated by ERP technology. *Depth* was measured by asking the respondents to indicate the vertical impact of ERP systems on their business activities, ranging from planning to decision making. In this research setting, our focus is on how

⁶According to Mabert et al. (2000), an ERP implementation project could last from 6 months to 2 years.

ERP is used for back office automation, so we did not include the breadth dimension in the scale for the degree of ERP assimilation.

Top Management Beliefs

This refers to the extent to which top management considers that using the ERP system can potentially benefit the organization. A three-item reflective scale was derived from the four-item scale used by Chatterjee et al. (2002a). We used the first two that were relevant to the ERP context and we added a third negatively worded item.

Top Management Participation

This was adapted from Chatterjee et al. (2002a) as a three-item reflective scale. It refers to the extent to which top management actively participates in the management of the ERP initiative.

Mimetic Pressures

Following Teo et al. (2003b), this construct was measured in terms of the perceived extent to which competitors have benefited from assimilating ERP. In our context, we believe that the respondents might not be able to accurately gauge the extent to which their competitors have assimilated ERP; however, they would be knowledgeable about their competitors' degree of success after adopting ERP. We adapted Teo et al.'s (2003b) scale in the following way. Instead of capturing two dimensions of this construct in the context of EDI (extent of adoption of among competitors and perceived success of adopters who are competitors), we focused on the second dimension (i.e., *perceived success* of adopters who were competitors) because the first dimension (competitors' *adoption decisions*) is unnecessary in the post-implementation context, assuming that any firm would decide to use its ERP after adoption.

Coercive Pressures

This construct was operationalized in terms of the extent of formal and informal pressures perceived by virtue of the competitive conditions, and requirements and incentives from the local government and industry associations. The scale was different from the one used by Teo et al (2003b). Based on an analysis of the context of ERP assimilation in China's organizations, we argue that coercive pressures mainly arise from regulations and government incentives, as discussed in

detail earlier. We initially devised a three-item reflective scale and found that one of the items that referred to competitive pressures did not load well onto the latent construct. On reexamining, we dropped this item from further analysis.

Normative Pressures

This refers to the perceived extent to which members of the dyadic relational channels have adopted ERP and the extent to which the government and industry agencies promote the use of information technology and especially ERP systems. We emphasize the importance of the interorganizational networks primarily based on the relationships between top management of the organizational filed as well as the government agencies in shaping the norm of ERP assimilation because they have played a central role in cultivating the development of domestic ERP vendors and the culture of using ERP in businesses (Xue et al. 2005). This scale is largely consistent with the three dimensions measured by Teo et al. (2003b).

Absorptive Capacity

We devised our own reflective scale based on items from Szulanski (1996) and Teo et al. (2003a). We also added two additional items to capture the readiness of the organization for assimilating ERP systems and paid particular attention to the context of the post-implementation where technical support and training are essential. Some of the items did not load well and were subsequently removed from further analysis. Since this construct is used as a control variable, we believe it is adequate to proceed with the truncated four-item scale.

Organizational Compatibility

This refers to the perceived alignment between the IT innovation and the culture, values, and preferred work practices of the assimilating organization (Jones and Beatty 1998). Using past studies (Beatty et al. 2001; Jones and Beatty 1998; O'Callaghan et al. 1992), we measured this using a four-item reflective scale adapted from Jones and Beatty (1998) and then dropped one of the items before further analysis because it did not load well.

Data Collection

The survey was administered to managers in Chinese companies which have implemented ERP systems. A sample was

drawn from the clients of UFIDA (known as UFSOft before 2005), the vendor with the largest market share in China's ERP market (Liang et al. 2004). We requested a marketing manager at UFIDA to randomly distribute 100 questionnaires to the directors of its 14 subsidiaries and 15 offices. These subsidiaries and offices are located in China's four largest cities, three autonomous regions, and 17 provinces, representing a wide range of geographical and cultural diversity. Each of the 29 directors randomly selected some ERP customers from his or her region and handed questionnaires to the persons who supervised the ERP projects in these companies.

We believe this design is suitable for this research in light of China's unique social and cultural context. In China, many business activities are largely based on personal relationships, or *guanxi*, instead of formal rules (Martinsons and Westwood 1997). Collecting data for research purposes from Chinese companies is extremely difficult unless it is done through personal liaisons. Only with the help from UFIDA were we able to access the key person in the ERP project of each company of interest. These informants were members of the senior management team and played a key role in the ERP initiative within their companies. They not only were involved during ERP vendor selection but also supervised its implementation, and interacted with other members of the top management team frequently with respect to ERP issues in their companies. Hence, they are likely to provide a better evaluation of external pressures imposed on their companies, and top management's beliefs and participation regarding ERP usage. Even after the projects were over, the ERP usage status report was a topic of many companies' management meetings and was documented. In order to preserve relative objectivity of the ERP assimilation measures, the key informants were requested to provide answers based on minutes of the meetings or other documentation. The risk of inaccuracy in survey responses due to memory-related issues was alleviated because UFIDA's sales representatives had continuous interactions with their clients even after implementations were completed. They intentionally monitored ERP usage for the purpose of acquiring additional sales and maintenance contracts.

Several finance managers were among the respondents because of the ERP implementation history in Chinese companies. The predecessor of ERP software in China was accounting and financial software. Therefore, a significant number of Chinese ERP vendors and their clients were financial software vendors and financial managers respectively (Xue et al. 2005). Consequently, finance managers

emerged at the helm of many IT initiatives within Chinese companies.

Of the 100 questionnaires distributed, 80 questionnaires were returned and 77 questionnaires were completed and usable for data analysis, showing an effective response rate of 77 percent. We assessed nonresponse bias using Chi-square tests or t-tests to compare the responding and nonresponding companies' business type, ownership, revenue, and number of employees and found no significant differences ($p > .05$). Table 1 presents the types of business and ownership represented in the sample. Table 2 presents the profiles of the responding companies. Table 3 presents the demographics of the respondents. As the data indicate, the respondents were mostly senior managers or middle level managers in the IT or finance departments. In many Chinese firms, there is no CIO or CFO position and so a director is often the senior executive who oversees these functions.

There were 28 missing values in the data set, which accounted for 1.35 percent of the total number of values. We performed Little's MCAR test (Little and Rubin 1987) and found that these values were missing completely at random ($p > .05$). This test suggested that the missing values were not based on a hidden systematic pattern and any imputation methods could be applied to replace them (Hair et al. 1998). A regression imputation method was applied because it predicts the missing value of a variable based on its relationship with other variables, thus ensuring that the replacing value is consistent with the existing relationship structure in the data set (Hair et al. 1998). After replacing the missing values, a data set with 77 complete cases was obtained. Kolmogorov-Smirnov and Shapiro-Wilk tests show that each indicator of the major constructs is normally distributed. Q-Q plots also indicate that our data are normally distributed.

We used Cohen's (1988) power table for multiple regression (MR) analysis to calculate power values for our partial least squares (PLS) model. This is because PLS is performed by iterative regression analysis (Chin 1998). Hence, power analysis on MR should be also applicable for PLS. PLS estimates a structural model block by block. To ensure that every block of our model has adequate power, we calculated power values block by block. Each block consists of a dependent variable (DV) and its independent variables (IVs). Our research model has three DVs: assimilation, TMP, and TMB. So we will have three major blocks. Because the assimilation block involves control variables and mediation effects, we took a hierarchical approach to analyze power for incremental explanation of variance, as suggested by Cohen (1988). Thus we had five power analyses. The power values ranged from .83 to .99.

Table 1. Types of Participating Firms and Ownership

		N	Percentage (%)
Types of business	Manufacturing	52	67.5
	Service	21	27.3
	Other	4	5.2
Ownership	Private	35	45.5
	Publicly Traded	20	26.0
	Joint venture	14	18.2
	State owned	8	10.4

Table 2. Responding Company Demographics

	Mean	SD
Number of employees	880.62	1777.90
Revenues (million dollars)	48.47	69.12
Time* (months)	21.88	15.47

*Time period from the completion of the ERP project to the point when the questionnaire was filled out.

Table 3. Respondent Demographics

Title	CEO	VP	CIO	CFO	IT director	Finance director	Finance manager	Sales director	Total
N	2	3	10	8	16	18	16	4	77
%	3	4	13	10	21	23	21	5	100

Data Analyses and Results

Since our research model contains both reflective and formative constructs, and we have a relatively small sample size, partial least square was chosen for data analysis. Unlike a covariance-based structural equation modeling method such as LISREL, PLS employs a component-based approach for estimation purposes (Lohmoller 1989), and can handle formative constructs (Chin et al. 2003). In general, PLS is better suited for explaining complex relationships as it avoids two serious problems: inadmissible solutions and factor indeterminacy (Fornell and Bookstein 1982).

Measurement Model

We note that all of the reliability coefficients are above .70 and each AVE is above .50 (see Appendix B), indicating that the measurements are reliable and the latent construct can

account for at least 50 percent of the variance in the items. As shown in Appendix B, the loadings are in an acceptable range and the t-values indicate that they are significant at the .01 level. If the square root of the AVE is greater than all of the inter-construct correlations, it is evidence of sufficient discriminant validity (Chin 1998). The results in Table 4 suggest that our measurement model demonstrates sufficient discriminant validity. In order to further assess validity of our measurement instruments, a cross-loadings table (Appendix C) was constructed, as suggested by Gefen et al. (2000). It can be seen that each item loading in the table is much higher on its assigned construct than on the other constructs, supporting adequate convergent and discriminant validity.

As Chin (1998) states, covariance based estimates such as reliability and AVE are not applicable for evaluating formative constructs. Instead, the path weights of indicators need to be examined to check if they significantly contribute to the emergent construct. The measurement of ERP assimilation

Table 4. Correlations among Major Constructs

Construct	TMB	TMP	MIM	COE	NOR	OC	AC	ASSIM
TM Beliefs	.565							
TM Participation	.403***	.636						
Mimetic	.277*	.243*	.658					
Coercive	.120	.232*	.034	.821				
Normative	.086	.148	.284*	.044	.762			
Org. Compatibility	.001	.255*	.021	-.030	.021	.650		
Absorptive Capacity	.126	.217	.265*	.023	.265*	.027	.585	
Assimilation	.346**	.521***	.388***	.144	.306**	-.027	.433***	n/a

*** $p < .001$; ** $p < .01$; * $p < .05$; AVEs are in bold.

was assessed by examining significance of the three path weights. As shown in Appendix B, all three path weights are significant at the .01 level, suggesting that they contribute significantly from different paths to form the construct of ERP assimilation.

Common Method Bias

As with all self-reported data, there is a potential for common method biases resulting from multiple sources such as consistency motif and social desirability (Podsakoff et al. 2003; Podsakoff and Organ 1986). Following Podsakoff and Organ (1986), we attempted to enforce a procedural remedy by asking the respondent not to estimate ERP assimilation outcome measures according to personal experience, but to get this information from minutes of company meetings or documentation. In addition, we performed statistical analyses to assess the severity of common method bias. First, a Harmon one-factor test (Podsakoff and Organ 1986) was conducted on the six conceptually crucial variables in our theoretical model including TMB, TMP, mimetic, coercive, and normative forces, and ERP assimilation. Results from this test showed that six factors are present and the most covariance explained by one factor is 24.69 percent, indicating that common method biases are not a likely contaminant of our results. Second, following Podsakoff et al. (2003) and Williams et al. (2003), we included in the PLS model a common method factor whose indicators included all the principal constructs' indicators and calculated each indicator's variances substantively explained by the principal construct and by the method.⁷ As shown in Appendix D, the results demonstrate that the average substantively explained

variance of the indicators is .67, while the average method-based variance is .016. The ratio of substantive variance to method variance is about 42:1. In addition, most method factor loadings are not significant. Given the small magnitude and insignificance of method variance, we contend that the method is unlikely to be a serious concern for this study.

Hypothesis Testing⁸

Figure 3 presents the estimates obtained from PLS analysis. The R^2 value of .389 indicates that the model explains a substantial amount of variance for ERP assimilation. The results provide evidence for the hypothesized mediating role of TMP between the institutional forces and ERP assimilation. As shown in Figure 3, the TMB–TMP link and the TMP–assimilation link are significant, offering evidence for Hypotheses 1 and 2. In a follow-up test, a TMB–assimilation link was added (with TMP–assimilation link simultaneously included) and found to be insignificant, suggesting the mediating role of TMP between TMB and assimilation. However, this mediation is spurious if TMB is not significantly related to ERP assimilation when TMP is absent. To test TMB's independent effect on ERP assimilation, we removed TMP and conducted another run of PLS analysis. Results of that analysis showed that the TMB–assimilation link becomes significant ($b = .315$, $p < .05$) when TMP is excluded from the model, supporting the hypothesis that TMB could influence ERP assimilation, but its effect is mediated by TMP.

⁸We also conducted regression analyses to test the hypotheses. The regression results are consistent with the PLS results. Since regression analysis cannot assess measurement error and regression at the same time, the regression results might be misleading (Gefen et al. 2000). Hence, we primarily rely on the PLS results.

⁷Please see Appendix E for a detailed description of the procedure we used to assess common method bias.

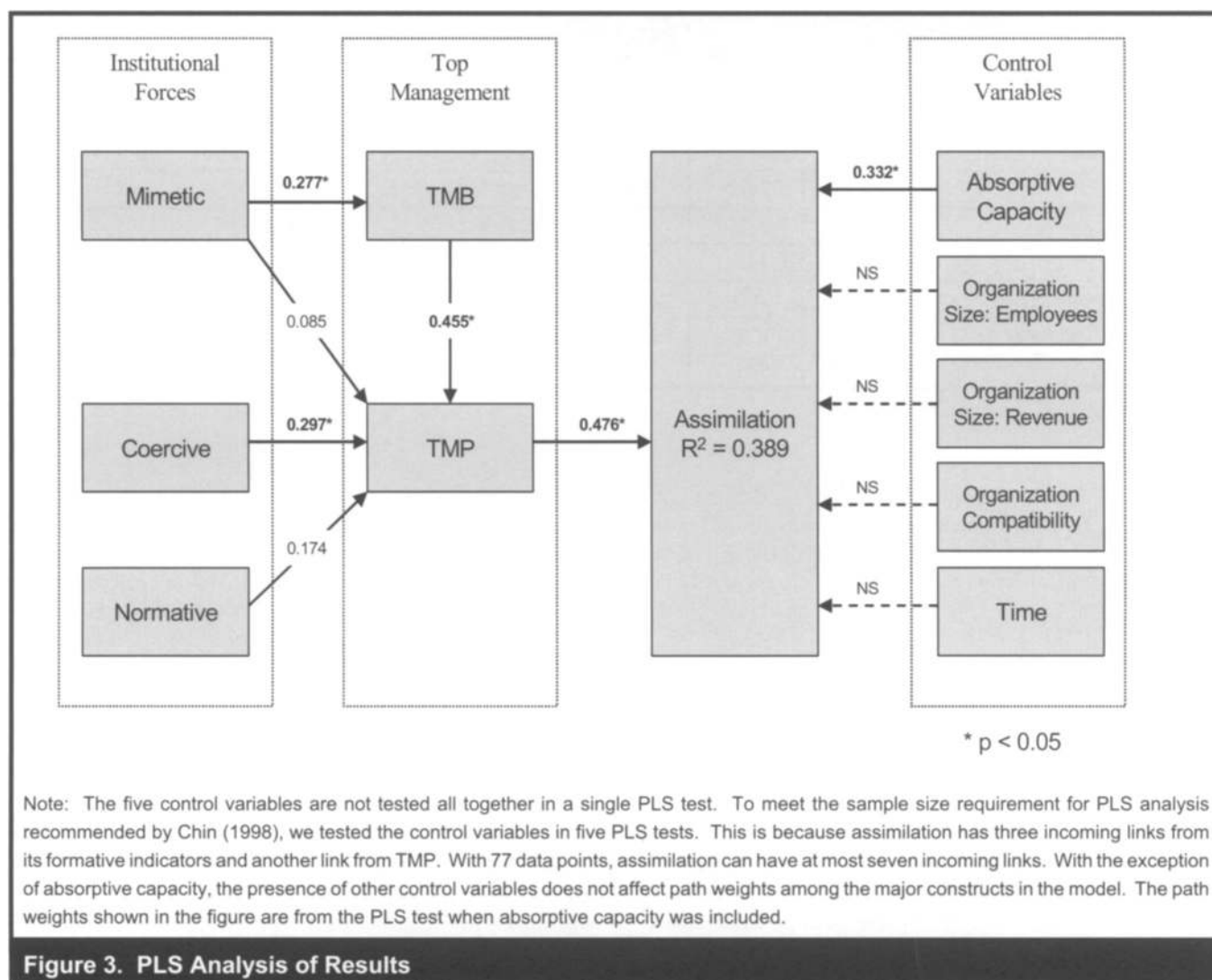


Figure 3. PLS Analysis of Results

Figure 3 also shows that the mimetic–TMB link is significant and the mimetic–TMP link is insignificant, hence Hypothesis 3a is supported while Hypothesis 3b is not. We further demonstrate that the effect of mimetic pressures on ERP assimilation is mediated by TMB and TMP. As shown in Figure 3, mimetic pressures relate significantly to TMB, TMB relates significantly to TMP, and finally TMP significantly relates to ERP assimilation. This causal chain signifies dual mediation effects: (1) TMB mediates between mimetic pressures and TMP, and (2) TMP and TMB mediate between mimetic pressures and ERP assimilation. To test the first mediation, we removed TMB from the model and found that the mimetic–TMP link became significant (.257, $p < .05$). Combined with Figure 3, this finding indicates that the effect of mimetic pressures on TMP is fully mediated by TMB. To

test the second mediation, the independent effect of mimetic pressure on ERP assimilation needs to be examined. We connected mimetic to assimilation, removed TMB and TMP from the model, and conducted another run of PLS analysis, which yielded a significant mimetic–assimilation link ($b = .275$, $p < .05$). To better understand the mechanisms of how institutional forces interact with human agencies within organizations in the ERP assimilation processes, we constructed an alternative model in which all three institutional forces have direct links to the assimilation variable in addition to the mediated links, as shown in Figure 4. The results of this alternative model show that the direct link between mimetic forces and assimilation is still significant. These results jointly indicate that the influence of mimetic force on ERP assimilation is partially mediated by TMB and TMP.

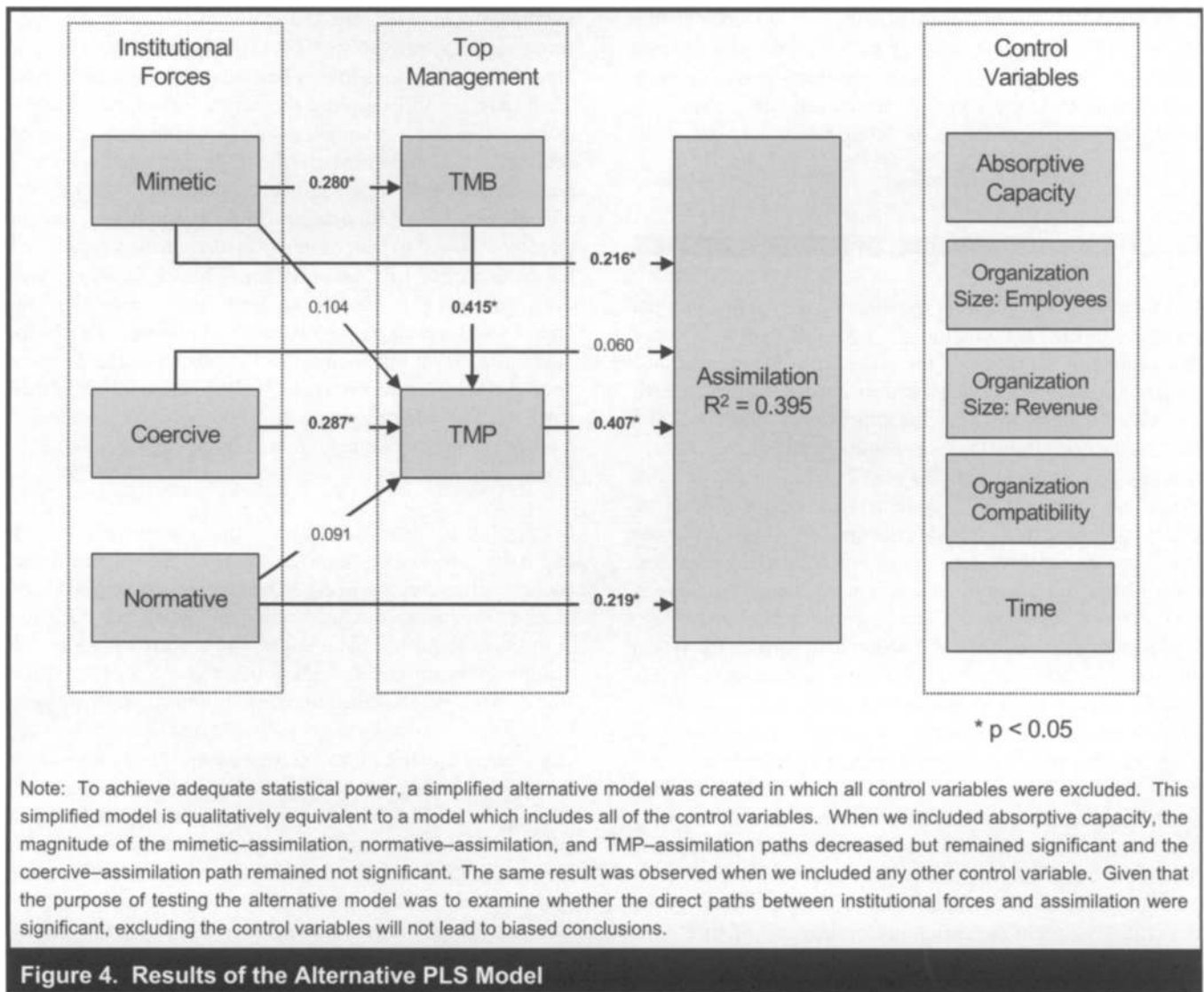


Figure 4. Results of the Alternative PLS Model

The significant path between coercive pressures and TMP in Figure 3 provides support for Hypothesis 4. This finding suggests that the effect of coercive pressures on assimilation is mediated by TMP. To examine the independent effect of coercive pressures on ERP assimilation, we tested the model after excluding TMP from it and found that the coercive–assimilation link was insignificant ($b = .186, p > .05$). Results of the alternative model testing (Figure 4) reveal that this direct link is still nonsignificant when the TMP–assimilation link is simultaneously included in the model. These results suggest that coercive pressures do not seem to have a direct impact on ERP assimilation. However, it indeed significantly influences TMP. Even though there is no empirical evidence suggesting that the portion of TMP's variance explained by coercive pressures is related with variance of ERP assimilation,

based on the logic of Hypothesis 2, we conclude that partial evidence is obtained which implies the impact of coercive pressures on ERP assimilation.

As to Hypothesis 5, Figure 3 shows that the normative–TMP link is nonsignificant, failing to confirm that normative pressures affect top management's participation in activities advancing ERP assimilation. Test results of the alternative model (Figure 4) show support for the direct link between normative forces and assimilation, suggesting that top management may not be a mediator of normative pressures on ERP assimilation. Perhaps normative pressures affect ERP assimilation through other human agency, such as middle level managers, power users, and operational level knowledge workers.

With regard to the five control variables included in the model, all but absorptive capacity are not significantly related with ERP assimilation. The exact role of absorptive capacity in the assimilation and its relationships with other constructs remain interesting questions for future research.

Discussion

Our interest in investigating the role of external institutional pressures in ERP assimilation was triggered by two facets of the assimilation processes for large-scale IT innovations: first, the inherent uncertainty in usage and outcomes of ERP initiatives widely noted in the practitioner literature, and second, the institutional nature of managerial practice as theorized by Swanson and Ramiller (1997). A couple of decades ago when packaged ERP systems were newly offered by vendors, we note that a learning perspective would have been more appropriate for understanding how pioneering organizations identify and assimilate such innovations.⁹ However, ERP systems have now become so common that, over time, organizations have engendered an organizing vision (Swanson and Ramiller 1997) at the industry or vendor level, which is now a source of much of the institutional influence on adoption and usage of ERP systems. Under these circumstances we argue that the institutional perspective is equally, if not more, relevant for understanding IT assimilation. To lend further coherence to our conceptual model, we also identified top management as the primary human agency which mediates the effect of isomorphic pressures on the ERP assimilation process. The mediation offered by a human agency is useful to explain the variability in the level of ERP assimilation even across those organizations embedded in similar institutional contexts. Of course, a rigorous test of the usefulness of mediating constructs could be ascertained only if the study had been restricted to a single industry sector, where all companies face the very same institutional pressures.

By elaborating our conceptual model in terms of the three distinct isomorphic pressures and two top management constructs, we offer a rich set of results. Broadly, we find that isomorphic pressures affect ERP assimilation in different ways, and to some extent are partially mediated by top management. First, we find that the effect of mimetic pressures on ERP assimilation is partially mediated by top management. This supports our conceptualization of the interaction between institutional forces and top management. Results from an

alternative model (Figure 4) also suggest that mimetic pressures might directly affect ERP assimilation. There are two plausible explanations to this finding. First, our measure of TMP may not fully capture the active influences of senior managers. For example, allocating resources or aligning incentives is not measured by the TMP construct. So it is possible that there are other effects operating through senior management. Second, operational level employees may be directly exposed to isomorphic pressures, which results in a higher degree of ERP assimilation. This explanation, however, presumes a significant level of exposure of the operational level employees to external pressures. That is, the operational level knowledge workers and managers experience the pressure to use more ERP functionalities in their work routines and processes due to the perceived success of their peers or competitors, an assumption difficult to verify from existing studies.

Our analytical distinction between top management beliefs and participation also helps us to refine the argument that coercive pressures are likely to be mediated by top management participation. This finding is consistent with our discussion about the main source of coercive pressure for using ERP being government policies in the context of this study. In this type of institutional environment, top managers' belief structures are not likely to be affected by coercion from government agencies and industry association, rather these coercive pressures result in higher level of top management participation which in turn positively affects ERP assimilation. This interpretation is consistent with the findings by Hu et al. (2006) that the pressure to implement information security policies and procedures due to government regulations has the most significant impact on the behavior (and not the belief structures) of senior executives.

For similar reasons, we hypothesized that normative pressures should affect top management participation since norms carry with them accepted practices pre-evaluated within the organizational field without needing further cognitive effort on the part of top management. Thus, we hypothesized that top management participation should mediate the effect of normative isomorphic pressures on ERP assimilation. Surprisingly, this hypothesis was not supported. Rather we find a direct link between normative pressures and ERP assimilation to be significant. Perhaps this is a reflection of successful user training programs and the dissemination of best practices through the extensive network of local ERP user groups and vendor sponsored ERP user conferences. We must be cautious about this conjecture since no end user data was collected in our survey. We hope that in future studies this type of data will be collected and hypotheses about the extent to which end users yield to normative pressures can be tested.

⁹This is not to say that a learning perspective is not relevant today. In view of the extensive adaptation required post-implementation, a learning perspective remains just as useful.

Yet top management may not be the only mediating factor. The significant direct paths between mimetic and normative pressures and ERP assimilation in the alternative model (Figure 4) suggest that there are alternative firm-level factors mediating external influences. For example, in addition to top managers, perhaps the mid- or lower-level managers, and even power users and knowledge workers, may also be exposed to mimetic pressures and thus imitate competitors' assimilation strategies at the department or process level. Isomorphic pressures from such a channel are more likely to take effect through end users since mutual adaptations between ERP and the users involve business operational details and thus are usually performed by line managers and knowledge workers who actually use the ERP systems.

Theoretical Contributions

The role of institutional forces in affecting adoption of innovations is well discussed in the organizational literature (Pennings and Harianto 1992). What is less understood is how institutional forces affect process innovations and particularly IT innovations. Three key aspects of this study signify our contribution to the theory of IT innovation assimilation. First is the focus on *post-implementation* assimilation in the context of *enterprise systems*. These findings extend the work of Teo et al. (2003b) from the adoption phase to the assimilation phase of IT innovations. Furthermore, considering that ERP systems are probably the most challenging to assimilate among various enterprise systems, our findings are particularly noteworthy. The finding that institutional forces play a significant role indicates that it is not just the IT systems deployed *at* the interfaces of organizations such as EDI, but also IT artifacts deployed *within* organizations, that are exposed to the external institutional pressures. These forces can be interpreted as guiding the assimilation process by proxy, that is, the mimetic and coercive pressures still influence the behavior of senior managers and thus impact IT assimilation.

Second, this study integrates institutional forces and the influence of top management on the assimilation process into one model and reconciles what had previously been presumed to be independent in the literature. In the prevalent literature, top management and the three forces of institutional influence are rarely studied together. In this study, we show that at least some of the external forces manifest their influence on organizational behavior through changing the beliefs and behavior of top management.

Finally, by adopting the approach of decomposing top management construct into two distinct sub-constructs (top

management beliefs and participation), we show that such decomposition helps enrich the understanding of IT phenomena. We discover that while mimetic pressures influence the beliefs of top managers and thus their behavior indirectly, coercive pressures may directly influence the managerial behavior.

Managerial Implications

Many of our findings offer guidance to management and IT practitioners. The mediating role of top management participation clearly highlights that concrete meta-structuring actions by the top management play a significant role in assimilating IT innovations in organizations. Conversely, if managers lower their level of participation in instituting meta-structuring activities, assimilation is likely to suffer or even stop. Since our study is in the context of post-implementation, senior managers should be well aware of the level of their participation that will be required even after a technology implementation project has been declared a success.

The finding that institutional forces strongly influence assimilation is revealing for ERP consultants, vendors, and government agencies. Traditionally, an ERP contract is over when the system implementation is completed. Consequently, the involvement of vendors and consultants in ERP assimilation is usually reduced. Our findings suggest that even after the contract expires, ERP vendors could and should still exert significant influence on their clients in terms of best practices and norms of ERP usage. The active online forums and chat rooms of ERP users groups and vendor-sponsored ERP user conventions are prominent examples of the benefits of post-implementation support and influence. In the same vein, since the mimetic and normative mechanisms are found to be effective in directly influencing ERP assimilation, we suggest that top management should encourage their line managers and end users to exchange information with their counterparts in other organizations by actively participating in industry, trade, vendor, and professional events.

We recognize that the idea of recommending organizations to actively expose themselves to institutional influences sounds ill-advised because the recent management and IS literature blames institutional pressures for organizational "mindlessness" in terms of adopting innovations (Fiol and O'Connor 2003; Swanson and Ramiller 2004). However, it should be noted that our findings are based on those organizations that had already invested significant resources in implementing ERP systems. Presumably, it is in the best interest for such companies to endeavor to completely assimilate their ERP systems. From this perspective, we view institutional pres-

asures as positive and beneficial to companies struggling to reap benefits from their sunk ERP investments.

Limitations and Future Research Directions

While we believe we have developed a sound and rich theoretical model and tested it with a reliable survey instrument and data, we also enumerate next some limitations and unanswered questions. First, we did not have an avenue to collect data from a random sample of companies and all of our data was collected from the clients of a single ERP vendor in China. Therefore, we are limited in generalizing our finding widely. An interesting follow-up study would be to collect data from a random sample of firms that have implemented ERP products from multiple vendors and in a difficult part of the globe. The comparison of the results would most certainly shed some interesting light on the ERP assimilation processes under various institutional and organizational contexts. On the other hand, the single vendor choice does make data collected from different companies more comparable since they implemented similar ERP modules. If multiple vendors are considered, their modules may vary too much to allow meaningful interpretation of the data or may require an impossibly large sample and variables for control. Thus, there is a tradeoff between generalizability and meaningful data interpretation with respect to choice of vendors. Another possibility for a follow-up study would be to investigate the potential impact of ERP products and vendor characteristics on the assimilation process.

Our theorizing is heavily driven by the institutional perspective and not by the learning perspective whereby the top management and other organizational members engage in active learning in order to adapt the IT application. Conceptualizing how organizational learning contributes to this process is outside the scope of this particular study, although existing literature offers a solid conceptual grounding in terms of constructs such as managerial IT knowledge (Armstrong and Sambamurthy 1999) or IT competence of business managers (Bassellier et al. 2003). Future studies can be conducted to study how institutional pressures interact with such learning-related constructs to affect ERP or other IT innovation assimilation processes. Specifically, the interaction of top managers' tendency to passively conform to institutional practices and their ability to actively learn from other firms' failures (Denrell 2003) should be investigated.

We also noted that while our alternative model indicates direct impact of mimetic and normative forces on the assimilation of ERP, we did not have data collected from the end

users of ERP systems, such as the line managers and knowledge workers, to confirm such impact directly and to understand why and how such impact occurs. Future studies could extend the current model to the end-user level and further deepen our knowledge of IT innovation assimilation. In addition, our attempt to contextualize the measures for institutional forces may affect the interpretation of our findings. Caution should be used when generalizing our findings to other contexts in which institutional pressures emerge from different sources.

Conclusions

Drawing broadly on institutional theory, the influence of top management, and the extant literature on IT adoption and diffusion, we developed and tested an IT assimilation model in the context of ERP systems. Our theoretical framework reconciles the independent contributions of two well-established streams in the literature: studies that explain the impact of top management on IT assimilation and those that explain the effect of institutional pressures. We attempt to explicate how top management mediates the influence of institutional forces on ERP assimilation. Analyses based on 77 Chinese firms largely support the hypothesized relationships in the model. This research contributes to the IT innovation literature by focusing on the much neglected assimilation stage and extending and enriching the extant literature on IT innovation. It confirms that institutional pressures, which have been shown to be important for IT adoption and implementation, are also significant in the assimilation stage. It highlights the importance of top management in facilitating ERP assimilation by complying with institutional pressures. Although institutional pressures are accused of giving rise to mindlessness in IT adoption, this research suggests that such mindlessness might be beneficial to organizations that have already implemented ERP systems and would like to ensure that all of the features of the ERP system are integrated into their business processes.

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Appendix A

Scales and Items

ERP Assimilation

1. Volume: Percentage of the firm's business processes that are using the ERP system (%)
2. Diversity: Number of functional areas that are using the ERP system
3. Depth: For each functional area identified above, identify the level at which the ERP system is used:
 - a. Operation
 - b. Management
 - c. Decision making

Top management belief (1 = strongly disagree; 5 = strongly agree)

The senior management of our firm believes that

1. ERP has the potential to provide significant business benefits to the firm
2. ERP will create a significant competitive arena for firms
3. it is NOT necessary to use ERP to conduct business activities

Top management participation (1 = strongly disagree; 5 = strongly agree)

The senior management of our firm actively

1. articulates a vision for the organizational use of ERP
2. formulated a strategy for the organizational use of ERP
3. established goals and standards to monitor the ERP project

Mimetic pressure (1 = strongly disagree; 5 = strongly agree)

Our main competitors who have adopted ERP

1. have greatly benefitted
2. are favorably perceived by others in the same industry
3. are favorably perceived by their suppliers and customers

Coercive pressure (1 = strongly disagree; 5 = strongly agree)

1. The local government requires our firm to use ERP
2. The industry association requires our firm to use ERP
3. The competitive conditions require our firm to use ERP

Normative pressure (1 = very low; 5 = very high)

Please indicate

1. The extent of ERP adoption by your firm's suppliers
2. The extent of ERP adoption by your firm's customers
3. The extent to which the Government's promotion of Information Technology influences your firm to use ERP

Absorptive capacity (1 = strongly disagree; 5 = strongly agree)

1. Prior to the ERP implementation, our employees in general had extensive experience in using computer based applications in their work processes
2. It is well known who can help solve problem associated with the ERP package
3. Our company can provide adequate technical support to using ERP
4. Our company provides ERP training opportunities to employees on a regular basis

Organization compatibility (1 = strongly disagree; 5 = strongly agree)

Using ERP in our company

1. created a disruption in the workplace at first
2. decreased productivity at first due to time to learn
3. required an overall change in the values, norms and culture within the company

Appendix B

Loadings of the Indicator Variables (Composite Reliability) (AVE)

Construct	Indicator	Mean	SD	Loading	T-value
Top management belief (.789)(.565)	TMB1	3.77	.65	.706	4.226
	TMB2	4.10	.50	.893	12.137
	TMB3	3.88	.49	.783	7.626
Top management participation (0.839) (0.636)	TMP1	3.78	.74	.829	16.509
	TMP2	3.82	.66	.866	24.730
	TMP3	3.87	.73	.716	4.515
Mimetic pressure (0.852) (0.658)	MIM1	3.34	.72	.728	6.779
	MIM2	3.61	.63	.856	18.513
	MIM3	3.35	.60	.844	16.492
Coercive pressure (0.902) (0.821)	COE1	3.23	.76	.902	5.590
	COE2	2.82	.70	.911	5.332
Normative pressure (0.906) (0.762)	NOR1	2.43	.83	.874	17.704
	NOR2	2.77	.84	.922	35.208
	NOR3	3.65	.84	.821	9.457
Organization compatibility (0.843) (0.650)	OC1	3.88	.58	.803	11.543
	OC2	3.77	.54	.971	33.306
	OC3	3.71	.54	.712	4.553
Absorptive capacity (0.875) (0.585)	AC1	3.58	.88	.799	10.060
	AC2	3.75	.84	.847	13.410
	AC3	3.45	.90	.810	9.253
	AC4	3.44	.88	.801	14.650
ERP assimilation (n/a) (n/a)	Volume	54%	21%	n/a	9.866
	Diversity	2.92	1.68	n/a	12.780
	Depth	2.60	.63	n/a	3.086

Appendix C

Item Loadings and Cross Loadings

	TMB	TMP	MIM	COE	NOR	AC	OC
TMB1	.706	.173	-.035	.085	-.187	.024	-.099
TMB2	.893	.350	.302	.108	-.074	.305	.058
TMB3	.783	.346	.224	.012	.027	-.057	-.026
TMP1	.386	.829	.302	-.222	.030	.354	-.197
TMP2	.336	.866	.179	-.295	.010	.065	-.254
TMP3	.236	.716	.026	-.237	.207	.140	-.144
MIM1	.254	.090	.728	.181	.291	.261	-.042
MIM2	.251	.130	.856	.048	.237	.110	-.046
MIM3	.225	.328	.844	.020	.260	.236	.053
COE1	.057	-.340	.120	.901	.059	.108	.144
COE2	.092	-.267	.079	.911	.050	-.036	.070
NOR1	-.105	.168	.237	-.035	.874	.238	.019
NOR2	-.063	.020	.269	.073	.922	.225	-.064
NOR3	.052	.027	.360	.121	.821	.210	.056
AC1	.128	.246	.015	.001	.135	.799	-.049
AC2	.129	.309	.307	-.068	.269	.847	-.109
AC3	.057	.157	.296	-.008	.279	.810	-.024
AC4	.131	.069	.048	.007	.183	.801	.228
OC1	-.071	-.112	-.258	.040	.003	-.049	.803
OC2	.028	-.242	-.008	.091	-.004	.034	.971
OC3	-.036	-.194	-.077	.094	.009	-.046	.712

Note: TMB = top management beliefs; TMP = top management participation; MIM = mimetic forces; COE = coercive forces; NOR = normative forces; AC = absorptive capacity; OC = organizational compatibility. Bold numbers indicate item loadings on the assigned constructs.

Appendix D

Common Method Bias Analysis

Construct	Indicator	Substantive Factor Loading (R1)	R1 ²	Method Factor Loading (R2)	R2 ²
Top management belief	TMB1	0.851**	0.724	-0.311**	0.097
	TMB2	0.774**	0.599	0.205**	0.042
	TMB3	0.712**	0.507	-0.061	0.004
Top management participation	TMP1	0.723**	0.523	0.147	0.022
	TMP2	0.908**	0.824	-0.092	0.008
	TMP3	0.760**	0.578	0.056	0.003
Mimetic pressure	MIM1	0.621**	0.386	0.101	0.010
	MIM2	0.970**	0.941	-0.143	0.020
	MIM3	0.816**	0.666	0.065	0.004
Coercive pressure	COE1	0.912**	0.832	0.036	0.001
	COE2	0.901**	0.812	0.037	0.001
Normative pressure	NOR1	0.861**	0.741	0.010	0.000
	NOR2	0.930**	0.865	-0.021	0.000
	NOR3	0.827**	0.684	0.013	0.000
Absorptive capacity	AC1	0.828**	0.686	0.097	0.009
	AC2	0.830**	0.689	0.004	0.000
	AC3	0.828**	0.686	0.100	0.010
	AC4	0.688**	0.473	0.011	0.000
ERP assimilation	Volume	0.982**	0.964	-0.169	0.029
	Diversity	0.668**	0.446	-0.250*	0.063
	Depth	0.723**	0.523	-0.117	0.014
Average		0.815	0.674	-0.013	0.016

*p < .05; **p < .01

Appendix E

Using PLS to Assess Common Method Bias

We took a statistical approach suggested by Podsakoff et al. (2003) to address concerns regarding common method bias. To our knowledge, this is the first time the approach has been applied using PLS. Podsakoff et al. recommend that this *ad hoc* approach should be taken if the independent and dependent variables were not obtained from different sources and not measured in different contexts and the sources of the method bias cannot be identified, because it controls for any systematic variance among the items that is independent of the covariance due to the constructs of interest. In this approach, the variance of a specific observed indicator is partitioned into three components: trait, method, and random error. To assess method variance, a latent method factor needs to be added in the structural model. Each indicator is specified to be determined by its substantive construct, the method factor, and measurement error. Figure E1 shows a simple model which includes an independent variable, A, and a dependent variable, B. Indicators are represented by a1, a2, b1, and b2, whose measurement errors are represented by e1 to e4 and factor loadings represented by λ_1 to λ_4 .

Using covariance-based SEM methods (e.g., LISREL and AMOS) to execute the above model may result in problems with identification (Podsakoff et al. 2003). To avoid this problem we used PLS (Fornell and Bookstein 1982). However, we recognize that PLS does not accommodate random errors. Further, PLS Graph 3.0 does not allow an indicator to be determined by more than one construct. To finesse this constraint, we converted each indicator to a single-indicator construct. As a result, all major constructs of interest and the method factor become second-order constructs. Figure E2 shows the model converted from the model in Figure E1.

This conversion is valid because an observed indicator in a structural equation model is statistically equivalent to a construct which is measured solely by that indicator. Little et al. (2002) explain that “with respect to measurement error, a single-indicator latent variable is essentially equivalent to a manifest variable” (p. 162). Marcoulides and Moustaki (2002) suggest that a single-indicator latent variable determined by an independent latent variable can be viewed as an indicator of the independent variable and the regression coefficient between the two variables is the factor loading (p. 90). In Figure E2, for example, when a1 is converted into construct A1, its measurement error and loading have to be constrained to zero and one, respectively. Its original loading (λ_1) and measurement error (e1) become the A-A1 path coefficient and A1’s error term, respectively. Hence, there is no information loss after the conversion.

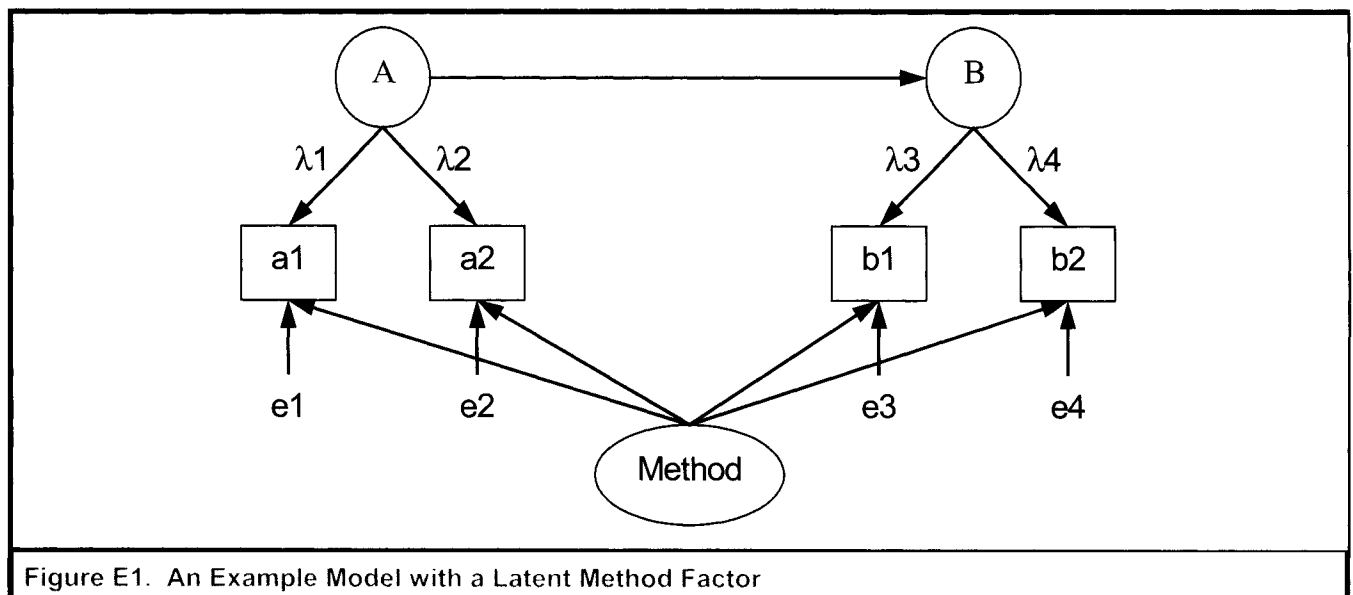


Figure E1. An Example Model with a Latent Method Factor

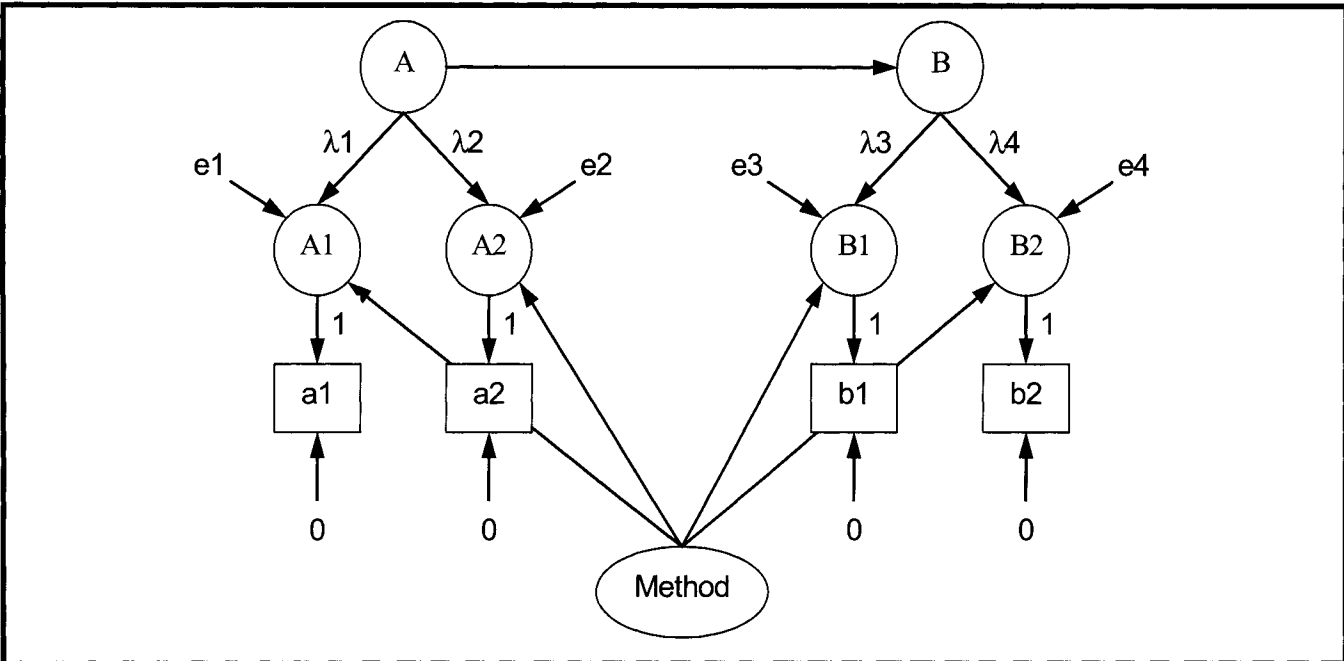


Figure E2. An Example of Converting Indicators to Single-Indicator Constructs

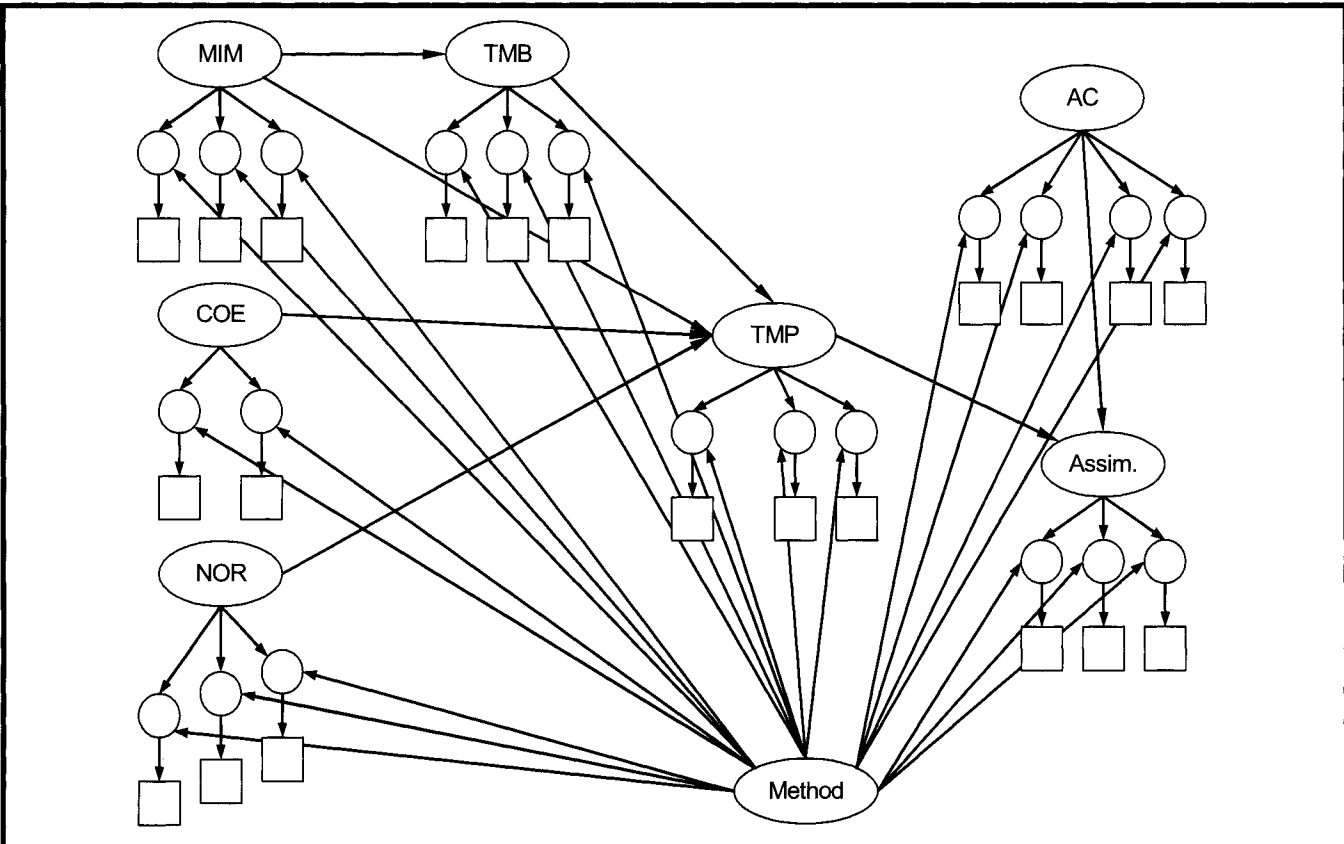


Figure E3. The PLS Model for Assessing Common Method Bias

Given that the conversion described above is valid, we created a PLS model (Figure E3) to assess common method bias in this study using the Podsakoff et al. method. We included in the PLS model a common method factor which links to all of the single-indicator constructs that were converted from observed indicators. It should be noted that assimilation was modeled as a formative construct when we tested our theoretical model (Figure 3). We tested two versions of our theoretical model: one with assimilation as a formative construct and another with assimilation as a reflective construct. We found that there are no qualitative differences in statistical results: No paths gained or lost statistical significance and no significant paths changed signs. Based on this finding, assimilation was modeled as a reflective construct when we assessed common method bias to ensure interpretability of results. For each single-indicator construct in Figure E3, we examined the coefficients of its two incoming paths from its substantive construct and the method factor. These two path coefficients are equivalent to the observed indicator's loadings on its substantive construct and the method factor and can be used to assess the presence of common method bias.

According to Williams et al. (2003), evidence of common method bias can be obtained by examining the statistical significance of factor loadings of the method factor and comparing the variances of each observed indicator explained by its substantive construct and the method factor. The squared values of the method factor loadings were interpreted as the percent of indicator variance caused by method, whereas the squared loadings of substantive constructs were interpreted as the percent of indicator variance caused by substantive constructs. If the method factor loadings are insignificant and the indicators' substantive variances are substantially greater than their method variances, we can conclude that common method bias is unlikely to be a serious concern.