ORGANIZATIONAL STRUCTURE AND INTRA-FIRM INNOVATION DIFFUSION

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This research applies innovation diffusion theory to intra-organizational innovation adoption using U.S. governmental agencies as a subject pool. Agencies that feature broad (decentralized) leadership control favor social network effects or word of mouth channels of communication whereas agencies that have a direct, top-down, chain of leadership authority rely more on leader initiated communications leading to more rapid innovation adoption. This research is significant in that it applies the popular Bass (1969) Diffusion Model to an intra-organizational context further explaining how processes and technology come to be used in organizations.

1. INTRODUCTION

There are clear benefits organizations may gain by adopting innovative practices prior to their competitors including such as first mover advantage and the establishment of a sustained competitive advantage derived from more efficient work processes and greater operational efficiency. As a result, rapid intra-organization diffusion of new work practices results in positive effects on an organization's economic performance (McKee, Varadarajan & Pride, 1989), greater efficiency (Kim & Srivastava, 1998), and according to Frambach (1993) the overall success of an organization. Levin, Levin & Meisel (1992) found that the rapid adoption of new work processes across an organization produces noticeable cost savings which lead to enhanced profitability. What is less clear is the internal procedure that takes place while the new work process or technology diffuses across an organization. Ultimately, innovations are adopted through a process where the new product, process or practice is amalgamated into the adopting organizations (Damanpour & Wischnevsky, 2006). As such, intra-organization diffusion closely resembles 'innovation implementation,' which has been studied in the innovation process literature (Zaltman, Duncan & Holbrek, 1973, Rogers, 1983, Hage & Aiken, 1970).

From an organizational perspective innovation is defined as newness or novelty in regard to people, process or products within an organizational setting. It is something that, when implemented, brings added value to the organization (Taylor & McAdam, 2004). Damanpour (1991) identifies a typology of three forms commonly found in organizational innovations; administrative and technical, product and process, and radical versus incremental. Administrative innovation is the focus of this current research and is about organizational structure and administrative processes. Such innovations are "directly related to the basic work activities of an organization and more directly related to its management" (Damanpour, 1991, pg. 560) and, when implemented, mediate between organizational inputs and outputs (Abrahamson, 1991).

The application of diffusion theory has been of particular interest in marketing since its early applications by Fourt & Woodlock (1960), Mansfield (1961), Cox (1967), and Bass (1969). Broadly speaking, diffusion research in marketing is concerned with measuring how an innovation spreads through a market or social organization. Often research associated with the diffusion of an innovation (especially in marketing and communication fields) places strong emphasis on information transfers that lead to some adoption decision (Rogers, 2003). Following a mixed-model approach contagion theory is used to explain how information about an innovation is spread through multiple communication channels (Bass, 1969). First, non-personal communications flow from sources outside a potential adopter's social network, including media and promotional

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efforts. Second, communication happens between members of a social structure such as a reference group, community or organization in the form of inter-personal communications (Lundbland, 2003).

In most cases new technology adoption decisions are made by organization leadership and then adopted by rank and file employees representing a two-step process of organizational engagement. Thus, initial adoption among leadership is essential yet it does not guarantee adoption takes place at a subservient level (Jaakkola & Renko, 2007). Once initial rank and file employees begin to use the innovation its success triggers a 'bandwagon' effect (O'Neill, Pouder & Buchholts, 1998). Therefore, the more willing a potential adopter is to receive information about an innovation the more likely they are to process that information, leading to a greater probability that they will adopt (Frambach, 1993). Given that the phenomenon of workplace diffusion provides many positive outcomes for the organization it is imperative to study the process especially for the academic and practitioner communities that focus on business-to-business interactions and sales.

To examine the intra-organization diffusion process we investigate the adoption and use of an emerging payment technology (purchase cards) among U.S. government agencies from 1997 to 2008. The technology is widely regarded as a tool to improve efficiency and reduce costs associated with organizational administrative activities (Palmer & Gupta, 2012). Unlike intra-firm diffusion literature (e.g. Fuentelsaz, Gomez & Polo, 2002; Ingham & Thompson, 1993) this data comes from organizations that demonstrate heterogeneity in structure, size, complexity and management style which provides a sample whereby organizational effects (upon the diffusion process) may be demonstrated. An additional feature of this research setting is the influence that external publics have on the sample frame. When cost-saving pressures are applied by external groups, agile organizations are expected to react quickly by adopting cost-saving practices swiftly. Therefore, those organizations where costs saving innovations manifest themselves quickly reap the benefit of positive public opinion. Likewise, when public sentiment turns negative, nimble agencies can abandon unpopular practices promptly.

The following article proceeds with a review of relevant literature in organizational adoption and innovation diffusion, followed by the study report, discussion of results and concluding remarks which include study limitations and future research opportunities.

2. BACKGROUND AND THEORY

Innovation diffusion is thought to be aided when information is made available to potential adopters. In consumer markets product information is communicated from organizations such as the firm to a targeted consumer market using promotional and advertising tools. This information may then be further communicated within the market among market members through social and word of mouth exchanges (Katona, Zubcsek & Sarvary, 2011). Given this context, information originating from outside the target market is thought to come from external sources where market members who share information among themselves act as internal sources of innovation information. When considered together information gained from both internal and external sources provide potential adopters with enough information to make confident, informed adoption decisions. When innovation diffusion within an organization is considered our perspective shifts slightly, however the theoretical argument used to describe the diffusion process remains unchanged. Viewed as a two-step process, key decision makers and leaders first adopt an innovation then communicate this decision (acting as an external information source) to the rest of the organization (acting as the market of potential adopters) (Arakji & Lang, 2010). Therefore, the initial adoption decision by organization leaders is merely the first step in a complex adoption process. Upon making the adoption decision leaders promote the innovation to the organization's members who then communicate among themselves. In organizational parlance, the decision leader may be referred to as a "champion" of the new innovation (Rothwell & Zegveld, 1985). In such a case the champion seeks a quick adoption process leading to an immediate impact and realization of benefits

gained by its adoption (Akhavein, Frame & White, 2005).

While organizational innovation diffusion has garnered less attention in the literature than that of consumer market diffusion (Frambach, 1993) there exists a body of innovation literature at the organizational level and in business-to-business contexts (Taylor & McAdam, 2004; Gatignon & Robertson, 1989). A variety of studies have focused on the diffusion of manufacturing technologies such as computer-integrated manufacturing (Bessant, 1988), flexible manufacturing (Bessant & Haywood, 1985), computer-aided production management (Bessant & Lamming, 1987), and computer-aided design (Lamming, 1987). Additional research on organizational adoption exists such as Webster (1969), Zaltman, et al (1973), Baker and Parkinson (1977), Cooper (1979), Robertson & Gatignon (1986) and in economics (Stoneman, 2003). In some of this literature a macroscopic diffusion approach is used where innovations diffuse across entire populations of organizations (Attewell, 1992). For social scientists, research at the macroscopic level uses economic modeling technique in an effort to describe macro-level diffusion patterns over time. Early cross-industry examples are provided by Chow (1967) and Stoneman (1976) who focus on the adoption of mainframe computers.

Taking a microscopic view prior research assumes the organization to be the entire market, that is, employees represent the potential population of adopters (Kim & Srivastava, 1998). At the organizational level innovation adoption has been defined "as the development (generation) and/or use (adoption) of new ideas or behaviors" (Damanpour & Schneider, 2008, pg. 496). To operationalize intra-organizational diffusion Bretschneider & Wittmer (1990) simply use the number of employees who use a focal innovation. Meanwhile, Kim & Srivastava (1998) operationalize it as the percentage of employees who use or have ever used the innovation out of the total number of employees. They follow by defining the rate of intra-organizational diffusion based on how quickly organizational units or members adopt.

2.1 Influences upon Innovation Diffusion

Rogers (2003) describes four aspects of organizational structure and design that are instrumental in innovation diffusion within an organization. The first is the centralization of power which focuses on linear vertical control of the organization. The second is organizational complexity, which relates to the layered or hierarchical organization as well as the intricate relationships required to maintain multi-tiered organizations. The third aspect of organizational structure and design is the formality or legalism imposed by rules of order. Strict rules constrict the ability for innovation adoption if it falls out of mainstream activities or processes. Finally, the degree to which an organization is socially connected fosters inter-personal communication and organizational learning. Such interconnectedness focuses on internal channels similar to networks by which information about a new innovation can be spread. Following Contagion Theory social connectedness through social and peer-group networks affects the manner in which a message spreads (e.g. product information, news, and advice) (Van Den Bulte & Stremersh, 2004). Thus, the 'spreading' of innovation adoption information happens largely through social interactions triggering an organization bandwagon effect also altering initial adoption patterns (O'Neill, Pouder & Buchholts, 1998; Kimberly & Evanisko, 1981). The following literature review illustrates the complexity of these issues.

2.2 Influences upon Innovation Diffusion: Leadership and Network Associations

An important criterion that organizational leaders use to evaluate innovations is the adoption behavior of other organizations. Studies on adoption in industrial markets that take a macroscopic view tend to treat the firm as a unit of analysis. Given this view, pressure from competing firms is realized and drives the firm to adopt technologies in order to stay competitive (Kim & Srivastava, 1998). Through imitation, organizational leaders reduce potential uncertainty and legitimacy for a newly proposed technology (Massini, Lewin & Greve, 2005; O'Neill, Pouder & Buchholts, 1998; Kimberly, 1981). Repeated successful innovation adoptions across organizations in an

industry signal other organizations to follow especially in a competitive environment (O'Neill, Pouder & Buchholts, 1998). Such mimetic behavior has been described as a valid firm strategy (Haunschild & Miner, 1997). As more firms that have adopted an innovation come into contact with non-adopting firms, their apparent superior performance encourages the non-adopters resulting in rapid adoption (Rogers, 1983) thus illustrating the 'imitation' feature of diffusion (Mahajan, Sharma & Bettis, 1988).

Supported by Institutional Theory, organization leaders may make an adoption decision as a result of mimetic behaviors (DiMaggio & Powell, 1983; Massini, Lewin & Greve, 2005) and is an important practice found in competitive industries. In addition, the Behavioral Theory of the Firm (Cyert & March, 1963) supports this conclusion since managers look to make strategic changes when performance is seen as falling short of peer institutions. Industrial adoption begat from imitation has the effect of reducing heterogeneity of organizational strategies across organizations. Institutional Theory argues that such imitation of organizational structures and procedures is driven by norms of rationality (Meyer & Rowan, 1977). Relatedly industrial isomorphism and more specifically mimetic isomorphism happens as an outcome of organic behavior conformity motivated by a desire to copy perceived behaviors that will likely lead to a successful outcome (Massini, Lewin, & Greve, 2005).

Individuals within an organization seek guidance and support for their actions from organizational leaders. Thus, when organizational leaders endorse or advocate a new technology they offer such guidance and provide incentive for its adoption (Fuentelsaz, Gomez & Polo, 2002; Stoneman, 1981). While this helps explain why individuals within the organization become motivated to adopt, it does not address the adoption choice made by organizational leaders. For leaders, the drive to adopt the technology on behalf of the organization is associated with several factors, including greater efficiencies in operation and cost savings, response to competitive pressure, and environmental uncertainty.

Following Davis (1989), the Technology Acceptance Model (TAM) suggests that organizational acceptance comes from both the perceived usefulness of a new technology and its ease-of-use influence intention to use and actual use of an innovation (Lee, 2003). This well-known model is relevant to organizational leaders who are accountable for organization performance, to wit: managers seeking to increase operational efficiency should actively promote innovations that can be rapidly employed and whose usefulness will lead to cost reductions. TAM is anchored by the Theory of Reasoned Action (Ajzen & Fishbein, 1980) and focuses on the behavior of end users in the workplace. The extended TAM2 incorporates social forces including subjective norms, voluntariness and image (Venkatesh & Davis, 2000). The model stresses that leaders must not only make the technology available, but also place emphasis on its ease of use and potential productivity gains (Agarwal & Prasad, 1997).

Network analysis is another area of research that may be used to explain how an innovation becomes diffused (Abrahamson, 1991; Rogers, 1983) and has been shown to contribute to social contagion in industrial settings (Midgley, Morrison & Roberts, 1991). Specifically, it helps define the nature of the social infrastructure which is used to describe the relationship members have with each other (Pastor & Mayo, 1994). Researchers in sociology have made extensive use of network analysis in innovation diffusion literature (Rogers, 1962; Burt, 1982; Burkhardt & Brass, 1990). Networks can have a significant impact on observed adoption patterns, even to the extent of determining the success or failure of an innovation (Gatignon & Robertson, 1985). Czepiel (1975) investigates industrial networks using a cohesion model which assumes that influence is passed directly from adopters to potential adopters during discussions on the merits of the innovation. Even the military, often considered the quintessional example of a hierarchical organization, is driven by network structure where adaptation may become slow and costly because entrenched interests seek to preserve their power (Achrol & Kotler, 1999). Such behavior resulting from competition between people of similar status and roles

within a social structure evolves into counterproductive turf wars.

Within network analysis research, the evaluation and decision to adopt an innovation is primarily the result of interpersonal communication within a system (Rogers & Shoemaker, 1971) through personal influence and transmitted within a network of peers. The composition of the network is assumed to be of similar members who share thoughts and patterns of consumption behavior (Gatignon & Robertson, 1985). However, awareness of an innovative practice or process is often accomplished initially through leadership communication. In a network context opinion leaders have been found to have significant influence in adoption (Groves, et al, 2002). Decentralized networks which feature loose degrees of leadership oversight are unlikely to function smoothly without an overarching structure and leadership at the top (Achrol & Kotler, 1999). Based on prior research, the number of users of an innovation within an organization will increase when encouraged by higher authorities (Kim & Srivastava, 1998). Burkhardt & Brass (1990) employ a social network perspective to examine organizational structure and focus on leader power as a key variable. When centralized, powerful employees who are early adopters, use existing social patterns to encourage adoption and thus reinforce a stable power structure. Conversely, if less powerful, peripheral employees are early to adopt a new innovation then centrally focused power shifts and power becomes distributed throughout the structure of the organization (Burkhardt & Brass, 1990). Therefore, leaders may feel compelled to promote adoption early as a means to maintain their existing power paradigm. Yet, in the absence of a strong centralized leadership structure the influence of a network performs the role of information dissemination and positively influences adoption.

2.3 Influences upon Innovation Diffusion: Internal Characteristics; Centralization and Structure

Internally, organizational characteristics such as size and workforce dynamics likely play a role in the adoption of new processes within an organization (Damanpour & Schneider, 2006; Rivera, Streib & Willoughby, 2000). Organization size is commonly found to be related to the adoption of innovations (Dewar & Dutton, 1986; Damanpour, 1992; Stock, Greis & Fischer, 1996; Kessler & Chakrabarti, 1996). Large organizations adopt industrial innovations before small ones (Davies, 1979) and size is positively related to the rate of adoption of innovations (Taylor & McAdam, 2004). Size provides a critical mass of users to be reached, thus causing the acquisition and use of the innovation to be cost effective on a per-user basis. As such it may be more beneficial for larger organizations to make an initial adoption decision as opposed to smaller ones (Frambach, 1993).

Other internal influences include organizational psychographics (Robertson & Wind, 1980), decision making processes (Rogers & Shoemaker, 1971; Wind, 1978), benefits sought by the adopting organizations (Moriarty & Reibstein, 1986), diversity in the background of organizational members (Zaltman, et al., 1973; Attewell, 1992), conflict resolution mechanisms and leadership style (Evkall, 1991), hierarchy of authority (Kim, 1980), task specialization, professionalism and traditionalism (Downs & Mohr, 1976), perceived profitability (von Hippel, 1976), the presence of internal innovation champions (Rothwell & Zegveld, 1985), management's support and involvement as well as the internal allocation of resources (Lilien & Yoon, 1989), and organizational structure (Burns & Stalker, 1961; Hage & Aiken, 1970; Zaltman, et al, 1973; Kim, 1980; Jackson, John & Morgan, 1982; Rogers, 1983; Mahajan & Peterson, 1985; Damanpour, 1987; Marcoulides & Heck, 1993).

Drawing on organizational theory researchers suggest that structure has an effect on companywide and individual operating unit performance, including the rate in which technologies are adopted across the organization (Hage & Aiken, 1970; Webster & Wind, 1972; Marshall & Vendeburg, 1992; DeCania, Dibble & Amir-Atefi, 2000). Multi-divisional organizational structure (or M-form) is a type of organization in which operating authority is assigned to divisions organized along product, service, or geographic lines. Divisions are designed as profit centers organized to maximize profit or the efficient

execution of other organizational activities. The chief executive has responsibility for strategic decision making and allocates capital among divisions based on performance and need (Mahajan, Sharma & Bettis, 1988). As a result, higher degrees of complexity in an organization comprised of a high number of specialized units that focus on labor specialization "may facilitate adoption of an innovation" (Frambach, 1993, pg. 25).

Numerous studies investigate the specific influence of organizational centralization and structure on innovation diffusion (Kim, 1980; Kimberly & Evanisko, 1981; Subramanian & Nilakanta, 1996; Damanpour, 1991; Kim & Srivastava, 1998). Centralization "is a loose term for the degree to which authority and influence regarding decisions are consolidated in higher echelons rather than being spread among lower ones" (Downs & Mohr, 1976, pg. 703). Centralization is defined as the "degree to which power and control in a system are concentrated in the hands of relatively few individuals" (Rogers, 1983, p. 359; Kim & Srivastava, 1998, pg. 232). Decision centrality is the level of centralization in organizational decision making and it has been hypothesized that higher the perceived decision centrality leads to greater innovativeness (Hage & Dewar, 1973; Moch & Morse, 1977; Zaltman, et al, 1973; Robertson & Wind, 1980). The conclusions are that high-levels of centralization facilitate initiation (building awareness) of the innovation and low-levels expedite implementation (Zaltman, et al, 1973; Sapolsky, 1967).

2.4 Influences upon Innovation Diffusion: Formalization

Identified by Downs & Mohr (1976) and later by Frambach (1993), formalization places emphasis on rules and procedures. Formalization is the "degree to which an organization emphasizes following rules and procedures in the role performance of its members," (Rogers, 1983, pg. 359) and like centralization low-levels of formalization enable better awareness and expedite implementation (Zaltman, et al, 1973; Sapolsky, 1967). A high level of formalization is desirable at implementation, because role ambiguity and conflict are reduced (Kim & Srivastava, 1998). Top-down change from senior executives is generally coercive while implementation of an innovation is the work of middle managers who are responsible for the detailed coordination of the anticipated change. Top down change is thought to be needed if the change is dramatic or radical (Ryan, Williams, Charles & Waterhouse, 2008; Hammer & Champy, 2003). Generally though, less emphasis on hierarchical structure encourages a broader voice from more people, thus greater participation and enhanced information accessibility (Zaltman, et al, 1973). Yet, strict "channels of authority (high centralization) can reduce potential ambiguity and conflict in innovation implementation" (Kim & Srivastava, 1998, pg. 233-234).

3. CONCEPTUALIZING INTRA-ORGANIZATION INNOVATION ADOPTION

Adoption and diffusion of business practice innovations is conceptualized as a dynamic process where practices propagate vertically then, as a result of successive user experiences, horizontally across organizational units as a result of imitation and replication.

Jensen (2001) found that adoption of innovations in the intra-organization context follows an S-shaped or concave diffusion pattern with greater emphasis on an S-shaped curve if the implementation occurred over a long period of time. In fact he suggests that new technology may be managed to diffuse slowly if a cost savings can be prolonged through the adoption process. Additional support that suggests cost savings is an important motivator (particularly in resource starved organization) is provided in the literature (Fliegel & Kivlin, 1966; Tornatzky & Klein, 1982; Bessant, 1982; Damanpour & Schneider, 2008). Conversely, innovation complexity (i.e., with concomitant increased cost) inhibits adoption. Innovations which are more difficult to implement require greater resources and less trialable are less likely to be adopted by the organization because of higher uncertainty of their success (Gopalakrishnan & Damanpour, 1994).

The Bass (1969) Model is a commonly used hazard model that assumes potential adopters of an innovation are influenced by external and

internal communication channels. Individuals adopting an innovation do so because of simultaneous internal and external pressures. However, over time internal influence plays an increasingly important role due to increased word-of-mouth activity. The effect of which is a bell-shaped distribution and an S-shaped cumulative distribution of new-product diffusion (Rogers, 2003). To forecast intra-organizational diffusion, Randles (1983) used a logistical internal influence model applied to the diffusion of computer terminals within a firm. In a later study, Brancheau & Wetherby (1990) studied spreadsheet software adoption, adding social interaction variables such as communication channels and mass media as explanators. Adding model variables extends basic diffusion models much the way Bass, Krishnan& Jain (1994) include price and advertising to the Generalized Bass Model, thereby extending the original Bass model to incorporate the effects of market variables.

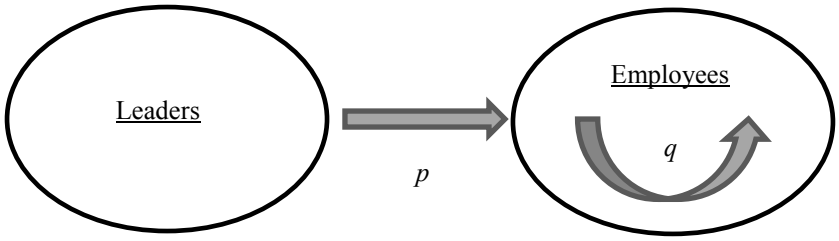
The original Bass Model is a mixed-model that combines Fourt& Woodlock's (1960) model of external influence represented by the parameter p with Mansfield's (1961) model of internal influence represented by the parameter q. Lekvall & Wahlbin (1973) were the first to interpret the Bass model parameters as coefficients of external (p) and internal (q) influence as it is interpreted in the context of this current research; however it should be noted that this interpretation is not universally agreed upon. The Bass Model may be written as: $N_t = p(m - Y_{t-1}) + q(Y_{t-1}/m)(m - Y_{t-1})$, where, N represents the number of adopters in the current time period, Y is the cumulative number of adopters up to the current time period, m is total anticipated number of adopters over time (or market size), q is a parameter representing the rate of adoption due to internal influence, and p is the rate of adoption due to external influence (Bass, 1969).

The convenience of the Bass model is seen when either p or q approaches zero. In either case the model reduces to one of either pure internal influence (when p à 0) or external influence (when q à 0). As such the model can result in either an exponential or logistical pattern of adoption. The relevance of this is not trivial. It is suggested that as leadership strength and its ability to communicate effectively increases so should parameter q. As leadership communication strength declines so does the relative importance of p upon the empirical model of diffusion. Likewise regarding q, if the organization's social structure is loosely formed, without strong inter-connected ties (as in network ties), then the relative impact q diminishes giving external information sources (i.e. leadership) an opportunity for stronger control of the diffusion process. In addition to measuring the effect of internal and external communication channels model parameters may be used to estimate the time period when peak usage of an innovation will occur; $1 / (p+q) * \ln(q/p)$, and the peak usage rate at that time equal to; $m*(p+q)^2 / (4*q)$.

Gopalakrishnan & Damanpour (1997) identify these two stages in the adoption process as initiation and implementation. Initiation is subdivided into awareness of the innovation, formation of an attitude towards it and its evaluation from an organizational standpoint. Implementation includes the decision to adopt, trial implementation and sustained implementation. Hence a two-level model is developed that represents the organization and its adoption of newly innovated processes and practices and how these innovations diffuse across organizations. The two levels are linked through a selection mechanism that determines how practices replicate within an organization (Arakji & Lang, 2010). The two-level model is composed of an initiation and an implementation stage (Zaltman, et al, 1973, Damanpour & Schneider, 2008). During initiation the user becomes aware of the innovation and considers their use of it concluding with an eventual decision to use it on a trial basis. During the implementation stage the user makes the innovation part of their permanent routine, leading to full institutionalization (Chow, Hutchins, & Sikorski, 1973).

Therefore, we propose that (1) the influence organizational leaders have to initiate adoption may be represented by the Bass model p (external influence) parameter, and (2) the influence employees have on implementation is appropriately represented by the Bass model q (internal influence) parameter.

FIGURE. 1:
Intra-Firm Innovation Model of Adoption



'*p*' represents the impact external (leadership provided) communication has during intra-organization diffusion.

'*q*' represents the impact internal (employee networking) communication has during intra-organization diffusion.

3.1. Research Hypotheses

As a study of communication, Diffusion Theory's special focus is on interpersonal communications within social systems, where the process of personal influence is seen to mediate information flow. In this context, adoption becomes a function of how individuals come across innovation information. Some rely on information primarily from external sources, while others rely more on internal information sources, such as word of mouth. All adopters within the organization rely on a blend of external and internal sources for information, early adopters rely more heavily on external sources and those that adopt later rely more heavily on internal sources (Mahajan, Muller & Srivastava, 1990). As such, the relative influence of external sources of information is stronger during early stages of diffusion until a critical mass of adopters can transmit innovation information to the rest of the organization that has not yet adopted. To incorporate both external and internal communication channels the proposed theoretical model suggests that leader supplied information acts as an external information source and has greater influence during early diffusion, while interactions among employees provides internal channels of information flow that is more relevant during late diffusion.

A central question posed by this research asks what influence leadership and organizational structure has on the rate of innovation diffusion? While it is assumed that larger organizations benefit from greater access to scarce resources (financial, physical, technological, etc.) counterarguments have been made suggesting that larger organizations are more likely to be susceptible to the loss of managerial control (Cohen & Levin, 1989) as well as strategic inertia (Crozier, 1964). To this point organizations that possess highly de-centralized organizational structure are less able to adapt rapidly enough to gain a competitive advantage when adopting a new technology. Illustrated in the context of information systems (IS), "A central IS staff with a broad overview of the company's information needs can champion [process] integration far more effectively than decentralized IS units (Simson, 1990)." Following Siggelkow & Levinthal (2003 p. 651) we define a decentralized structure "when decision making has been disaggregated into a number of subunits, or divisions, each making its own decisions." As a result of this structure, decentralized organizations are slower than others to adopt an innovation, thus eliminating any first-mover advantage that may have existed prior to making an early technology adoption (Fuentelsaz, Gomez & Polo, 2002; Romeo, 1975). Meanwhile, when leadership is centralized, limited and concentrated within fewer subunits, or divisions organizations are more likely to be early adopters of a technology innovation (Akhavein, Frame & White, 2005).

Therefore, when leadership power is concentrated among few leaders (analogous to market share concentration among a product's leadership firms) it represents a centralized organizational form and the following hypotheses are predicted.

> Hypothesis 1a: Leader concentration/ centralization and the degree to which external influence affects diffusion are positively related.

Conversely, when leadership positions are spread out (de-centralized) we anticipate the diffusion of an innovation to be influenced more by subordinates who are given greater autonomy and adoption authority, thus,

> Hypothesis 1b: Leader concentration/ centralization and the degree to which internal influence affects diffusion are negatively related.

Finally, because leadership concentration positively influences the early initiation stages of adoption (HO_{1a}) then we expect the entire diffusion process to happen faster when leadership's strength is concentrated.

> Hypothesis 1c: Leader concentration/ centralization and the rate of organizational adoption are positively related.

In addition to the structure of the organization, the nature of the relationship between leaders and subordinates has influence on the rate of innovation diffusion. After organizational leaders choose to adopt an innovation they must then convince the rest of the organization (presumably rank and file subordinates) to also adopt the innovation. Therefore, the power of external communication to influence the rate of adoption varies by leadership structure and style. A key aspect in the relationship between leaders and subordinates is voluntariness in the workplace, which relates to the degree to which adoption of an innovation is perceived as being a result of one's free will (Van Slyke, Lou & Day, 2002; Agarwal & Prasad, 1997; Moore & Benbasat, 1991). If an employee feels compelled to adopt a new process or procedure insomuch as it is a requirement of their job then diffusion is all but assured within an organization. Therefore, we use the phrase 'command-oriented leadership' to imply a strong, top-down, management style, whereby subordinates perceive legitimate coercive power. Coercive power is "based on a subordinate's perception that a superior has the ability to punish him or her for failure to conform to the superior's influence attempt" (Rahim, 1989, p. 545; French & Raven, 1959). Thus,

> Hypothesis 2a: Leadership focused on a command-oriented style and the degree to which external influence affects diffusion are positively related.
>
> Hypothesis 2b: Leadership focused on a command-oriented style and the degree to which internal influence affects diffusion are negatively related.
>
> Hypothesis 2c: Leadership focused on a command-oriented style and the rate of organizational adoption are positively related.

4. RESEARCH STUDY

4.1 Data Sample

The U.S. Government recognized the potential benefit of purchase card use as far back as, 1982 and has reaffirmed its value to operations through many administrations (see a brief history of government purchase cards contained in Palmer & Gupta (2007)). In, 1993, the Vice President's National Performance Review recommended that U.S. Government agencies increase their use of purchase cards for high volume, small dollar purchases to cut the red tape normally associated with the federal procurement process (U.S. GAO, 1996). The benefits of purchase card use are several, including the reduction and elimination of the paperwork associated with requisitions, purchase orders, invoices, and payments. Additionally, purchase cards have been found to reduce the time required to process paperwork transactions, enhance control over and visibility into spending patterns, and generate "cash back" card issuer incentives for their use (Federal Reserve Bank of Philadelphia, 2011; U.S. GSA, 2006). These benefits combine for an estimated cost savings ranging from $54 to $92 per transaction (U.S. GAO, 1996; Cohen, 1998). Operational efficiencies are created as a result of these cost savings and are an important force behind the

usage of the purchase card, making purchase card adoption an ideal application for diffusion research.

The data related to the growth of spending, transactions, and cardholders of government purchase cards have been retrieved from the General Services Administration (GSA); specifically, the GSA SmartPay 2 Program. The SmartPay 2 Program provides the aforementioned purchase cards to the government agencies through contracts negotiated with major national banks, including Citibank, JPMorgan Chase, and U.S. Bank. The database used in this research is extensive, containing information related to each individual governmental agency from, 1997 through 2008.

Employed in this study 40 U.S. Federal agencies provide a broad spectrum of organizational structure. Sixteen of the agencies are under the direct oversight of the executive of the government including direct executive (Presidential) oversight while twenty-four are overseen by the U.S. Congress. Although each agency is responsible for the creation of policies and procedures to implement and control their own purchase card program (Office of Management & Budget, 2009) including but not limited to card distribution and spending, the Office of Management and Budget oversees card usage (see Table 1). Data relating to organizational size and structure including number of leadership divisions and oversight responsibilities has been retrieved from publically accessible government agency web-sites. It should be noted that agencies which were added or have experienced significant change over the study period (i.e. the Department of Homeland Security) were not included in the data set.

The use of this data source and subject choice for analysis is unique. First, few studies focus on government institutions. Within the context of public organizations innovation adoption has been investigated by Ryan, et al (2008) in their work with new public management initiatives in Australia. Second, government spending and the transparency of government operations are of particular interest to the general public. Third, access to data from a broad collection of large, autonomous organizations is difficult to obtain.

4.2 Measures

Diffusion models provide an appropriate vehicle to examine organization-level diffusion since both external and internal effects may be represented parsimoniously by a parameter representing the influence organizational leadership have on adoption and a measure of internal influence representing influence of inter-personal communications among organization members. The sample units used in this research are agencies and the key measure of innovation diffusion is the number of purchase-card holders within each agency by year following Bretschneider & Wittmer's (1990) operationalization of organizational adopters. Within each agency, employees (or their supervisors) must request that a card be issued. Thus, as in product diffusion, individual managers and employees act as discrete units that make a decision to adopt the card technology to support "electronic" purchase activity. Each agency provides 11 years of data regarding distribution and purchase card use. In typical agencies the number of card users grows slowly over time until it peaks after which the rate of card distribution diminishes. From these agency-level data a hazard model is estimated for each agency providing the Bass Model parameters for external (p) and internal (q) influence, and total employee size (m). Simultaneously, the time of peak distribution (in years) measures how quickly the innovation is adopted, thus it is used to operationalize the rate of adoption (Kim & Srivastava, 1998). The underlying assumption is that organizations which reach their peak adoption quickest are those that implement the innovation fastest. Thus, organizations that reach peak card distribution earlier than others demonstrate a more efficient adoption process.

To measure organizational structure three variables are used; average number of employees, organizational divisions, and the primary source of oversight. It should be noted that average employee size over time is remarkably stable across most agencies. As such, no agency experiences sharp increases or decreases in size relative to other agencies during the study period. To measure

TABLE 1:
Model Parameter Estimates by Agency

Agency	p	q	m	Time To Peak Card Use (yrs.)	Over-sight*
Agency for International Development	0.0546	0.2598	2851	5.0	C
Consumer Product Safety Committee	0.0400	0.3740	1709	5.4	C
Corporation for National and Community Service	0.0208	0.4419	2121	6.6	C
Defense- Administration	0.0564	0.3402	93773	4.5	E
Defense- Air Force	0.0615	0.2860	635021	4.4	E
Defense- Army	0.0668	0.2944	867591	4.1	E
Defense- Navy	0.0825	0.3537	292430	3.3	E
Department of Agriculture	0.0557	0.1731	323394	5.0	E
Department of Commerce	0.0616	0.1539	96249	4.2	E
Department of Education	0.0928	0.1838	2779	2.5	E
Department of Energy	0.0884	0.3031	56990	3.1	E
Department of Health and Human Services	0.0497	0.1929	95856	5.6	E
Department of Housing and Urban Development	0.0852	0.1251	4634	1.8	E
Department of Justice	0.0592	0.2575	160635	4.6	E
Department of Labor	0.0797	0.4148	15045	3.3	E
Department of State	0.0425	0.5197	12067	4.5	E
Department of Transportation	0.0826	0.3782	197017	3.3	E
Department of Treasury	0.0828	0.2415	105111	3.3	E
Department of Veterans Administration	0.0654	0.1442	512724	3.8	E
Environmental Protection Agency	0.0702	0.2340	21620	4.0	E
Equal Opportunity Commission	0.0522	0.3414	2063	4.8	C
Export-Import Bank	0.0528	0.6219	330	3.7	C
Farm Credit Administration	0.0552	0.4066	420	4.3	C
Federal Communications Commission	0.0456	0.1176	3960	5.8	C
Federal Deposit Insurance Corp	0.0600	0.2303	5727	4.6	C
Federal Labor Relations	0.0633	0.1845	227	4.3	C
Federal Mediation and Conciliation	0.0645	0.9113	235	2.7	C
Federal Trade Commission	0.0622	0.1557	1062	4.2	C
Government Printing Office	0.0370	0.2392	1307	6.8	C
NASA	0.0757	0.3399	46313	3.6	C
National Archives Records	0.0511	0.1791	3372	5.4	C
National Credit Union	0.0126	0.1314	1631	16.3	C
Nuclear Regulatory Commission	0.0577	0.312	2442	4.6	C
Office of Personnel Management	0.0584	0.4958	1947	3.9	C
Overseas Private Investment	0.0446	0.2784	301	5.7	C
Railroad Retirement	0.0451	0.2613	1103	5.7	C
Securities and Exchange Commission	0.0288	0.3358	776	6.7	C
Small Business Administration	0.0653	0.2866	3267	4.2	C
Smithsonian Institute	0.0165	0.6392	5253	5.6	C
Social Security Administration	0.0533	0.1505	49492	5.1	C

* C = Congressional; E = Executive

organizational leadership structure the number of major functional units or divisions was counted directly from agency organizational charts. By considering the number of functional units within an agency one can get an understanding of its scope of dispersion. Coupled with organizational size the ratio of employees to leadership divisions is calculated in order to provide a measure of leadership presence while controlling for the size of the agency. Finally, the data is categorized by the authoritative body charged with oversight of each agency. Agencies are generally accountable to either the congressional or executive branches of the Federal government. Agencies operating under Executive branch oversight (e.g., branches of the military, Department of Education, Department of Health and Human Services, etc.) tend to be more centralized and subject to greater top-down authority, whereas agencies operating under congressional oversight (EEOC, FCC, FDIC, etc.) are viewed as less centralized given their broader chain of command which may be spread through multiple committees, sub-committees and Congressional leadership boards.

5. RESULTS

5.1 Model Estimation

Bass model parameter estimates for each agency are made using the SAS statistical software package's Proc NLIN statement for non-linear least squares (SAS Institute, 2010, pg. 2373). This procedure allows for the estimation of non-linear distributions and follows the research tradition of Srinivasan & Mason (1986) followed by Jain & Rao (1990). This estimation technique can handle non-linear data patterns and overcomes potential time-interval bias to which least squares estimation is subject.

In addition, using non-linear least squares provides estimated standard errors and T-ratios (Chandrasekaran & Tellis, 2007). A factor limiting the use of non-linear least squares estimation is the tendency to overestimate m and p, especially when limited data are available. However, given that eleven (1997-2008) years of data is provided this presents a minor concern. Other estimation techniques have been developed to estimate model parameters such as maximum likelihood estimation (Schmittlein & Mahajan, 1982), hierarchical Bayesian methods (Lenk & Rao, 1990; Talukadar, Sudhir, & Ainslie, 2002), adaptive techniques such as the feedback filters (Bretschneider & Mahajan, 1980; Xie, Song, & Wang, 1997) and genetic algorithms (Venkatesan, Krishnan & Kumar, 2004). However, each of these techniques have some trade-off value and while modest improvements in estimation can be made the straight-forward method of non-linear least squares is often just as robust as other more elaborate methods (Chandrasekaran & Tellis, 2007).

To execute the research plan a separate model was estimated for each agency. Based on the data provided, model parameters for p, q and m are reported for all 40 agencies. Prior research in marketing has found the mean value of p for new products to lie between .00007 and .03, while for q the mean value is between .38 and .53 (Sultan, Farley, & Lehmann, 1990;, 1996; Talukadar, Sudhir, & Ainslie, 2002; Van Den Bulte & Stremersh, 2004). In this current research the mean agency parameter estimate for p is .0575 and the mean of q is .31 (see, Table 1). As model parameters from intra-organization diffusion studies are absent it is unclear whether this data is consistent with data relative to other organizational forms. However, given the influence leaders have on subordinates in a typical employment scenario it is not unexpected for external influence to be higher and internal influence lower than in an open market scenario, thus providing initial face validity check of the study's key measures.

5.2 Hypothesis Assessment

Using estimated p, q parameters the time to peak-use is calculated for each agency. Using these variables and the ratio of employees to leadership division, a linear model (OLS) is estimated and reported in Table 2 which corresponds to Hypothesis $1_{a\text{-}c}$. The results of the estimated model indicate strong fit with significant relationships among hypothesized variables. The model demonstrates fit by a robust r^2 of .63 and significant F statistic (22.34, $p < .001$).

The ratio of employees to organizational division measures centralization or leader concentration. If the number of employees goes down or the number of divisions goes up then centralization of leadership is diminished inasmuch as there will be fewer employees per division or more divisions act to spread employees out. In such a case innovation diffusion must rely more heavily on internal methods of communication such as interpersonal communications which are enhanced through a networked organization. Additionally, leaders may exert less influence on their employees.

Contrariwise, if the number of employees per division goes up or divisions are consolidated then each division leader will be responsible for more employees and the organization will demonstrate a stronger vertical chain of command. Table 2 shows that we find parameter p, the measure of external influence, is positively associated with the ratio of employees to organizational divisions. That is, as the number of employees per division goes up (indicating stronger vertical linkages) the relative size of p goes up significantly. This result supports hypothesis 1a that leadership concentration, which illustrates organizational centralization, and model parameter p are positively related.

We also find that the model estimate for q, the measure of internal influence, is negatively associated with the employee-division ratio. In this case we expect that as divisions are added relative to employee size, leadership power is at greater risk of becoming decentralized and greater need for internal information exchange is required for innovation adoption, confirming hypothesis 1b.

Finally, we measure the relationship between leadership concentration and the rate in which the innovation is adopted. To measure the rate of adoption we use model parameters to estimate when (in years) peak adoption will occur. We theorize that organizations with centralized leadership structures will reach peak adoption faster than decentralized counterparts. Observing the data we find this to be true supporting hypothesis 1c. When the ratio of employees to divisional leaders goes up, so does the rate of innovation adoption as it becomes fully implemented sooner.

-Hypotheses 2_{a-c} use averaged data across agencies that are overseen by either congressional or executive bodies (reported in Table 3). This reflects leadership style as it may be command-oriented (executive) or non-command-oriented (congressional). Additionally, the impact that agency oversight has on diffusion is illustrated in Figure 2 (panels A, B and C). The results in Table 3 report ANOVA comparisons (and supportive t-statistic and significance levels) between both executive and congressional agencies for model parameter estimates p and q as well as the computed time each agency takes to reach peak adoption. This straightforward comparison compares estimated p and q parameters by

TABLE 2:
Employee-to-Division Ratio Model, operationalized to measure Leader Concentration

	Estimated Co-efficient	Sign. (p)
Constant	-1045.10	< 0.001
H_{1a}: External Influence	193214.06	< 0.001
H_{1b}: Internal Influence	-5243.32	< 0.001
H_{1c}: Rate of Adoption*	101.83	< 0.001

* Rate of adoption is measured by the time it takes a firm to reach peak card distribution; therefore the measure is reverse coded.

agency oversight. Testing hypothesis 2a we find that the estimated effect of internal influence is stronger (though not significantly) in agencies that have executive oversight. Supporting hypothesis 2b, the effect internal influence is found to be significantly stronger in agencies with congressional oversight. Finally, when the rate of adoption is compared between agencies it is found that those with executive oversight adopt a full 29.6% faster.

It appears that agencies subject to executive oversight have a greater number of adopters over time from external influence (Panel A), while those under congressional oversight demonstrate greater adoption from employee-to-employee internal communication (Panel B). Meanwhile, when computed together, executive branch oversight which is used to denote stronger command-oriented leadership structure reaches peak usage faster (Panel C).

6. DISCUSSION

Though much research exists in the diffusion literature, Kim & Srivastava (1998) contest that existing studies don't pay adequate attention to diffusion within organizations and its importance is subsequently under-researched. Research in intra-organizational diffusion has emerged from the marketing literature in a few early studies concerning organizational implementation of new products from an informational technology perspective (Zmud, 1982; Brancheau & Wetherby 1990) and even today this research stream is limited when compared to consumer market diffusion.

Based on the results of this study it appears that organizational structure and leadership ethos play significant roles during the innovation process. There could be several reasons that explain these results beginning with the theoretical positions made earlier in this article as well as direct pressure from tax-paying public that demand greater accountability from their elected officials. Top-down change has been advocated where there is external pressure to effect change (Ryan, et al, 2008). Executive pressure to adapt and use efficient practices is encouraged from an informed public.

The associations that are predicted and supported by data show a strong positive relationship between leader-initiated communication and leadership centralization during the adoption process. It is shown that when fewer leaders exists under a narrow hierarchy of divisions, their voice and unfiltered message is not diluted, but rather, amplified and acted upon by others. The data also suggest that organizations which have broad (horizontally focused) lines of authority rely less on leader initiated communication and more on adopter communications. We contend that in this case more divisions provide more lower-level managers who act not only as divisional leader, but also internal communicator to those individuals that they manage. The result of these two findings (H_{1a-b}) combine to show that centralized structure and it subsequent leader initiated communications contribute a greater overall effect which leads to a more rapid adoption of the innovation (H_{1c}). That is, organizations reach peak adoption faster when greater leader initiated communication is present represented by p in the diffusion model.

TABLE 3:
Variable Comparison by Oversight Structure ANOVA

Variable	Executive Oversight (n=16)	Congressional Oversight (n=24)	Significance t-stat. (p)
H_{2a}: Estimated External Influence (p)	0.07	0.05	3.87 (.000)
H_{2b}: Estimated Internal Influence (q)	0.27	0.33	1.11 (.273)
H_{2c}: Average Time to Peak Card Use	3.8 years	5.4 years	2.31 (.027)

FIGURE. 2:
Panel A, Average Agency Adopters over Time Due to External Influence by Oversight

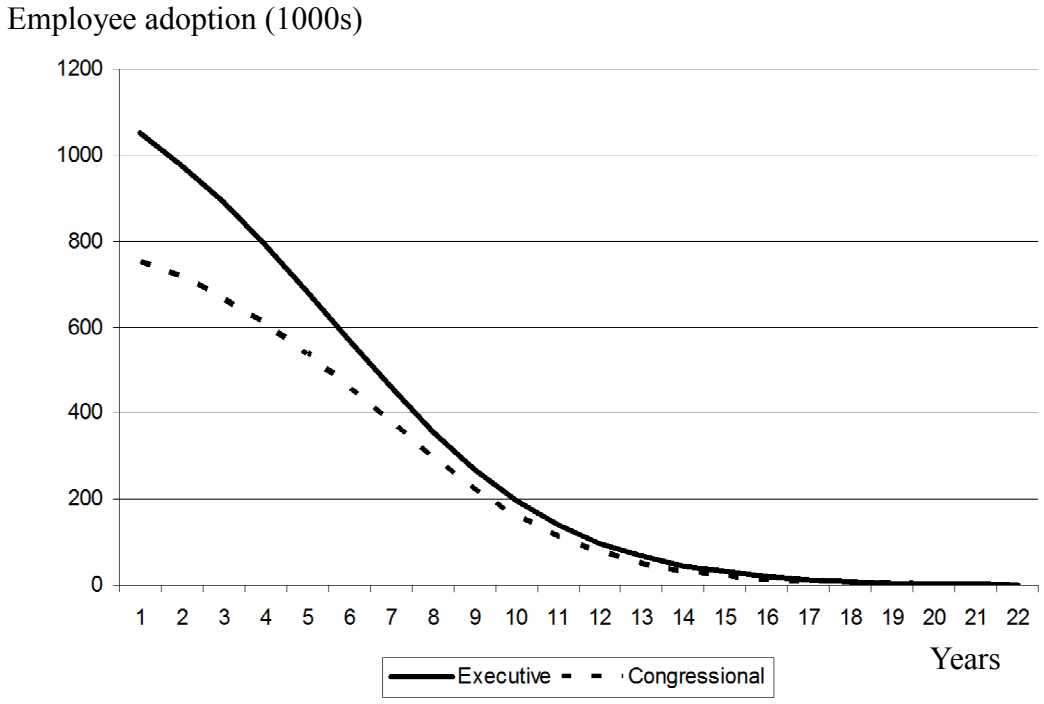


FIGURE. 2:
Panel B, Average Agency Adopters over Time Due to Internal Influence by Oversight

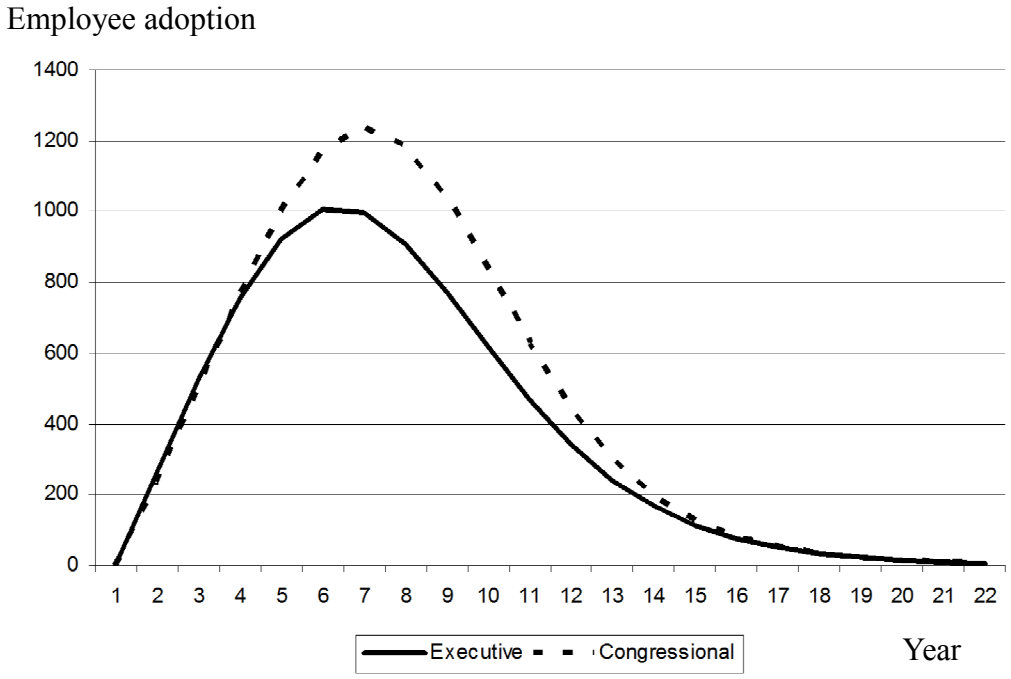
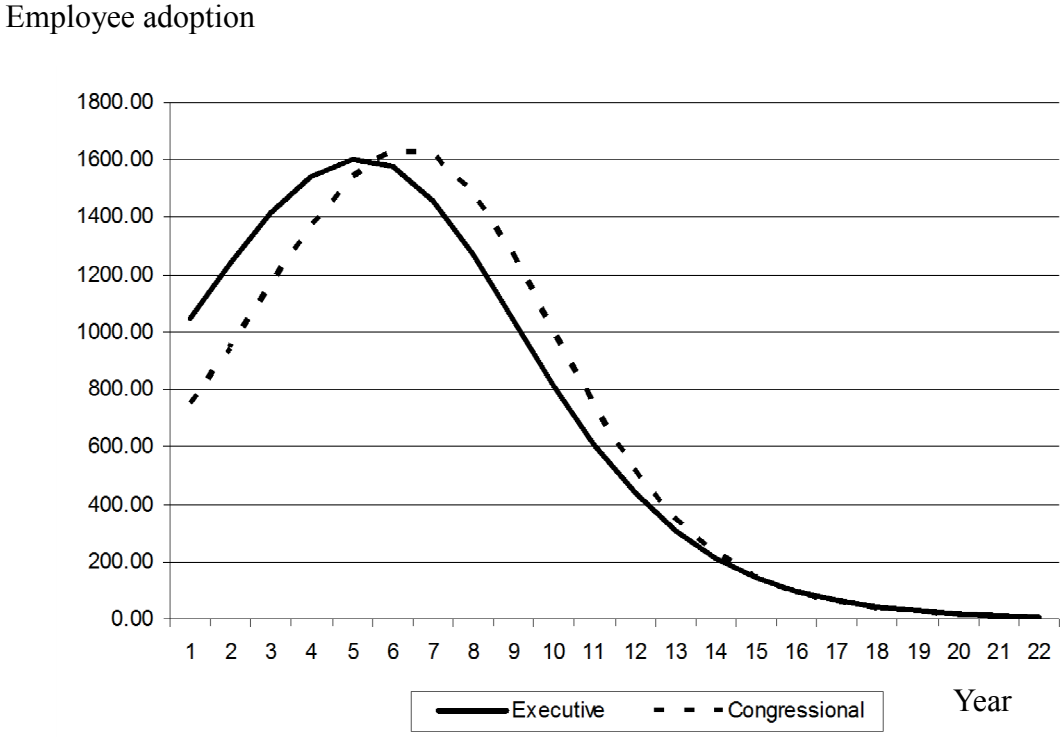


FIGURE. 2:
Panel C, Average Agency Total Adopters over Time by Oversight



The second set of hypotheses ($H_{2\text{-}a\text{-}c}$) broadly predicts that organizational culture plays a role in the dissemination of information which leads to innovation adoption. Though the measures are not conventional we contend that in the case of the U.S. Federal Government there is sufficient dissimilarity between agencies run by the executive and congressional branches of government. These two branches differ in two very significant ways. First, the Congressional body (both Senate and Congress) have layers of operational committees and sub-committees that review performance and as such move slower to act. In the case of gross negligence or malpractice within an agency it may take several committee hearings for action to take place. In addition, the nature of congressional committees is that of a deliberate actions where provides due process precedes action. By contrast the executive branch is traditionally much more agile and flexible through executive order privileges afforded the President. In many cases, if action is required then an agency leader may act (up to even the President) unilaterally.

Second, public media and opposing party politics is increasing focused on the performance of incumbent politicians. In congress a direct link between an agency and an elected official is very hard to make. Again, due to committee oversight a failing agency may not be the result of a single politician, thus the political assault from the public media or opposing party is dampened. Executive branch oversight however is always in the crosshairs of ambitious sycophants.

The results of the data analysis show a significant difference in model parameters and the rate of adoption is compared by agency oversight. As predicted, agencies overseen by executive officials show a greater degree of adoption as a result of leader initiated communication. As a result these agencies reach peak innovation usage faster than agencies under congressional oversight.

7. CONCLUSION

A major contribution of this research is the application of a traditional marketing model,

the Bass model, to diffusion within an organization. The impact of this is significant for Business-to-Business researchers and practitioners including those focused on sales, purchase agents, and buying centers. Our research setting is unique, but the application may be replicated across many organizational forms. Innovation of the kind that improves responsiveness and efficiency is a core task of public organizations (Mulgan & Albury, 2003; Walker, 2006). Some public organizations may adopt innovations to deliver better services to users, others for to remain responsive and relevant in the eyes of the public who draw from their services and fund their existence (Walker, 2006). Yet, public institutions are thought to have several barriers restricting their ability to adopt new technologies. Included are lack of incentives, insufficient funding, short-term pressure associated with political cycles and the need for public support. Helping to successfully implement innovation adoption are managers who lend their support which may be influenced by their attitudes and value system (Damanpour & Schneider, 2008).

The literature on strategic marketing management has emphasized the importance of considering technology in the strategic posture of the firm. The firm should identify a technology strategy that addresses its policy and procedure for gaining knowledge including the ability to manage technology while exploiting it for profit or gain (Frambach, 1993).

This research provides insight regarding the role firm leadership structure and culture plays on innovation diffusion. While command-oriented leadership presented in a highly centralized form may overshadow employee autonomy and freedom it plays an important role in employee technology acceptance as it provides a key external communication source. Therefore, organizations that are not strongly linked through a clear and direct leadership hierarchy may experience longer adoption times and fewer overall employee adopters.

The major contribution of this research is the unique application of a hazard model (the Bass Model) to measure technology diffusion driven by communication source and channel within an organization. This research relies heavily on the interpretation of key model variables including p as the influence leaders (conceptually viewed as outside the social mass of the firm) and q as the influence of rank and order firm employees upon each other. This application, while novel, appears to support the notion that product diffusion research techniques may be applicable to innovation adoption within a firm.

This research and the interpretations of the results are constricted by several specific limitations. First, the meager sample size provides just 40 observations. These data are further split by oversight responsibility (24 congressional and 16 executive). As such, the statistical power needed to uncover significant relationships is muted. A second limitation is the reliance on secondary data as the sole form of supportive evidence. While secondary data does provide a historical account of events it (by its nature) is dated and is subject to time dependent constraints. In addition, the secondary data is collected for purposes other than the current research study; therefore the variables are not always ideal. A third limitation to this research includes the potential lack of generalizability to the assertions and conclusions made as a result of data drawn from one unique set of organizations and one diffused innovation. Given this limit we assume but cannot be certain that the influence organizational structure has on the rate of adoption is as we suggest. As such, more research is called for including a) research with extended diffusion model versions that allow for repeated adoption, b) the inclusion of other model influences such as adopter cost or innovation characteristics, and c) varied innovation types such as high and low technology offerings or product versus service offerings.

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