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Executive Migration and Incumbent Adaptation to Technological Change

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Abstract

This paper examines how bringing new executive members to a top management team (TMT) affects an incumbent?s adaptation to technological change. Departing from prior studies, we study new executives? (1) level of executive experience (?rookie? or seasoned), (2) their origins (inside or outside the firm, inside or outside the industry), and (3) whether technology age at the time they enter a TMT influences their impact on adaptation. Our empirical analysis of the U.S. cellular phone service industry in 1991¬?1998, early in the transition to digital technology, shows that incumbent cellular operators were more likely to adapt to digital technology when their TMT included rookie executives hired away from competitors or seasoned executives hired from other industries; they were less likely to adapt to digital when their TMT included rookie executives promoted from inside the firm. This effect changed as the digital technology aged. In later years, promoting rookies from within the firm to the TMT becomes more important for driving an incumbent?s digital adaptation, relative to hiring outside rookies or seasoned executives. These results suggest that the value of firm-specific experience increases as a new technology ages.

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ABSTRACT

This paper examines how bringing new executive members to a top management team (TMT) affects an incumbent's adaptation to technological change. Departing from prior studies, we study new executives' (1) level of executive experience ('rookie' or seasoned), (2) their origins (inside or outside the firm, inside or outside the industry), and (3) whether technology age at the time they enter a TMT influences their impact on adaptation. Our empirical analysis of the U.S. cellular phone service industry in 1991–1998, early in the transition to digital technology, shows that incumbent cellular operators were more likely to adapt to digital technology when their TMT included rookie executives hired away from competitors or seasoned executives hired from other industries; they were less likely to adapt to digital when their TMT included rookie executives promoted from inside the firm. This effect changed as the digital technology aged. In later years, promoting rookies from within the firm to the TMT becomes more important for driving an incumbent's digital adaptation, relative to hiring outside rookies or seasoned executives. These results suggest that the value of firm-specific experience increases as a new technology ages.

Keywords: Executive migration, Adaptation, Middle managers, Incumbents, Technological change

INTRODUCTION

Adaptation is generally conceptualized as a change in a significant attribute of an organization in response to its environment, made by retaining, adopting, and discarding templates for organizing (Greenwood & Hinings 1996; Levinthal 1997). Extant literature has shown that incumbent organizations are often unable to successfully adapt to environmental changes because of constraints created by their governance capabilities, knowledge, structures, relationships, cultures, social identities, routines, and resource endowments (Hannan & Freeman 1984; Mitchell 1989; Moore & Kraatz 2011; Stinchcombe 1965; Tripsas 2009). Following technological changes, incumbents[1] face an even greater level of constraints because the outcome and the process of technological adaptation are often highly uncertain, ambiguous, and complex, involving fundamental changes to the product or service, to scientific methods and materials, and to organizational attributes (Eggers & Kaplan 2009; Taylor & Helfat 2009).

Nevertheless, in explaining an incumbent's technological adaptation, prior research has typically viewed adaptation as an outcome of purely economic calculations (review in Ansari and Krop, forthcoming), overlooking mangers' bounded rationality under highly uncertain, ambiguous, and complex situations. Moreover, despite scholars' increasing attention to the managerial constraints on adaptation, we know very little about the approaches incumbents use to overcome this constraint. More importantly, no study has examined if these approaches remain effective as a new technology, and industry conditions, evolve over time (Kaplan & Tripsas 2008).

Our research objective is to understand the extent to which an incumbent's technological adaptation is influenced by adding new members to its top management team (TMT), and how that

[1] The term "incumbent" has been defined in various ways in the literature and implicitly defined in studies of industry/technology evolution or organizational adaptation. In general, studies of industry/technology evolution largely sort firms along separate dimensions of incumbency: firm size, firm tenure in industry, and changing technology regime, while studies focusing on the survival of incumbents and entrants often extol the virtues of entrepreneurial firms that displace incumbents with *innovations* (see review in Chen et al. 2012). In the context of organizational adaptation to environmental change (e.g. technology shock), the distinction between incumbents and non-incumbents (entrants) should be based on a firm's choice of entry institution or technology. Thus, firms that enter an industry conforming to an old institution or technology regime—although a new institution or technology has been introduced—should not be considered new entrants because they operate in the same manner as incumbents.

influence changes as a technology ages. We focus on top management change because top managers are the ones directing and contemplating the economic gain from organizational change (Finkelstein & Hambrick 1996), and because top management change often facilitates organizational reorientation (Tushman & Rosenkopf 1996). Specifically, changing top management by bringing new members to a TMT has been argued and shown to help incumbents adapt to environmental changes because new executives may introduce new managerial skills, knowledge, insights, mental models, and assumptions, may be the conduit for promoting inter-organizational learning, and may attenuate or replace institutional values (Boeker 1997; Cao et al. 2006; Helmich & Brown 1972; Kraatz & Moore 2002; Virany et al. 1992; Wiersema & Bantel 1993). However, prior studies say much less about "what kind" of new executive is more (less) likely to encourage adaptation. They also say very little about "when" their entry is more (less) likely to have an effect.

These critical questions underlie the theory of our paper. First, not all new executives are seasoned. Some were top managers of existing firms before joining the focal TMT, but others were rookies who were previously operational (middle) managers of existing firms and took on top management responsibilities for the first time when they joined the focal TMT. While inexperienced as strategic decision makers, rookies may influence an incumbent's technological adaptation because the intra-industry migration of operational talent facilitates recipient firms' product innovation and technological reposition (Rao & Drazin 2002; Tzabbar 2009). Second, due to differences in the hierarchical, organizational, and industrial origins of managerial experience, managers may differ in their levels of ability and types of human capital, social capital, and cognition (Adner & Helfat 2003; Finkelstein et al. 2008; Kaplan & Tripsas 2008). These differences may influence how top managers notice, interpret, and construct technological change (Kaplan & Tripsas 2008; Kiesler & Sproull 1982; Reger & Palmer 1996). Third, top managers' cognition about competitive environment and ability to affect important organizational outcomes can change with the evolution of industry environment as a new technology ages (Debruyne & Reibstein 2005; Hambrick & Finkelstein 1987;Johnson & Hoopes 2003). The impact of new executives' origins on an incumbent's adaptation should also

depend on when they join the TMT. Therefore, this paper posits that new executives' influence on an incumbent's technological adaptation varies with (1) their level of executive experience (rookie or seasoned), (2) where they come from (inside or outside the firm and inside or outside the industry), and (3) at what stage of technology transition they join the TMT.

Drawing on prior literature, we make more specific arguments about how the origins of new executives and the timing of their move to a TMT affect an incumbent's technological adaptation. Like earlier authors, we suggest that the experience of new executives needs to be ***distant*** from the existing TMT because different experience (and thus different knowledge, skills, values, assumptions, and so forth) facilitates the overturning of existing institutions (Kraatz and Moore 2002). More importantly, these differences need to be ***valuable*** to the existing TMT, because certain knowledge, skills, and social capital might be valueless across firm or industry boundaries (Castanias & Helfat 2001) and because the perceived value of others' experience affects the likelihood that recipients will learn from it (Argote & Ingram 2000; Song et al. 2003). Thus, we argue that *when a new technology is introduced*, an incumbent will be more likely to adapt to that new technology when its TMT includes a new executive whose managerial experience, and thus his/her origin, is more ***distant*** from and ***valuable*** to the existing TMT. However, *when a new technology ages*, an executive's ***internal*** (inside-firm) experience becomes more important to facilitating adaptation because, at this stage, innovative ideas are more likely to originate from within the firm (Gort & Klepper 1982), absorption depends more on integrating knowledge of the firm (Lim 2009), and structural inertia decreases (Hannan & Freeman 1984; Stinchcombe 1965).

To gain a better understanding of how new executives' origins and their time of entry to the TMT affect an incumbent's technological adaptation, we studied the digital transition of cellular phone (cell-phone) service incumbents in the U.S. from 1991 to 1998, the early period of digital transition. The cell-phone service industry commenced its service utilizing analog transmission technology in 1983 and faced a disruptive technological change when the first commercial digital cell-phone call was placed in 1991. We define TMT members as the first tier of the focal firm's

management, which includes the CEO/president and those reporting directly to him/her. New TMT members in our sample came from both operational (rookie)- and top- (seasoned) level management and from the industries of cell-phone service, traditional landline telephones, and radio communications. Our empirical results suggest that bringing in rookies from competitors and seasoned executives from other industries can facilitate technological adaptation *when a technology is very new*, while promoting rookies from inside the firm can actually hamper adaptation at this stage. We also show that bringing rookies from inside the firm to the TMT becomes increasingly important to facilitating an incumbent's adaptation *as a new technology ages*.

These results enhance our knowledge of the comparative advantages and constraints of bringing new executives to the TMT from various sources, and provide insight into when it may be most advantageous to add them. Specifically, this paper is the first to show that bringing rookies to a TMT is associated with organizational adaptation, and that the association varies with rookies' organizational and industrial origins. Moreover, this paper reveals that populating a TMT with seasoned executives from outside the industry, rather than from inside the industry, facilitates an incumbent's adaptation to technological change. More importantly, our paper shows that, in technological adaptation, the firm-specific experience of rookie executives promoted internally can be a liability initially but can become an asset as a new technology ages. In contrast, the importance of importing external knowledge and leadership decreases with technological age.

THEORETICAL BACKGROUND

Building on the studies of experience-based managerial ability (Adner & Helfat 2003) and technology-life-cycle (Tushman & Rosenkopf 1992; Utterback & Abernathy 1975), this paper proposes that an incumbent's adaptation to technological change will depend on new executives': (1) level of executive experience (rookie or seasoned); (2) types of firm and industry experience (inside or outside), and (3) entry timing to the TMT along a technology life. Here is our logic reasoning.

Rookie vs. Seasoned. Not all new executives are *seasoned*, meaning they were top managers of existing firms before joining the focal TMT. Some are *rookies,* meaning they had been operational

(middle) managers of existing firms before taking on TMT responsibility for the first time with the focal TMT. When focusing only on the migration of "seasoned" executives, prior studies overlook the important ways that bringing rookies to a TMT may drive organizational change. Operational talent migration has been shown to allow recipient firms to transform a firm's technological or product attributes (Rao & Drazin 2002; Tzabbar 2009), as it is a means of acquiring external and unique knowledge/skills (Almeida & Kogut 1999; Rosenkopf & Almeida 2003; Song et al. 2003) while buffering the impact of uncertainties on an organizations' technical structures (Thompson 1967). Thus, bringing rookies to a TMT should affect an incumbent's technological adaptation.

More importantly, without distinguishing how the hierarchical origins of new executives may drive organizational adaptation, we might miss the differential impact that rookies and seasoned executives have on organizational change. Compared to seasoned executives, rookies are inexperienced at institutional-level tasks, mainly formulating strategies, building inter-organizational relationships, and institutionalizing the organization to a broader community (Barr et al. 1993; Boeker 1997; Mintzberg 1973), while they are experienced at operational level tasks, mainly implementing organizational strategic objectives (Floyd & Wooldridge 1997). Basically, rookie executives will bring their *operational experience* to the focal TMT whereas seasoned executives will bring their *institutional experience*. In addition, compared to seasoned executives, rookies should be more likely to carry new market and technology knowledge because their prior job as an operational manager placed them in direct contact with new technological and market developments (Burgelman 1991; Nonaka 1994). In turn, managers with different levels of managerial experience could be endowed with different capacities to notice, interpret, and construct technological change. Thus, to fully understand how adding new executives to a TMT influences an incumbent's technological adaptation, it is necessary to separate the effect of bringing in rookie executives from the effect of bringing in seasoned executives.

Inside vs. Outside the firm and industry. Although prior studies only consider executive recruits from competitors in the same industry, sourcing new executives from inside the firm or from

outside the focal industry is common. This is an important dynamic to consider given that the variance among individual executives' perceptions of their respective organization's environment is largely explained by their organizational and industry memberships (Sutcliffe & Huber 1998). In addition, firms in the same industry may make different assumptions about their industry environment because they interact with different sets of suppliers and customers. Similarly, differences in managers' assumptions between industries can be observed with regard to strategic issues such as competitor definition, establishment of group boundaries, and industry recipe (Phillips 1994). Executive tenure in a TMT is also positively related to changes in the level of diversification (Wiersema & Bantel 1992). However, executive tenure in an organization and an industry is negatively related to an organization's changes in the level of diversification and business strategies, respectively (Grimm & Smith 1991; Wiersema & Bantel 1992). Thus, differences in new executives' organizational and industrial origins should create different impacts on incumbents' technological adaptation.

Entry timing to the TMT along the technology life. Prior studies have suggested that managerial ability to affect important organizational outcomes can be influenced by characteristics of the industry environment (Abrahamson & Hambrick 1997; Hambrick & Finkelstein 1987), and that managerial competences might become obsolete in an evolving industry (Henderson, Miller, & Hambrick 2006). Moreover, according to technology life-cycle studies, an industry goes through three different stages as a new technology ages: the era of ferment, the convergence of dominant design, and the era of incremental innovation; at each stage there will be different sources of uncertainty, opportunities, and threats and different environmental forces such as market structure (Abernathy & Utterback 1978; Tushman & Rosenkopf 1992). Thus, new executives' impact on an incumbent's technological adaptation should also depend on the stage of technology life during which they join the TMT.

HYPOTHESIS DEVELOPMENT

How would new executives with experience in different organizations and industries at the rookie

and seasoned levels influence an incumbent's technological adaptation? Like earlier authors, we suggest that adding new executives with similar experiences (and thus similar knowledge, skills, social capital, values, assumptions, understanding, and so forth) to an existing TMT contributes to the persistence of existing institutions (old technology), while augmenting a TMT with new executives with different experiences will facilitate the overturn of existing institutions (Kraatz & Moore 2002). More importantly, different experiences need to be valuable to the existing TMT to initiate organizational change because the value of others' experience could affect the existing TMT's learning from others and because certain managerial experiences might become valueless across the firm or industry boundary (Argote & Ingram 2000; Castanias & Helfat 2001; Song et al. 2003). Thus, when new executives' managerial experience, which is fostered within certain hierarchical, organizational, and industrial domains, is more ***distant*** and ***valuable*** to the existing TMT, bringing them to the TMT should be more likely to initiate an incumbent's technological adaptation.

Typically, new executives can come from the following five sources: rookies from inside the firm, rookies from competitors, rookies from other industries, seasoned executives from competitors, and seasoned executives from other industries. As we previously addressed, experience of rookie executives should not be compared to that of seasoned executives directly in the context of organizational change. Here we will discuss new executive effects within the same hierarchical level.

Rookies from Inside the Firm, from Competitors, or from Other Industries

What rookies would bring to the TMT is their operational experience, which is distant from and valuable to the rich institutional experience of the existing TMT. However, we maintain that the extents of distance and value will further vary with rookies' organizational and industrial origins.

First, rookie experience inside the firm should be neither distant nor valuable to the existing TMT. In general, managerial perceptions of their organization's environment are more similar within organizations than across organizations (Sutcliffe & Huber 1998). In addition, extended experience in the same organization may diminish managers' connections with external environments, subsequently reducing their awareness of critical events and their inclination to seek external information sources

and advice, making it more difficult to refresh their knowledge base (Horta et al. 2010; Pelz & Andrews 1966). Even when rookies from inside the firm hold distant and valuable experience, they might not share it with the existing TMT during technology transition. This is because internal rookies have a high familiarity and social connectivity with the intra-firm network and are highly cognizant of the organization's existing configuration of intellectual (and other) resources. Thus, firms with more internal rookies will be more likely to locate and mobilize existing resources to exploit existing markets (Cao et al. 2006) and less likely to promote organizational change and disruption (Grusky 1963; Helmich & Brown 1972). Furthermore, because internal knowledge is more readily available, making it subject to greater scrutiny, while external knowledge is more scarce, making it appear more special and unique (Menon & Pfeffer 2003), the experience of rookies from inside the firm could actually *hinder* an incumbent's technological adaptation.

Second, rookies from competitors should have experience that is both distant and valuable to the existing TMT. The intra-industry mobility of operational talent can be used to extend the technological boundaries of a hiring firm (Song et al. 2003). In addition, rookies from competitors are more likely to share their distant experience because organizational inertia often pushes innovative employers to leave to join other firms or start new ventures (Klepper 2001). Moreover, existing TMT members might place more value on external experience from competitors than on internal experience because external knowledge is more scarce, they fear being outcompeted in the market place, and they can learn and borrow without facing the status cost of validating or legitimating an insider for organizational rewards (Menon & Pfeffer 2003). Thus, the experience of rookies from competitors could actually facilitate an incumbent's technological adaptation.

Third, while rookies from other industries could also bring distant experience to the existing TMT, that experience is less likely to be valuable to the TMT. The possibility of learning from others' experience, in part, depends on that experience being "relevant" to the issues the existing TMT is trying to solve (Szulanski 1996). Rookie experience in other industries might not be relevant to the challenge of technological adaptation facing the existing TMT, since that experience may be industry-

specific and hard to transfer across industry boundaries (Castanias & Helfat 2001). Thus, rookies with experience in other industries should have little impact on an incumbent's technological adaptation. In all, this logic leads us to the following predictions:

Hypothesis 1: Bringing rookies from inside the firm to the TMT will be negatively associated with an incumbent's adaptation to new technology.

Hypothesis 2: Bringing rookies from competitors to the TMT will be positively associated with an incumbent's adaptation to new technology.

Hypothesis 3: Bringing rookies from other industries to the TMT will not be associated with an incumbent's adaptation to new technology.

Seasoned Executives from Inside or Outside the Industry

Seasoned executives can come from competitors and from other industries, bringing a TMT outside institutional experience (formulating strategies, building inter-organizational relationships, and institutionalizing the organization to a broader community). If we focus on the hierarchical similarity, seasoned executives' experience seems only marginally different from the experience of the existing TMT. However, subtle differences show up when seasoned executives' industrial origins (inside or outside the focal industry) are considered.

For seasoned executives from competitors, we assert that their experience should be neither distant nor valuable to the existing TMT. First, under the high uncertainty that prevails during technological transition, top managers inside the firm may not know exactly what sorts of organizational linkages would work best, or how to implement them (Taylor & Helfat 2009). It is not reasonable to expect that top managers would suddenly realize these unknowns simply by joining the TMT of a competing firm. Second, the ability of executives to identify novel opportunities or conceive of innovative strategic options is likely to diminish with greater intra-industry social contact, making executives less likely to envision and implement alternatives that deviate from the most common tendencies in the industry (Geletkanycz & Hambrick 1997). Third, seasoned executives in an industry often share similar beliefs about their industry environments (Abrahamson & Fombrun 1994; Porac et al. 1989; Sutcliffe & Huber 1998), and with their long industry tenures, they often tend to view problems in a similar fashion and approach decisions in much the same way (DiMaggio & Powell 1983). The existence of an industry mindset might be viewed as a "mobility barrier", possibly

impeding an organization's or an individual's entry into other industries (or markets) (Phillips 1994). Fourth, it is rare to see executives who can greatly transform their mindset, aptitudes, and skills in response to environmental change, and an executive's paradigms grow obsolete more quickly than they are able to learn in a dynamic industry (Henderson et al. 2006; March 1991; Miller & Shamsie 2001). For example, prior research finds that top managers' cognitive maps of competitive positioning post-deregulation reflect obsolete industry boundaries (Reger & Palmer 1996). Thus, the experience of seasoned executives from competitors is likely to be similar to the experience of the existing TMT, subsequently having little impact on the incumbent's technological adaptation.

In contrast, we assert that the experience of seasoned executives from industries outside the focal firm's competitive field should be distant and valuable to the existing TMT. First, seasoned executives from other industries typically have bridging ties outside the industry, which could expose the firm to new ideas and perspectives and allow the firm to overcome any conformist pressures coming from intra-industry ties (Perry-Smith & Shalley 2003), to depend less on industry peers for access to new knowledge, and to verify and triangulate any information received (Stam & Elfring 2008). Second, extra-industry relationships should increase managers' abilities to formulate strategies that deviate from common practice in the industry, because extra-industry contacts do not rely on the same frame of reference shared by members of the industry and because extra-industry interaction provides opportunities to acquire insight into courses of action that extend beyond prevailing industry practices (Geletkanycz & Hambrick 1997). Third, radical change occurs *only if alternatives to the prevailing archetypal template are known* (Greenwood & Hinings 1996; Kraatz & Moore 2002; Oliver 1992), and "*truly innovative start-ups are often the results of creative experimentation with new ideas by outsiders to a population"* (Aldrich 1999: 90). For instance, prior research finds that, due to their past experience in 'different systems', immigrant executives may often import new and very different conceptions of what is natural, reasonable, or inevitable, thus overcoming the limiting assumptions of 'institutional natives' (Kraatz & Moore 2002). Thus, the experience of seasoned executives from other industries is likely to be distant and valuable to the existing TMT, subsequently changing the TMT's dominant

industry perspectives and facilitating the incumbent's technological adaptation. Our logic development predicts that

Hypothesis 4: Bringing seasoned executives from competitors to the TMT is not associated with an incumbent's adaptation to new technology.

Hypothesis 5: Bringing seasoned executives from other industries to the TMT is positively associated with an incumbent's adaptation to new technology.

Conditioning Effect of the Age of New Technology

According to the technology-life-cycle literature, a technological breakthrough initiates an era of intense technical variation and selection culminating in a single dominant design, followed by a period of incremental technical progresses (Anderson & Tushman 1990; Utterback & Abernathy 1975). Basically, as a new technology ages, the industry environment changes in several specific ways. First, new institutions gradually come into existence, progressively lowering knowledge barriers and making it easier for firms to adopt and use the technology (Attewell 1991). Similarly, tacit knowledge of change processes becomes more codified, making it possible to learn by imitating competitors (Kaplan & Tripsas 2008). Second, the environment becomes more stable, making executives' adaptive learning possible since the cause–effect relationships that executives glean today remain relevant tomorrow (Henderson et al. 2006). Third, the early focus of innovative activity on product innovation shifts towards process innovation, which affects the economies and scale of production (Utterback & Abernathy 1975), and the sources of innovative ideas shift from distant places to local places (Gort & Klepper 1982). All these trends suggest that internal (firm-specific) experience at the operational level becomes more important than external experiences as a new technology ages.

Unlike outsiders, internally promoted rookies, through their prior operational experience within the firm, hold firm-specific "transformational knowledge" and "organizational linking", which are critical to the success of radical change encompassing new technologies and processes (Taylor & Helfat 2009; Volberda & Lewin 2003). Also, bringing internal rookies to the TMT could disrupt existing exchange relationships since internal promotion initiates the process of learning new routines and responsibilities, diverting rookies' attention away from current exchange partners (Amburgey, Kelly, & Barnett 1993; Barnett & Carroll 1995; Broschak 2004). Thus, when new

technology ages, the experience of rookies from inside the firm would become more valuable to the existing TMT than the experience of outsiders. Our logic development predicts that

Hypothesis 6: When new technology ages, bringing rookies from inside the firm to the TMT will become more positively associated with an incumbent's adaptation to new technology than bringing rookies or seasoned executives from outside the firm to the TMT.

EMPIRICAL SETTING

Industry Context

We empirically test our hypotheses on firms that entered the U.S. cell-phone service industry with analog technology and trace their transition into the digital technology regime between 1991 and 1998. Firms in this industry provide wireless radio communications services based on regional licenses issued by the Federal Communications Commission (FCC). The industry commenced in 1983 when Ameritech Mobile Communications launched the first "analog" commercial cell-phone service in Chicago, and started a disruptive technological change in 1991 when Pactel Cellular rolled out the first "digital" commercial service in Los Angeles.

Digital technology presumably offered more advantages than analog technology, including increased capacity, better security, longer phone battery life, lower costs, and the opportunity to provide enhanced services such as improved data transmissions, short messaging, caller ID (Calhoun 1988; Gruber 2005). Yet, incumbents did not quickly jump on the bandwagon of digital technology due to multiple challenges in the process of digital transition (see detailed examples in Chen et al. 2012). For example, several digital standards competed for the dominant position in digital era. Moreover, digital transition required incumbents to significantly restructure their existing internal operations. In addition, the digital transition often significantly disrupted incumbents' existing external relationships related to sourcing new technology, complementary products, and distribution channels. Technological uncertainty and ambiguity were high until Personal Communications Service (PCS) operators (using new micro-cell technology) joined the field offering purely digital service networks in 1998. Thus, we believe that the history of digital transition in the U.S. cell-phone service industry in 1991–1998 makes it an ideal setting for testing our hypotheses.

Data Description

We defined incumbents as operators that provided analog wireless radio communications service at the time of their entry to the U.S. cell-phone service industry from 1983 to 1998 (see footnote 1), and traced their digital transition events, a movement from the analog to the digital transmission technology, from 1991 to 1998. In addition, following the tradition of TMT studies, we defined TMT members as the first tier of a focal firm's management, which includes the CEO/president and those directly reporting to him/her.

Information on our list of incumbents and variable measurements were mainly collected from the following sources, including industry directories published by Phillips Publishing annually, the FCC's Universal Licensing System (ULS) and annual competitive report, and industry magazines and publications such as Cellular Business, Cellular Radio: Birth of an Industry (1983), Cellular Marketplace (1984) and The Status of the Cellular Industry (1986-1992). We supplemented the previous sources with corporate news from LexisNexis and company annual reports.

From 1983 to 1998, there were fifty-three incumbents, cell-phone service operators entering the industry with analog technology, and 3 left before 1991, when firms first became subject to the hazard of technological adaptation. Our final sample reduced to 30 incumbent-operators with a total of 102 firm–year observations from 1991 to 1998 because in some cases we were unable to obtain information about incumbents' TMT recruitment choices and firm size.

Variable Definitions

Dependent variable(s)

Adaptation to digital technology. If firm *i* commercially launched digital network services at the end of year *t*, "Adaptation to digital technology" is coded as 1 for year *t*, and 0 otherwise.

Explanatory variables

Rookie executives from inside the firm is the sum of newly added TMT members of firm *i* who were operational (middle) managers of firm *i* before joining the TMT in the beginning of year *t*.

Rookie executives from competitors is the sum of newly added TMT members of firm *i* who were

previously operational (middle) managers of any competing firms in the cell-phone service industry before joining the TMT in the beginning of year *t*.

Rookie executives from other industries is the sum of newly added TMT members of firm *i* who were operational (middle) managers of any existing firm outside the cell-phone service industry before joining the TMT in the beginning of year *t*.

Seasoned executives from competitors is the sum of newly added TMT members of firm *i* who were previously a TMT member of any competing firms in the cell-phone service industry before joining the TMT in the beginning of year *t*.

Seasoned executives from other industries is the sum of newly added TMT members of firm *i* who were previously a TMT member of any firms outside the cell-phone service industry before joining the TMT in the beginning of year *t*.

Age of digital technology is the sum of years elapsed since the first commercial digital cell-phone service commenced in the cell-phone service industry in 1991.

Control variables

In addition to the above variables of interest, we included several firm- and industry-level controls to account for both fixed- and time-varying effects. For example, our firm-level controls include entrant type *startup* to capture the organizational-level renewal capability, *firm tenure in cell-phone service industry* to capture effects of inertia in the cell-phone service industry, *team size* to capture the team-specific influence due to size, *industry-specific executive experience of existing TMT members* to control for the potential obsoleteness in industry-specific managerial capability of existing members, *firm size at year t-1* to capture the potential network benefits from conversion, and *% of TMT members are newly added*—the percentage of new members in a TMT—to capture the potential disruption due to changes in membership. To control the effect of knowledge transfer directly from digitalized competitors through migrated executives, we included the control variable *If any TMT additions from digitalized competitors*. As some might argue that TMT turnover is designed for the anticipated change, we also controlled for *Changes in team size between year t and year t+1*. Internal and external CEO

succession events are also controlled because changes in corporate leadership have a strong influence on organizational change: *If any internal CEO succession* and *If any external CEO succession*. Please note that switch equipments are important purchases for incumbents preparing to join the digital technology regime, and all existing switch equipment suppliers had capabilities in manufacturing digital switches for sale in 1991. To control for incumbents' intention to adapt to digital based on the willingness of its existing switch suppliers to supply complementary products (digital cell-phone handsets), we also included the percentage of an incumbent's switch suppliers who had digital handsets for sale in the focal year, *% of incumbent's switch suppliers provide digital cell-phone handsets*. Further, our industry-level controls include *Firm count*, the total number of firms in the prior year, and *Firm count_sqd*, firm count and firm count square in year *t* to capture the competitive intensity and munificence of the environment. The percentage of industry subscribers using digital services, *% of industry subscribers are in digital*, controls for the potential industry-wide network benefits from digital transition.

Table 1 shows the summary statistics and the correlation matrix. While the high bivariate correlation between *Age of digital technology* and *% of incumbent's switch suppliers provide digital cell-phone handsets*, 0.84, might raise some concern about multicollinearity, the variance inflation factor (VIF) values for the two variables are 5.41 and 3.94, respectively. It is generally accepted that a variable whose VIF value is greater than 10 merits further investigation for multicollinearity (Hair et al. 1995).

*** Table 1 about here ***

Model Specification and Estimation

Both logit and random-effect complementary log-log (random c-loglog) models are used to estimate the hazard rate of an incumbent's adaptation to digital technology, as each model has its comparative advantages. For example, one advantage of the logit function over other link functions is that differences on the logistic scale are interpretable regardless of whether the data are sampled prospectively or retrospectively (Mccullagh & Nelder 1989: Chapter 4). Unlike logit & probit, the distribution of the complementary log-log response function is asymmetrical (Hedeker & Gibbons

2006). Using a complementary log-log response function is very common in the area of survival analysis because it can be shown to provide a proportional hazard model for grouped-time survival data (Allison 1995; Hedeker & Gibbons 2006).

In addition to logit and random-effect complement log-log regression models, we used Clarify to predict the marginal effects of our key explanatory variables on an incumbent's adaptation to digital technology. Clarify is a STATA program that uses Monte Carlo simulation to convert the raw output of statistical procedures into results that are of direct interest to researchers (King et al. 2000; Tomz et al. 2001). Our Clarify results are based on the output from the logit model because Clarify does not simulate for the complement log-log response function.

RESULTS

Logit and Random-effect Complementary Log-log Analysis

Models 1, 2, and 3 in Table 2 present the results from the logit model; Model 4 in Table 2 presents the results from the random-effect complementary log-log model. Model 1 is the baseline model, which excludes the variables for five new executive origins, while Model 2 includes only the simple effects of bringing new executives from five different origins to a TMT. Models 3 and 4 are the fully specific model, which further incorporates the interaction between the age of digital technology and the five new executive origins. In Model 2, all coefficients for the simple effects of bringing new executive from five different origins are insignificant, which may suggest that these effects are cancelled by contrasting forces over time. This suggests the importance of considering time, *Age of digital technology*, and estimation under a fully specified model. Thus, our following discussion will focus on the results from the fully specified models, Model 3 and Model 4.

Basically, the results from logit and random-effect complementary log-log models are very consistent and our empirical results, showing support for all hypotheses. When testing for Hypothesis 1, 2, 3, 4, and 5, we look at the main effects of the five new executive origins in models 3 and 4 in Table 3. The coefficient for testing Hypothesis 1, which predicted a negative relationship between bringing rookies from inside the firm to the TMT and an incumbent's likelihood of adapting

to digital technology, is significantly negative in both Model 3 and Model 4 (β=-5.79,$p<0.05$;β=-5.10,$p<0.05$); the coefficient for testing Hypothesis 2, which predicted a positive relationship between bringing rookies from competitors to the TMT and an incumbent's likelihood of adapting to digital technology, is significantly positive in both models 3 and 4 (β=8.66,$p<0.1$;β=7.64,$p<0.10$); the coefficient for testing Hypothesis 3, which predicted that bringing rookies from other industries to the TMT will not be associated with an incumbent's likelihood of adapting to digital technology, is negative but highly insignificant in both Model 3 and Model 4; the coefficient for testing Hypothesis 4, which predicted that bringing seasoned executives from competitors to the TMT will not be associated with an incumbent's likelihood of adapting to digital technology, is negative but highly insignificant in models 3 and 4; the coefficient for testing Hypothesis 5, which predicted that bringing seasoned executives from outside the industry to the TMT will be positively associated with an incumbent's likelihood of adapting to digital technology, is significantly positive in both Model 3 and Model 4 (β=2.88,$p<0.05$;β=2.66,$p<0.05$).

When testing for the moderating effect proposed in Hypothesis 6, which predicted that as new technology ages, bringing rookies from inside the firm to the TMT becomes more important for facilitating incumbents' digital adaptation than bringing rookies or seasoned executives from outside the firm, we look at the coefficients of interaction terms between the age of digital technology and bringing new executive from five different origins. The coefficient for the interaction between the age of digital technology and bringing rookies from inside the firm to the TMT is significantly positive in Model 3 and 4 (β=1.57, $p<0.01$; β=1.31, $p<0.01$). The coefficient for the interaction between the age of digital technology and bringing rookies from competitors to the TMT is significantly negative in Model 3 and 4 (β=-2.66,$p<0.05$;β=-2.28,$p<0.05$). The coefficient for the interaction between the age of digital technology and bringing seasoned executive from other industries to the TMT is significantly negative in models 3 and 4 (β=-0.47,$p<0.10$;β=-0.47,$p<0.10$). These results suggest that as digital technology ages, rookies from inside the firm facilitate incumbents' digital adaptation more than rookies or seasoned executives from outside the firm.

To show the substantive or economic significance of incorporating the interaction between the age of digital technology and bringing new executives from five different origins, we conducted a Likelihood-Ratio (LR) test between Model 2, the simple-effect mode, and Model 3, a fully specified model. The LR test result ($chi^2(5)=18.05$) indicates that Model 3 is economically different from Model 2.

*** Table 2 about here ***

Clarify Analysis

Figures 1, 2, and 3 present our results from the Clarify simulation. Figure 1 shows the marginal effects of bringing one rookie to the TMT from inside the firm, from competitors, and from other industries on an incumbent's likelihood of adapting to digital technology. When bringing one rookie from inside the firm to the TMT, we can expect a 45% decrease in the odds of an incumbent's digital adaptation. When bringing one rookie from competitors to the TMT, we can expect a 129% increase in the odds of an incumbent's digital adaptation. When bringing one rookie executive from other industries to the TMT, we can expect a 7.7% decrease in the odds of an incumbent's digital adaptation. The simulation results show support for hypotheses 1, 2, and 3.

Figure 2 shows the marginal effects of bringing one seasoned executive from competitors and from other industries to the TMT on an incumbent's likelihood of adapting to digital technology. When bringing one seasoned executive from competitors to the TMT, we can expect an 11% decrease in the odds of an incumbent's digital adaptation. When bringing one seasoned executive from other industries to the TMT, we can expect a 46% increase in the odds of an incumbent's digital adaptation. The simulation results show support for hypotheses 4 and 5.

Figure 3 shows how the marginal effects of bringing one rookie from inside the firm, one rookie from competitors, and one seasoned executive from other industries to the TMT change as digital technology ages. The graphs show that the marginal effect of bringing one rookie from inside the firm to the TMT is initially negative but rises with the age of digital technology. In contrast, the marginal effects of bringing one rookie from competitors and one seasoned executive from other

industries to the TMT are initially highly positive but decline with the age of digital technology. The graph shows strong support for the moderating effect of the age of digital technology on new executive origins.

*** Figures 1, 2, and 3 about here ***

Robustness Check

In addition to our control variables, we ran additional tests to rule out some alternative explanations. First, some might suggest that the results are simply driven by migrating people from digitalized competitors, and our robustness check showed that this effect is not equal: only rookies, not seasoned executives, from digitalized competitors are associated with an incumbent's likelihood of adapting to digital technology. Second, our Granger casualty test showed that only bringing rookies from digitalized competitors to the TMT is significantly associated with anticipated digital adaptation, ruling out the alternative explanation that an incumbent's anticipated digital adaptation caused the addition of executives to the TMT. Third, some might suggest that our results are simply driven by the event or magnitude of TMT recruitment, our robustness check showed that a dummy for the event of TMT recruitment does not have a significant impact on an incumbent's digital adaptation, and that total number of new TMT members added in a year does not have a significant effect on an incumbent's likelihood of digital adaptation. Last, our robustness check showed that the independent effects of three contexts of new executive origins on incumbents' digital adaptation are insignificant, suggesting that our results are not driven by the simple difference in new executives' origins in hierarchy, firm, or industry. All results for robustness check are available upon request.

CONCLUSIONS AND DISCUSSIONS

This paper examines the extent to which an incumbent's technological adaptation is facilitated by bringing new members to its TMT, and whether the timing of those executive additions moderates the previous relationship. We proposed that new TMT members from different hierarchical origins (rookie or seasoned), organization origins (inside or outside the focal firm), and industry origins (inside or outside the industry) bring different levels and types of knowledge, skills, social capital, and

cognitive processes to the TMT, and that these need to be distant and valuable to the existing TMT members to facilitate an incumbent's technological adaptation. Moreover, the influence of new executives' origins further depends on the timing of new executives' entry to the TMT in terms of the age of a new technology. Our empirical results suggest that bringing rookies to an incumbent's TMT from inside the firm hampers technological adaptation. At the same time, an incumbent's technological adaptation is enhanced when its TMT adds rookies from other firms or seasoned executives from other industries. However, when considering technology age, we show that bringing rookies from inside the firm to the TMT has an increasingly positive influence on an incumbent's technological adaptation as a new technology ages; in fact, once a technology becomes about 4 years old, the positive effect of internally promoted rookies is greater than the impacts of either rookies from other firms or any type of seasoned executives.

This paper makes several important contributions. First, for organizational adaptation or change research, our paper shows that the influence of outsiders on a firm's organizational adaptation depends in part on their hierarchical and industrial origins, and that bringing rookies (as well as seasoned executives) to a TMT can be an important catalyst for organizational adaptation. In addition, we show that the influence of new TMT recruits should depend on characteristics of the industry environment at the time they enter the TMT, and that the importance of bringing internal operational knowledge to the TMT increases as a new technology ages. Second, for research on incumbent technological adaptation, our paper provides a new perspective by focusing on the value of people in facilitating incumbents' technological adaptation rather than on the value of technology and organizational routines. Incumbents' responses to technological change are often explained by focusing on attributes of the focal technology (Folta & O'Brien 2004; Lane 1991) and on existing organizational knowledge and capabilities of incumbents (Helfat & Lieberman 2002; Mitchell 1989). However, these explanations overlook that decision makers may be subject to bounded rationality, cognitive constraints, and competence traps under high uncertainty and ambiguity during technological change (Eggers & Kaplan 2009; Taylor & Helfat 2009). Our focus on TMT recruits

and their origins addresses this gap in the literature. Third, for technology-life-cycle research, our paper, by showing that the value of internal knowledge to technological change increases with technology age, provides indirect empirical support for the assertion that, as technology ages, the focus of innovation shifts from product to process innovations and that the source of innovative idea shifts from distant places to local places to the firm. Last, to practitioners, our results provide insights about where and when to bring in new talent to the TMT to encourage organizational adaptation, especially in the context of technological change.

We need also to be mindful of our paper's limitations, which in some cases provide interesting opportunities for future research. For instance, our study does not capture differences in the functional origins of new executives because the data for rookies' functional origin is only rarely available. Second, our paper does not consider the distribution of power among new and existing TMT members, although managerial power is a central element in strategic choice (Finkelstein 1992). Third, we do not consider how heterogeneity of organizational structure affects rookies' impact on organizational adaptation. It is likely that organizations with flatter structures have a shorter distance between the top and the bottom, such that existing TMT members might be less likely to lose touch with their own organizations and the market. Future research could investigate how functional origins, power distance, and organizational structure might impact organizational adaptation.

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Table 1
Summary Statistics and Correlation Matrix

Variables	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
(1)Adaptation to digital technology	0.24	0.43	1.00																			
(2)Rookie executives from the focal firm	0.47	0.84	0.10	1.00																		
(3)Rookie executives from competitors	0.08	0.27	0.10	0.27	1.00																	
(4)Rookie executives from other industries	0.55	1.06	-0.03	0.16	0.02	1.00																
(5)Seasoned executive from competitors	0.23	0.56	0.02	0.00	0.01	0.06	1.00															
(6)Seasoned executives from other industries	0.36	0.79	0.18	0.08	0.10	0.09	0.08	1.00														
(7)Age of digital technology	3.26	1.85	0.22	0.08	0.04	-0.07	-0.21	0.04	1.00													
(8)Startup	0.24	0.43	-0.04	0.21	0.10	-0.16	-0.10	-0.17	-0.04	1.00												
(9)Firm tenure in cell-phone service industry	8.39	2.46	0.11	0.06	0.00	0.06	-0.22	0.22	0.58	-0.13	1.00											
(10)TMT size	9.28	5.51	0.10	0.34	0.10	0.40	0.06	0.27	0.09	0.13	0.29	1.00										
(11)Industry-specific executive experience of existing TMT members	5.79	1.72	-0.03	-0.02	-0.02	-0.01	-0.10	-0.12	0.28	0.11	0.38	0.04	1.00									
(12)Firm size at year *t*-1	0.31	0.41	0.24	0.16	0.00	0.09	0.04	0.09	0.07	0.05	0.40	0.34	0.07	1.00								
(13)% of TMT members are newly added	0.17	0.16	0.09	0.50	0.27	0.47	0.41	0.41	-0.05	-0.18	0.01	0.09	-0.15	0.04	1.00							
(14)If any TMT additions from digitalized competitors	0.06	0.24	0.25	0.01	0.55	-0.05	0.35	0.25	0.10	-0.04	-0.01	-0.04	-0.13	-0.07	0.31	1.00						
(15)Changes in TMT size between *t* and *t*+1	0.37	2.25	-0.15	0.11	0.15	-0.07	0.07	-0.12	-0.03	0.13	-0.01	0.19	-0.13	0.14	0.00	-0.06	1.00					
(16)If any internal CEO succession	0.06	0.24	0.06	-0.09	-0.07	0.11	-0.03	0.04	-0.01	-0.14	0.05	-0.04	0.02	0.13	0.04	-0.06	-0.02	1.00				
(17)If any external CEO succession	0.08	0.27	-0.08	-0.16	-0.09	-0.01	0.40	0.05	-0.12	-0.08	-0.14	-0.12	-0.21	-0.10	0.22	0.08	0.20	-0.07	1.00			
(18)% of incumbent's switch suppliers provide digital cell-phone handsets	0.27	0.41	0.13	0.10	0.06	-0.13	-0.11	0.04	0.84	-0.04	0.41	0.04	0.23	0.05	-0.01	0.07	-0.09	-0.06	-0.06	1.00		
(19)Firm count	43.90	1.76	0.16	-0.08	-0.09	-0.12	0.08	0.17	0.31	-0.07	0.29	0.05	0.03	0.04	-0.06	0.20	-0.21	0.04	0.04	0.21	1.00	
(20)% of industry subscribers are in digital	0.00	0.02	0.10	-0.07	-0.04	-0.07	0.06	0.11	0.41	-0.08	0.30	-0.03	0.14	-0.02	-0.02	0.26	-0.24	-0.04	-0.04	0.30	0.76	1.00

Table 2

The effects of bringing new executives to a TMT on an incumbent's likelihood of digital adaptation

***DV*: Adaptation to digital technology** =1 if firm *i* offers commercial digital cell-phone service at *t* yet	**(1)** Logit	**(2)** Logit	**(3)** Logit	**(4)** Random cloglog
Age of digital technology	0.93*	0.91*	1.50*	1.41*
	(0.42)	(0.44)	(0.64)	(0.56)
Rookie executives from the focal firm		0.22	-5.79*	-5.10*
		(0.60)	(2.35)	(2.08)
Rookie executives from competitors		-0.65	8.66+	7.64+
		(1.73)	(4.83)	(4.11)
Rookie executives from other industries		-0.56	-0.68	-0.61
		(0.53)	(1.32)	(1.12)
Seasoned executives from competitors		-0.39	-2.27	-2.24
		(0.83)	(1.80)	(1.55)
Seasoned executives from other industries		0.38	2.88*	2.66*
		(0.44)	(1.21)	(1.06)
Age of digital technology X				
Rookie executives from the focal firm			1.57**	1.31**
			(0.58)	(0.50)
Rookie executives from competitors			-2.66*	-2.28*
			(1.18)	(0.96)
Rookie executives from other industries to			-0.09	-0.11
			(0.42)	(0.37)
Seasoned executives from competitors to			0.70	0.64
			(0.61)	(0.52)
Seasoned executives from other industries			-0.47+	-0.47+
			(0.25)	(0.24)
Startup	-0.24	-0.43	0.25	0.50
	(0.73)	(0.78)	(0.99)	(0.84)
Firm tenure in cell-phone service industry	-0.32+	-0.41*	-0.64*	-0.59**
	(0.18)	(0.20)	(0.26)	(0.22)
Team size	0.01	0.03	0.02	0.04
	(0.05)	(0.08)	(0.11)	(0.09)
Industry-specific executive experience of existing TMT members	-0.05	-0.00	0.01	-0.01
	(0.19)	(0.20)	(0.25)	(0.21)
Firm size at year *t*-1	2.08**	2.29**	3.38**	2.71**
	(0.73)	(0.79)	(1.08)	(0.80)
% of TMT members are newly added	1.19	1.81	6.40	6.83
	(2.01)	(4.10)	(5.92)	(5.14)
If any TMT additions from digitalized competitors	2.23*	2.74	2.75	2.06
	(1.09)	(2.04)	(2.69)	(2.32)
Changes in TMT size between *t* and *t*+1	-0.26+	-0.29+	-0.24	-0.23
	(0.13)	(0.16)	(0.19)	(0.16)
If any internal CEO succession	0.31	0.68	0.90	1.00
	(1.08)	(1.10)	(1.41)	(1.18)
If any external CEO succession	-0.88	-0.50	-1.29	-0.96
	(1.44)	(1.78)	(1.89)	(1.66)
% of incumbent's switch suppliers providing digital cell-phone handsets	-2.49+	-2.94+	-6.17*	-5.23*
	(1.42)	(1.56)	(2.45)	(2.08)
Firm count	-15.10	-26.86	-36.74	-30.40
	(22.33)	(25.30)	(32.09)	(27.24)
Firm count_sqd	0.18	0.31	0.43	0.35
	(0.26)	(0.29)	(0.37)	(0.31)
% of industry subscribers are in digital at *t*-1	-132.45	-209.12	-303.92	-255.10
	(152.76)	(171.10)	(230.32)	(201.32)
_cons	323.14	581.64	787.71	651.64
	(488.34)	(553.87)	(700.17)	(594.37)
N of observations	102	102	102	102
Log likelihood	-42.28	-40.5	-31.47	-30.05
LR or Wald chi2(N of independent variables)	26.74	30.30	48.35	21.91
Prob > chi2	0.031	0.065	0.003	0.64
Likelihood-ratio test		LR chi2(5) = 18.05		
Assumption: Model (2) nested in Model(3)		Prob.>chi2=0.0029		

Standard errors in parentheses: + p<.1, * p<.05, ** p<.01

Please note that a time lag between the transition to digital and new executive sourcing choices is built into year *t*.

Figure 1

Marginal effect of adding 1 rookie executive to a TMT on an incumbent's likelihood of digital adaptation

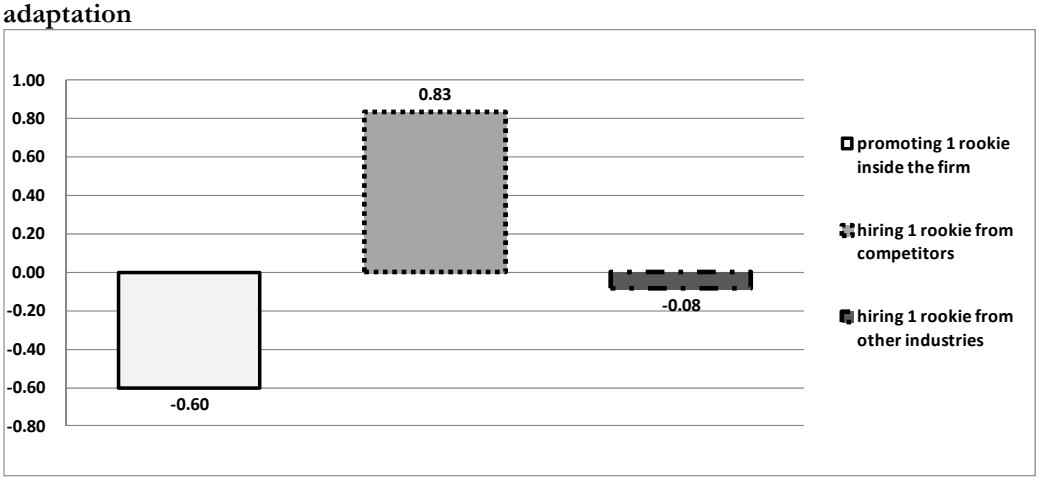

Figure 2

Marginal effect of adding 1 seasoned executive to a TMT on an incumbent's likelihood of digital adaptation

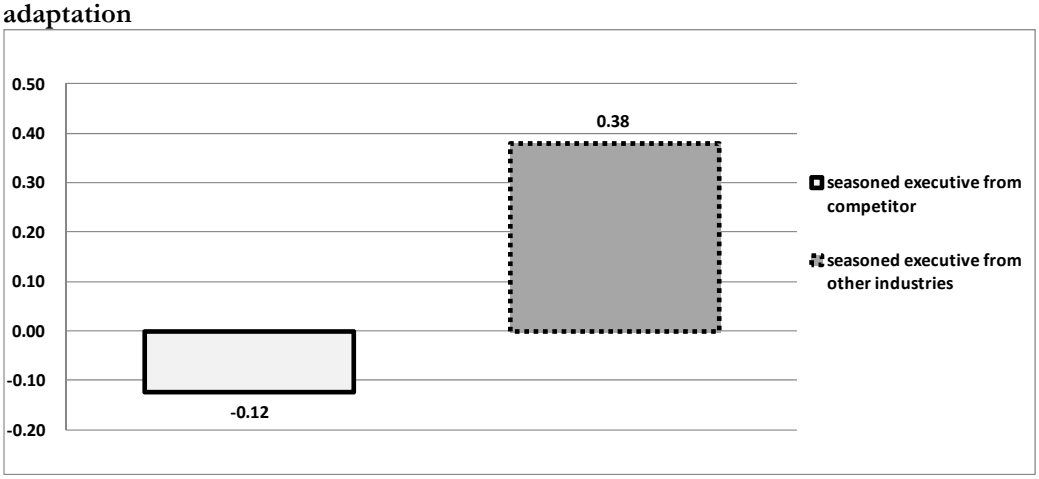

Figure 3

Conditioning effect of the age of digital technology on the relationship between new executives' origins and an incumbent's likelihood of digital adaptation