

Social Capital for Hire? Mobility of Technical Professionals and Firm Influence in Wireless Standards Committees

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The movement of personnel between firms has been shown to have important implications for firms, yet there has been little direct investigation of the underlying mechanisms. We propose that in addition to their human capital, mobile individuals carry social capital, affecting the outcomes of the firms they join and leave by altering the patterns of interaction between firms. In this study, we examine how job mobility affects firm influence in a technical standards setting committee for U.S. wireless telecommunications. We hypothesize and find that hiring individuals who are richer in social capital increases firm influence in technical standards setting committees by increasing the hiring firm's social capital. We also find the benefits of hiring social capital are attenuated when an interfirm relationship is maintained by multiple individuals. In contrast, we find that the loss of personnel does not affect a firm's social capital or influence over standards directly but that it does have an effect on firm social capital and influence contingent on changes in the firm's business strategy. In advancing these arguments, we address the broader question of individuals as carriers of social capital and the conditions under which interpersonal connections are appropriate by firms.

Key words: interorganizational networks; social capital; job mobility; technical standards

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Introduction

Despite increasing evidence that personnel flows have important consequences for firm performance and competitive advantage, the mechanisms by which these outcomes occur are not well understood. Studies of personnel flows generally consider hiring to be a source of new resources available to a firm (Almeida et al. 2003, Madsen et al. 2002, Rao and Drazin 2002, Song et al. 2003), but experience and performance do not consistently transfer to new contexts (Dokko et al. 2009, Groysberg et al. 2008, Huckman and Pisano 2006). Similarly, though firms can draw on their employees' knowledge and relationships, the extent to which the resources of individuals remain with organizations after employment ends is open to investigation (Somaya et al. 2008).

Recently, researchers have turned to distinguishing social capital from human capital for understanding the ways in which firm performance outcomes are affected by the movement of individuals. Social capital represents resources embedded in relationships (Adler and Kwon 2002, Leana and Pil 2006) and changes in employment affiliations can change the relationship-based resources available to firms in complex ways. For instance, rather than decreasing knowledge, personnel

outflows can increase a firm's interfirm learning, as exiting employees retain social ties with former coworkers and open new conduits for knowledge flow (Agrawal et al. 2006, Corredoira and Rosenkopf 2009). Professional service providers can bring client relationships with them when they join or exit firms (Broschak 2004, Wezel et al. 2006), but firm performance suffers only when professionals move to competitors; losing personnel to clients can actually result in increased business (Somaya et al. 2008). Furthermore, inflows and outflows result from different processes and can have different effects. Inflows are the result of intentional hiring, whereas outflows may be intentional or surprising to a firm; these processes can affect the value of individuals' social capital that is hired or lost. Therefore, focusing on social capital has enabled researchers to find areas where personnel flows do not have straightforward effects for firms. These studies of job mobility find that embedded relationships and social capital play a role in firm performance outcomes after job moves; however, they do not distinguish between social capital held by individuals and social capital held by firms and do not address the process by which individuals' social capital affects the performance of firms.

Our study complements previous studies in this stream by focusing on the mediating role of firm social capital. Our primary argument is that the social capital of individuals who join and exit firms affects firm performance because it changes the social capital of firms. In an interfirm network, relationships are conducted by boundary-spanning individuals who represent firms (Pennings and Lee 1999), yet the role of individuals in embedding interfirm action has had little empirical investigation (Rosenkopf et al. 2001). If boundary-spanners never changed jobs, an interfirm network would be perfectly represented by the network of individuals. However, they do change jobs and employers, and the social capital of these individuals may be portable across firm boundaries. That is, when these boundary-spanners change employers, the social capital they acquired through dealing with boundary-spanners in other firms may still be useful to themselves and their new employers: Hiring firms may be able to use individuals' connections to create and maintain a firm-level relationship and increase their own social capital. Conversely, if the loss of the boundary-spanner results in loss of interfirm relationships, the tie between firms might be lost (Broschak 2004, Palmer 1983). In this way, job mobility can change the structure of an interfirm network and the social capital of firms. Though studies of interfirm networks recognize that informal relationships underlie more formal interfirm arrangements (Powell et al. 1996, Rosenkopf et al. 2001), how these networks interact is not well understood; in particular, little is known about how the movement of individuals affects the network structure of firms (Brass et al. 2004) and whether social capital in organizations is the property of firms, individuals, or both (Adler and Kwon 2002, Somaya et al. 2008).

In the current study, we address these gaps by exploring social capital as a mechanism through which personnel flows affect firm performance in an interfirm network for technical standards setting. Specifically, we investigate how inflows and outflows of engineers' social capital affect their employers' social capital and subsequent influence over technical standards setting in a technical standards development organization (SDO) for U.S. wireless telecommunications. Technical SDOs comprise member firms whose recurring interactions at regular meetings creates an interfirm network. The engineers who represent member firms at standards setting meetings can create social capital for their employers through their boundary-spanning interactions, but they are separable from the firms they represent. They can, and do, change employers within the interfirm network, and we use these changes to examine how the movement of individuals affects the social capital of firms and firms' ability to influence technical standards. By explicitly considering the mediating role of firm social capital, we concretely show a social capital link between individual mobility and firm influence in standards setting.

We argue that new hires' social capital can be appropriated by firms to increase firm social capital, even if the employee's social capital was acquired while representing another firm. We also argue that losses to a firm's social capital resulting from exiting personnel are conditional on the strategic value of connections held by exiting individuals.

Research Setting: The Technical Standards Development Organization

Social capital is defined as the resources embedded in relationships, but the ultimate value of these relationships and the outcomes they engender need to be understood in a particular context (Adler and Kwon 2002, Leana and Pil 2006). The context of the current study is an SDO. SDOs are committee-based organizations that meet regularly to share technical information, select standards and set a migration path for a technology.¹ Most technical standards in the United States are set by SDOs (Shapiro and Varian 1999). Technical standards are important to industry growth because they ensure compatibility of equipment from various manufacturers (e.g., wireless telephone handsets) and interoperability between the components of a complex technology (e.g., handsets with wireless service). Standards enable market acceptance and market growth for complex technologies that are subject to network externalities (Shapiro and Varian 1999). SDOs that are accredited by the American National Standards Institute (ANSI) have voluntary and open membership for any firm with direct and material interest in the technology, and they adopt standards based on the consensus of their members.²

Despite the importance of consensus standards to market growth, achieving consensus in SDOs is not straightforward. For complex technologies, there are often no technical options that are objectively superior on all dimensions of quality and performance (Garud and Ahlstrom 1997). Therefore, the process of developing and adopting standards depends on social as well as technical factors (Tushman and Rosenkopf 1992). Influence in standards setting committees is important to firms for two reasons. First, the adoption of a standard containing proprietary intellectual property rights (IPR) can have an important direct effect on firm financial performance. Other firms could be required to license the intellectual property to comply with the industry's adopted standard and pay royalties to the IPR holder. For example, wireless handset manufacturers have paid Qualcomm billions of dollars in royalties since its code division multiple access (CDMA) patents were used in a wireless telecommunications standard in 1993.³ Second, standards choices can affect competitive advantage in product development and delivery. Standards that favor one firm's technological capabilities over those of its competitors can yield competitive advantage for that

firm because the firm can use existing capabilities rather than have to acquire new ones. Furthermore, a standard is often part of an interdependent system of standards, making standards decisions difficult to change in the short run and giving long-term competitive advantage to firms whose technological capabilities are congruent with the adopted standard. Therefore, influence over which standards are developed and adopted is an important aspect of performance for firms in high-technology industries.

The context of committee-based technical standards setting is an excellent one for understanding how the social capital of job changers relates to firm influence. In SDO meetings, firms are typically represented by engineers who both guard the interests of their employers and collaborate to develop standards that will result in products that are attractive to the marketplace. The work conducted in SDOs is specialized and highly technical, so firms tend to have stable, dedicated representation over time. The recurrent, face-to-face interaction inherent in this venue provides a setting for the formation of embedded relationships at both the individual and firm levels of analysis. The individual engineers who represent firms act on behalf of their employers, but their social exchanges may also be attributed to them personally (Isaak 2006). Moreover, representatives join and leave employers in this setting, sometimes for other firms in the SDO, and the social capital they accrued in the past might still have value, even if exercised on behalf of a new employer. Therefore, an SDO context is one where the individual relationships that underlie interfirm relationships can be observed and where hiring or losing individuals may have a visible effect on the social capital and influence of firms.

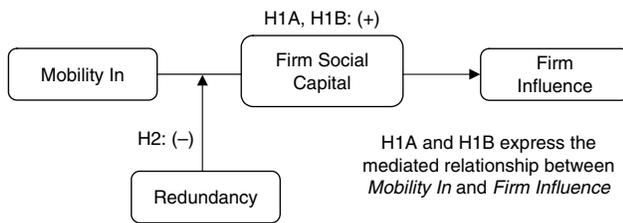
Personnel Inflows, Firm Social Capital, and Firm Influence in Standards Setting

Hiring can change the resources available to organizations. Hiring technical personnel or managers can lead to innovation (Ettlie 1980, Song et al. 2003) or can substitute for other ways of acquiring external knowledge (Almeida et al. 2003, Rao and Drazin 2002). Hiring leadership from outside firms can lead to strategic change as newly hired managers bring experience with different markets or strategies (e.g., Boeker 1997, Kraatz and Moore 2002). Most studies of personnel inflows theorize that knowledge or expertise brought by a new hire is the primary mechanism for hiring's effect on firm outcomes. However, in addition to their human capital, new hires may also bring social capital that is useful to the hiring firm (Huckman and Pisano 2006). Anecdotes abound about consultants or sales representatives being hired for their client lists, suggesting that firms might even actively seek out new hires for their preexisting relationships.

A new hire's interfirm relationships, to other firms or back to his or her old employer, can increase the hiring firm's influence in a standards setting committee in several ways. First, the new hire's existing ties may increase the employer's influence through interfirm learning or knowledge transfer. Access to the knowledge of others is an important social capital resource, and individual-level relationships can be used to acquire knowledge that is useful to an employing firm. Moreover, the informal exchange of strategic knowledge is conditioned on personal acquaintance and mutual trust at the individual level (Bouty 2000, Levin and Cross 2002, Liebeskind et al. 1996), so a new hire may be able to use existing close relationships to effectively acquire strategic knowledge or act as a conduit for interfirm learning. Aside from any benefits to a new employer's innovative output or learning, the knowledge acquired might allow the employer to gain influence in technical standards setting by having a better understanding of the technology positions and capabilities of other firms in the network. Understanding other firms' capabilities can facilitate influence by providing more accurate assessments of firms' likelihoods of supporting particular standards or of where technological capabilities might be complementary or in conflict (Rosenkopf et al. 2001). Additionally, the new hire might have access to information about competitors' technologies that allows the new employer to better position its preferred standard against alternatives and make its influence efforts more effective.

A new hire's interfirm relationships can also facilitate political action, such as coalition-building or negotiation. In SDOs, political action is often conducted in offline conversations where informal deals are struck to trade support for standards (Isaak 2006, Shapiro and Varian 1999). Well-connected individuals may be particularly able to conduct political action because they have a more accurate conception of who interacts with whom and where coalitions might form (Krackhardt 1990). In addition, the trust built between individuals in established relationships facilitates negotiations in boundary-spanning deals (Friedman and Podolny 1992, Zaheer et al. 1998) because it provides assurance that informal deals will be honored. However, interpersonal trust and interorganizational trust are distinct constructs (Zaheer et al. 1998), and representatives may go to some lengths to distinguish their own trustworthiness from their employer's. For example, one representative reported commonly hearing during offline negotiations, "[T]his is not what I believe; it's just what the company that pays my salary tells me to do."⁴ Therefore, individual representatives' established relationships are separable from those of their employing firms and may be continue to be useful even to a new employer.

To summarize, in addition to knowledge or skill, individuals can carry preexisting relationships to a new

Figure 1 Overview of Model for Personnel Inflows

employer that can facilitate the transfer of knowledge or informal political action that increases the employer's influence in a technical standards setting committee. Though human capital carried by incoming personnel may also increase the influence of firms, we focus here on the contribution of the new hire's social capital, over and above any effects for human capital. An employee's social capital benefits a firm by enabling it to initiate or maintain a desirable interfirm tie. Existing interpersonal relationships that span organizational boundaries provide the opportunity for an interfirm tie to form because the new hire may be able to use his or her connections to better detect and evaluate areas of possible collaboration or coalition (Adler and Kwon 2002, Ahuja 2000, Rosenkopf et al. 2001). A new hire can also provide an introduction or endorsement for the new employer based on his or her personal relationships.

Thus, changes to employment relationships can create changes in an interfirm network by creating new linkages that change the network position of firms and the resources available from relationships; i.e., hiring can increase the social capital of a firm and in turn increase the firm's influence over standards. If a firm does not appropriate its new hire's relationships to form or strengthen interfirm relationships, it will not gain influence through hiring. Therefore, a positive effect of hiring on firm influence is transmitted through the mechanism of increasing the firm's social capital (see Figure 1).

HYPOTHESIS 1A (H1A). *Personnel inflows have a positive effect on firm influence in technical standards setting committees.*

HYPOTHESIS 1B (H1B). *The effect of personnel inflows on firm influence in technical standards setting committees is mediated by firm social capital.*

According to the above hypothesis, individual-level social capital can be carried across firm boundaries to supplement a hiring firm's social capital and ensuing influence. However, the effect of hiring individual-level social capital on a firm's social capital may be contingent on the strategic value of the new hire's connections. An incoming individual's social capital has strategic value to the extent that it offers access to resources that are incrementally useful to a firm.

One factor that affects the value of a new hire's social ties is exclusivity of connections. Some structural perspectives hold that exclusive relationships generate social capital for an individual because they provide the opportunity to gain faster access to information or to control the flow of information (Burt 1992, Cook and Emerson 1978). In fact, social capital's value can be regarded as contingent on the number of structurally similar others because people who are structural equivalents can act as substitutes (Burt 1997). If new hires have social ties that are redundant with ties held by existing employees, i.e., they occupy similar positions in the network, then they may be less able to parlay their social connections into returns. However, not only is the value of redundant ties lower for individuals, but it is also worth less to the firm that employs them. If a firm has multiple boundary-spanners for the same interfirm tie, each of these individual's relationships are likely to overlap in usefulness. From a firm's perspective, individual representatives who have relationships with a given partner firm may be able to substitute for each other in managing the overall firm relationship. As the social capital of individuals aggregates across a firm, the net incremental value for a redundant tie should be lower than that for an exclusive tie to a given firm. For this reason, hiring individuals for their social capital should be incrementally more valuable to a firm to the extent that the new hires bring new relationships; i.e., redundancy in a new hire's interfirm relationships should moderate the effect of hiring on the firm's social capital (see Figure 1).

HYPOTHESIS 2 (H2). *The mediated relationship between personnel inflows and firm influence in technical standards setting committees is contingent on the exclusivity value of the connections held by the incoming representatives, such that the effect of hiring personnel on firm social capital will be weaker when there are redundant ties between firms.*

Personnel Outflows, Firm Social Capital, and Firm Influence in Standards Setting

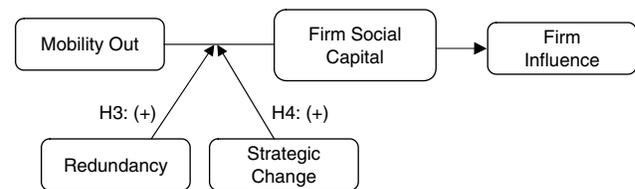
Losing employees can affect firm influence via the same firm social capital mechanism as hiring people, i.e., when exiting employees change the relationships between firms. Parallel to hiring, the exiting of employees can affect flows of knowledge and the ability to carry out political action by changing a firm's social capital. However, it is unclear *how* the loss of personnel affects the relationships between firms. On one hand, there is empirical evidence that losing personnel leads to the loss of interfirm relationships. Losing key personnel in advertising agencies, as Broschak (2004) demonstrates, can lead to the dissolution of agency-client ties. Similarly, Silicon Valley law firms (Phillips 2002) and Dutch accounting firms (Wezel et al. 2006) were found to be

more likely to fail when they lost personnel to competitors or when exiting personnel founded competitive startups. In all of these studies, the exiting personnel were boundary-spanning professionals who carried firm-level client relationships with them when they moved. As discussed earlier, to the extent that meaningful connections between firms are built on individual-level relationships, then trust and the history of exchanged favors built by an individual might be attributed to the individual in addition to, or instead of, the employer. These findings indicate that clients may prefer to preserve their relationships with an individual professional after a job move rather than with an employing firm.

The studies cited above are situated in professional service firms and involve job moves to competitors, where exiting professionals can carry client relationships because their unique expertise is the important resource that client firms want to access through the interfirm relationship. Therefore, market exchange relationships can break when boundary-spanning employees with client-specific resources exit to competitors. For different kinds of interfirm moves and different relationships, the effect of losing employees is not always loss. Mobile boundary-spanners can strengthen relationships between their ex-employers and new employers if the firms have complementary, instead of competitive, relationships (Corredoira and Rosenkopf 2009, Somaya et al. 2008). Moreover, the loss of an individual boundary spanner might be less detrimental for bureaucratic firms or interfirm relationships more generally. First, even if the relationship was initiated at the individual level, an institutional structure could have been built to support the relationship on both sides (Gulati and Singh 1998), reducing reliance on individual boundary-spanners or making changes to interfirm relationships costly or cumbersome. Second, the influence of individuals in an interfirm relationship can be related to having access to resources of an organization rather than the individual's personal resources. From this perspective, individuals should be replaceable without affecting a firm's relationships, and losing personnel should have little effect on interfirm relationships.

Therefore, prior literature suggests that the effect of losing personnel on interfirm relationships is contingent. Analogous to the effect of personnel inflows, the effect of personnel outflows should depend on the value of the relationships held by the outgoing person. First, parallel to the argument for hiring personnel, redundancy in ties can attenuate an effect for losing personnel. If an interfirm relationship is managed by multiple individuals, remaining employees can substitute for the exiting individual and maintain the tie. By contrast, if a single employee has exclusive responsibility for the relationship, losing that employee might make the interfirm tie more likely to dissolve (see Figure 2).

Figure 2 Overview of Model for Personnel Outflows



Additionally, the value of an exiting individual's relationships can depend on changes to the employer's business strategy; i.e., the loss of personnel might not be harmful if a firm is undergoing a change in business strategy. Unlike hiring, losing personnel can be unexpected and unwelcome. However, under conditions of strategic change, firms may wish to dissolve interfirm ties that do not advance their new strategy because ties are costly to maintain (Burt 1992, Gulati and Singh 1998). Observing an effect for personnel outflows might be conditional on the relationships that the firm wants to maintain with other firms. If a firm's strategy is stable, the unexpected loss of a boundary-spanner might unintentionally disrupt an interfirm relationship (Palmer 1983), and the firm may suffer at least a temporary loss in social capital. Conversely, if a firm changes its strategy, individuals who maintained interfirm relationships that are less useful under the new strategy might exit the firm, voluntarily or not, without negatively affecting the firm's social capital (see Figure 2).

HYPOTHESIS 3 (H3). *The mediated relationship between personnel outflows and firm influence in technical standards setting committees is contingent on the exclusivity value of the connections held by the outgoing representatives, such that the effect of losing personnel on firm social capital will be weaker when there are redundant ties between firms.*

HYPOTHESIS 4 (H4). *The mediated relationship between personnel outflows and firm influence in technical standards setting committees is contingent on the strategic value of the connections held by the outgoing representatives, such that the effect of losing personnel on firm social capital will be weaker when the firm is experiencing strategic change.*

Data and Methods

Research Setting

We test our hypotheses in a standards development organization for the U.S. cellular wireless telephone industry. The cellular telephone industry has typical characteristics of network industries, where standardization of technology is critical for cross-compatibility of products and services (Shapiro and Varian 1999). The U.S. cellular industry also has a well-established

standards development organization, the Telecommunications Industry Association (TIA), which publishes technical standards that are authored, negotiated, and agreed on by member firms.

The TIA is a U.S.-based trade association located in Arlington, Virginia. It is accredited by the ANSI to develop voluntary industry standards for many telecommunications products. Here we focus on the two mobile telephone committees in the Wireless Communications Division of the TIA: TR-45 and TR-46 (Public Mobile and Personal Communication Services Standards, operating in the 800 and 1900 MHz bandwidths, respectively) that develop performance, compatibility, interoperability, and service standards for cellular telephones and personal communication services (PCS). Each of these committees is further divided into subcommittees that split functional responsibilities (TR-45.1, etc). A total of eleven subcommittees dealing with wireless telecommunications forms the basis on which common participation is calculated. The subcommittees meet face to face quarterly or monthly, depending on the needs of the member firms, in locations across the United States and Canada. Meetings are typically a week in length, starting with plenary sessions on the first day and breaking into separate tracks for subcommittees or smaller working groups for subsequent days of the meeting.

TIA activity in these areas was intense during the 1991–2000 study period because of the emergence of CDMA standards as well as the rise of the PCS family of services enabled by the auction of new wavelengths by the federal government. Elaboration of CDMA standards began after demonstration of the technology to the Cellular Telephone Industry Association, the trade association of U.S. cellular providers, in 1991. The CDMA technique, developed for commercial use by Qualcomm in the late 1980s, was adopted as a digital standard by the TIA in July 1993. PCS efforts were concentrated in the middle part of the study period, in conjunction with the 1994 federal auction of the higher frequency spectrum. In the latter part of the study period, the next generation wireless telephony standards were debated, culminating in adoption of CDMA2000 standards in 2000.

Standards are adopted by the TIA based on votes by member firms. The TIA follows a one member-one vote rule, so the number of representatives a firm sends to meetings does not directly influence the adoption of a standard. However, firms often send multiple representatives. A single meeting could have as many as 13 participants from a single firm (e.g., Lucent, Motorola), and firms sent more than one representative to a meeting 30% of the time.

Data

Participation data were obtained from Communications Standards Review (CSR) and directly from the TIA. The

bimonthly radiocommunications issues of CSR report on all TR-45 and TR-46 subcommittee meetings, publishing meeting minutes and attendance rosters. The publisher of CSR provided us with rosters in electronic form from all issues of CSR from January 1991 to June 1996.⁵ The TIA provided access to attendance rosters from 1996 to 2000. Meeting rosters are generated as meeting attendees sign their names and firm affiliations on lists generated and kept by the TIA. Over the 10-year study period, the rosters listed 936 separate meetings, attended by 2,187 different individuals, with more than 23,000 instances of participation over all meetings. The rosters also indicate which individuals held leadership positions (chair or vice chair) for each subcommittee. The TIA also provided records of standards projects that we used to develop measures of influence. Other controls (detailed below), such as size and technological strength Measures, were obtained from Compustat, CorpTech, Moody's International, the Asian Company Handbook, the Japan Company Handbook, and the NBER Patent Citation Data File (Hall et al. 2001).

Sample Frame

The population of interest in this study is the firms participating in the TIA standards setting process for wireless telecommunications technologies. The networks derived from the data are, therefore, bounded to include all of the firms that sent representatives to at least one TR-45 or TR-46 subcommittee meeting during the study period. We identified 353 organizations by their listings on meeting rosters in the 10-year period; we excluded 106 organizations from the data set because they were not firms (e.g., government organizations, universities, consultants) or because they could not be identified from their listing.⁶ Additional data on firm size and patenting activity were collected for each year for each of the remaining 247 identifiable organizations. Accordingly, the data have a panel structure with unique observations for each firm-year, and the unit of analysis is the firm-year.

Not all data were available for all years for all firms, resulting in a data set that is unbalanced; i.e., there are different numbers of time series observations per firm. The resulting unbalanced panel data set consists of a maximum of 186 firms for which all information was available for at least one year.⁷ There was an average of 6.9 time series observations per firm. The methods used in this analysis adjust for unbalanced panels, so all complete firm-year observations are used. Because the independent variables are lagged, and some of them are derived from these data, usable observations are restricted to those for years 1993–2000. Given 186 firms and eight years, 1,488 observations are potentially available, but only 1,146 observations (77%) are actually available because of missing data.⁸

Variables

Descriptive statistics and correlations for our data are included in Table 1, which contains cross-sectional bivariate correlations that do not reflect the yearly panel structure of the data. Therefore, the correlations do not have straightforward implications for collinearity; however, the cross-sectional time series models we use properly account for within-firm, cross-year correlations. We describe each of the variables in turn. All independent variables are lagged, as explained in the descriptions.

Influence. We represent influence in two distinct ways. First, firms participating in the TIA are required to file disclosures that reveal patent holdings relating to the standards under discussion when a project or technical document is formalized. A number of possible projects or technical directions can be considered before the formal initiation of a project. *IPR* is a count of formal TIA projects that contain protected intellectual property of each firm. We take this measure to represent influence because having a formal project that contains a firm’s IPR could be evidence that the firm exerted influence to initiate this project. Firms benefit from holding intellectual property rights for technology contained in a standards project, which may take the form of revenue from license fees or from “bargaining chips” (Hall and Ziedonis 2001) that the firm can use in cross-licensing or other technology-sharing arrangements. Because of changes to the TIA’s record-keeping, IPR data are available only for the period 1996 to 2000.

Second, *Editor* is a count of TIA project initiation forms where a firm representative is identified as the document editor. Project initiation forms formally open discussion of draft technical documents that may become standards or technical bulletins published by the TIA. The forms were revised in 1998 to capture the name and affiliation of the document’s editor, so the data for the *Editor* variable are available for three years from 1998 to 2000. *Editor* is also an appropriate operationalization of influence because the document editor is typically the document’s author. Authorship and editorship of a document indicate influence in that the document is likely to contain technical content favorable to the firm if it is authored by one of the firm’s employees. Editors also exert editorial control over documents.

Firm Social Capital. Following other scholars (e.g., Ahuja 2000, Moran 2005), we represent firm social capital (*Firm Social Capital*) with degree centrality at the firm level (Freeman 1979). Degree centrality captures regular participation and interaction with other participants for affiliation data. In this context, meaningful social capital consists of being central, in the sense of regular participation at meetings (Faust 1997). Regular participation over time constitutes social capital in these affiliation networks for several reasons. First, regular participants interact repeatedly and directly with other

Table 1 Descriptive Statistics

	Obs.	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) <i>IPR</i>	719	0.16	1.05															
(2) <i>Editor</i>	425	0.16	0.98	0.16														
(3) <i>Firm Social Capital</i>	1,146	9.71	20.22	0.32	0.57													
(4) <i>In x Redundancy</i>	1,146	2.15	17.08	0.19	0.59	0.38												
(5) <i>Out x Redundancy</i>	1,146	1.84	11.21	0.11	0.75	0.45	0.31											
(6) <i>Out x Strategic Change</i>	1,146	1.81	10.74	0.15	0.29	0.31	0.24	0.41										
(7) <i>In-Social Capital</i>	1,146	0.00	20.46	0.18	0.41	0.47	0.27	0.28	0.27									
(8) <i>Out-Social Capital</i>	1,146	0.00	16.27	0.15	0.52	0.46	0.23	0.73	0.55	0.27								
(9) <i>Redundancy</i>	1,146	0.00	0.23	0.33	0.57	0.74	0.49	0.55	0.28	0.46	0.50							
(10) <i>Strategic Change</i>	1,146	0.00	0.41	0.29	0.11	0.45	0.10	0.15	0.36	0.17	0.27	0.34						
(11) <i>In-Human Capital</i>	1,146	0.11	0.45	0.07	0.24	0.37	0.31	0.20	0.15	0.48	0.23	0.33	0.20					
(12) <i>Out-Human Capital</i>	1,146	0.13	0.48	0.20	0.37	0.38	0.19	0.36	0.29	0.23	0.43	0.34	0.25	0.19				
(13) <i>Size</i>	1,146	8.30	2.90	0.11	0.18	0.38	0.13	0.14	0.12	0.19	0.19	0.30	0.26	0.20	0.16			
(14) <i>Patents</i>	1,146	1.90	2.02	0.22	0.28	0.50	0.19	0.23	0.18	0.30	0.30	0.43	0.36	0.29	0.30	0.59		
(15) <i>Experience</i>	1,146	0.22	0.35	0.16	0.15	0.40	0.10	0.11	0.10	0.20	0.24	0.28	0.38	0.14	0.16	0.23	0.31	
(16) <i>Chair</i>	1,146	0.07	0.25	0.23	0.40	0.59	0.31	0.29	0.27	0.39	0.35	0.42	0.37	0.30	0.34	0.22	0.38	0.28

participants, which is important for influence through negotiation. Effective negotiations in this context are unlikely to be conducted through intermediaries, given the easy accessibility of member firms at the meetings; i.e., participating firms are all present at the same time. Second, regular participation facilitates coalition-building by allowing a regular participant to connect other participants over time to form coalitions. Less regular participants are less likely to be able to tie groups of firms into coalitions. Finally, repeated experience between particular pairs of firms leads to trust that manifests itself in lower perceived risk in subsequent similar dealings (Gulati and Singh 1998) because firms that participate regularly are more likely to have a more substantial track record of fair dealing that they can build on in the next influence effort.

To calculate degree centrality, we computed each firm's centrality based on its participation in subcommittee meetings. Using the meeting rosters, we create a firm-by-meeting affiliation ($f_i \times m_i$) matrix for each year. We then convert each yearly affiliation matrix to a yearly firm-by-firm ($f_i \times f_i$) matrix using the minimums method for valued data. This method accounts for the number of times representatives of a firm encountered representatives of another firm, limited by the lower number of representatives in each meeting. For example, in 1996 Alltel Mobile attended three 45.2 meetings where it sent one representative to each meeting. For those same meetings, Bellcore sent four representatives to each meeting. Therefore, these two firms are coded 3 (one person for each of three meetings) in their joint cells of the $f_{1996} \times f_{1996}$ matrix. The yearly $f \times f$ matrices represent networks of joint participation for the firms in our set, where an encounter is interpreted as a tie between firms. The values in the cells represent the frequency of interaction. Centrality scores were normalized by dividing by the largest centrality in that year to allow for yearly differences in number of meetings held and firms participating.

By constructing the network in this way, we make the implicit assumption that joint participation in a meeting leads to the type of interaction that results in the formation and maintenance of social capital. Though it is by no means assured that such interaction did occur for each pair of firms, the average size of a technical committee meeting is 26.2 people, with meetings ranging in size from 2 to 99, providing some assurance that coparticipants can obtain relevant information about each other through exposure. Furthermore, firms have repeated contacts over substantial periods of time: 139 of the 186 firms in our sample attended meetings in at least five of the years of the study. Degree centrality was set to 0 for those firm-years where a firm did not attend any meetings.

Mobility. Our aim was to identify as many instances as possible where an individual participant moved from

one firm in our sample to any other firm in the sample during the study period. The mobility event of interest is the hiring or loss of individuals whose attributes are known by the group; therefore, we do not consider total inflows and outflows from the firms in our sample, but only the job moves of the meeting participants between the firms in our sample. We gathered mobility data from two sources: meeting rosters and patent records. Because representatives sign the rosters with their names and firm affiliations, we identified interfirm mobility when the firm affiliation of an attendee changed over meetings.

If a person changes firms, and concurrently stops going to meetings or begins to attend meetings, we cannot identify this change through the roster data, resulting in an undercount of mobility events and a potential sample bias. Therefore, we supplemented our mobility data with employer information from patents. If one of the attendees patented for another firm in the set after their last meeting attendance, we inferred an instance of mobility happening at the midpoint in time between the application date of the patent and the most proximate meeting attended. We included only those moves that were inferred to fall within our study period. Only 31% of the people in our sample are listed as inventors on at least one patent application, so there may be a bias toward specifically undercounting the mobility of non-inventors. In fact, though 31% of the representatives are inventors, 59% of the movers are inventors. However, analysis using mobility counts with and without those from patents showed substantively the same results, mitigating concerns about bias. Thus, only results for the full mobility counts are shown. For mobility derived from rosters, there were 150 instances of mobility for the firms in our final set. Patent information added an additional 151 mobility events, yielding a total of 301 mobility events.

We expect the effects of mobility into a firm will differ from the effects of mobility out of a firm, so we recorded mobility data in separate variables for inflows and outflows (*In-Social Capital* and *Out-Social Capital*). To test our hypotheses, we must account for the amount of social capital held by the individuals moving in and out of the firms. To develop the variables *In-Social Capital* and *Out-Social Capital*, we aggregated the social capital of individual representatives moving into or out of each firm in a given year, representing their social capital with degree centrality. As for degree centrality at the firm level, degree centrality at the individual level accounts for prominence in the network (Wasserman and Faust 1994) and linkages across meetings for affiliation data (Faust 1997) and captures regular participation and interaction with other representatives. Regular participation and interaction with other representatives represents social capital because in this context, the important resources accessible through social relationships are knowledge transfer and deal-making supported by embedded relationships.

We use a similar procedure to that used to for firm social capital to calculate individual representatives' social capital. First, we used meeting rosters to create a person-by-meeting affiliation ($p_t \times m_t$) matrix for each year. We then converted each yearly affiliation matrix to yearly person \times person ($p_t \times p_t$) matrices of joint participation in meetings during a year. Like the procedure for firm social capital, the $p_t \times p_t$ matrices are valued matrices that account for tie strength by recording the number of coattendances between the same individuals in a year. From these matrices, we calculated yearly degree centrality of the individual in the network of individuals using UCINET 6 (Borgatti et al. 2002). A mover's social capital is this degree centrality for the two years preceding the move, normalized for the number of meetings held in that year. Implicit in this measure of mobility is the assumption that individuals who attend many meetings can have a different effect on a firm's influence and social capital than individuals who attend few meetings. Though the procedure is the same as that for calculating the firm's centrality, the resulting matrices are substantially different because they account for firms replacing representatives over time, sending specific representatives to specific types of meetings, or having representatives with different levels of participation. For example, though AT&T and Alltel are connected in the 1991 firm-level network, only 3 of AT&T's 13 representatives in 1991 attended meeting #123, so only those 3 individuals encountered Alltel's single representative in that year. Furthermore, an individual's centrality can be highly distinct from that of the employer. For example, AT&T's normalized degree centrality in 1995 is 100, but the normalized degree centrality of the individuals representing AT&T in 1995 ranged from 4.2 to 44.6. These variables were centered to eliminate unnecessary correlation when used in the interaction terms (Cohen et al. 2003, Jaccard et al. 1990) and were lagged one year.

Redundant Participation. To capture the effects of redundant participation, we create interaction terms with the mobility variables using an index of redundant participation (*Redundancy*). This index averages the number of participants for each meeting the firm attended in a given year. Most firms did not have multiple representatives in meetings, but 45% of the firms had redundant participation for at least one year in the sample. We expect the effect of redundancy to decrease with each additional redundant participant, so we log transform this index. For firms that failed to participate in any meetings during a given year, the index was set to 0. This variable was centered to eliminate unnecessary correlation when used in the interaction terms (Cohen et al. 2003, Jaccard et al. 1990). The interaction terms used in the hypothesis testing models are the product of *Redundancy* and *In-Social Capital* ($In \times Redundancy$), and *Redundancy* and *Out-Social Capital* ($Out \times Redundancy$).

Strategic Change. We expect that the effects of losing personnel are contingent on strategic change, so we create interaction terms using the personnel outflow variable (*Out-Social Capital*) and an indicator of strategic change (*Strategic Change*). This measure represents the natural log of the count of subcommittees that a firm stopped participating in from one year to the next. For example, Airtouch Cellular participated in subcommittee TR-45.2, TR-45.5, and TR-46.0 in 1996 but stopped participating in TR-46.0 in 1997. We take this as signifying a strategic change that might result in the deliberate outflow of personnel and count one strategic change in 1997 for Airtouch. In the time period studied, there were 208 firm-year observations where at least one subcommittee was dropped, approximately 20% of the observations in the sample. Like the other variables used in interaction terms, this variable was centered, and it was lagged one year. The interaction term used in the hypothesis testing models is the product of *Strategic Change* and *Out-Social Capital* ($Out \times Strategic Change$).

Controls. Though the fixed effects models we use effectively control for firm-level factors that do not vary over time (Halaby 2004, Hamilton and Nickerson 2003), we also controlled for time-varying factors that might affect the relationships between mobility and centrality and influence. First, we control for year effects by including year dummy variables to account for any time-dependent trends that may affect centrality, e.g., business cycles or technology cycles. Additionally, to isolate the effect of social capital carried by individuals who join and leave firms, we include control variables for these individuals' human capital (*In-Human Capital* and *Out-Human Capital*). We represent human capital flows with a count of patents that have the mover listed as an inventor. We count patents that were filed up to and including the year of the move, and that were eventually granted.

Next, a number of firm characteristics may affect the firm's participation patterns and influence. Larger firms will be more likely to have the resources to invest in sending representatives to meetings.⁹ We measure size by yearly headcount, to simplify comparison of firms in different industry segments or regions. Size data were log-transformed because of high skew (*Size*). Technical expertise could also affect a firm's social capital and influence. Firms that are more technically expert may be more likely to benefit from the standards setting process because their proposals may be more likely to be accepted, making them more likely to actively participate. Alternatively, they could feel less of a need to participate because of their technological strength. We make no prediction about this effect, but we control for patent filings by including the number of filed patents granted in a rolling five-year window (*Patents*). This variable was also log transformed because of high skew. Furthermore, firms that hold official positions of leadership,

such as chair or vice chair, might have more influence and be more central, so we control for this factor by including a binary indicator of whether the firm held a leadership position in that year (*Chair*). A final factor that may affect a firm's social capital is the expertise that the firm's representatives hold in the standards setting process. To control for this characteristic, we include in the model the percentage of the firm's representatives in a given year that attended standards setting meetings in the prior year (*Experience*).

Analytical Approach and Results

We have argued that the process by which the flows of personnel affect influence in standards setting is a mediated process. To show mediation, we must (1) find a significant relationship between an independent variable (personnel flows and moderated personnel flows) and a mediator (firm social capital); (2) find a significant relationship between the independent variables and a dependent variable (influence); and (3) show that the mediator and the dependent variable are significantly related, even when the independent variables are included in the model. If the independent variables become statistically insignificant when the firm social capital mediator is included in the influence model, the model is fully mediated; if not, it is partially mediated (Baron and Kenny 1986). For each of our influence measures (*IPR* and *Editor*), we present each of the three steps of the test for mediation.

Panel data, like the data used in this analysis, provide repeated observations on an individual unit over time. Because there are multiple observations for each firm in our data set, variance that is because of unique characteristics of the firm can be accounted for through the use of cross-sectional time series panel data methods that correct for firm-level correlation between the regressors and the error term (Hsiao 1986). For the analyses with *Firm Social Capital* as the dependent variable (the intermediate stage of the mediated model), we use fixed effects OLS modeling, a restrictive test of our hypotheses, that captures time-invariant firm level unobserved heterogeneity.¹⁰ Because personnel mobility and firm social capital could both be driven by some unobserved factor, it is important to address the possibility of omitted variable bias. Fixed effects methods do so by essentially controlling for all firm characteristics that are stable over time (Wooldridge 2002). Therefore, omitted variables that are related to stable firm characteristics are accounted for in this model. In addition to the firm fixed effects, we also control for year effects and firm effects that vary over time, as described above.

For analyses with *IPR* and *Editor* as dependent variables, we use cross-sectional time series negative binomial models because these variables are counts with overdispersed distributions. We use random effects specifications for the influence models because there are a

number of firms that participate in the standards setting process without claiming intellectual property rights or having editorial control of documents. Under a fixed effects specification, these firms would be excluded from the analysis.

Table 1 shows descriptive statistics and correlations for the variables included in this study. Because the dependent variables for this study come from different sources, the time periods for analysis of *Firm Social Capital*, *IPR*, and *Editor* differ. Table 1 contains descriptive statistics for the largest sample, i.e., the period 1993–2000. Note that, although *IPR* and *Editor* both represent firm influence in standards setting, they are only weakly, though significantly, correlated ($\rho = 0.16$, $p < 0.05$), suggesting that they may capture different aspects or different types of influence.

Table 2 contains coefficients for the hypothesis testing models for the influence measure *IPR*. Models 1–3 show the steps for mediation for the moderated model for personnel inflows (H1A, H1B, and H2), and Models 4–6 include moderators for personnel outflows in the models (H3 and H4). Model 1 shows the first step of the test of mediation (Baron and Kenny 1986), testing the relationship between the independent variables of personnel inflows and moderated personnel inflows, and the mediator of firm social capital. Model 2 shows significant effects of the variables for inflows and moderated inflows on the *IPR* dependent variable, fulfilling the second condition of mediation. As expected, the coefficient for inflows is positive and significant and the coefficient for the interaction between inflows and redundancy is negative and significant for Models 1 and 2. To show a mediated relationship between personnel inflows and firm influence, we need to show that the mediator of firm social capital is also significantly related to firm influence, while controlling for personnel inflows. Model 3 shows the firm social capital mediator added to the model of personnel inflows. In this model, the mediator of *Firm Social Capital* is positively and significantly related to *IPR*, whereas the effect sizes of the personnel inflows and the interaction of inflows and redundancy are reduced and no longer statistically significant. Taken together, these three models provide support for H1A, H1B, and H2, which predict that firm social capital mediates the relationships between personnel inflows and firm influence in standards setting. To supplement this analysis, we also performed a product of coefficients test of mediation (Sobel 1982) for a baseline model of personnel inflows, which also provides support for the mediation model ($p < 0.05$).

Models 4–6 in Table 2 use the same analytical strategy as above but include effects for personnel outflows and the moderation effects we predict for outflows (H3 and H4) in predicting *IPR*. Model 4 shows the effects of personnel flows on firm social capital. This model shows that the coefficient for $In \times Redundancy$

Table 2 Cross-Sectional Time Series Panel Regressions for Firm Social Capital and Influence (IPR)

	Inflows			Full models		
	Firm Social Capital	IPR		Firm Social Capital	IPR	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Firm Social Capital</i>			0.03* (0.01)			0.03* (0.01)
<i>In × Redundancy</i>	−0.04* (0.02)	−0.02* (0.01)	−0.01 (0.01)	−0.04* (0.02)	−0.02* (0.01)	−0.01 (0.01)
<i>Out × Redundancy</i>				0.09** (0.03)	−0.01 (0.02)	−0.01 (0.02)
<i>Out × Strategic Change</i>				0.05* (0.02)	−0.03* (0.01)	−0.02* (0.01)
<i>In-Social Capital</i>	0.06*** (0.02)	0.02* (0.01)	0.01 (0.01)	0.06*** (0.02)	0.02* (0.01)	0.02 (0.01)
<i>Out-Social Capital</i>	0.04* (0.02)	−0.01 (0.01)	−0.01 (0.01)	−0.02 (0.02)	0.02 (0.02)	0.01 (0.02)
Controls						
<i>Redundancy</i>	15.13*** (1.57)	1.76* (0.70)	0.39 (0.96)	14.39*** (1.64)	1.57* (0.77)	0.26 (1.04)
<i>Strategic Change</i>	−1.17 (0.64)	0.88* (0.41)	0.69 (0.42)	−1.57* (0.67)	1.27** (0.49)	1.08* (0.50)
<i>In-Human Capital</i>	1.18* (0.53)	−0.04 (0.27)	−0.11 (0.25)	1.28* (0.53)	−0.07 (0.28)	−0.13 (0.26)
<i>Out-Human Capital</i>	−0.45 (0.50)	0.12 (0.32)	−0.17 (0.36)	−0.54 (0.49)	0.21 (0.33)	−0.05 (0.36)
<i>Size</i>	0.19 (0.48)	−0.27** (0.10)	−0.35** (0.11)	0.17 (0.48)	−0.29** (0.10)	−0.37** (0.11)
<i>Patents</i>	1.68*** (0.43)	0.39* (0.17)	0.46** (0.18)	1.71*** (0.43)	0.35* (0.17)	0.39* (0.18)
<i>Experience</i>	0.96 (0.76)	1.98** (0.69)	1.77* (0.72)	1.15 (0.76)	1.72* (0.73)	1.59* (0.74)
<i>Chair</i>	−0.15 (1.17)	0.04 (0.51)	−0.49 (0.53)	−0.12 (1.17)	0.01 (0.53)	−0.48 (0.55)
Constant	5.45 (3.85)	−3.18*** (0.86)	−2.98*** (0.81)	5.24 (3.83)	−2.70** (0.93)	−2.66** (0.84)
Year controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes			Yes		
<i>N</i>	1,146	719	719	1,146	719	719
Number of groups	186	183	183	186	183	183
<i>R</i> ² (within)	0.182			0.192		
Log likelihood		−134.02	−130.99		−132.3	−129.73
−2(ΔLL)			6.06*			5.13*

Notes. One-tailed test for hypothesized effects; two-tailed tests otherwise.
 * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

is negative, and those for *Out × Redundancy* and *Out × Strategic Change* are positive, as expected. Model 5 is the second stage of the mediation test for the full model, showing the relationship between personnel flows and *IPR*. These results show the expected negative relationship between *In × Redundancy* and *IPR*, consistent with Model 2; however, the relationship between the personnel outflow variables and influence does not show the expected positive relationship. Instead, the effect of *Out × Redundancy* is not significant, whereas the effect of *Out × Strategic Change* is negative and significant.

In Model 6, the *Firm Social Capital* mediator is positive and significantly related to *IPR* even controlling for the personnel flows variables, fulfilling the third condition of mediation and again providing support for H1A and H1B. However, the effect of *Out × Strategic Change* is not significantly diminished in Model 6. Therefore, the effects of personnel outflows are not fully consistent with our expectations: H3 is not supported for the *IPR* measure of influence because *Out × Redundancy* is not significantly related to *IPR*. H4 is not supported because firm social capital only partially mediates the

Table 3 Cross-Sectional Time Series Panel Regressions for Firm Social Capital and Influence (Editor)

	Inflows			Full models		
	Firm Social Capital	Editor		Firm Social Capital	Editor	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Firm Social Capital</i>			0.06*** (0.02)			0.10*** (0.02)
<i>In × Redundancy</i>	−0.04* (0.02)	−0.02* (0.01)	−0.01 (0.01)	−0.04* (0.02)	−0.03* (0.01)	−0.02* (0.01)
<i>Out × Redundancy</i>				0.09** (0.03)	−0.02 (0.01)	0.02* (0.01)
<i>Out × Strategic Change</i>				0.05* (0.02)	0.03* (0.02)	0.04** (0.01)
<i>In-Social Capital</i>	0.06*** (0.02)	0.02* (0.01)	0.01 (0.01)	0.06*** (0.02)	0.02* (0.01)	0.01 (0.01)
<i>Out-Social Capital</i>	0.04* (0.02)	−0.01 (0.01)	0.00 (0.00)	−0.02 (0.02)	−0.02 (0.02)	−0.04** (0.02)
Controls						
<i>Redundancy</i>	15.13*** (1.57)	4.35*** (1.10)	0.77 (1.12)	14.39*** (1.64)	5.02*** (1.24)	−0.85 (1.33)
<i>Strategic Change</i>	−1.17 (0.64)	−0.03 (0.50)	−0.50 (0.43)	−1.57* (0.67)	−1.12 (0.83)	−2.57*** (0.72)
<i>In-Human Capital</i>	1.18* (0.53)	−0.16 (0.27)	−0.19 (0.21)	1.28* (0.53)	−0.11 (0.29)	−0.16 (0.21)
<i>Out-Human Capital</i>	−0.45 (0.50)	0.02 (0.38)	−0.35 (0.31)	−0.54 (0.49)	−0.29 (0.46)	−0.76* (0.36)
<i>Size</i>	0.19 (0.48)	0.30 (0.19)	0.21 (0.16)	0.17 (0.48)	0.33 (0.21)	0.18 (0.16)
<i>Patents</i>	1.68*** (0.43)	0.07 (0.17)	−0.07 (0.13)	1.71*** (0.43)	0.21 (0.22)	0.17 (0.15)
<i>Experience</i>	0.96 (0.76)	0.34 (1.09)	−0.69 (1.24)	1.15 (0.76)	0.57 (1.10)	−0.68 (1.16)
<i>Chair</i>	−0.15 (1.17)	0.80 (0.75)	0.28 (0.59)	−0.12 (1.17)	1.10 (0.73)	0.61 (0.55)
Constant	5.45 (3.85)	−5.52** (2.09)	−5.60** (1.69)	5.24 (3.83)	−5.01 (2.58)	−4.99* (2.23)
Year controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes			Yes		
<i>N</i>	1,146	425	425	1,146	425	425
Number of groups	186	166	166	186	166	166
<i>R</i> ² (within)	0.182			0.192		
Log likelihood		−81.13	−70.542		−79.74	−64.782
−2(ΔLL)			21.17***			29.92***

Notes. One-tailed test for hypothesized effects; two-tailed tests otherwise.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

relationship between *Out × Strategic Change* and *Firm Social Capital*; also, results indicate that there may be a direct negative relationship between *Out × Strategic Change* and influence measured by IPR.

Table 3 shows analysis for the *Editor* measure of influence, using analyses that are parallel to the *IPR* analyses shown in Table 2. The first step of the mediation analysis for both the models for personnel inflows (Model 1) and the full models (Model 4) are identical to those in Table 1, and they are reproduced in Table 2 for ease of comparison. Model 2 shows the effect of person-

nel inflows on the *Editor* measure of influence. In this model, *In × Redundancy* has a negative effect on *Editor* and *In-Social Capital* has a positive effect, consistent with our expectations. When *Firm Social Capital* is added to the model (Model 3), the coefficient for *In × Redundancy* becomes smaller but is still statistically significant, suggesting that the relationship between personnel inflows and influence is partially mediated by firm social capital rather than fully mediated as we predicted (H1A and H1B). As for *IPR*, we also performed a product of coefficients test of mediation (Sobel 1982) for a

baseline model of personnel inflows for *Editor*, which also showed a significant mediating effect for firm social capital ($p < 0.01$).

Models 4–6 in Table 3 include the interaction variables for personnel outflows to the *Editor* models. In Models 4 and 5, the main effect for personnel inflows (In) is again positive and significant, and the interaction term ($In \times Redundancy$) is again negative and significant, fulfilling the first and second conditions of a mediated model. Again, adding the *Firm Social Capital* mediator reduces the magnitude of the main effect and the moderated effect but does not eliminate it, suggesting that firm social capital moderated by redundancy partially mediates the relationship between personnel inflows and firm influence. These results provide additional support for H1A, H1B, and H2.

In order for H3 and H4 to be supported for the *Editor* measure of influence, the moderated terms for outflows ($Out \times Redundancy$ and $Out \times Strategic Change$) should be positive and significantly related to both the *Firm Social Capital* mediator (step 1 of mediation test) and the *Editor* measure of influence (step 2), and the *Firm Social Capital* mediator should be related to *Editor* in a full model that includes the moderated terms for outflows (step 3). Model 4 shows that the relationships between the moderated terms for outflows and firm social capital are positive and significant (step 1). Model 5 shows that $Out \times Strategic Change$ is positive and significantly related to *Editor* but that $Out \times Redundancy$ is not. This model satisfies the second condition of mediation for the interaction between personnel outflows and strategic change but not for the interaction with redundancy. In Model 6, adding firm social capital to the model satisfies the third condition of mediation for the interaction between personnel outflows and strategic change because *Firm Social Capital* is significantly related to *Editor*, even when the interaction term is included in the model. Taken as a group, these models provide support for H1A, H1B, and H2, and some support for H4, though there appears to be an additional direct effect of $Out \times Strategic Change$ on *Editor*. H3, which concerns the effect of the interaction between personnel outflows and redundancy on influence, is again not supported.

Discussion and Conclusion

By calling attention to the social capital-related consequences of job mobility for technical standards setting, we contribute to the literatures on interfirm job mobility and interfirm social capital. First, we demonstrate that new hires can carry social capital as they move across firm boundaries, in addition to any human capital they may bring. As well as, or instead of, building social capital through the process of interaction over time, firms can use hiring as a shortcut to increase their social capital,

which can in turn be used to increase their influence in standards setting. Our study builds on studies that highlight the importance of individual-level social connections to firm outcomes (e.g., Broschak 2004, Pennings et al. 1998, Seabright et al. 1992, Somaya et al. 2008) by explicitly focusing on the mediating mechanism of firm social capital and the process by which hiring translates into firm-level outcomes. Firm social capital is strongly associated with firm influence, and the direct effect of personnel inflows on firm influence is dramatically reduced when firm social capital is controlled, demonstrating the mediating effect. We also find that the effect of hiring social capital is particularly important when firms are conservative in their technical committee representation; firms with low redundancy in representation benefit more from the social capital that new hires bring than those that use more representatives. This moderating effect of redundancy on inflows is also mediated by firm social capital, as we expected. Our models show a full mediation for most specifications, though the full model for *Editor* (Table 3) shows a partially mediated relationship between personnel flows and firm influence. As our control for hired human capital captures patenting activity on the part of movers, it may better account for an additional firm knowledge or skill mechanism related to the intellectual property measure (*IPR*) than the *Editor* measure.

Additionally, we find that losing people does not have a straightforward effect on firm social capital or influence. Although individuals may carry useful social capital to a new employer, their old employers do not necessarily suffer a loss. Consistent with our expectations, there appear to be contingencies in the relationships between personnel outflows and firm social capital and influence; however, the contingent effects are more complex than we expected. We found that the interactions between personnel outflows and redundancy or strategic change were positive in determining firm social capital but indeterminate in their effect on firm influence. That is, redundancy and strategic change mitigated the negative effect of losing representatives on the outcome of firm social capital, as hypothesized, but this effect did not carry through consistently on influence. This result suggests that there may be other mediating mechanisms between personnel outflows and firm influence that do not operate in the same way as inflows or that losing personnel might have an additional direct relationship with firm influence that is not captured by the interactions we tested. For instance, knowledge is a commonly cited mechanism through which job mobility may affect firm outcomes (Almeida et al. 2003, Song et al. 2003). However, similar to social capital effects, knowledge may impact inflows and outflows differently. A characteristic of knowledge is that it can be transmitted between parties and still held by the originator (Arrow 1962). Therefore, like social capital, knowledge can be carried into a

firm by a new hire, but institutionalized such that exiting employees can both take the knowledge and leave it behind. Though we control for the human capital of movers, we cannot track the knowledge retained by the firm in a fine-grained way. Alternatively, the inconclusive results could be driven by differences in the two measures of influence we use, as we discuss later in this section. However, we do establish that effects for personnel inflows and outflows are not symmetric and that the value of the connections held by outgoing personnel interacts with outflows in determining influence in standards setting.

Our examination of the social benefits and costs of personnel inflows and outflows for firms is facilitated by the rich technical committee context that is so prevalent in high-technology industries. Not only does this context deal with the important phenomenon of technological standardization, it is also a window into an interfirm network. Because interactions can be observed and recorded at both individual and firm levels of analysis, this setting enables us to address the broader issue of whether social capital is the property of firms or individuals. Though professionals have been shown to carry clients with them to competitors (Broschak 2004, Somaya et al. 2008, Wezel et al. 2006), our findings suggest that even when individual boundary-spanners represent the resources and goals of their employers, they can also accrue personal social capital that is portable to other firms.

Despite the advantages of this study's context, it poses some limits to the generalizability or interpretation of our findings. First, technical standards setting committees provide a venue for the ongoing congregation of large numbers of firms, which, as we have discussed, allows us to examine interactions in an interfirm network. However, most interactions between firms, like alliances, joint ventures, or customer-supplier relationships, are dyadic in nature and do not involve the concurrent interaction of numerous industry participants. Therefore, social capital in this study may not reflect more commonly studied types of interfirm social capital, and the social effects of mobility may be contingent on our setting and our outcome of interest. Influence is a social outcome that may be particularly sensitive to personnel mobility and social capital. In more commonly studied interfirm settings like alliance networks, mobility may have weaker effects because the alliance networks may generally be less dense than the network created within an affiliation context like an SDO. Alliances are costly to initiate and maintain, relative to participation in an SDO, and are more specifically tailored to the needs of two or three firms rather than an entire industry. At the same time, the regular and predominantly stable core membership of these committees allows the rare opportunity to directly observe the formation of firm-level social capital based on microsocial

interaction. Furthermore, committee-based standards setting is a common and consequential activity in technology industries (Farrell and Saloner 1988, Simcoe 2007), and understanding the social bases of influence in these settings is worthwhile. Even so, future research should explore these dynamics in a variety of settings.

Second, in this study, we reason that centrality represents social capital and that centrality can be measured by coattendance at meetings. However, joint attendance at a meeting on the firm level does not guarantee the kind of interaction that leads to norms or trust. Given the intermittent nature of interaction, the ties may not be strong enough or the content flowing through the ties may be acrimonious in nature; i.e., competitive behavior during the meetings may be such that individuals do not develop the goodwill that is the essence of social capital (Adler and Kwon 2002, Brass and Labianca 1999). A better measure of social capital, e.g., superior ability to acquire knowledge or perceived trustworthiness in offline negotiations, may require more richness than is available in archival data. However, regular participants in technical standards committees typically spend four to five days per month together in offsite locations, eating meals and sharing breaks together. Though plenary meetings can get quite large, committees divide into much smaller working groups whose stable core of membership can develop strong ties. The committee meetings do in fact result in consensus standards, and our own and others' (e.g., Isaak 2006) observation of subcommittee meetings and interviews with participants indicates that trust, friendship, and sanctions against opportunistic behavior do operate, alongside competition. Nevertheless, incorporating the effect of social ties can enrich future research on interfirm networks generated by interpersonal ties.

Third, the influence that we have attributed to social capital and the trust it engenders could be actually because of underlying trading relationships not visible in the current data set. A wireless handset manufacturer may submit to the influence of a service provider not because of trust but because the service provider is a large customer and important channel for end user sales. Certainly, influence has an economic basis as well as a relational basis, and interviews with technical committee participants informed us that service providers have the most trading-based power. As a high-level assessment of the effect of trading relationships, we performed supplemental analysis of influence using information on market segment. We inserted a dummy variable for service provider in the models of social capital and influence. We found the results for the variables of interest did not change, and there was no effect for the dummy variable. These results suggest that the relational basis of influence functions independently of the market basis. As one TIA engineer said, "[C]oalitions often reflect trading relationships outside of the committee, but trust eases

consensus.” One implication of separate effects of market and relational bases of influence is that firms with little or no market power may still be able to influence the direction of technology evolution through the management of their relationships. Future research should investigate bases of influence separately.

Despite these limitations, our study highlights several intriguing contrasts that merit further examination. Three of these contrasts arise because our research design enables the separation of constructs that might otherwise be considered symmetric, correlated, or analogous. First, although each instance of mobility can generate both an inflow and an outflow, the effects of inflows and outflows are asymmetric. Inflows cause the new employer to benefit from the social capital the engineer accrued with a previous employer, and this social capital generates influence. While a naïve assumption could suggest that outflows would have a corresponding negative effect, our results demonstrate that the effects of outflows are far more nuanced. As we expected, main effects for outflows are ambiguous. Accounting for the interactions of outflows with both redundancy and strategic change, however, suggests that changes in firm social capital are driven by each of these two contingencies. Nonetheless, firm social capital does not fully mediate the relationships between outflows and influence. Instead, the relationship between outflows and influence is direct, yet differs for our two measures of influence, as we discuss below.

Second, this study uses two distinct measures for firm influence. Though the effects of mobility and social capital are generally similar on *IPR* and *Editor*, the two influence measures are not highly correlated ($\rho = 0.16$), suggesting that they capture different aspects of firm influence. *IPR* relates to the exertion of influence for a material end that is of clear benefit to the IPR holder. This aspect of influence is congruent with theory about social capital’s uses (e.g., Lin 2001). *Editor* is more about control over the standard-writing process, i.e., how technical alternatives are framed, presented, and updated in written documents. This measure of influence is less explicitly beneficial to an employing firm, but it captures a meaningful form of power having to do with formal position (Pfeffer 1981). Document editors do not determine the content of written documents without contest, though interviewed participants believe that document editors use their positions to shape the content of standards documents. These differences may drive the contrast in results for the personnel outflow interactions. The interaction of personnel outflows and strategic change is positively related to *Editor*, as expected, yet it is unexpectedly negative in relation to *IPR*. The pattern of results for *IPR* suggests that firms may actually benefit from personnel outflows with respect to getting proprietary intellectual property rights written into standards documents but that strategic change attenuates this

benefit. This finding could be the result of ties back to an ex-employer that can benefit a new employer by opening lines of communication or strengthening relationships between firms (Agrawal et al. 2006, Corredoira and Rosenkopf 2009, Somaya et al. 2008). Outflows may make a firm more likely to get IPR written into standards documents because former employees can more accurately assess the risk presented by IPR in a standard and allay concerns of their new employers. Strategic change might attenuate this benefit if the experience of the former employees is no longer relevant to the old employer’s new strategy. Unlike IPR, which stay with a firm when employees leave, editorship is associated with a person in the TIA. When a document editor changes employers, he or she retains the editor position. Therefore, the loss of an editor may represent a true loss of influence, which is attenuated by strategic change, as we hypothesize. Indeed, movers are more likely to be editors than nonmovers; 6.3% of movers are editors, versus only 2.7% of nonmovers.

Third, one might also expect that human and social capital could play analogous roles for firms, but our results demonstrate otherwise. The finding that firms can hire social capital is consistent with studies that highlight the importance of individual-level social connections to firm outcomes (e.g., Broschak 2004, Pennings et al. 1998, Seabright et al. 1992). However, the majority of studies that examine firm-level outcomes of job mobility posit human capital mechanisms (e.g., Almeida and Kogut 1999, Boeker 1997, Madsen et al. 2002), which offer an alternative explanation for our findings. Human capital, or expertise, also serves as a basis of influence (French and Raven 1959). At the same time, social capital relevant to performance may not be easily portable across firm boundaries. Groysberg et al. (2008) find that hiring star financial analysts does not bring the expected benefit to the hiring firm unless the analysts move with their teams. In the technical committee context, social capital may be more portable because of the recurrent nature of the interaction at the individual level, which allows former coworkers to maintain relationships easily and which may provide the social benefits of hiring from a pool of known workers. This strategy may also come with costs, however. Sorensen (1999) finds hiring from the same sources as competitors decreases performance, which may be a result of decreased innovation (Song et al. 2003). In addition, the fully mediating effect of firm social capital may be partially attributable to the fact that the technical committee context is one where individuals and firms inhabit the same social world. In contexts where the relationship between the interpersonal and interfirm networks is weaker, social capital may play a different role. Nevertheless, the findings of this study suggest that social capital accrued by individuals on behalf of firms has a

portable component that can be useful to future employers. Future research can investigate the conditions under which social capital accrued in one job can be useful for a future job and what costs might be exacted.

More broadly, although we demonstrate that personnel movement has consequences for firms in a technological community, our findings also have implications for the community itself. Prior work has highlighted the importance of sociopolitical processes in the evolution of complex technologies (Rycroft and Kash 1994, Tushman and Rosenkopf 1992). This study explicitly considers social capital as one mechanism of the sociopolitical process, and the findings suggest that job mobility increases social capital in the community over time; moves create new connections without necessarily sacrificing old ones. As technical personnel change employers, they create a web of interfirm relationships that supports the community's coordinated action. In a network sense, this means that the interfirm network becomes more dense and multiplex. Not only do firms develop direct relationships with more firms in the community, they may become tied together through multiple means, e.g., alliances, common membership in technical committees or trade associations, and personnel transfers. Both density and multiplexity imply faster and richer information flows. The increasing speed and richness of information flows can enhance learning and innovation within the community and shape the evolution of the technology, yet they can also lead to increasingly constrained and incremental innovation as knowledge in the community become increasingly redundant. In this way, job mobility is one means by which technology cycles progress through eras of ferment and incremental progress (Anderson and Tushman 1990, Tushman and Rosenkopf 1992).

Moreover, influence in an interfirm network is an important outcome, and the role of individuals in generating and exercising interorganizational influence merits further exploration. Individuals have been shown to be agents of influence in director interlocks (Mizruchi 1996), and characteristics of the individuals representing the interfirm relationship appear to affect the outcomes. For instance, director interlocks can influence the formation of strategic alliances, contingent on the relationship between the CEO and outside directors on the board (Gulati and Westphal 1999). Our findings suggest that close ties between individual boundary-spanners can also be a vehicle through which a firm can exert influence even when those individuals have no formal governance role or direct resource dependencies (Davis and Marquis 2005). The informal influence mechanism studied here is particularly interesting in that it provides a window into direct influence activities between firms in the same industry. Future research can address these important issues.

Finally, our research has an important practical implication. For managers, the mediating role of firm social capital should put increased emphasis on considering the social role of mobile individuals. In addition to human capital gained or lost, hiring managers can evaluate the social capital carried by individuals and whether a job candidate offers social connections to the firm in addition to skills and knowledge. Evidence suggests that social connections serve as a factor in hiring for technical standards setting committees. In an interview, one committee member who had recently changed employers said that his new employer knew he had both the technical knowledge and connections to push through favorable standards. In technological communities more generally, hiring someone who can maintain relationships with a former employer or third party firms can create informal linkages between firms that can result in learning and innovation (Bouty 2000, Liebeskind et al. 1996) or that may lead to more formal alliances (Rosenkopf et al. 2001).

In conclusion, this study's exploration of the role of personnel flows in affecting firm influence contributes to the study of job mobility and social capital by demonstrating that firms can hire social capital that can be parlayed into strategically important outcomes. In other words, we show that social connections held by individuals can be portable across organizational boundaries for the benefit of their new employers. Though our study is not conclusive about the effects of personnel outflows, we establish that the effects of inflows and outflows are not symmetric with respect to firm influence and that outflows effects are contingent on the value of the connections held by outgoing personnel. Future studies can address additional aspects of the relationship between the social capital held by mobile personnel and performance outcomes for prior and future employers, and much work remains to be done in this area to uncover the role of individual action in creating, maintaining, and breaking interfirm relationships in a variety of industries and contexts.

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Endnotes

¹For an extended description of technical standards setting committees, see Rosenkopf et al. (2001).

²<http://www.ansi.org>.

³Halper, M. 2006. Nokia battles Qualcomm over royalties. *Fortune* (December 19) http://money.cnn.com/magazines/fortune/fortune_archive/2006/12/25/8396726/index.htm.

⁴Because the SDO context is relatively unusual in management research, we informed our deductive analysis with nonparticipating observation of meetings and interviews with meeting participants and representatives from the SDO's administration. It should be noted that we did not use this information to develop theory in an inductive way but instead used it to ensure our theoretical ideas are accurately portrayed in our empirical models (cf. Kim and Miner 2007).

⁵CSR terminated coverage of TR-45 and TR-46 after June 1996.

⁶The 106 excluded organizations included 30 government agencies, 14 other trade associations or standards setting bodies, 12 consulting firms, and 2 universities. The participation of these organizations was sporadic and mostly nontechnical. The remaining 48 organizations could not be identified primarily because of the use of initials or acronyms for organizational affiliation on the meeting rosters.

⁷Firm size data were missing altogether for 61 firms in the sample. Because of the sources used for firm size information, it is possible that the final sample of firms analyzed is biased toward larger, publicly held, or U.S. firms. However, 75 firms of the 186 firms in the final sample have fewer than 1,000 employees for at least one year of the analysis, and analyses run on this subsample are consistent with the analyses run on the full sample. The only substantive difference is that the standard error of $Out \times Strategic\ Change$ increases such that it is no longer significantly associated with firm social capital.

⁸During the study period there were two major events affecting the firm affiliation of representatives: the spinoff of Lucent from AT&T in 1996 and the merger of Bell Atlantic and GTE to form Verizon in 1998. Given the unusually large scale of these events, we chose to exclude the observations affected by these events from the results presented. When these observations were included in the analyses, the results were substantively the same, though the absolute magnitudes of the coefficients for the mobility variables were smaller.

⁹Age may also be of theoretical relevance because more established firms might have more to lose from not participating in the standards setting process. However, our use of cross-sectional time series methods does not allow inclusion of age because the year-on-year variation of age is always 1 and the correction for interyear correlation removes the effect of the variable. Therefore age is not included in the analysis. However, we did test for the effects of age using standard OLS methods and found that age was not significant in any models when size was included in the regressions.

¹⁰Both random effects and fixed effects models were run. Hausman tests of the models indicate that fixed effects modeling is statistically preferred for this model.

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