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DOES TENURE HETEROGENEITY HELP OR HARM PATENT ACTIVITY?

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Abstract

This paper focuses on the impact of top tenure heterogeneity on patenting activity. The study sample uses 290 firms in 23 industries over the period 1996-2006. Tenure heterogeneity is measured as how long top managers have been with the firm and whether they came from the same or a different industry. Competing hypotheses were developed for the impact of heterogeneity combining both the industry and time with the firm. Top managers from the same industry had no impact on patenting activity in the overall sample, however significant positive and negative effects were found for pharmaceuticals and computers respectively in the subsample. Top managers from outside the industry had a significantly negative impact on patenting activity in the overall sample but no significant effects in the subgroups. The measures of intraindustry and extraindustry importation were used in a new context and are an important contribution of this study. Additionally the study uses the complementary frameworks of upper echelons and social capital theory.

Keywords: Upper Echelons, Social capital, patents, top management teams, panel, negative binomial

Introduction

New products and services are frequently the result of research and development and in some instances; these new products are the end result of multiple patents. While the importance of innovation varies from industry to industry, its value can hardly be overlooked even in low velocity industries. Innovation occurs in companies where human capital and corporate resources are combined in ways that develop new products and services. However research and development and deployment of innovation are both expensive and risky to the extent that the outcomes are difficult to predict. As a result, support by the top management team is critical for successful innovation (Hitt, Nixon, Hoskisson, & Kochar, 1999; Hsieh, Chung, & Lo, 2010).

Innovative activity is enhanced when the top management team (TMT) considers a diverse set of alternatives, which is enhanced by the differing mental models of team members (Bantel & Jackson, 1989). However multiple views may also lead to conflict, which can harm teamwork and sabotage the innovative efforts. Various measures for diverse mental models have been used based on the theoretical framework of upper echelons theory (Hambrick & Mason, 1984). The central premise of upper echelons theory is that executives' experiences, values, and personalities greatly influence their interpretations of the situations they face and, in turn, affect

their choices. One of the more popular proxies of this theory is the diversity of views among top managers with measures of heterogeneity. Heterogeneity has been defined in a number of ways including team and individual tenure, function, age, education, industry tenure, executive team tenure, military experience, and personality (Bantel & Jackson., 1989; Ferrier, 2001; Hambrick, Cho, & Ming-Jer, 1996; Jackson, Brett, Sessa, Cooper, Julian, & Peyronnin, 1991; Pennings and Wezel, 2010; Pitcher & Smith, 2001 Wieresma & Bird, 1993). In this paper, we define tenure heterogeneity as the *length of time managers have been with the company* and *whether they came from the same or a different industry* (Geletkanyz & Hambrick, 1997; Yoo, Reed, Shin & Lemak ,2009).

Surprisingly few studies have been conducted on the influence of the TMT on the creation of new knowledge (Heyden, Sidhu, Van den Bosch, & Volberda, 2013). An example of this lack of studies occurred when hypotheses in a meta-analysis to connect diversity with innovation could not produce enough studies for analysis (Bell, Vilado, Lukasik, Belau, & Briggs, 2011). Additionally studies that have considered the impact of functional diversity on innovation have produced inconsistent results (Daellenbach, McCarthy, & Schoenecker, 1999; Yap, Chai, & Lemaire, 2005). Additionally, a study by West and Anderson (1996) found no impact of tenure on innovation. In this study, we examine tenure in a different way, considering the impacts of the length with an organization along with whether the executive came from the same or different industry.

The theoretical perspectives of this paper come from upper echelons theory and social capital theory. Upper echelons posits that the mental models of the team of executives can be understood through proxies such as tenure and functional diversity and that studying the entire top management team provides more information than studying the CEO alone (Hambrick & Mason, 1984). Social capital theory provides additional justification for this study. Social capital theory considers the value of networks and relationships in corporate performance (Nahapiet & Ghoshal, 1998). These theories are complementary since the contributions of top executives do not occur in isolation but also in their interactions with other members of the top management team and their ties to outside information.

Research Model

This study examines the impact of top management team heterogeneity and social ties on patenting activity within organizations. Patents provide a direct measure of research activity in firms in the form of creative output. While patents will not always translate into actual products, they are in many cases an important step toward that goal. Further patents are strongly associated with R&D in cross sectional samples and significantly although less strongly associated in time series samples suggesting that they have some value in representing innovative activity (Griliches, 1990). While patents have been used in a number of ways, here they are considered narrowly as inputs to innovative activity. They also provide a measurable form of success and to some extent a measurement of strategic intent. In this paper, the impact of imported managers is viewed through the lenses of upper echelons theory and social capital. These dual perspectives are complementary in this paper with upper echelons offering a perspective on the mental models of the top management team and the impact of heterogeneity and social capital emphasizing the knowledge brought from prior employers and the network of relationships with those prior employers.

Contributions

This paper contributes to existing literature in several ways. First, we look at the impact of tenure heterogeneity on patenting activity which has not previously been studied. Secondly, we draw implications from the findings that could impact hiring practices for firms engaging in innovation. Thirdly, we advance upper echelons theory by indirectly considering the impact of mental models of executive teams on patenting activity. Fourthly we consider the impact of social capital on innovative performance. Fifthly, we measure tenure heterogeneity differently. It is most commonly defined by the coefficient of variation, which is the standard deviation of TMT tenure divided by the mean of that tenure (Elenkov, Judge, & Wright, 2005; Jaw & Lin, 2009; Wiersema & Bird, 1993). Other measures of tenure heterogeneity are the average tenure, the standard deviation of tenure, and Blau's index (Hambrick, Cho, & Ming-Jer, 1996; Julian, Wachter, & Mueller, 2009; Ozer & Cebeci, 2010). In this study, we have chosen to examine tenure heterogeneity as a combination of the length of time managers have been with the company and whether they came from the same or a different industry. We use intraindustry and extraindustry importation as proxy for TMT diversity, whereby the number of years with the company is normalized. Finally, the study examines 10 years of data for 290 companies in 23 industries making the findings generalizable.

In the following sections, we provide the literature review, explicating the conflicting arguments for the benefits and problems resulting from TMT homogeneity and heterogeneity, social capital, and intraindustry and extraindustry importation. Hypotheses, methodology, results and discussion sections are then presented.

LITERATURE REVIEW

Researchers have validated the advantages and disadvantages of both tenure homogeneity and heterogeneity alike. In the following sections, this research will be briefly presented.

TMT Homogeneity

One consequence of TMT homogeneity is that top managers have extensive agreement and expertise within a well-defined field of knowledge. One well known benefit of this agreement is faster execution of decisions and strategic actions (Hambrick, et al 1996). To the extent that a field is not well developed, patenting activity should be high.
However as a field becomes better developed, the tendency of homogeneous managers to search their local environment for new ideas may actually hinder innovation (Stuart & Podolny, 1996). Access and application of redundant knowledge, reduces the proliferation of novel idea generation within organizations. However the ease of communication within teams can also increase innovation. Kivimaki et al (2000) found that a participative climate and the absence of collaboration problems predicted higher patenting activity. These characteristics are common on homogeneous teams suggesting that homogeneous teams may actually be better at innovation than heterogeneous teams. Another argument in favor of homogeneous teams is the higher level of trust resulting from similar mental models. Dayan, DiBenedetto, and Colak (2009) found that managerial trust had a positive impact on team learning. Team learning should be expected to have a positive impact on innovation since greater information among team members and the ability to communicate that information should increase idea generation. Jackson et al, 1991

found that homogeneous teams have lower turnover than heterogeneous teams. Turnover would likely reduce communication and trust leading to lower innovation. However turnover can also break down organizational inertia and lead to a willingness to consider new ideas which could enhance innovation (Tripsas & Gavetti, 2000). As the brief survey of homogeneity shows, reasonable arguments can be found for and against the positive impact of homogeneity on innovation.

TMT Heterogeneity

Heterogeneity among top managers is likely to foster affective and cognitive conflict (Amason, 1996; Hsieh et al, 2010). Cognitive conflict occurs when managers disagree about the nature of the problem to be solved while affective conflict occurs when disagreements are viewed as personal attacks. For instance, disagreement about the approach for developing a new product would be cognitive while interpreting disagreement as a political power play would be affective (Hsieh et al, 2010). When conflict is cognitive, new product development is enhanced through the expression of divergent ideas (Hsieh et al, 2010; Julian, Wachter, & Mueller, 2009). However, heterogeneity that results in conflict becomes harmful in the implementation phase of product development (Hsieh et al, 2010). Srivasta and Lee (2005) found marginal support that TMTs with high tenure heterogeneity were more likely to be first movers. This suggests a delicate balance between problems with conflict and benefits from divergent ideas. Thus, while a new concept and preliminary research might increase innovative output, the failure to carry through developing new products might actually hinder innovative activity. While conflict may increase with heterogeneity, crises do not (Greening & Johnson, 1996). Since crises would be expected to reduce innovative output, the absence of these crises would remove a possible roadblock for heterogeneous teams to engage in innovation. Diversity may also reduce the quality of decisions by decreasing the extent to which problems are analyzed (Miller, Burke, & Glick, 1998). This finding runs counter to the view that diversity increases the number of alternatives considered and makes a strong counterargument against the causal relationship between innovation and diversity.

Social Capital Theory

Importation of top managers can benefit companies by increasing social capital within the firm. Social capital theory views networks and relationships as a valuable resource (Nahapiet & Ghoshal, 1998). Imported managers bring over their mental models from previous jobs but they also bring knowledge that may be difficult to obtain such as tacit knowledge from their previous employer. In two ways, these new managers can act as bridging ties to their previous employer. Bridging ties refer to relationships that occur outside of the organization, where individuals or groups in one company can form relationships with groups in other companies (Burt, 2000). Strategic alliances are an example of bridging ties. Imported managers still retain some relationships with their previous employer which may give them access to knowledge and resources. Additionally, the new manager also fills the function of a bridging tie by bringing information and resources from one company to another. Previous research has associated bridging ties with entrepreneurial orientation, and innovation (Burt, 2000; Stam & Elfring, 2008).

Strong ties are formed as the new manager brings over all of their knowledge, skills, and ability to the new company and also retains established relationships with their previous employer. Strong bridging ties allow managers to break core rigidities and extend their search for new ideas (Leonard-Barton, 1992; Podolny, 2001; Tripsas & Gavetti, 2000).

Simmelian ties also occur when top managers are imported. These ties occur when two parties connect to a third party which adds stability to the relationship and is also associated with increased innovation (Tortoriello & Krackhardt, 2010). These ties occur within the top management team through the interaction of top managers with the CEO who can arbitrate differences and maintain healthy relationships. However innovation isn't merely the result of the presence of ties but rather an outcome of what these ties allow executives to accomplish. First ties provide access to information exchange between parties. In this way, they act as pipes of information which can result in the discovery of new ideas (Podolny, 2001). This information can then be combined in new ways resulting in innovative products (Haragadon, 2002; Nahapiet & Ghoshal, 1998; Shu, Page, Gao, & Jiang, 2011).

Intraindustry and Extraindustry Importation

Research on the benefits and problems with teams and social capital theory provide a framework for understanding the possible outcomes of intraindustry and extraindustry importation. One way of viewing TMT heterogeneity is the industry from which top managers are hired. Employees can be hired from competitors, a related industry, or a completely different industry (Geletkanycz, & Hambrick, 1997; Yoo et al, 2009). Bringing in managers from the same industry with varying tenure is referred to as intraindustry importation while mangers brought in from different industries with varying tenure is referred to as extraindustry importation (Geletkanycz & Hambrick, 1997). Through intraindustry importation, managers familiar with the industry may bring different strategic approaches since no two companies are exactly alike. These new managers may view strategic issues through the lens of their previous organization's culture, which may have both positive and negative implications. On the other hand through extraindustry importation, the managers may use novel competencies to solve the same problems and initiate new strategic initiatives, thus enhancing strategic decision-making.

HYPOTHESES

Intraindustry Importation

Intraindustry importation occurs when managers from competitors or closely related industries are hired into the TMT (Geletkanycz, & Hambrick, 1997; Yoo, et al, 2009). These new employees bring new approaches to strategic problems by approaching their firm's strategic issues with the insights, culture, and mental models developed with their previous employers. The positive benefit provided by these new managers is that they can bring fresh insight to old problems and enhance learning through their interactions with other top managers.

Importation in general is also supported by the higher levels of innovativeness associated with lower average TMT tenure (Liu, Li, Hesterly, & Cannella, 2012). This finding lends credence to the view that newer team members will enhance innovation due to their open mindedness to new ideas. While their sample was not broken down into intra and extra industry importation, it suggests the likelihood of a relationship between heterogeneity and patents.

Further, new managers can break organizational inertia and core rigidities that result from a firm following a standard line of product development (Leonard-Barton, 1992; Tripsas & Gavetti, 2000). For instance, top managers might demonstrate less commitment to the status quo (Hambrick, Geltkanycz, & Fredrickson, 1993). With regard to research activity, new top managers might also bring new ideas, which in turn could increase the number of patents by the firm. The generation of new ideas is further enhanced by a greater diversity of views (Bantel & Jackson, 1989).

Newer managers will also be more active in environmental scanning (Cho, 2006). Although Cho examined scanning in the context of deregulation, environmental scanning increases do not need to be limited to special circumstances. In particular, for industries that produce patents, knowledge of the external environment is critical for being aware of new scientific developments, as well as what research competitors are engaged in. Increased scanning will uncover increased research opportunities and should have a positive impact on research output.

Social capital also increases innovation by adding access to information through external networks and the ability to recombine knowledge through internal networks (Haragadon, 2002; Nahapiet & Ghoshal, 1998; Podolny, 2001; Shu, Page, Gao, & Jiang, 2011). Gao et al 2008 found that absorptive capacity interacts with business ties to significantly increase innovation. Imported managers bring new knowledge and mental frameworks which increase absorptive capacity and they also bring relationships with former employers and strong ties within their organization. Podolny 2001 argues that strong ties are actually superior for firm innovation due to their superior informational benefits. Further, the addition of outside managers adds bridging ties with previous employers as well as bridges to the knowledge of those organizations through hiring their managers which also increases innovation (Hargadon, 2002). Further, bridging ties increase entrepreneurial performance which should have an indirect influence on innovation (Stam & Elfring, 2008). Finally, the presence of an internal mediator in the form of a CEO provides stability to the relationships between imported managers and long tenured managers as well as among other imported managers. These Simmelian ties, by providing stability, also increase the long term prospects for innovation (Tortoriello & Krackhardt, 2010). The access to new information through imported managers and the recombining of knowledge in new ways through the differing mental models of old and new managers provide the environment and the means for innovation. Thus it is argued that:

Hypothesis 1A*: Intraindustry importation will be positively related to higher patenting activity.*

Despite the previous arguments, a significant amount of theory and research offers an opposing view to the benefits of heterogeneity. For instance social cohesion was found to increase with tenure homogeneity (Michel & Hambrick, 1992). From a practical viewpoint the opposite argument applies as well. When tenure heterogeneity is greater less social cohesion should be present. For instance TMT fragmentation can result from tenure heterogeneity (Hambrick, 1995). When social cohesion is low and fragmentation occurs, harmful rivalries may emerge leading to a lack of trust and an unwillingness to share information (Mesmer-Magnus, & DeChurch 2009). However information sharing is critical for successful innovation. Additionally, Dayan et al 2009 found that trust enhanced team learning in high turbulence environments. Team learning then promotes innovative activity and should generally lead to more patents. However when trust is not present, team learning will be inhibited as members are less willing to share information and patenting activity should decline.

Similarly, fragmentation may lead to perceptions of team relationships. Liu, Keller, & Shih (2011) found that when team members are heterogeneous with respect to their perception of exchange relationships with the group, team performance is lower. When team members are newer, they may have different perceptions of their relationships with other team members than longer tenured teammates resulting in lower performance.

Team heterogeneity may also lead to greater conflict. When cognitive conflict occurs, innovation increases however when that conflict becomes affective, trust and information sharing will be stifled ((Amason & Sapienza, 1997; Richard & Shelor, 2002). Thus ideas are generated through cognitive conflict but may not be developed due to affective conflict.

Further, although heterogeneity is proposed to increase the diversity of idea generation, the opposite result may occur. For instance Miller et al (1998) found that team diversity reduced the extent to which teams utilized an extensive decision making process with regard to long and short term goals. Executives imported from other firms may hold different views of goals for the firm and of cause-effect relationships. As a result of these different goals and views, infighting and in group out group stereotyping can occur, lowering cooperation and information sharing and producing lower innovation. Kivimaki et al (2000) also found that patenting activity is higher when there are few problems in collaboration and when the climate is participative. However team heterogeneity can weaken collaboration and participation when opposing ideas and mental models produce conflict. Instead heterogeneity can lead to in group out group behavior where executives holding similar views collaborate with each other but not with the entire group.

Additionally, tenure diversity could have no impact on patenting activity. Wiersema & Bantel (1992) found no relationship between organizational tenure and strategic change. While this is different than research activity, strategic change can in some instances be associated with increased research activity. Their finding does not support the view that the cognitive diversity of new organizational members will have an impact.

Granovetter (1973) argues that weak ties are superior to strong ties for improving innovation. The point is that weak ties are more likely to have non redundant information and to be associated with structural holes. Structural holes occur when a party acts as a sole link between other parties allowing them unique access to information. Thus the strong ties that former employees have might not add much innovative value.

It could also be argued that the ties formed by imported managers might not be strong at all. For instance, if trust fails to develop, information sharing may not occur among managers, even when it is available. Further, imported managers will not necessarily have good relationships with their former employers. They may have departed under inauspicious circumstances such as being forced to resign or their former employer may resent their leaving for another company and think poorly of them. Rather than making the ties of imported managers weaker, these factors could make their ties non existent and actually decrease innovation by replacing stable ties of former managers with useless ties of imported managers. Further, the presence of ties is not sufficient to create innovation but requires both knowledge exchange and knowledge recombination (Haragadon, 2002; Nahapiet & Ghoshal, 1998; Shu, Page, Gao, & Jiang, 2011). When trust among managers fails to develop, knowledge recombination becomes much more difficult since the firm is left with a team of individuals rather than a group effort. For these reasons:

Hypothesis 1B*: Intraindustry importation will be negatively related to higher patenting activity.*

Extraindustry importation

Extraindustry importation occurs when top managers are hired into the company from another industry. Many of the previously discussed issues surrounding heterogeneity apply to managers brought in to the firm from different industries. However differences can also be found between managers from inside the industry and those from outside the industry. Geletkanycz and Hambrick (1997) found that strategic conformity was lower for managers from different industries. They further mentioned the possibility that innovation would be greater for the firm when managers come from outside the industry although this wasn't tested. Yoo et al, 2009 observed with regard to company resources that resource substitution was used as a strategy more frequently than resource imitation. Both of these differences suggest a greater likelihood of choosing a more radical strategic direction among these managers. One possible outcome could be that firms with higher percentages of managers from outside the industry will pursue new areas of innovation leading to increases in patenting activity. Finally, the addition of managers from industries that require different competencies may help the firm escape the competency trap and expand into new areas of innovation (Leonard-Barton, 1992; Tripsas & Gavetti, 2000).

From a social capital perspective, relationships outside the industry have greater potential to create unique relationships and structural holes since relationships with unrelated companies are less likely to be pursued. Since these ties would be non redundant, they would also be more efficient which has been associated with increased innovation (Kim & Park, 2010). These efficient bridging ties would also be strong ties given the previous relationships of imported managers and the actual knowledge they bring from their company and the strength of these non redundant ties further increases innovation (Podolny, 2001). Therefore, imported managers from outside the industry provide unique knowledge and connections which improve the conditions for innovation. Therefore:

Hypothesis 2A*: Extraindustry importation will be positively related to higher patenting activity.*

On the other hand, managers from other industries have less industry specific knowledge. They will have a greater amount of learning to catch up to the industry veterans. For an example in a related argument, Baysinger and Hoskisson (1990) argue that outside directors will rely on financial and measurable outcomes while inside directors will be more likely to focus on less measurable strategic goals and outcomes. The reason for this disparity is the knowledge difference between the two types of directors. In a similar vein, managers who have industry specific knowledge can make better informed judgments about the direction for company research. Further, lower conformity may commit the company to an uncertain future with a lower certainty of success. Since R&D is an inherently uncertain activity, the choice to diverge from the company's core competencies may actually hinder innovation (Leonard-Barton, 1992; Tripsas & Gavetti, 2000).

Further, social capital may never be realized for several reasons. First, managers coming from different industries will bring significantly different business approaches. The divergence of business approaches may increase conflict and lower trust. When trust is lowered, the unique knowledge brought by these extraindustry managers may not be accepted or conveyed destroying the value of their ties. Also the ability to recombine knowledge is critical for innovation; however the significantly different knowledge bases of these managers may make such recombination difficult or impossible. In a related article about alliances, Li, Eden, Hitt, and Ireland, 2008 discuss the benefits and difficulties in working with firms that are familiar and unfamiliar with a partner's operations. Partners unfamiliar with each others operations and

knowledge bases have much greater problems with creating new products. Similarly, managers that come from outside the industry should face greater difficulties working with managers due to lower familiarity with operations in their new industry. Therefore:

Hypothesis 2B*: Extraindustry importation will be negatively related to higher patenting activity.*

RESEARCH METHODOLOGY

Sample

The data for this study were gathered using the United States Patent Office (USPTO), Mergent Online, and the Edgar database. The USPTO provided patent information, the Edgar database provided data from 10K and Def14A statements that public firms are required to file, and Mergent Online provided financial data. The sample contains firms in four fields: pharmaceutical (SIC 2833, 2834, 2835, 2836), chemicals (SIC 2812, 2813, 2819, 2869, 2879, 2891), materials (SIC 2841, 2842, 2843, 2844, 2851, 2899) and computers (SIC 3572, 3578, 5045). These industries were chosen because they have high patenting activity and generally represent the tech sector of American business. All companies in the study are public firms; however the diversity of industries strengthens the claim for generalizability.

Data for the sample firms cover a 10 year period from 1997-2006 which includes the dot.com bubble and bust as well as legal changes resulting from the passage of the Sarbanes-Oxley act in 2002. The total number of firms in the sample is 290 companies and the size of the companies ranged from small to large since all publicly traded companies were included. The number of observations in the total sample was 1594 while the number of observations in the subgroups was 1145 for pharmaceuticals, 143 for computers, 209 for chemicals, and 97 for materials.

Measures

Dependent Variable. The dependent variable is total patents. This is measured as the number of number of patents each firm obtained for each year in the sample. While it is dangerous to interpret total patents too broadly, this measure has been associated with R&D activity in cross sectional and time series samples (Griliches, 1990). The focus in this paper is more on the inputs to innovation rather than innovation in totality and patents are frequently a first step in the development of new products.

Independent Variables. Intraindustry importation occurs when a manager comes from another firm but from the same industry whereas extraindustry importation occurs when managers are brought into the firm from outside of the industry. Following the methods used by Geletkanyz and Hambrick (1997) and Yoo et al (2009), intraindustry and extraindustry importation was adjusted for the number of years since their hire.

Importation was limited to top management hiring within the last ten years. However recency is likely to influence the impact of managerial importation. Therefore each hiring is adjusted by the formula 10 – years since hire/10. For example, a manager hired 4 years ago would receive a score of .6. Intraindustry and extraindustry importation is measured by the sum of importation for all managers in the TMT divided by TMT size.

Control Variables

CEO tenure has been posited to reduce R&D spending and lead to persistence in the same strategic direction (Henderson, Miller, & Hambrick, 2006; Kor, 2006). CEO tenure is calculated as the number of years the CEO has held that position with the firm.

CEO duality occurs when the chief executive officer is also the chairman of the board. Kor (2006) suggests that duality negatively impacts R&D spending. Duality is a dummy variable with 1 if duality is present and 0 otherwise.

Board tenure represents the average length of tenure with the firm for the board of directors. Following the literature on tenure which generally supports strategic persistence, board tenure is included as a possible drag on R&D investment (Cho & Hambrick, 2006; Kor, 2006; Walters, Kroll & Wright, 2006).

Outside directors have been viewed as an important check on managerial risk taking (Fama & Jensen, 1983). Others have seen positive benefits for R&D investment as a result of their influence however (Kor, 2006). Outside directors are represented by the percentage of the board composed of directors who are not employed by the company and have not been employed by the company for the prior five years.

Inside directors have greater knowledge of the firm than outsiders and may be able to see benefits from long term investment through R&D (Baysinger & Hoskisson, 1990). Inside director percentage has also been associated with higher R&D spending (Baysinger, Kosnik, & Turk, 1991). Inside directors include all presently employed directors as well as those directors who have been employed by the firm within the prior five years and are represented as a percentage of the board.

Earnings per share is calculated as (net profit – preference dividend)/number of common stock shares and provides a market measure of performance. This ratio reflects the amount of dollars an investor is paying for each dollar of earnings and is calculated as stock price/earnings per share. Since the stock price of a firm reflects future expectations as well as current assets and earnings, it is included as a measure since patents can reflect the potential for future earnings. Return on investment (ROI) measures the efficiency of an investment and is calculated as (Gain from investment – Cost of Investment)/Cost of investment. ROI is a frequently used measure to evaluate investments and is one of the measures that firms are likely to use in evaluating R&D investments.

R&D intensity is measured as R&D/Sales and should be highly associated with patenting activity. The Sarbanes Oxley Act (SOX) was passed in 2002. This act impacted the prescribed behavior of board members and may have created more risk aversion by board members concerned about poor investments (Arnold et al, 2007). The data set in this study includes the year 2002-2006. As such a dummy variable will be created for whether the firm year is pre SOX or post SOX with 1 representing SOX and 0 representing otherwise. Log Sales is included as a measure of firm size. Larger firms generally have more resources for research and firm size should be highly related to the number of patents.

Model and Estimation

The dependent variable in this study, total patents is a positive count variable with a mean of 8.58 and a variance of 900. Negative binomial regression is appropriate when the dependent variable is a count measure and when overdispersion is present (Greene, 1997). Negative binomial distribution takes the form: $\ln \lambda_i = \beta' x_i + \varepsilon$. The disturbance term ε can reflect

specification error or cross-sectional heterogeneity, λ_i represents the mean and variance of the distribution, and x_i is a vector of regressors.

In the context of panel analysis, another choice must be made between random and fixed effects. The general form of the panel regression equation is $y_{it} = i\alpha_i + X_i\beta + \varepsilon_i$ (Greene, 1997). The random effect model preserves degrees of freedom but assumes that individual effects are uncorrelated with other regressors. The Hausman test was used to determine which model is more appropriate (Greene, 1997). The null hypothesis that random effects was appropriate was rejected (p=.000). Therefore the model used in this analysis is a fixed effects negative binomial model.

RESULTS

Table 1 presents descriptive statistics and correlations. Table 2 provides the negative binomial regression results for patents. Four models are reported below. Model 1 includes only control variables. Model 2 adds intraindustry importation to the control variables. Model 3 adds only extraindustry importation to the control variables. Finally model 4 adds both forms of importation to the control variables.

Insert Table 1 & 2 Here

H1A predicted that intraindustry importation would lead to increases in patenting activity. The results were not significant for intraindustry importation in the partial .176 (p>.10) or the full 060 (p>.10) models. Extra industry importation was significant and negative in the partial -.407 (p<.05) and in the full models -.384 (p<.05) supporting H1B. Among the control variable, EPS -.010 (p<.10) and R&D intensity .000 (p<.10) were slightly significant in the full model while logsales .075 (p<.001) was highly significant in the full model.

One possible reason for the insignificant results for intraindustry importation is that the relationship is too indirect and that R&D or R&D intensity would provide more direct outcomes. As a check against this possibility, linear panel regression with fixed effects was run against both independent variables. Neither intraindustry nor extraindustry importation had significant impacts on R&D or R&D intensity.

Previous research has shown differences in patenting activity among different fields (Brower & Kleinknect, 1999; Schoenecker & Swanson, 2002). In both studies, the authors used a similar sample of fields as the current study. For this reason and in order to gather more fine grained information, subgroup analysis was performed on the four major fields in this dataset: pharmaceuticals, computers, chemicals, and materials. The results were surprising and different from the broad sample. Intraindustry importation was significant and negative for pharmaceuticals -.508 (p<.05) and significant and positive for computers 1.21 (p<.01). The other two fields were insignificant for intraindustry importation. Another surprising finding was that extraindustry importation was insignificant across all four fields in the subgroup analysis; however the direction was negative in all cases. An additional check of R&D intensity was run against all four subgroups and was insignificant in all analyses. Table 3 provides the negative binomial regression results for patents by industry.

Insert Table 3 here

DISCUSSION

No support was found for H1A or H1B that intraindustry impacted patenting activity in the main sample. However the subgroup analysis showed distinct industry effects. Specifically, significant negative impacts were found for intraindustry importation in the pharmaceutical industry and significant positive impacts were found in the computer industry offering support for both hypotheses. While it is possible that the mental models differ among executives in these industries, it seems more likely that other industry conditions produced this result. Perhaps knowledge diffusion is more difficult in the pharmaceutical industry since even the molecules are patented while the computer industry might leave room for more work arounds of patents. There might also be differences in access to social capital in the two fields. For instance in the related field of software, open source codes can be used across many companies and a good deal of collaboration among developers occurs. It may be that this climate caries over to the hardware sector to some extent. For the pharmaceutical sector, protection of information is critical since the drug development process is expensive and critical for company success. Thus the pipes and prisms of information flow in the networks of these two fields might be quite different (Podolny, 2001).

The results for intraindustry importation on chemicals and materials were positive but insignificant. Since the subgroup sample size was smaller for chemicals (N=209) and materials (N=97), the lack of significant results might be due to power. However, these industries might not have significant impacts from hiring executives in the same industry.

One possible reason for this finding is that managers from these fields may hold similar mental models and approaches broadly speaking. If this speculation is accurate, then new managers hired from inside the industry will use similar strategies and will not bring great change in patenting or other innovative areas. (Cho & Hambrick, 2006; Geletkanycz & Hambrick, 1997). Another possibility is that moderators such as discretion, compensation, and institutional support will reveal the relevance of intraindustry importation (Chen & Hsu, 2010; Cho & Hambrick, 2006; Wheatley & Doty, 2010). A third possible reason for the finding is that importation should be a moderator rather than a moderated variable. In this situation, the way that importation is used would cause the failure to find a significant result. Several studies have in fact used some form of tenure heterogeneity as a moderator (Alexeiv, Jansen, Van Den Bosch, & Volberda, 2010; Elenkov et al, 2005). Finally, no effect may have been found due to endogeneity and reverse causality (Hambrick, 2007). Many control and independent variables in top management studies bear close relationships. For instance, does innovation change because new managers were added or were new managers drawn to a culture that was becoming more innovative? In this case, the finding of no effect may not be accurate and the discovery of instrumental variables may reveal previously unfound differences.

Extraindustry importation was significantly negative in the main sample suggesting that bringing managers in from other industries hinders innovation supporting hypothesis 2B. However the subgroups revealed no significant relationships for the four fields. The significant result in the main sample is likely the result of all four subgroups having a negative relationship between extraindustry importation and patenting activity. In breaking the main sample into subgroups, statistical power was lost due to smaller sample sizes. It might be that larger samples would produce significant results in all of the fields. Another possibility is that importing managers from other industries might have no effect. This could be due to the function of the

managers who are hired. For instance, a CFO would be expected to have less impact on patents than a chief science officer and a CEO could have impact on the entire research process. It may be that executives hired from other industries are more likely to be generalists such as a CFO.

The finding of a negative impact of extraindustry importation in the full sample suggests that new managers from outside the industry will negatively impact patenting activity and by extension innovation in some cases. Several reasons for this result should be considered. One possibility is that bringing in managers from outside the industry is a bad idea. This result takes the study finding at face value that if you want innovation and research, you shouldn't hire managers from outside the industry. There is some validity to this view since managers from different industries are less likely to understand the products and markets of the industry they are entering. As a result, these managers are ill equipped to lead research and development into productive avenues. A second possibility is that certain types of managers are hired from outside the industry creating problems with endogeneity. Since companies know that extraindustry importation should not improve R&D due to the lack of managerial knowledge, the managers being brought in may function in non R&D areas such as accounting and finance. In fact, companies may hire these managers for the express purpose of increasing efficiency which could reduce R&D in favor of more certain outcomes. Finally, including moderators should reveal more detailed relationships and could possibly change the significance of the findings in this study.

From a practical position, companies need to be aware of the consequences of hiring managers from outside the industry. Some of these questions should be considered. If the company is hiring managers to improve efficiency, will they lose their innovativeness? If firms hire managers to bring a different perspective, will that perspective be productive or destructive? Will the mental models of the new hires be so different that they are unable to communicate effectively with other managers? Will conflict increase due to the differences between managers from different industries?

Limitations

As with any study, certain limitations are present. First, the sample of industries with high patenting activity may introduce a third variable, discretion, into the discussion. Firms with higher levels of innovative activity will probably also be firms with higher levels of managerial discretion. If this is accurate, we still know little about importation in low discretion environments. Secondly, this study did not attempt to examine any moderated relationships and so does not examine the phenomenon of importation at a more detailed level. Third, patenting activity is only one form of innovation and companies can still be innovative in other ways such as administrative innovations and process innovations, which are not frequently patented. Fourth, the issue of sample bias was not explicitly addressed in this study. We do not know the reason why specific managers were hired from outside the firm. Perhaps they didn't have a large qualified pool of candidates inside their company or possibly they were looking for a specific type of skill in their new hire. On the positive side, this study used panel data for a ten year period over 4 major fields and multiple industries which suggest that the results are generalizable. Additionally, board, TMT, and performance variables were considered in the study. While it is true that more controls could be included, the variables are representative of firm considerations of profitability, the makeup of the board, and the size of the firm. Finally, the

study added value by looking at the industry effects which revealed that the impact of imported managers may vary between industries, particularly pharmaceuticals and computers.

As the previous statements suggest, fruitful research avenues are opened up by parsing tenure heterogeneity into intraindustry and extraindustry importation. Previous research using moderators such as managerial discretion and managerial compensation may reveal more specific results for tenure heterogeneity. Further, using importation as a moderating variable may open up our understanding of heterogeneity by specifying the form of that heterogeneity more clearly.

Table 1. Correlations and descriptive statistics for the sample.

Variables	Average	Std. Dev.	Patents	IntraT	ExtraT	Duality	CEO Tenure	Board Tenure	Outside	Inside	SOX	EPS	ROI	R&D Intensity	Log Sales
Patents	8.58	30.00	1.00												
IntraT	0.25	0.24	-0.12***	1.00											
ExtraT	0.15	0.18	-0.04**	-0.28***	1.00										
Duality	0.56	0.50	0.11***	-0.19***	0.01	1.00									
CEO Tenure	7.60	7.66	-0.06***	-0.34***	-0.20***	0.26***	1.00								
Board Tenure	6.81	4.08	0.04	-0.42***	-0.25***	0.07***	0.57***	1.00							
Outside	0.74	0.62	0.04	0.03	0.01	0.02	-0.03	-0.05***	1.00						
Inside	0.27	0.16	-0.18***	-0.20***	0.08***	-0.01	0.12***	0.15***	-0.24***	1.00					
SOX	0.50	0.50	-0.01***	0.01	-0.06***	-0.05*	0.04	0.07***	0.05***	-0.14***	1.00				
EPS	2.08	24.59	0.03†	-0.10***	-0.01	-0.02	0.04	0.08***	-0.01	0.03†	-0.01	1.00			
ROI	-41.30	197.48	0.08***	-0.10***	-0.06***	0.04	0.08***	0.14***	0.01	0.05*	0.02	0.04*	1.00		
R&D Intensity	22.26	222.25	-0.03	0.05*	-0.05*	0.01	0.00	-0.04†	0.02	-0.02	0.03	-0.01	-0.05*	1.00	
Log Sales	3.63	3.32	0.36***	-0.19***	0.00	0.16***	-0.06	0.22***	0.04*	-0.18***	0.03	0.11***	0.24***	-0.22***	1.00

†p≤0.10, *p≤0.05, **p≤0.01, ***p≤0.001, using a two-tailed test with standard errors in parentheses.

Table 2 - Negative binomial panel regression of patents

	Model 1	Model 2	Model 3	Model 4
IntraT		0.176		0.060
		(.159)		(0.169)
ExtraT			-0.407*	-0.384*
			(0.178)	(0.188)
IndNum	-0.008	-0.007	-0.003	-0.003
	(0.012)	(0.012)	(0.012)	(0.012)
Duality	-0.016	-0.016	-0.022	-0.022
	(0.071)	(0.071)	(0.071)	(0.071)
CEOTen	0.006	0.007	0.005	0.006
	(0.006)	(0.006)	(0.006)	(0.006)
BoardTen	0.019†	0.021†	0.015	0.016
	(0.011)	(0.011)	(0.012)	(0.012)
BdOutside	0.035	0.015	-0.024	-0.028
	(0.579)	(0.575)	(0.576)	(0.575)
Inside	0.062	0.048	0.054	0.051
	(0.626)	(0.623)	(0.624)	(0.623)
SOX	-0.061	-0.059	-0.060	-0.059
	(0.041)	(0.041)	(0.041)	(0.041)
EPS	-0.010†	-0.010†	-0.010†	-0.010†
	(0.005)	(0.005)	(0.005)	(0.005)
ROI	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
R&D	0.000†	0.000†	0.000†	0.000†
Intensity	(0.000)	(0.000)	(0.000)	(0.000)
LogSales	0.077***	0.078***	0.075***	0.075***
	(0.018)	(0.017)	(0.018)	(0.018)
Constant	0.907	0.848	1.019	0.993
	(0.603)	(0.602)	(0.603)	(0.606)
LR chi^2	32.56***	33.72***	37.55***	37.72***
Δ chi^2		1.16	3.83	.17
Number of Observations				

†p≤0.10, *p≤0.05, **p≤0.01, ***p≤0.001, using a two-tailed test with standard errors in parentheses.

Table 3 - Negative binomial panel regression of patents by industry

	Pharma	Computers	Chemicals	Materials
Duality	-0.076	-0.233	0.192	0.143
	(0.088)	(0.230)	(0.157)	(0.157)
CEOTen	-0.002	0.024	- 0.011	-0.004
	(0.008)	(0.021)	(0.014)	(0.012)
BoardTen	0.008	-0.027	0.052**	-0.020
	(0.018)	(0.048)	(0.016)	(0.033)
BdOutside	0.688	0.916	-2.622	-2.869
	(0.645)	(1.290)	(1.891)	(8.506)
Inside	0.769	2.810†	-3.090	-2.290
	(0.694)	(1.500)	(2.010)	(8.623)
SOX	-0.082	0.513**	-0.302	-0.077
	(0.054)	(0.129)	(0.084)***	(0.087)
EPS	-0.000*	0.000	-0.004	-0.029
	(0.000)	(0.034)	(0.029)	(0.050)
ROI	-0.000	-0.002	-0.004*	-0.002
	(0.000)	(0.002)	(0.002)	(0.005)
R&D	0.002*	- 0.126	- 0.022*	- 0.747
Intensity	(0.000)	(0.245)	(0.011)	(2.020)
LogSales	0.108***	0.527***	-0.147***	-0.112
	(0.022)	(0.085)	(0.054)	(0.113)
IntraT	-0.508*	1.210**	0.239	0.265
	(0.223)	(0.433)	(0.409)	(0.518)
ExtraT	-0.333	-0.160	-0.335	-0.738
	(0.276)	(0.259)	(0.394)	(0.549)
Constant	0.582	-3.88*	5.806***	6.521
	(0.676)	(1.69)	(2.004)	8.636

†p≤0.10, *p≤0.05, **p≤0.01, ***p≤0.001, using a two-tailed test with standard errors in parentheses.

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