IMPACT OF TOP MANAGEMENT TEAM DIVERSITY ON FIRM INNOVATION

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Abstract: The success and failure of companies can be attributed to many causes, but innovation is often cited as one of the key factors. Innovation can be defined broadly as the successful exploitation of new ideas (Nathan & Lee, 2013). Though innovation has been found to be a strong predictor of a firm's future returns, factors contributing to successful corporate innovation are not fully understood. One area recently attributed to innovation is diversity. According to Joshi & Jackson (2003), diversity can be defined as "the distribution of personal attributes among interdependent members of a work unit." As diversity propels ideas and perspectives from different people, the creativity process is energized and thus, innovation rises. Innovation can be further influenced at the top management team (TMT) level given the ability of this group to define the direction of the firm. The purpose of this study is to assess whether diversity at the TMT level drives firm innovation. This research question is tested using a sample of S&P 500 firms over the period 2010-2017. Innovation is measured by patent filings and citations. The empirical results show diversity traits such as tenure, culture, education and political affiliation do positively influence innovation. Gender, age and job diversity were found not to be significant.

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CHAPTER I

INTRODUCTION

Over the last two decades, we have seen the fall of powerful companies, such as Blockbuster Video, Blackberry and Polaroid, once seen as corporate icons, due to their lack of innovation (10 companies that failed to innovate, 2014). Innovation, which can be defined broadly as the successful exploitation of new ideas (Nathan & Lee, 2013), can be influenced by many different factors, such as development costs, new product complexity, creativity, risk tolerance and regulatory environment. However, one area that has been recently attributed to innovation is diversity. According to Joshi and Jackson (2003), diversity can be defined as "the distribution of personal attributes among interdependent members of a work unit." As diversity propels ideas and perspectives from different people, the creativity process is energized and thus, innovation rises. The purpose of my study is to assess whether diversity at the top management team level drives firm innovation and if so, what are the most important diversity attributes.

My intention is to look at the impact of diversity at the top management team (TMT) level given the ability of this group to define the direction of the firm. Finkelstein, Hambrick and Cannella (2009) define TMT as a relatively small group of individuals at the top of an organization, such as the CEO and those who report directly to him or her. TMT members can encourage employees to think creatively and even set corporate policies and diversity

targets to support the development of new ideas. A Harvard study shows that when an individual in a team shares a common trait with the end user, the entire team better understands the end user. As a result, those firms with a diverse leadership can out-innovate and out-perform others (Hewlett, Marshall & Sherbin, 2013). Likewise, a study conducted by Boston Consulting Group (BCG) and the Technical University of Munich found a positive relation between the diversity of company's management teams and their financial performance driven by the introduction of innovative products and services. The study identified industry background, country of origin, career path and gender as the top 4 diversity attributes that positively correlate with innovation. Age diversity was found to have a negative relation while academic background has no effect on innovation (Lorenzo, Voigt, et al, 2017).

In the last decade, innovation has become one of those buzz words that any firm must adopt in their corporate culture. After all, innovation has even been found to be a strong predictor of a firm's future returns. Hirshleifer, Hsu and Li (2013) developed a measure of innovation called innovative efficiency (IE) and after studying public US firms for the period 1981 to 2006, they found those firms that exhibit higher IE tend to have on average higher subsequent market valuations and superior future operating performance and stock returns. It is not surprising then that many scholars have been researching the concept of innovation extensively to understand what drives this construct. Hirshleifer, Low and Teoh (2012) conducted a study on managerial overconfidence and found those firms managed by overconfident managers exhibit a greater innovative activity as measured by research & development expenditures and patents and citations. Baranchuk, Kieschnick and Moussawi (2013) took a different approach by looking at managerial incentives. They

studied a sample of 360 US firms that went public from 2001 to 2004 and found a positive relation between a firm's innovative activity and managers' incentive compensation based on unexercised options. Chang, Fu, Low and Zhang (2015) performed a similar study to understand the impact of non-executive stock options on corporate innovation. They defined non-executive employees as all employees except the top five executives in a firm and also found a positive relation between these two constructs. Sunder, Sunder and Zhang (2017) explored the concept of innovation from a psychology perspective and determined sensation seeking is associated to a greater innovative output. Sensation seeking was tested through participants' hobby of flying airplanes and was defined as the pursuit of new, intense and diverse activities along the hazard to experience such activities. Then, Mayer, Warr and Zhao (2018) examined corporate policies and found that those policies that promote diversity enhance firms' ability to innovate.

This study contributes to the existing literature in two streams, innovation and diversity. First, to the best of my knowledge, this is the first study linking innovation to TMT diversity using factual diversity attributes and actual patent data. As shown in the next section, previous studies linking these two constructs have relied on surveyed data. As surveys are dependent on participants' input, a major concern regarding respondent bias is present threatening the validity of the findings (Buil, Chernatony & Martinez, 2012). Secondly, this study covers a broad spectrum of the U.S. economy by targeting the S&P 500, which represents over 80% of the U.S. market value and over one-half of the global stock market (Gunzberg & Edwards, 2018). Previous innovation studies have focused either in a specific sector of the economy or countries other than the U.S. Third, this study includes diversity traits on top management such as gender, age, tenure, education, job and cultural

diversity as well as political affiliation, which has not been included in prior studies. People's political orientation has been found to influence their personal and professional economic decisions (Han, 2018). The purpose of this study is to assess whether diversity at the TMT level drives firm innovation and if so, what are the most important diversity attributes.

CHAPTER II

LITERATURE REVIEW

To gain a solid understanding on the impact of TMT diversity, the existing research has been examined from two different strands of literature: innovation and firm performance. By doing so, gaps in research have been identified and addressed with this study.

TMT Diversity and Innovation

Bantel and Jackson (1989) studied the relation between social composition of top management teams and innovation. The authors examined traits such as age, tenure, education and functional background. TMT members from 199 banks were interviewed to collect the data. Their findings included a positive relationship between education and diversity in functional background and innovation. Talke, Salomo and Rost (2010) studied how top management team diversity influences firm performance by focusing on innovation fields. Innovation fields were defined as multiple innovation projects often related by a common attribute (e.g. customer, core competence, technology, etc.). The findings show TMT diversity does affect firms' strategic decision to focus on innovation

fields. The study included participants from 10 manufacturing industries representing 17 countries who were interviewed to gather the data. The study was restricted to firms with a dominant or single-product business to ensure firms' performance is reflective of their strategic choices. Then, Talke, Salomo and Kock (2011) extended this study to analyze how TMT characteristics influence a firm's strategic innovation orientation and how this relates to innovation outcomes and firm performance. Strategic innovation orientation represents the collective guidance and direction that enable sustainable competitive advantage. Diversity attributes included education, functional, industry and organizational background. The authors found TMT diversity is positively related to a firm's innovation orientation. The authors acknowledged the limitations of this study due to the restricted focus (e.g., manufacturing, single product) and suggested broader studies and longitudinal in nature. This study helps to address the gap identified by that limitation.

Ostergaard, Timmermans and Kristinsson (2011) performed a study to analyze the relationship between employee diversity and innovation based on gender, age, ethnicity and education. Their findings include a positive relationship between diversity in education and gender and innovation, negative relationship of age diversity and no relationship of ethnicity on the likelihood to introduce an innovation. Furthermore, their study found a positive relationship between an open culture towards diversity and innovation. The data for their study was based on an innovation survey distributed to 4136 Danish firms resulting in a response rate of 42.9%. Bozinelos and Hoyland (2014) studied the impact of cultural diversity among owners and partners on firm performance in terms of innovation, commercialization and sales orientation. Their study used a

sample of 7,600 London-based firms between 2005 and 2007 and found cultural diversity does result in greater innovation. However, this positive effect did not translate in better commercialization or greater growth.

Yoon, Ji Kim and Song (2016) studied the characteristics of top management team that drives organizational creativity. Organizational creativity was defined as the creation of a valuable, useful new product, service, idea, procedure or process by individuals working together in a complex social system. Their study found a significant positive relationship between functional diversity and organizational creativity. However, size of the TMT and the average age of the TMT was found negatively associated with organizational creativity. The data for this study was based on a survey conducted with 1,500 employees from 47 Korean firms. Likewise, Ruiz-Jimenez, Fuentes-Fuentes and Ruiz-Arroyo (2016) studied the impact of gender diversity at the TMT level on the relationship between knowledge combination capability and organization's innovative performance. Knowledge combination capability was defined as individuals' ability to absorb and integrate knowledge. Innovative performance refers to the impact of the innovation activities and the organization's ability to adopt and implement new ideas, processes or products successfully. Their study used a sample of 205 small- and medium sized firms from the Spanish technology industry and found gender diversity to positively moderate the relationship between knowledge combination capability and innovation performance. Han (2018) studied the impact of CEOs' political preference on corporate innovation. The study found firms with Republican CEOs are less likely to innovate as measured by the number of patents and their citations. This

study covered the period 1991 to 2004 to leverage an existing database that provided data for the similar period.

The review of the existing research on TMT diversity and innovation provides valuable insights on their methods and findings but there are shortfalls, which are addressed on this study. First, prior studies on TMT diversity collected data on diversity traits using surveys or questionnaires. Participants' responses to a survey may be influenced by many factors resulting in response bias and affecting the validity of the findings. This study calls for the use of archival data from recognized sources to minimize these issues. Secondly, surveys were conducted at one point in time. As a result, no time series variation has been captured by these studies. This is critical as the impact of both constructs, diversity and innovation, are realized over time. Third, the studies described previously were conducted for a specific sector of the U.S. economy or another country. As the U.S. is the largest economy on the world (The World's biggest economies in 2018), it is critical to understand how these variables play on this market. Finally, as TMT members are responsible for corporate decisions and the strategic direction of the firm, it is critical to study the impact of top management diversity traits, such as political affiliation, on firm innovation.

TMT Diversity and Firm Performance

Knight, et al (1999) conducted a study to understand how TMT diversity and group processes influence strategic consensus. Strategic consensus was defined as the degree to which individual mental models of strategy overlap. The study tested diversity traits such as functional background, age, education and employment from TMT

members of 83 high-technology companies located in the mid-Atlantic region of the U.S. The study found TMT diversity has a negative impact on strategic consensus and suggested few avenues of future potential research, including further understanding of the impact of culture on consensus.

Kilduff, Angelmar and Mehra (2000) examined the link between TMT diversity and firm performance. Specifically, the authors tested the relationship between demographic and cognitive team diversity and then, the impact of diversity and firm performance. The study found no evidence of any effect of demographic diversity, which includes traits such as nationality, functional background and age, on measures on cognitive diversity. The study was conducted through a Markstrat simulation, which is a game where players compete against each other in a consumer entertainment market. Participants were recruited from students attending an executive education program. Tihanyl, Ellstrand, Daily and Dalton (2000) studied the impact of TMT diversity on firm international diversification and found some diversity traits such as age, tenure, education and international experience are positively related to international expansion. Their study was focused on the electronics industry as the authors assert the U.S. electronics industry significantly increased their international operations during that time.

Carpenter (2002) studied the link between TMT diversity and firm performance and found a positive relationship that is dependent on complexity and gets stronger on short-tenure TMT members. Diversity traits tested included education, work experience and tenure. Complexity was tested through a firm's international strategy and was defined as the degree to which a firm depends on foreign markets for revenues and owned-factors of production. Therefore, firms lacking data, such as international

strategy, were excluded resulting in a final sample of 247 firms. The authors acknowledged the impact of other sources of complexity, such as firm- or environment-driven which could be subject of future studies.

Cannela, Park and Lee (2008) studied the link between TMT functional background diversity and firm performance. Two types of functional diversity were identified: dominant, which was defined as the functional area where a TMT member has spent most of the time, and intrapersonal, which was defined as the average breadth of functional experience. In conducting this study, the authors introduced the concept of TMT member colocation, which was defined as the proportion of TMT members working at the same physical address. The authors found a positive relation between functional diversity and firm performance, which is positively moderated by TMT member colocation. Buyl, Boone, Hendricks and Matthyssens (2011) also studied TMT functional diversity and firm performance and concluded CEO characteristics do positively moderate this relationship. CEO characteristics included functional background, status as founder, and shared experience with other team members. The study was conducted on a final sample of 54 Dutch and Belgian IT firms by using structured interviews with the CEOs along questionnaires distributed to other TMT members. Dezso and Ross (2012) studied the impact of women in top management on firm performance. The authors conducted a 15-year panel study from 1992 to 2006 on S&P firms and concluded female representation does improve firm performance but only to the extent a firm's strategy is focused on innovation. The authors explain that under such conditions, the informational and social benefits of gender diversity will benefit managerial performance.

Homberg and Bui (2013) performed a meta-regression analysis (MRA) of 53 empirical studies to understand the impact of TMT diversity on managerial decision. Diversity traits examined included functional, educational, tenure and gender. Their findings do not show a link between these two constructs but rather evidence for publication bias. The authors stated the results do not imply diversity efforts must be terminated but rather having just a diverse workforce may not generate the expected benefits. The authors also shared some of the limitations, including additional modeling analysis, the use of MRA as the analytical tool and strong reliance on data reported in primary studies. Authors confirmed such limitations open the possibilities for future research. Nielsen and Nielsen (2013) studied TMT nationality diversity and firm performance. The study was conducted on 146 Swiss firms representing 32 industries. The authors found a positive relation between nationality diversity and firm performance, which is stronger in the presence of longer tenure teams, highly internationalized firms and munificent environments. The authors state munificence refers to the extent an environment can support sustained growth thus enabling the generation of slack resources which in turn can protect organizations from external threats.

An examination of the extant research on TMT diversity and firm performance reveals conflicting results on these studies which then indicate the need to perform a more comprehensive analysis. Such study should be inclusive of variables such as cultural diversity and gender which have been studied in isolation. In addition, the use of a panel study should provide an understanding of how each of these variables change over time. This study addresses both of these issues by including common diversity traits

such as age and gender but also uncommon traits like cultural diversity and political affiliation over an eight-year panel study.

CHAPTER III

THEORY AND HYPOTHESIS DEVELOPMENT

Upper echelons theory states managers' strategic decisions may be influenced by their individual characteristics and these strategic decisions will influence firm performance (Hambrick & Mason, 1984). There are several models to explain the decision-making process in an organization (Daft & Weick, 1984; Nutt, 1984; Van de Ven & Ferry, 1980) but in general these models follow this path: 1) problem identification and formulation; 2) exploration, formalization, and problem solving; and 3) decision dissemination and implementation. Managers' individual characteristics may influence each of these phases. When identifying and formulating a problem, managers may arrive to a different understanding based on the information provided. As a result, the team of decision makers (e.g., top management team) can draw a more accurate picture of the problem. Then, as the team attempts to solve the problem, the team composition may influence the number, variety and quality of solutions to be considered (Bantel & Jackson, 1989).

The relationship between team composition and innovation can be analyzed from two different views. First, the psychological view, which is based on the role of

cognitive resources in group problem solving. This view states that groups consisting of people with a greater level of knowledge, a variety of skills and ability perform better than groups with lower level of these resources when dealing with complex problems where creativity is required. The second view is derived from the organization demography literature, which is based on the impact of team heterogeneity in organizational processes. This view states that organizations benefit from team diversity when facing complex problems (Bantel & Jackson, 1989).

The benefit behind diversity is also supported by resource-based theory (RBT), which states organizations consist of valuable resources and diversity is deemed to be a valuable, rare and inimitable resource that enhances the firm's competitive advantage (Yang & Konrad, 2011). This statement is documented by meta-analysis studies conducted at the group level where a variety of perspectives in a diverse group was found to be beneficial when creativity was needed to solve complex problems. At the firm level, greater gender and race diversity also resulted in better outcomes when innovation and creativity were required. Indeed, firms with access to a greater variety of knowledge resources have been found to be more effective innovators (Yang & Konrad, 2012) and knowledge, which is an intangible resource, enables the achievement of a sustainable competitive advantage (Nonaka & Takeuchi, 1995).

To ensure innovation can flourish, a culture of innovation is critical and this requires a supportive management, communication and teamwork, structural flexibility, empowered employees and risk-taking (Ismail & Abdmajid, 2007). This is where the top management team of a firm is critical as senior executives, TMT members, can provide support for these elements so that different views, employee involvement and risk-taking

are appreciated and encouraged. As a result, it is critical to have diversity at the TMT level. Having TMT members from different genders will ensure different perspectives can be brought into the innovation process. Extant research has shown the presence of female members in top management does have an impact in their firms. Peni and Vahamaa (2010) found female chief financial officers (CFOs) follow more conservative earnings management strategies. A recent study performed by Zalata, Ntim, Aboud and Gyapong (2017) found female CEO's engage less in classification shifting, a form of earnings manipulation, than their male counterparts after the passage of the SOX Act. Women have also been associated with greater accounting returns (Pletzer, Nikolova, Kedzior, & Voelpel, 2015) though their impact on firm performance has been mixed (Smith, Smith & Verner, 2006; Darmadi, 2013). Previous studies have determined the presence of gender diversity contributes to a greater variety of perspectives. After all, women add to the diversity of life experiences among TMT members and provide additional insights into key strategic topics especially those that relate to female consumers, employees and business partners (Dezso & Ross, 2012). As a result, my first hypothesis comes as follows:

H1: There is a positive relation between TMT gender diversity and firm innovation

Similar to gender, age heterogeneity provides different views and perspectives. Group of members from different age cohorts most likely have been exposed to different social, political and economic events, which in turn have shaped their attitudes, beliefs and values. As a result, teams consisting of people from different ages should be able to provide different views and interpretations of problems and thus, more likely to drive

innovation (Bantel & Jackson, 1989). Therefore, my second hypothesis comes as follows:

H2: There is a positive relation between TMT age heterogeneity and firm innovation

Tenure heterogeneity can be determined by cohort groups classified by their professional tenure. Similar to age heterogeneity, where cohort groups are classified by age, tenure heterogeneity can bring different perspectives and views into an organization. TMT members with long work experience may bring a set of skills needed for the success of the organization. However, prior studies have also shown teams tend to become more isolated the longer the members' tenure (Katz, 1982). Therefore, a variety of TMT members' tenure is critical to achieve the right balance of cognitive and communication skills into the team. As a result, my third hypothesis is developed as follows:

H3: There is a positive relation between TMT tenure heterogeneity and firm innovation

Consistent with previous studies (Bozinelos & Hoyland, 2014; Ostergaard, Timmermans & Kristinsson, 2011), I posit cultural diversity has a positive effect on innovation. As people are exposed to different cultures, they assimilate a different set of values that will have a strong impact on their behaviors (Luijters, van der Zee & Otten, 2008). As a result, cultural diversity will increase the number of views and perspectives in an organization, which may result in novel ways to solve problems. Watson, Kumar and Michaelsen (1993) performed some empirical research using experiments to test problem solving abilities of groups with different degrees of cultural background. After this 17-week study, they found the heterogenous groups performed better than the

homogeneous groups once communication barrier issues were overcome. As a high level of diversity on this aspect may result in communication issues and dysfunctional conflicts (Bantel & Jackson, 1989), it is critical to keep the right balance of variety of cultural backgrounds. Therefore, my fourth hypothesis is developed as follows:

H4: There is a positive relation between cultural diversity at the TMT level and firm innovation

Job diversity is driven by a variety of working experience brought by each TMT member. That diverse work experience may shape a member's cognitive and attitudinal perspectives, which in turn it can be translated in different types and levels of knowledge. Thus, top management may benefit as vigorous group discussions are conducted among team members resulting in more creative solutions (Yoon, Kim & Song, 2016). Hence, my next hypothesis comes as follows:

H5: There is a positive association between the variety of TMT members' working experience and firm innovation

A greater level of education should enable an individual's ability to solve more complex problems. After all, the level of education indicates a person's knowledge and skill base (Hambrick & Mason, 1984). As a result, a variety on educational backgrounds in team members should provide the team with greater cognitive abilities and mental maps and thus, improve the decision-making process and enable the implementation of more appropriate strategies in a firm (Yoon, Kim & Song, 2016). Therefore, next hypothesis is developed as follows:

H6: TMT education diversity is positively related to firm innovation

Research has shown individuals' political ideology could influence several dimensions of their economic behavior. This is also supported by behavioral consistency theory which states individuals are expected to behave consistently across situations (Cronqvist, Makhija & Yonker, 2010). Hong and Kostovetsky (2012) found money managers' personal political preferences influence their investment decisions. They particularly found mutual fund managers who are identified with the Democratic party hold less of their portfolios in companies that are deemed socially irresponsible (e.g. tobacco, guns or defense firms or companies with bad employee relations or diversity records) relative to those money managers affiliated with the other political party. Hutton, Jiang, and Kumar (2014) found Republican managers are more likely to adopt conservative corporate policies, which is consistent with their conservative personal ideologies. Therefore, adopting conservative policies may result in risk aversion but a liberal position may also result in excluding potential profitable investments (Hutton, Jiang & Kumar, 2014). With this in mind, my last hypothesis comes as follows:

H7: There is a positive relation between the variety of TMT members' political ideologies and firm innovation

CHAPTER IV

METHODS

Data and Sample

Data were extracted from multiple sources. First, the population for this study includes large firms in the S&P 500 industrial index for the period 2010 to 2017. These firms were selected as the S&P 500 is considered a proxy for the U.S. market and represents about 80%-85% of the U.S. stock market capitalization (Gunzberg & Edwards, 2018). The 8-year time period from 2010 to 2017 was selected to ensure findings would be timely relevant. As this study is attempting to understand the impact of diversity on firm innovation, it is critical to understand how long it takes for a firm to achieve diversity in their top management. A study conducted by Harvard Business Review shows it took eight years for an accounting firm to lower the turnover among women and increase the proportion of female partners to some noticeable levels. It also mentions improvement in the proportion of ethnicity groups takes about five years as the result of active diversity management (Dobbin & Kalev, 2016).

Diversity

To obtain the diversity measures, the starting point was to identify members of the

top management team in ExecuComp database, which provides company name, company ID (GVKEY), executives' names, title, age, gender and compensation rank among other datapoints. The sample was restricted to the top five executives based on their compensation ranking. Previous studies have determined that top management team has a median size of five (Birley & Norburn, 1987). Chang, Fu, Low and Zhang (2015) also defined non-executive employees as all employees except the top five executives in a firm. It is also important to mention that data gathering efforts were labor intensive and therefore, the need to keep the study restricted to a sample size that could be manageable. Then, a manual search was conducted in the BoardEx database to extract additional measures for each executive related to work experience and educational background. Work experience measures include total tenure, number of years with current employer and number of companies each individual has worked for. Educational background measures include the name of the institutions each executive attended for their bachelor's, master's and Ph.D. degree, if applicable.

Cultural diversity has been found difficult to measure due to the lack of reliable official resources to measure this construct. Several proxies have been used such as language spoken at home, ethnic group, ancestry and country of birth (Octaviano, Bellini & Manglietta, 2007). For the purposes of this study, the country where the executive attended to earn his or her bachelor's degree was used as a proxy for cultural diversity. As a result, a search was conducted to identify the country where the undergraduate institution is located based on the institution name pulled from BoardEx. Then, countries were classified by regions according to the global taxonomy provided by the Inglehart

Welzel cultural map of the world. This map classifies countries based on closely linked cultural values ("The WVS Cultural Map," 2012).

Next, information on each executive's political contributions were extracted to determine political affiliation. Consistent with prior research, political contributions provided by the Federal Election Committee (FEC) was used to determine executives' political orientation (Hong & Kostovetsky, 2012; Hutton, Jian & Kumar, 2014; Han, 2018). Using executives' names and company names obtained from Compustat, a manual search was performed using the Donor Lookup database available at opensecrets.org. Data from this database is sourced from the FEC and represents contributions from all individuals who contribute at least $200. An executive may be classified as Democrat, Republican or Republican/Democrat based on their annual contributions. If no contributions are found in a given year, contributions from prior or subsequent years were used as a proxy. If no contributions are found in any year, then no political affiliation were attributed to the executive.

Innovation

Patents are the most important measure of contemporary firms' innovative output. Numerous studies have used patent data as a proxy for innovation (Mayer, et al, 2018; Sunder, et al, 2017; Chang, et al, 2015; Baranchuk, et al, 2013; Hirshleifer, et al, 2012, 2013). Using patent data provides several advantages such as highly detailed information on the invention, large number of patents, continuity since patents have been granted since the late 18th century, and availability of information including citations to previous patents and to the scientific literature (Hall, Jaffe & Trajtenberg, 2001).

Furthermore, patent data provides insights in a firm's long-run inventive ability (Griliches, Pakes & Hall, 1988). As a result, my first measure of innovation is the number of patents applied by a firm in a given year. However, as previous research has also indicated, a simple count of patents is an imperfect measure of innovation as patents may have a significant difference on their technological and economic impact. As a result, the number of subsequent citations received by patent are often used as a measure of the relevance of such patents (Chang, Fu, Low & Zhang, 2015). That is, the count of patents represents a measure of innovation quantity (output) whereas the number of citations captures innovation quality. Data on patent and as well as patent citations were extracted from the database available at the US Patent and Trademark Office (USPTO). When examining patents, there are two important dates to consider: the patent application year and the grant year. The former is the most relevant date for the purposes of my study because it is closely related to the time the actual innovation is made.

Patent data are subject to two types of truncation biases. First, there is, in average, two-year lag between a patent's application date and grant date. Because patents are included in the database only if they are granted, those patents that were applied for but still under review by 2017 are missed from my data. The second truncation bias affects citations as those patents granted in the later years of the sample will have less time to accumulate citations. As a result, to address this truncation bias, patent counts are multiplied by a weighting index based on the application-grant empirical distribution. Citation counts are adjusted with a weighting index determined through a quasi-structural approach based on the shape of the citation-lag distribution (Hall, Jaffe & Trajtenberg, 2005). Another issue affecting patent data refers to the

difficulty in matching the names of patent assignees to company names provided by the ExecuComp database. Assignees may apply for a patent under their own name or one of their subsidiaries or even a different name for strategic reasons. To make things worse, spelling mistakes and abbreviations further complicate this matching task. Previous research has included a disclaimer so users understand results should be viewed with some caution due to matching errors and omissions (Hall, Jaffe & Trajtenberg, 2005).

Other Firm Data

Firm-level accounting variables were extracted from Compustat including Net Sales, Pretax Income, Net Income Before Extraordinary Items and Discontinued Operations, Total Assets, Total Debt, Long-Term Debt, Total Equity number of employees and Research & Development Expenditures.

Study Design

Drawing on the definition of employee diversity provided by Ostergaard, Timmermans and Kristinsson (2011), TMT diversity is defined as the distribution of differences among the TMT members of a firm with respect to a common attribute. To test the effects of TMT diversity on firm innovation, the following multivariate regression analysis is used:

$$\boldsymbol{Firm\ Innovation}_{i,t} = \propto_0 + \sum_{j=1}^{n} \boldsymbol{\beta}_j\ \boldsymbol{TMT\ Diversity}_{j,i,t} + \sum_{k=1}^{m} \boldsymbol{\gamma}_k \boldsymbol{X}_{k,i,t} + \ \boldsymbol{\varepsilon}_{i,t}$$

where the dependent variable refers to the measure of innovation of firm i at time t. Patents and citations are scaled as described earlier providing two innovation measures so that two models could be run for robustness and confidence. The independent variables consist of seven diversity attributes ($TMT\ Diversity_{j,i,t}$) indexed by *j* and measured for firm i at time t; and the vector of the control variables ($X_{k,i,t}$) and ε is the error term. Similar equation has been used in previous studies (Sunder, Sunder & Zhang, 2017; Chang, Fu, Low & Zhang, 2015).

TMT diversity is measured through several diversity attributes by using the Herfindahl-Hirschman Index (Blau, 1977), which has been used consistently in numerous diversity studies (Talke et al, 2010 and 2011; Bantel & Jackson, 1989; Nielsen & Nielsen, 2013; Carpenter, 2002). This index is determined as:

$$B = 1 - \sum(P_i)^2$$

where P_i is the percentage of individuals in the i^{th} category with the higher the score, the greater TMT diversity on that specific attribute (Carpenter, 2002). The theoretical maximum value of Blau's index can be computed as (i-1)/i where i represents the number of categorical variables. A standardized version of the Blau's index that ranges from 0 to 1, regardless of the number of categories, was obtained by dividing the Blau's index by the theoretical maximum value (Teachman, 1980; Agresti & Agresti, 1978).

The distribution of continuous variables, such as age, tenure and job diversity was analyzed to enable the setting of categories based on cohorts as explained in the Theory and Hypothesis Development section. Independent variables include Gender, Age

Diversity, Tenure Diversity, Cultural Diversity, Job Diversity, Education Diversity and Political Diversity and are defined as follows:

- Gender Diversity (Gen_Div): extent to which TMT members are evenly distributed across genders.
- Age Diversity (Age_Div): extent to which TMT members are evenly distributed across age cohorts
- Current Tenure Diversity (Cur_Ten_Div): extent to which TMT members are evenly distributed across cohorts of tenure in their current job
- Total Tenure Diversity (Tot_Ten_Div): extent to which TMT members are evenly distributed across cohorts of tenure through their professional career
- Cultural Diversity (Cul_Div): extent to which TMT members born or studied in different countries
- Job Diversity (Job_Div): extent to which TMT members are evenly distributed across the number of jobs hold by each executive
- Education Diversity (Edu_Div): extent to which TMT members hold diverse education levels.
- Political Diversity (Pol_Div): extent to which TMT members are evenly distributed across political affiliations.

The dependent variable is innovation and, as mentioned before, innovation measures are proxied using patents and citations and scaled accordingly to address truncation issues:

- Patents (Pat): count of patents applications.

- Scaled Patents (Scaled_Pat): patents scaled by a weighting index based on the application-grant empirical distribution.
- Citations (Cit): number of citations subsequently received by a patent.
- Scaled Citations (Scaled_Cit): total number citations received in life by each patent sorted out by their application year.

Since a variety of factors can influence firm innovation, numerous control variables have been included consistent with existing research such as firm size (natural logarithm of total assets); capital intensity (ratio of net property, plant and equipment to the number of employees); cash holdings (cash-to-asset ratio) and leverage (debt-to-asset ratio). In addition, industry growth rate has been incorporated into the model as industry life cycle may impact the level of innovation in some industries. All control and diversity variables are lagged by one year. Panel regression methodology is used to estimate the regression equation.

Summary Statistics

Table 1 provides information on diversity attributes for the sample of members from the top management team. Over 90% of the executives are male and over 50% are 50 to 60 years old. Over 50% hold master's degree and the great majority, over 90%, are from English-speaking countries. Societies from English-speaking countries place strong emphasis on traditional and self-expression values. Traditional values include religion, parent-child relationships, respect for authority and family. Self-expression values are characterized for an increasing tolerance for different society groups, such as foreigners,

gays and lesbians and gender equality as well as an increasing demand for participation in decision-making process in politics (Haerpfer & Kizilova, 2016). Over half of the executives have held one to four jobs and nearly 85% of these top management executives have been in their current job not more than five years. Over 40% have around 10 to 25 years of work experience while around one third have worked somewhere around 25 to 35 years. About 26% have contributed to the Republican party while about 17% have supported the Democratic party. Table 2 shows the distribution of patents across industries. Over 47% of the patents are generated by the electrical, electronic, computer and industrial equipment industry followed by the finance, insurance and real estate industry which generates 32% of the patents. Public administration and the oil and chemical industry follow with 6% each.

Table 3 reports descriptive statistics, including means, medians and standard deviations of the variables used in this study. At the firm-year level, an average firm has 52,000 employees; has book value of assets of $65,010 million; sales of $21,761 million; invests $20,000 on R&D for every million of assets; capital intensity of 0.528, which means companies in average hold $528,000 in property, plant & equipment per employee; cash holdings of 0.13, which means in average companies hold $130,000 in cash & short-term equivalents for every million of assets, leverage of 27% and ROA of 14%. A firm, on average, generates 69 patents a year and 2 patents per 1000 employees and these patents receive 329 citations in all and 4 citations per 1000 employees. Patent and citation counts follow a non-normal distribution with the presence of high skewness as over 50% of the firms apply for no patents and therefore, do not receive any citations. As a result, the median number of patent and citation counts is almost zero. Consistent

with Hall, Jaffe and Trajtenberg (2005), patent and citation raw counts have been corrected for truncation issues using a weighting index based on their application-grant or citation-lag distribution respectively. Then, innovation variables have been transformed using the natural logarithm of one plus either patent or citation corrected count to address the lack of normality (Brooks, 2014). Finally, to minimize the effect of outliers, dependent variables are winsorized at the 1st and 99th percentiles. Another issue that is common when dealing with panel data is heteroscedasticity, which is the non-constant variability of the error term over time. As a result, the reliability of the model is impacted. To address heteroscedasticity, robust standard errors are used in the panel data regression and thus, the regression model becomes more homoscedastic (Brooks, 2014).

A correlation matrix is presented in table 4. It is noted that correlations among our diversity measures, the predictor variables, are low indicating each of these variables are not necessarily addressing the same dimension. The highest correlation among the diversity variables is .084 between Total Tenure and Job diversity.

Correlations are also useful in identifying potential multicollinearity problems. A high correlation between two or more independent variables would indicate multicollinearity issues, which would then make hard to determine the relative degree of impact of each independent variable on the dependent variable (Blalock, 1963). Multicollinearity may result in misleading adjusted R^2 since the standard error for the regressions' coefficients will be artificially high (Tillenius & Lango, 2018). Pairwise correlation coefficients above |0.8| would indicate the presence of multicollinearity (Gujarati, 2003, p.387). As shown in table 4, none of the independent variables or control variables reflect a correlation coefficient above |0.8|. In addition, variance

inflation factors were calculated resulting in a VIF of 1.06 which is less than the threshold of 2. Therefore, we can conclude there are not severe multicollinearity issues (Chang, Fu, Low & Zhang, 2015).

With respect to innovation variables, as expected, correlations between patents, citations and R&D is high. Table 4 shows a correlation of 0.949 between patents and citations and then, 0.446 and 0.430 between patents and R&D and citations and R&D respectively. In addition, it is noted that there is positive and significant correlation between our innovation measures and several of the diversity measures, which indicate some degree of association between these variables (Rumsey, 2010).

CHAPTER V

EMPIRICAL RESULTS

The baseline model

Three regression models have been used for panel data analysis: ordinary least squares (OLS), fixed effect model and random effect model. Fixed effect model examines if intercepts vary across firms though it remains time invariant. Hence, the name of fixed effect. Random effect model, on the other hand, explores differences in error variance components across firms or time periods (Park, 2011). Fixed effect model allows us to explore the relationship between diversity traits and innovation measures within a firm (Torres-Reyna, 2007). In addition, the Hausman specification test was conducted and showed a significant p-value as it was less than 0.05. As result, the null hypothesis, which supports the random effect model as it assumes individual effects are uncorrelated with the other regressors, is rejected and thus, it confirms the fixed effect model is a better fit than the random effect model (Park, 2011).

A summary of the analytical results of these regression models is presented in table 5. The fixed effect model reflects a Rho of 94.85% and 90.53% for patents and citations, which is higher than those reported by random effect model of 93.66% and 88.24% respectively. Accordingly, the higher Rho can be interpreted as a goodness-of-fit of the fixed effect model over the random effect model (Park, 2011). However, fixed effects model shows a R-square of 0.0142 and 0.0394 for patents and citation counts respectively meaning this model explains just 1.42% and 3.94% of the variation in patents and citations around their mean. OLS model shows a higher R-Square at 0.1732 and 0.1699 for patents and citations respectively. As diversity variables do not change much over time, OLS model yields better results and therefore, it is more appropriate than the fixed effect model. Given the higher explanatory power of the OLS model and, consistent with previous studies which extensively used this model (e.g. Hirshleifer, Low & Teoh, 2012; He & Tian, 2013; Chang, Fu, Low & Zhang, 2015), primary results will be assessed using the OLS methodology.

Table 6 presents the results on the relation between TMT diversity and innovation as measured by patents and citation counts. OLS estimates are reflected in columns 1 and 2 for patent and citation counts respectively. In addition, estimates from the fixed effect model are displayed in columns 3 and 4 for patent and citation count as the dependent variables respectively. Estimates from the random effect model are shown in columns 5 and 6 for patent and citation count as the dependent variables respectively.

OLS estimates display positive coefficients for current tenure and significant at the 5% level for patents and 1% level for citations. Coefficients are estimated as 0.251 and 0.864 respectively as shown in columns 1 and 2. Accordingly, this indicates a

positive association between TMT members' total tenure and innovation as measured by patents and citations. OLS estimates also show a positive coefficient of 0.501 as shown in column 1 for total tenure and significant at the 1% level. In terms of economic significance, the impact on innovation for the median firm can be estimated by taking the median of the Blau ratio of our sample and adjusting this ratio to assume the theoretical maximum diversity. This assumes that all other values are held constant at their respective median values. The tenure attribute exhibits a median Blau ratio of 0.75 in our sample. By projecting the theoretical maximum Blau ratio of 1, innovation for the median firm would be improved by 6% and 3% as measured by patents and citations respectively. As a result, findings support hypothesis 3, which states a positive relationship between tenure and firm innovation.

OLS estimates indicate a positive relation between political affiliation and the innovation measures. As shown in columns 1 and 2, coefficients are estimated as 0.207 and 0.377 for patent and citation counts respectively, both of them significant at the 5% level. As in the case of current tenure, we can evaluate the economic significance of political affiliation diversity by examining the change in innovation if the median firm were to increase its diversity in political affiliation from the sample median to the theoretical maximum value. The political affiliation attribute shows a median Blau ratio of 0.75. By projecting the theoretical maximum Blau ratio of 1, innovation would be improved by 2% as measured either by patents or citations. Therefore, these findings support hypothesis 7, which states a positive relation between political affiliation and firm innovation.

OLS also shows a positive relation between culture and firm innovation. Columns 1 and 2 show coefficients of 1.700 and 2.592 for patents and citation counts respectively, both of them significant at the 1% level. As a result, these positive coefficients support hypothesis 4, which indicates a positive relation between culture and firm innovation. Following similar approach applied in the two previous diversity attributes, the economic impact of cultural diversity can be estimated by projecting the improvement in innovation output for the average firm from the median Blau ratio of 0.37 to the theoretical maximum of 1. By doing so, innovation would be improved by 40% and 35% as measured by patents and citations respectively.

OLS shows positive coefficients for education of 0.284 based on patents and 0.444 for citations and both significant at the 10% level. Thus, supporting hypothesis 6 which states a positive relation between education and firm innovation. Based on the same approach described earlier, the economic impact of education diversity can be estimated by taking the median Blau ratio of the sample, which is 0.72 and projecting the innovation improvement assuming the maximum theoretical diversity ratio of 1. The result would be an increase of 4% and 3% in patents and citations respectively for the median firm. Remaining OLS estimates were not significant at the 1% to 10% level. Columns 1 and 2 show mixed coefficients for age, gender and job diversity under patent and citation counts though such coefficients are not significant. As a result, not enough evidence was found to support hypotheses 1, 2 and 5.

The coefficients of the control variables selected for this study produced results consistent with prior studies. Firm size, which was proxied using total assets, shows a positive coefficient of 0.270 and 0.397 for patent and citation counts respectively and

significant at the 1% level. Accordingly, this would indicate the larger the firm, the more likely it will innovate which is consistent with other studies (He & Tian, 2013; Chang, Fu, Low & Zhang, 2015; Sunder, Sunder & Zhang, 2017).

Likewise, coefficients for other control variables are consistent with prior literature. Across all columns of table 6, the estimated coefficients on capital intensity are negative. OLS coefficients stand at -0.189 to -0.332 for patent and citation counts respectively and both significant at the 1% level. Column 3 and 4 shows positive association between cash holdings and firm innovation with coefficients of 4.705 and 7.528 for patents and citation counts respectively and significant at the 1% level. This finding is also consistent with Chang, Fu, Low and Zhang (2015) who reported OLS estimates in their study and supports the premise the firms with greater cash holdings are more likely to innovate as they possess more resources for investment.

Leverage show a negative association with innovative activity based on patent counts though relationship is not significant. Fixed effect model coefficients display a negative association as well for patents. Consistent with prior studies (He & Tian, 2013; Chang, Fu, Low & Zhang, 2015), this finding would show firms with lower leverage are more innovative.

Industry sales growth shows a negative association for patents and citation counts under OLS though relationship is significant at the 10% level for citations only. This finding supports the notion that a higher sales growth does not necessarily drive firms' innovative activity and is consistent with Yoon, Kim and Song (2016) who found pressure to innovate to be low in those industries with high growth rate. Hamermesh and

Silk (1979) states that a successful strategy is the pursuit of innovative products when the industry growth is declining. As these products are costly and difficult to imitate, firms often enjoy a price advantage. Likewise, a Harvard study (Prokesch, 2008) reveals economic downturns have resulted in numerous management inventions.

Alternative models

To further understand the impact of TMT diversity on innovation, a blended TMT diversity index was built by averaging the different diversity attributes selected for the study. As shown on table 7, columns 1 and 2 show OLS coefficients of 1.624 and 3.171 for patents and citations respectively indicating a positive relation between TMT diversity and innovation and significant at the 1% level for both measures. Overall, controls also exhibit similar results to those from the previous study at the diversity attribute level.

Furthermore, a regression was conducted based on data averaged over the entire sample period. That is, a cross-sectional regression was estimated using sample period time-series averages of the dependent and independent variables. Results are presented in table 8. Similar to previous results, tenure and culture are positively related to innovation and significant at the 5% level for both, patents and citations. Likewise, political affiliation shows a direct relationship with innovation and significant at the 1% level for citations. Control variables reflect a similar association to our dependent variables.

In addition, as a robustness test, hypotheses have also been tested using research & development (R&D) investments as the dependent variable. Watanabe, Tsuju & Griffy-Brown (2001) have found a strong relation between R&D investments and innovation. Jalles (2010) conducted a global study and found the larger R&D investments, the greater the innovation. Table 9 shows the results of this regression. Consistent with the previous analysis, coefficient for current tenure is positive and significant at the 5% level. However, it shows a negative coefficient for total tenure though it is not significant. Coefficients for culture and education are positive and both significant at the 1% level, which is in line with the previous analysis. Relation between political affiliation and R&D investment is positive but not significant. Previous analysis shows a positive relation significant at the 5% level. Likewise, a negative relation is displayed between gender and R&D investments and significant at the 1% level whereas previous analysis displayed negative relation though no significant at the 1%-10% level.

Last, industry fixed effects, instead of firm fixed effects, were also analyzed. Earlier it was indicated that the firm fixed effect model is not appropriate when variables (diversity measures) change slowly over time hence the preference for the OLS model. On the other hand, innovation activity is likely to vary systematically across industries, so it would be appropriate to try a fixed effect model clustered at the industry level. Table 10 shows the results, which indicate a positive and significant association between tenure, political affiliation, culture and education and firm innovation, as measured by patents and citations. The impact of our control variables displays similar results to our previous study.

CHAPTER VI

DISCUSSION AND CONCLUSION

Discussion

Can diversity at the top management drive a firm's innovation? In this paper, I studied different diversity attributes exhibited by top managers and how firm's innovation is affected. Diversity attributes include age, gender, tenure, political affiliation, cultural, educational and work diversity. Firms' innovation is proxied by the count of patents granted and citations received over these patents during 2010 to 2017. Accordingly, I found not all diversity attributes contribute to a firm's innovation. An individual's culture, tenure, educational background and political affiliation was found to be positively related to firm's innovative capability. As hypothesized in this study, a variety of top management members with different cultures, tenure, educational levels and political affiliation provide different views and perspectives along different types and levels on knowledge, which in turn results in a greater ability to solve complex problems. On the other hand, attributes, such as age, gender and work diversity were found not to be significant drivers of a firm's innovative output when other measures of diversity are included. The lack of significance in age heterogeneity and the impact of education were also found by Bantel and Jackson (1989)

who studied the impact of diversity in top management on innovation in the banking industry. Yoon, Kim and Song (2016) also found age diversity not to be significant on organizational creativity.

Based on the findings, the key contribution from this study would be that those companies seeking to innovate must be receptive to views and perspectives that can be generated from top management members of different cultures, tenure, educational background and political affiliation. In addition, while the outcome for some diversity attributes did not come as expected, it is possible a less variety of these attributes place a greater emphasis in some industries, such as age in the technology industry. As almost 50% of the firms can be classified in the technology sector, it would be interesting to conduct a future study focused on those more innovative industries. Likewise, as mentioned in the Methods section, several proxies have been used in the existing literature to measure cultural diversity (e.g. language spoken at home, ethnic group, ancestry and country of birth). As culture was found to be positively related to firm's innovation, it would be helpful to understand which proxy is a better indicator of cultural diversity.

Limitations

While this study has shown how some diversity attributes at the TMT level can impact firm innovation, the paper did not consider other explanations, such as corporate governance efforts and project-driven outcomes. This is especially true as this study was focused on the largest 500 public companies. Thus, results may differ in smaller and private companies. In addition, as mentioned above, further research is needed to

understand how these findings differ across industries. It is possible the impact of some diversity attributes may differ in knowledge intensive industries. Likewise, firms with a dominant or single-product business may stress a diversity attribute more than others.

Conclusion

In this paper, upper echelons theory is applied to the innovation literature. Upper echelons theory explains how individual characteristics from top management team (TMT) members can influence their decisions and how those decisions will ultimately impact firm performance (Hambrick & Mason, 1984). Based on this theory, hypotheses have been developed to link diversity attributes from TMT members and firms' innovative output. Empirical results from this study support those hypotheses related to TMT members' culture, tenure, educational levels and political affiliation diversity. While the remaining diversity attributes, which include gender, age and job diversity, were found not to be significant when other measures of diversity are included, the results still suggest innovative firms must place more attention to these corporate governance issues and how their innovative capability can be impacted.

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APPENDICES

Table 1: Diversity attributes

Number of executives	2,146
Gender	
Male	92.37%
Female	7.63%
Age	
Under 50	27.84%
Between 50 to 60	56.84%
Between 60 to 65	11.83%
Above 65	3.49%
Education	
Bachelor's degree	32.64%
Master's degree	52.48%
PhD	5.68%
Unreported	9.20%
Culture	
English Speaking	95.29%
Latin America	0.57%
African Islamic	0.59%
Catholic Europe	1.03%
Protestant Europe	1.01%
Confucian	0.22%
South Asia	1.19%
Orthodox	0.01%
Baltic	0.00%
Unreported	0.09%
Number of Jobs	
One job	17.49%
Between 1 to 4 jobs	58.54%
More than 4 jobs	23.97%
Tenure in Current Job	
Less than 1 year	23.07%
Between 1 to 5 years	61.33%
More than 5 years	15.60%
Total Professional Tenure	
Less than 10 years	9.44%
Between 10 to 25 years	44.98%
Between 25 to 35 years	31.26%
Above 35 years	14.32%
Political Affiliation	
Republican	25.66%
Democrat	16.65%
Republican/Democrat	8.78%
Unknown	48.90%

Table 2: Classification of patent by industry

Industry (1-digit SIC code)	% of patents
Agriculture, Forestry and fishing	1.29%
Mining & Construction	3.69%
Oil, Chemical, Tobacco, Textile, Paper	5.68%
Electrical, Electronic, Computer and Ir	46.73%
Transportation, Communications, Ele	1.94%
Wholesale Trade	0.71%
Retail Trade	1.85%
Finance, Insurance and Real Estate	31.85%
Services	0.30%
Public Administration	5.96%

Table 3: Summary statistics

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Number of patents (raw)	3,059	69	1	339	0	7,652
Number of citations (raw)	3,059	329	0.0	1,639	0	25,706
Scaled patents/employee	3,053	2	0.0	8	0	98
Scaled citations/employee	3,053	4	0.0	12	0	189
Assets ($millions)	3,059	65,010	15,855	213,680	254	2,573,126
Sales ($millions)	3,059	21,761	8,521	41,128	94	483,521
R&D-to-Assets	3,059	0.02	0	0.05	0	0.64
Employees (in thousands)	3,053	52	18.50	127	0.08	2,300
Capital Intensity	2,873	0.53	0.07	1.35	0.00	12.17
Cash Holdings	3,059	0.13	0.08	0.14	0	0.91
Book Leverage	3,048	0.27	0.25	0.18	0	1.67
ROA	2,890	0.14	0.13	0.10	(1.16)	0.95

Table 4: Correlation matrix

Pairwise correlations

Variables	Patents	Citations	R&D	Age	Current Tenure	Job	Total Tenure	Gender	Political Affiliation	Culture	Education	Firm Size	Capital Intensity	Cash Holdings	Book Leverage	Industry Growth Rate
Patents	1.000															
Citations	0.949*	1.000														
R&D	0.446*	0.430*	1.000													
Age	0.000	-0.007	0.037*	1.000												
Current Tenure	0.067*	0.111*	0.043*	-0.013	1.000											
Job	0.029	0.019	-0.012	-0.038*	0.012	1.000										
Total Tenure	0.046*	0.029	-0.052*	0.004	-0.035*	0.084*	1.000									
Gender	0.023	0.038*	-0.023	-0.070*	0.037*	-0.018	0.010	1.000								
Political Affiliation	0.071*	0.074*	-0.014	-0.024	-0.006	-0.032*	0.027	0.050*	1.000							
Culture	0.209*	0.208*	0.272*	-0.027	0.069*	0.020	-0.017	-0.033*	-0.012	1.000						
Education	0.054*	0.050*	0.125*	-0.033*	0.025	0.031*	0.031*	0.028	0.059*	0.052*	1.000					
Firm Size	0.109*	0.099*	-0.234*	-0.035*	0.090*	0.081*	0.071*	0.033*	0.165*	-0.015	0.035*	1.000				
Capital Intensity	-0.178*	-0.185*	-0.156*	-0.068*	-0.009	-0.073*	0.057*	-0.021	-0.025	-0.123*	0.045*	0.111*	1.000			
Cash Holdings	0.332*	0.331*	0.540*	0.027	0.001	-0.025	-0.030*	0.047*	0.006	0.198*	0.055*	-0.217*	-0.236*	1.000		
Book Leverage	-0.113*	-0.088*	-0.124*	-0.022	0.075*	-0.003	-0.030	0.020	-0.013	-0.035*	-0.004	-0.039*	0.099*	-0.224*	1.000	
Industry Growth Rate	-0.011	-0.012	0.036*	0.038*	-0.035*	-0.011	-0.045*	-0.017	-0.001	0.020	-0.044*	-0.069*	-0.153*	0.055*	-0.000	1.000

* shows significance at the .1 level

Table 5: Summary of analytical results

Model/Statistic	Patent	Citation
OLS		
R-Square	0.1732	0.1699
RMSE	1.9364	3.1694
Fixed Effects		
R-Square	0.0142	0.0394
Rho	0.9485	0.9053
Random Effects		
R-Square	0.0114	0.0334
Rho	0.9366	0.8824

Table 6: Relation between TMT diversity and innovation

	OLS		Fixed Effect		Random Effect	
VARIABLES	(1) Scaled_Pat	(2) Scaled_Cit	(3) Scaled_Pat	(4) Scaled_Cit	(5) Scaled_Pat	(6) Scaled_Cit
Age_Div	0.0153	-0.119	0.0104	-0.216	0.00549	-0.226
	(0.151)	(0.239)	(0.0512)	(0.150)	(0.0518)	(0.149)
Cur_Ten_Div	0.251**	0.864***	-0.144***	0.213**	-0.138***	0.286***
	(0.113)	(0.190)	(0.0334)	(0.0842)	(0.0333)	(0.0818)
Job_Div	-0.0179	-0.0915	-0.0277	-0.0153	-0.0263	-0.0199
	(0.149)	(0.232)	(0.0649)	(0.163)	(0.0653)	(0.160)
Tot_Ten_Div	0.501***	0.493	0.0670	0.0332	0.0816	0.0697
	(0.187)	(0.307)	(0.0637)	(0.161)	(0.0644)	(0.157)
Gen_Div	-0.141	-0.0843	0.0109	0.207	0.0125	0.215
	(0.115)	(0.188)	(0.0523)	(0.142)	(0.0524)	(0.139)
Pol_Div	0.207**	0.377**	0.0397	0.0107	0.0437	0.0242
	(0.103)	(0.169)	(0.0374)	(0.0922)	(0.0377)	(0.0914)
Cul_Div	1.700***	2.592***	-0.197*	-0.298	-0.101	0.0133
	(0.241)	(0.411)	(0.113)	(0.329)	(0.113)	(0.320)
Edu_Div	0.284*	0.444*	-0.0657	-0.190	-0.0379	-0.118
	(0.146)	(0.235)	(0.0636)	(0.161)	(0.0639)	(0.156)
Firm Size	0.270***	0.397***	0.0830*	0.573***	0.125***	0.459***
	(0.0277)	(0.0477)	(0.0446)	(0.117)	(0.0377)	(0.0783)
Capital Intensity	-0.189***	-0.332***	-0.0395	-0.136	-0.0748***	-0.218***
	(0.0303)	(0.0372)	(0.0278)	(0.0906)	(0.0265)	(0.0751)
Cash Holdings	4.705***	7.528***	-0.0861	-0.128	0.376*	1.184***
	(0.298)	(0.467)	(0.211)	(0.486)	(0.206)	(0.458)
Leverage	-0.103	0.173	-0.00574	0.640	-0.106	0.487
	(0.228)	(0.346)	(0.160)	(0.415)	(0.155)	(0.387)
Industry Growth Rate	-0.385	-0.732*	0.0853	0.0901	0.0802	0.110
	(0.291)	(0.436)	(0.0778)	(0.186)	(0.0788)	(0.186)
Constant	-2.134***	-2.816***	1.042**	-2.531**	0.570	-1.624**
	(0.340)	(0.565)	(0.436)	(1.151)	(0.384)	(0.751)
Observations	2,643	2,643	2,643	2,643	2,643	2,643
R-squared	0.173	0.170	0.014	0.039		
Number of firms			398	398	398	398

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Relation between total TMT diversity and innovation

	OLS		Fixed Effect		Random Effect	
VARIABLES	(1) Scaled_Pat	(2) Scaled_Cit	(3) Scaled_Pat	(4) Scaled_Cit	(5) Scaled_Pat	(6) Scaled_Cit
Total TMT Diversity	1.624***	3.171***	-0.270	0.270	-0.218	0.592*
	(0.385)	(0.625)	(0.177)	(0.353)	(0.174)	(0.343)
Firm Size	0.271***	0.402***	0.0332	0.653***	0.0901**	0.517***
	(0.0303)	(0.0478)	(0.0521)	(0.113)	(0.0425)	(0.0776)
Capital Intensity	-0.193***	-0.338***	-0.0455	-0.122	-0.0795**	-0.203***
	(0.0193)	(0.0360)	(0.0396)	(0.0904)	(0.0369)	(0.0752)
Cash Holdings	4.973***	7.959***	-0.0680	-0.118	0.381*	1.176***
	(0.309)	(0.466)	(0.234)	(0.480)	(0.229)	(0.454)
Leverage	-0.109	0.273	-0.109	0.822*	-0.212	0.736*
	(0.217)	(0.349)	(0.231)	(0.431)	(0.218)	(0.403)
Industry Growth Rate	-0.392	-0.768*	0.0948	0.0597	0.0878	0.0832
	(0.282)	(0.441)	(0.0660)	(0.183)	(0.0655)	(0.183)
Constant	-2.131***	-3.275***	1.628***	-3.615***	1.025**	-2.533***
	(0.316)	(0.510)	(0.510)	(1.090)	(0.409)	(0.718)
Observations	2,643	2,643	2,643	2,643	2,643	2,643
R-squared	0.156	0.153	0.004	0.032		
Number of firms			398	398	398	398

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Relation between TMT diversity and innovation using averaged data

VARIABLES	(1) Scaled_Pat	(2) Scaled_Cit
Age_Div	-0.0683	0.0488
	(0.516)	(0.632)
Cur_Ten_Div	2.940***	3.528***
	(0.716)	(0.866)
Job_Div	-0.0201	0.000736
	(0.403)	(0.492)
Tot_Ten_Div	0.644	0.750
	(0.689)	(0.814)
Gen_Div	-0.340	-0.280
	(0.344)	(0.420)
Pol_div	0.497	0.730*
	(0.350)	(0.423)
Cul_Div	2.070***	2.298***
	(0.717)	(0.832)
Edu_Div	0.183	0.0239
	(0.425)	(0.527)
Firm Size	0.237***	0.271***
	(0.0803)	(0.0965)
Capital Intensity	-0.241***	-0.274***
	(0.0589)	(0.0764)
Cash Holdings	5.310***	6.555***
	(0.809)	(0.945)
Leverage	0.193	-0.125
	(0.590)	(0.688)
Industry Growth Rate	-5.776***	-7.048***
	(2.026)	(2.496)
Constant	-2.788***	-3.123***
	(1.005)	(1.193)
Observations	398	398
R-squared	0.245	0.244

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Relation between TMT diversity and R&D

VARIABLES	OLS
Age_Div	0.00388
	(0.00249)
Cur_Ten_Div	0.00452**
	(0.00190)
Job_Div	0.00141
	(0.00267)
Tot_Ten_Div	-0.00510
	(0.00395)
Gen_Div	-0.00578***
	(0.00191)
Pol_Div	0.00113
	(0.00182)
Cul_Div	0.0322***
	(0.00537)
Edu_Div	0.0166***
	(0.00243)
Firm Size	-0.00355***
	(0.000464)
Capital Intensity	-0.000626***
	(0.000201)
Cash Holdings	0.129***
	(0.00817)
Leverage	-0.00146
	(0.00485)
Industry Growth Rate	-0.000179
	(0.00449)
Constant	0.0250***
	(0.00604)
Observations	2,643
R-squared	0.310
Number of firms	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Relation between TMT diversity and innovation using industry fixed effects

VARIABLES	(1) Scaled_Pat	(2) Scaled_Cit
Age_Div	0.0153	-0.119
	(0.146)	(0.239)
Cur_Ten_Div	0.251**	0.864***
	(0.114)	(0.190)
Job_Div	-0.0179	-0.0915
	(0.139)	(0.232)
Tot_Ten_Div	0.501***	0.493
	(0.187)	(0.307)
Gen_Div	-0.141	-0.0843
	(0.114)	(0.188)
Pol_Div	0.207**	0.377**
	(0.104)	(0.169)
Cul_Div	1.700***	2.592***
	(0.266)	(0.411)
Edu_Div	0.284**	0.444*
	(0.141)	(0.235)
Firm Size	0.270***	0.397***
	(0.0301)	(0.0477)
Capital Intensity	-0.189***	-0.332***
	(0.0201)	(0.0372)
Cash Holdings	4.705***	7.528***
	(0.309)	(0.467)
Leverage	-0.103	0.173
	(0.215)	(0.346)
Industry Growth Rate	-0.385	-0.732*
	(0.277)	(0.436)
Constant	-2.134***	-2.816***
	(0.348)	(0.565)
Observations	2,643	2,643
R-squared	0.173	0.170

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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