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CEO Political Ideology: Implications for Firm Innovation

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CEO POLITICAL IDEOLOGY: IMPLICATIONS FOR FIRM INNOVATION

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To my mom…

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ABSTRACT

In this dissertation, I examine the influence of CEO political ideology on firm's innovation strategy and outcomes. In my theorizing, I draw on upper-echelons theory that underscores the role of executives' personal orientations on their decisions as well as the scholarship in political psychology that demonstrates the different values and psychological needs of liberals and conservatives. Given liberals' lower need to manage uncertainty and their openness to new experiences, I propose that a firm with a more liberal CEO is likely to develop more innovations, pursue exploratory innovations and develop innovations with extreme quality (high and low). I also build on liberals' stakeholder orientation to corporate governance and their openness to new experiences to argue that liberal CEOs are more likely than their conservative counterparts to engage in basic research. Furthermore, considering liberals' view about gender roles, gender inequality and gender stereotypes I propose that female inventors are likely to have more representation in firms with liberal CEOs than in firms with conservative CEOs. I tested these relationships by analyzing a sample of CEOs who led S&P1500 firms from 1992 to 2014 and the results were largely consistent with my predictions. My findings show that firms with liberal CEOs pursue more exploratory innovations, basic research, and develop more high-quality innovations. The results also demonstrate that female inventors have more presence in firms with liberal CEOs. Contrary to my predictions, I found no evidence that the presence of a liberal CEO increases the number of innovations or the rate of low-quality innovations developed by a firm. This dissertation demonstrates that the ideology of CEOs is more consequential for how firms pursue innovation than for how much they prioritize innovation.

CHAPTER 1. INTRODUCTION

CEOs have political ideologies (Francia, Green, Herrnson, Powel, & Wilcox, 2005) that reflect their "beliefs about the proper order of society and how it can be achieved" (Erikson & Tedin, 2003: 64). Like for many people, such beliefs constitute a central aspect of CEOs' identities and influence their behavior (Burris, 2001; Jost, Federico, & Napier, 2009). CEOs' ideological beliefs often inspire them to take public stances on societal issues. For example, Jeff Immelt, the former CEO of General Electric, once stated that "I just think it's insincere to not stand up for those things that you believe in." (Chatterji & Toffel, 2018:51). Also, Brian Moynihan, the CEO of Bank of America, stated the belief that "our jobs as CEOs now include driving what we think is right" (Chatterji & Toffel, 2018:48). Furthermore, motivated by their political beliefs, CEOs often make significant personal political donations. A recent study (Cohen, Hazan, Tallarita, & Weiss, 2019) found that during the years 2000 through 2017 about 89% of CEOs of S&P500 had made political donations.

CEOs also bring their political ideologies to work and those beliefs play a critical role in shaping their judgments and decisions. A recent body of research in organizational sciences has begun to explore the implications of CEO ideology for firms. Because it is known to be "the single most useful and parsimonious way to classify political attitudes for more than 200 years" (Jost, 2006: 654), the liberal-conservative continuum has been used by researchers in this literature stream to conceptualize political ideology. It has been shown that CEO's liberal or conservative orientation is a significant source of inter-firm heterogeneity in a number of market and non-market strategies such as downsizing (Gupta, Nadkarni, & Mariam, 2019), capital allocation to business units (Gupta, Briscoe, & Hambrick, 2018), TMT pay dispersion (Chin & Semadeni, 2017), financial strategy (Hutton, Jiang, & Kumar, 2014), social performance (Chin,

Hambrick, & Trevino, 2013) and receptivity to social activists (Briscoe, Chin, & Hambrick, 2014). As society becomes more polarized between adherents of liberal vs conservative ideologies (Saad, 2019), more research on how CEOs' political beliefs shape their decisions helps scholars of strategy in their quest to answering the fundamental question of the field: *Why do firms perform differently?*

Although the body of research on the implications of CEO political ideology has been illuminating, its link to innovation as "the lifeblood of corporate survival and growth" (Zahra & Covin, 1994: 183) has remained largely unknown (Swigart, Anantharaman, Williamson, & Grandey, 2020). As the central decision maker of a firm, a CEO usually has such a substantial role in shaping the firm's innovation that in fact "innovation starts in the CEOs' suite" (Berger, Dutta, Raffel, & Samuels, 2008: 6). In light of the recent research demonstrating that liberal or conservative orientation of CEOs influences their choices, I expect that it also shapes decisions related to innovation.

This dissertation particularly aims to answer the following questions:

1) *How does CEO political ideology influence a firm's innovation outcomes?*
2) *How does CEO political ideology shape a firm's innovation strategies?*

My theorizing is grounded in research showing that liberals and conservatives have distinct perspectives and preferences (Jost et al., 2009). First, liberals and conservatives adhere to different values, with liberals tending to be more sensitive to social issues and matters regarding equality, diversity, social change, and the natural environment (Jost, 2006). Conservatives, on the other hand, are inclined to more highly value individualism, differential economic rewards, stability, preserving the status quo, and property rights (Jost, Glaser, Kruglanski, & Sulloway, 2003). Furthermore, consistent with their values, liberals favor an approach to corporate

governance that seeks to balance the claims of different stakeholders, while conservatives tend to advocate for a governance model in which shareholders' needs precede those of other stakeholders (Tetlock, 2000). Moreover, political psychologists have suggested that a relative preference for liberal vs conservative orientation is associated with basic psychological needs (Jost et al., 2003; Jost, Sterling, & Stern, 2017). On one hand, conservative ideology is associated with a strong need to avoid uncertainty and threat; conservative individuals prefer order and structure and try to mitigate potential negative outcomes when making decisions (Jost et al., 2003). Liberals, on the other hand, have a lower need to avoid uncertainty and threat. Liberal orientation is associated with openness to new experiences that typically characterizes individuals who enjoy novelty and embrace change (Carney, Jost, Gosling, & Potter, 2008). Conservatives, in contrast, tend to prefer the familiar over the unfamiliar, favor tried and true approaches, and are resistant to change (Carney, et al., 2008).

Given these differences, I first argue that firms with liberal CEOs tend to develop more innovations than those with conservative CEOs. Innovation almost always involves something new (Gopalakrishnan & Damanpour, 1997) and is usually associated with a high risk of failure either during the research and development (R&D) process or later in the commercialization stage (Mansfield, 1968). Because liberal CEOs enjoy trying out novel and new approaches that are relatively risky, they are more likely to view and prioritize innovation as a valuable means for achieving a firm's goals. Second, I maintain that the presence of a liberal CEO increases breakthrough (high-quality) and failure (low-quality) innovations, because the relatively stronger novelty-seeking and risk-taking characteristics of liberal CEOs is likely to prompt them to undertake riskier R&D projects. Such projects are often associated with the promise of a

remarkable payoff in form of a breakthrough innovation but also with the likelihood of complete failure (Cabral, 2003; Conti, 2014).

I further postulate that the effect of CEO political ideology goes beyond outcomes of innovation and shapes strategies that firms pursue in their innovative endeavors. I particularly focus on firms' choices between the pursuit of exploration vs exploitation strategies, firms' research and development strategy (basic vs applied research), and inventor-staffing strategies. First, I argue that liberal CEOs are more likely than conservative CEOs to pursue exploratory innovation strategies. Exploratory innovations often involve searching in knowledge and technology domains unfamiliar to a firm and dealing with unknowns (March, 1991), thus this strategy is more consistent with the novelty-seeking and risk-taking characteristics of liberal CEOs as opposed to the familiarity and certainty-seeking attitudes of conservatives. Second, I maintain that innovation strategy in firms with liberal CEOs is more likely to be directed toward basic research than in firms with conservative CEOs. Basic research, characterized by early-stage research directed toward understanding of fundamental principles about a phenomenon, is often launched without a clear-cut practical application in mind (Nelson, 1959;1962). Such research often leads to creation of knowledge with no immediate commercial benefits (Rosenberg, 1990). Also, knowledge resulting from often long and costly basic research activities could benefit other firms and even rivals without their incurring the costs (Rosenberg, 1990; Trajtenberg, Henderson, & Jaffe, 1992), so a mere profit maximization motive often could not justify the pursuit of basic research (Nelson, 1959; Rosenberg, 1990). I propose that, because liberals enjoy novelty and discovery and have a stronger belief in social responsibility of corporations, they are relatively more likely to be inclined to pursue basic research. Finally, I investigated the inventor-staffing strategies of liberal vs conservative CEOs by examining gender diversity among

inventors. I argue that liberal CEOs' lower adherence to gender stereotypes, their views about gender roles, and their belief in the necessity of mitigating gender inequality result in a higher presence of female inventors in their firms and more involvement of females in innovation teams.

I tested my hypotheses on a sample of S&P1500 firms and the results largely confirmed my predictions, i.e., the political ideology of CEOs was shown to be instrumental in shaping firms' innovation outcomes as well as the trajectory of their innovations.

This study extends the literature on executives' political ideology, innovation, and gender diversity in corporate R&D in several ways. First, it contributes to the literature examining the implications of CEO political ideology by showing how it shapes innovation as a significant source of a firm's competitive advantage and long-term performance (DiMasi, 2000; Schumpeter, 1942). My study demonstrates that a liberal or conservative CEO orientation is reflected more in the direction and trajectory of a firm's innovation than in how much it prioritizes innovation. According to my findings, a CEO's political ideology helps explain variations among firms with respect to innovation quality as well as understanding why different firms pursue different strategies in their innovative endeavors.

Second, my study contributes to several research streams on innovation and organizational search. First, it adds to the body of research on the impact of CEO characteristics on innovation, a small but growing research stream that has demonstrated that personal characteristics of CEOs (e.g. temporal orientation (Nadkarni & Chen, 2014), hubris (Tang, Li, & Yang, 2015), narcissism, and humility (Zhang, Ou, Tsui, & Wang, 2017)) influence firms' innovation. My study extends the range of CEO characteristics that shape innovation to include ideological beliefs. Second, my study contributes to the research stream that studies quality of innovations.

breakthrough innovations enable firms to revolutionize the current technological order, create new technological trajectories, and engage in new business development (Ahuja & Lampert, 2001). Because of the value of such innovations, understanding their antecedents is said to be a noteworthy contribution to the literature (Ahuja & Lampert, 2001). As another contribution, my study shows that CEO political ideology has a critical role in a firm's making a choice between exploration vs exploitation. The literature on determinants of firms' propensity to either explore or exploit mostly points to firm (e.g. Benner & Tushman, 2002; 2003) and environmental factors (Jansen, Van Den Bosch, & Volberda, 2006) while neglecting the behavioral/psychological determinants of the choice between these strategies (Lavie, Stettner, & Tushman, 2010; Wilden, Hohberger, Devinney, & Lavie, 2018), and my study helps narrow this gap in the literature. Finally, my study contributes to the literature related to the antecedents of basic research. Understanding factors that may lead profit-maximizing firms to pursue basic research has been an important inquiry in this research stream (Rosenberg, 1990; Nelson, 1959) because firms are usually hesitant to conduct basic research due to concern that they might not be able to fully appropriate the benefit of such endeavors. My results show that novelty-seeking and liberal values of CEOs offset, to some extent, such appropriability concerns and serve as a factor that encourages basic research.

Third, this study also contributes to the literature on gender diversity in corporate R&D. While prior research has shown a persistent gender imbalance in science in both academia and industry (Murray & Graham, 2007; Whittington, 2011; 2018), the current understanding of factors leading to under-representation of women in these domains is still limited (Whittington & Smith-Doerr, 2005, Whittington, 2018). My study advances this research stream by bringing the

political ideology of CEOs into the picture and illustrating CEO liberalism as a factor that can contribute to reduction of gender disparity in corporate R&D activities.

Dissertation Overview

The dissertation is organized as follows. In Chapter 2, I provide a literature review of political ideology, beginning with an overview of the different values and psychological traits of people with liberal or conservative orientations. I then delve into reviewing the current research on implications of liberal vs conservative orientations for organizational outcomes. In Chapter 3, I describe my proposed theory about the influence of CEOs' political ideology on innovation outcomes and strategies. Chapter 4, dedicated to methodology and results, introduces the sample, data-collection procedures, variables and measures, results, and supplementary tests I used to examine the robustness of the results. Finally, in Chapter 5, I provide a discussion of the results and the limitations of my study along with some suggestions for future research.

CHAPTER 2. LITERATURE REVIEW

This chapter has two sections. In the first section, I provide an overview of political ideology on a liberalism-conservatism continuum and discuss the distinct values, preferences, and desires of individuals who adhere to these beliefs. In the second section, I review the literature on how the distinct characteristics of liberals and conservatives discussed in the first section are reflected in organizational outcomes.

Political Ideology on Liberalism-Conservatism Continuum

Political ideology reflects peoples' beliefs about how a society ought to be structured and how to achieve such structure (Erikson & Tedin, 2003; Jost et al., 2009). An individual's political ideology is usually relatively stable and enduring throughout the course of life and is an important aspect of life for most people (Carney et al., 2008; Jost et al., 2009). For centuries, distinction between left-right or liberal-conservative has been the most useful way to conceptualize political ideology, and it is generalizable across countries and nationalities (Jost, 2006; Poole & Rosenthal, 1984; Ware, 1996).

Liberal and conservative ideologies represent systems of values that lead people to prefer certain states of affairs over others (Jost, 2006; Tedin, 1987). Kerlinger (1984) provides a list of distinct values that liberals and conservatives endorse. Liberals value "freedom of the individual, constitutional participatory government and democracy, the rule of law, free negotiation, discussion and tolerance of different views, constructive social progress and change, egalitarianism and the rights of minorities, secular rationality and rational approaches to social problems, and positive government action to remedy social deficiencies and to improve human welfare" (Kerlinger, 1984: 15). Liberals favor equality advancement and are sensitive to social issues such as diversity, environmental issues, and human rights (Jost, 2006). Conversely,

conservatives emphasize the uncertainty of progress and value stability and the status quo, religion and morality, and the natural inequality of men (Kerlinger, 1984). They also support conventional authority figures, the sanctity of property rights, and the importance of business in a society (Kerlinger, 1984). Moreover, conservatives tend to believe more in individualism and individual responsibility.

Despite the wide range of value differences endorsed by liberals and conservatives, these differences can be summarized in three broad groups that show how they believe society should be structured (Jost, et al., 2003; Swigart, et al., 2020). These broad categories include: 1) how much an individual advocate for equality verses hierarchy, 2) how much an individual supports social change versus traditions, and 3) how much an individual focus on external and contextual factors versus personal responsibility in explaining outcomes (Jost et al., 2003; Weiner, Osborne, & Rudolph, 2011; Zucker & Weiner, 1993). Liberal-oriented individuals believe in the necessity of social change to ameliorate inequality that they believe has resulted from situational and contextual factors that hinder individuals from achieving their desires, while conservatives value preserving current traditions and hierarchical structures of their society and believe in individuals' agency to achieving outcomes and changing their condition.

Research in political psychology also shows that liberals and conservatives significantly differ with respect to a wide array of attributes such as dogmatism, integrative complexity, personal needs for order/structure/closure, tolerance of ambiguity/uncertainty, cognitive/perceptual rigidity, and subjective perceptions of threat (Jost, et al., 2003; Jost, et al., 2017). Relying on these findings, political psychologists suggest that the type of political beliefs people embrace corresponds to their dispositional tendencies and preferences (Jost et al., 2003; Jost, 2017). In other words, "individuals are not merely passive vessels of whatever beliefs and

opinions they have been exposed to; rather, they are attracted to belief systems that resonate with their own psychological needs and interests" (Jost, 2017:167). Jost et al., (2003) demonstrated that adherence to liberal vs conservative values is associated with *the need to manage uncertainty and threat*. Specifically, conservative orientation has been shown to appeal to individuals who possess a strong need to reduce uncertainty and threat (Jost et al., 2003; Jost et al., 2017). As a result, conservatives tend to prefer the familiar versus the unfamiliar and desire order, structure, and predictability (Carney et al., 2008; Jost et al., 2003; Jost et al., 2017). They also strive to maintain a sense of safety and security (Jost et al., 2003; Jost et al., 2017) and try to diminish the possibility of negative events by avoiding unknowns and sticking to tried and true approaches (Hibbing, Smith, & Alford, 2014). Liberal ideology, on the other hand, is appealing to people with less fear of uncertainty and threat. Liberals have a higher propensity to take risks and tend to be more receptive to change (Jost, et al., 2003; Jost, et al., 2017).

Research in neuroscience provides further support for such psychological needs of liberals and conservatives by demonstrating that conservative and liberal individuals have different brain structures. Conservative-oriented individuals have a brain structure associated with more sensitivity to threat and fear (a larger right amygdala), liberal individual's brain structure is associated with greater tolerance of uncertainty and ambiguity (a larger anterior cingulate cortex) (Kanai, Feilden, Firth, & Rees, 2011; Schreiber et al., 2013).

Similarly, political ideology has been shown to map into two dimensions of the Big Five personality traits: openness to new experiences and conscientiousness (Carney et al., 2008; Gerber, Huber, Doherty, & Dowling, 2011). Openness has been shown to be the strongest personality trait that predicts political ideology (Gerber et al., 2011; Sibley, Osborne, Duckitt, 2012). Liberal orientation tends to be positively associated with openness to new experiences

while conservatives tend to be low in this trait (Carney et al., 2008; Gerber et al., 2011) and score higher than liberals in conscientiousness (Carney et al., 2008; Gerber et al., 2011).

In summary, political ideology involves a set of values and psychological dispositions that lead to certain preferences and priorities that shape decision-making in personal and organizational domains (Swigart, et al., 2020).

Political Ideology and Organizations

People bring their ideological beliefs to work (Bermiss & McDonald, 2018; Gupta, Briscoe, & Hambrick, 2016) and those beliefs are shown to play an important role in organizational outcomes. The extent to which firms' outcomes are shaped by the political ideology of members across organizational levels has recently attracted the interest of organizational scientists. In this section, I will provide a review of this new but growing research stream.

Swigart, Anantharaman, Williamson, and Grandey (2020)'s recent review of this research stream suggests that scholarship in this domain has been characterized by two main approaches. One approach is conceptualizing political ideology as an *identity* and examining its effect on the dynamics of social interactions. Specifically, the consequences of fit/similarity in political ideology of organizational members has attracted attention[1]. An example is the study carried out by Kim, Pantzalis, and Park (2013) that shows that diversity of political ideology in boards of directors[2] is associated with better firm performance and lower agency costs. Another interesting finding of Kim et al. (2013) is that incumbent directors prefer to hire new directors with political

[1] Political ideology as an identity also informs micro level research domain such as employee selection and evaluation, bias and stereotyping, team composition and team dynamics to name a few. Such research is beyond the scope of my dissertation and, therefore, are not reviewed here. Interested readers are referend to Swigart et al., (2020) for a review of the current developments in these areas.

[2] They measured board diversity with several measures of distance between political ideology of members. They considered ideological distance between 1) inside and outside directors, 2) outside directors and CEO, 3) inside directors and 4) among all board members.

ideologies similar to their own. Christensen, Dhaliwal, Boivie, and Graffin (2015) further support this evidence by showing a positive association between the political ideology of the incumbent TMT and that of a new TMT member. Lee, Lee, and Nagarajan (2014) complements the Kim et al. (2013) research by examining the alignment of political ideology between CEOs and independent board members. Their results show that such alignment increases agency costs reflected in lower firm valuation and profitability and higher likelihood of fraud. Lee et al. (2014) further show that in such firms poorly performing CEOs are less likely to be dismissed and their compensation is less contingent on performance. They attributed these results to a connection shaped through similarity of political beliefs (homophily principle) that in turn increases acceptance and empathy and consequently reduces oversight of boards with respect to CEO behaviors. Other studies in this domain have looked at the fit between the political ideology of CEO and organizational members' and have consistently shown that such fit increases the extent to which CEOs inject their ideological beliefs into their decisions. For example, a liberal CEO tends to allocate capital more evenly to subsidiary businesses in a predominantly liberal organization (Gupta et al., 2018) and decreases pay dispersion among TMT when compensation committee members are similarly liberal-leaning (Chin & Semadeni, 2017).

The second approach in this research stream, however, conceptualizes political ideology as a set of *values* that affects decision-making and brings about certain organizational outcomes. Because my dissertation falls within this category, I will devote the rest of this section to a detailed review of current studies associated with this conceptualization. My review differs from Swigart et al. (2020) in that it has a broader scope and includes papers published in Management and Finance journals. Finance scholars have shown a mounting interest in this subject and have

made interesting contributions that must be noted if a comprehensive review of this research stream is desired.

Studies in this category rely on the premise that political ideology acts as a lens through which people perceive and interpret situations, impacting their decisions and choices through "behavior channeling" and "perceptual filtering" (England, 1967). Through behavioral channeling, individuals consciously consider and compare different available alternatives, then choose the one that best fits their values (England, 1967). Through perceptual filtering, individuals subconsciously look for information and alternatives that suit their value system which consequently affect their choices and decisions (England, 1967). Thus, political ideology has a strong behavioral implication and ''helps to explain why people do what they do'' (Jost, 2006: 653).

A few papers in this research stream examine the role of the prevailing political ideology of organizational members. According to these studies, organizational ideology shapes outcomes because: 1) individuals that adhere to the prevailing beliefs behave in accordance with those beliefs and 2) members who do not embrace such beliefs tend to follow the predominant preferences to act appropriately (Gupta et al., 2016). However, majority of studies have focused on the political ideology of upper echelons, i.e., CEOs, top management teams (TMT), and boards of directors. They adopt the logic of upper-echelon theory, that an organization is a reflection of its top decision-makers (Hambrick & Mason, 1984). According to this theory, executives make decisions through highly individualized lenses shaped by their experiences, personalities, cognitions, and values.

Political ideology at the *individual level*, i.e., the CEO, and at the *group level*, i.e., TMT, board, and organization has been shown to shape a wide array of organizational outcomes. I organize

the examined outcomes into three categories: 1) market strategies, 2) non-market strategies[3], and 3) governance decisions.

Figure1 summarizes the current state of scholarship on the implications of political ideology as a set of values for organizational outcomes.

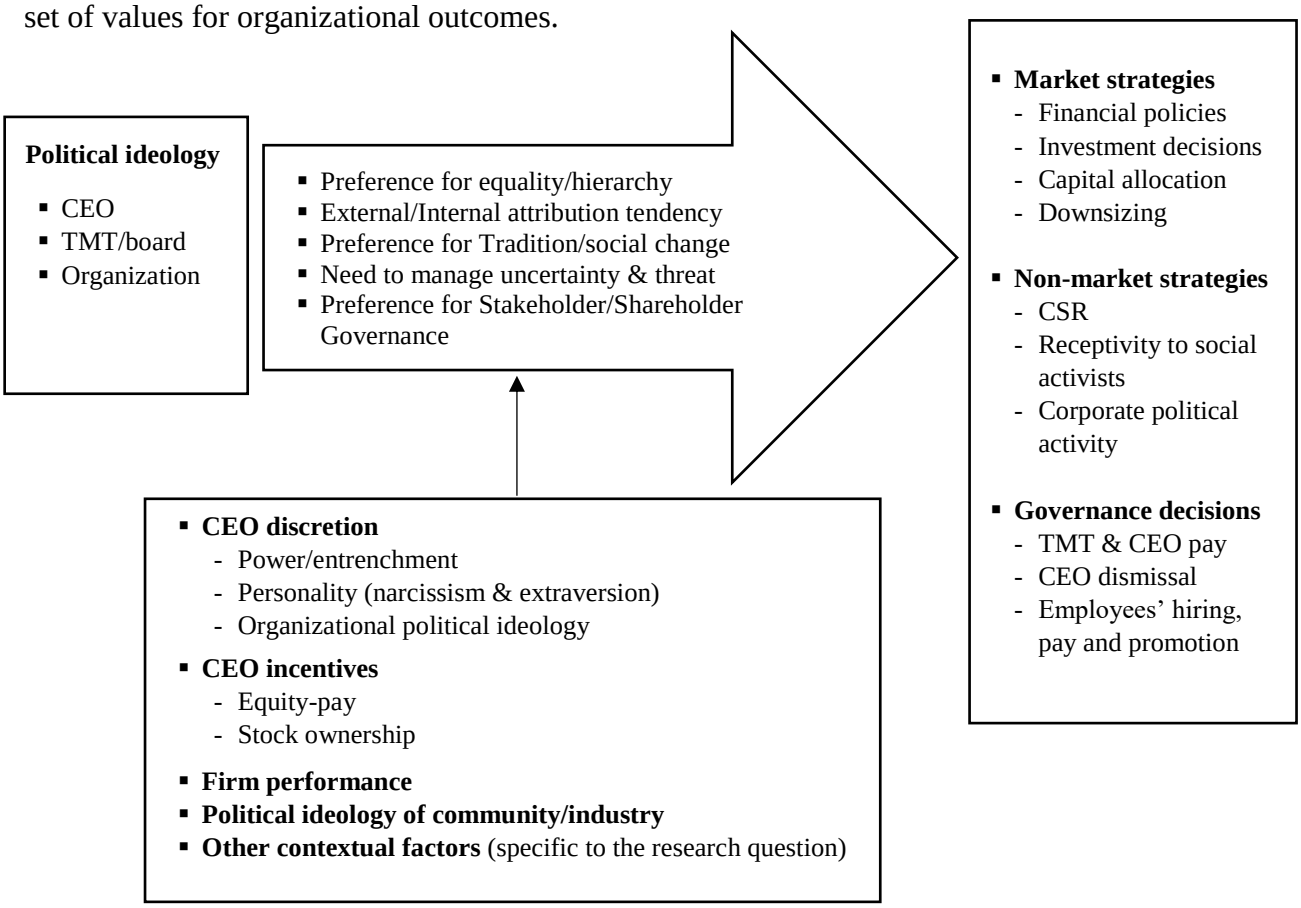

Figure 1. The Current State of Scholarship on the Organizational Implications of Political Ideology

Political ideology and market strategies

A group of studies in this category examine the financial policies of both conservative and liberal top executives, with some relying on the distinction between liberals and conservatives with respect to uncertainty avoidance and threat management preferences. For example, Hutton

[3] Mellahi, George Frynas, Sun, & Siegel (2016) defined non-market strategy as "a firm's concerted pattern of actions to improve its performance by managing the institutional or societal context of economic competition" (144). They also suggested that such strategies are studied in two strands of "corporate social responsibility" and "corporate political activity". I used their definition and categorization to group papers to market and non-market strategies.

et al., (2014) asserts that firms led by conservative TMTs have lower levels of corporate debt, lower capital and R&D expenditures, fewer risky investments, and are more profitable in the short term. Elnahas and Kim (2017) further examined the effect of CEO political ideology on corporate investment decisions and found that conservative CEOs are less likely than liberals to engage in mergers and acquisitions, and if they engage in such actions, they try to choose less risky options (acquiring public firms, avoiding cash payment and earnout clauses). Elnahas and Kim (2017) also show that acquisitions by conservatives tend to have long-term value for firms. Christensen et al., (2015) show that firms with conservative TMTs are less likely to engage in tax-avoidance than firms with liberal TMTs; this tendency is particularly observable when managers are entrenched and consequently have more leeway to influence financial decisions. In a relevant study, Francis, Hasan, Sun, and Wu (2016) show that partisan CEOs (conservative and liberal) are more likely than non-partisan CEOs to engage in tax sheltering[4]. In contrast to Christensen et al., (2015), they find that among partisan CEOs, conservatives are more likely to engage in tax-sheltering. Francis et al., attributed this finding to conservatives' and liberals' different views about the role of government and the distribution of wealth in a society that tends to make conservatives the advocates of tax reduction. In another interesting finding, they showed that liberal CEOs tend to engage in tax reductions only when their stock-based compensation is sufficiently high to provide enough incentive to outweigh the influence of their values. Another study in this domain by DeVault and Sias (2017) shows that characteristics of securities and portfolios of hedge funds are influenced by the political ideologies of their key decision-makers. Their findings show that conservative hedge funds tend to avoid stocks with greater uncertainty

[4] According to corporate tax literature, tax avoidance is a continuum of tax policies from less aggressive (measured by ETR and CETR) to more aggressive actions (tax sheltering) (Francis et al., 2016).

and are less likely to enter new security positions, fully exit their current positions, or adjust their U.S. equity market exposure.

The tendency of liberals to egalitarianism and conservatives to proportionality was shown by Gupta et al., (2018) to impact capital allocations in multi-business corporations. They showed that liberal-leaning CEOs allocate capital to subsidiary businesses more even-handedly. CEO equity pay and stock ownership make this association stronger. Interestingly, such an approach to capital allocation is value-enhancing for firms with prevailing liberal ideologies.

Gupta et al., (2019) examined liberal and conservative CEOs' tendencies to downsize their workforce and showed that the shareholder orientation of conservative CEOs makes them more likely to engage in such strategy.

Finally, Hong and Kostovetsky (2012) demonstrate that mutual fund investment decisions are determined by the political values of their top managers. Their results show that mutual funds with liberal-leaning managers invest less in companies that are socially irresponsible (firms with low KLD scores and firms in industries such as tobacco, guns, defense, etc.).

Political ideology and non-market strategies

Several papers examined the intersection of political ideology and CSR. These papers mostly rely on distinctions between liberals and conservatives in terms of stakeholder vs shareholder orientation. Chin et al., (2013) found that liberal CEOs emphasize CSR more than their conservative counterparts, especially when they have more power relative to board members. This study is complemented by Gupta et al., (2019) that shows liberal CEOs more likely to engage in CSR efforts, specifically those who are narcissistic or extraverted, because CEOs with these personality traits have more discretion. DiGiuli and Kostovetsky (2014) show that firms with liberal-leaning internal decision-makers (CEOs, founders, and directors) and

external stakeholders (headquarters located in Democratic states) score higher in CSR than their conservative-leaning counterparts. Furthermore, liberal firms' greater spending on CSR comes at the expense of future stock performance and a long-term decline in ROA. In a relevant study, Gupta et al., (2016) showed that CSR tends to be shaped by the political ideology of the entire organization. They found that organizational liberalism predicts advances in CSR, specifically in industries in which CSR is rare and in firms with longer-tenure CEOs and those with high human-capital intensity. Hutton, Jiang, & Kumar (2015) focused on the distinctions between liberal and conservative firms with respect to their likelihood of engaging in certain types of fraud and showed that liberal firms are less likely to violate civil-rights, labor, and environmental laws than conservative firms. Conservative firms on the other hand are less likely to be the subject of securities fraud and intellectual property rights violations.

Receptivity to social activism is another non-market strategy that has been studied through the lens of political ideology. Briscoe et al., (2014) find that CEO liberalism positively influences the likelihood of LGBT employee activism, specifically when the CEO is more powerful and when financial performance is poor. They conclude that CEO liberalism is a signal of a corporate opportunity structure for social activists. In a succeeding study, Gupta and Briscoe (2020) showed that liberal-leaning organizations tend to concede more to activists' demands than conservative-leaning organizations.

Overall, these papers underscore the idea that a liberal orientation leads to believing in the interdependence of firms with their social environment as well as their responsibility to contribute to social betterment and protect all stakeholders. Conversely, a conservative orientation tends to result in a specific focus on maximizing value for shareholders and believing that demands of other stakeholders should not garner much of a firm's resources.

The effect of liberal vs conservative-leaning on corporate political strategy has also been examined. Unsal, Hassan, and Zirek (2016) examined CEO political ideology and corporate lobbying and found that firms with conservative CEOs tend to have heavier involvement in lobbying and higher levels of lobbying expenditures. Their results also show that the costs of conservatives' lobbying efforts are typically higher than the benefits and do not tend to create value for their firms.

Political ideology and governance decisions

The political ideologies of leaders influence how firms are governed, specifically with respect to top executive pay and dismissal as well as employee hiring and promotion. The effect of political ideology on executive pay has been studied from different angles. Chin & Semadeni (2017) focused on horizontal and vertical pay dispersion within TMT and found that, because of their adherence to egalitarian values, liberal CEOs tend to decrease horizontal total pay disparity among the TMT, even though such values have no effect on the vertical total pay disparity between CEO and TMT pay. Gupta and Wowak (2017) studied the effect of board political ideology on CEO pay and showed that CEOs of firms led by conservative boards receive higher pay and their pay is more sensitive to financial performance. This effect is ascribed to the internal attribution tendency of conservatives and the greater weight they attribute to the CEO role in delivered performance. Relying on the same logic, Shi, Connelly, Mackey & Gupta (2019) examined the interactional effects of board conservatism and strategic investments (investments in R&D, capital expenditure, and acquisitions) on the effect of financial performance on CEO pay. They demonstrated that conservative boards tend to bolster CEO pay in cases when strategic investments accompanied with good financial performance. Such boards do tend to reduce CEO pay when strategic investments coexist with poor performance. Graffin,

Hubbard, Christensen and Lee (2020) focused on CEO initial pay packages, building on the distinction between liberals and conservatives with respect to uncertainty avoidance to show that CEOs receive initial pay packages that reinforce their risk propensity. Conservative CEOs tend to receive less performance-based pay and liberal CEOs tend to receive higher performance-based pay in their compensation mix. Based on these results, Graffin et al., concluded that boards offer similar pay packages from CEO to CEO but modify them according to CEO risk tolerance. They also show that liberal CEOs who receive higher performance-based pay tend to take more risks, but performance-based pay doesn't tend to influence conservative CEO risk-taking. Lastly, Park, Boeker, & Gomulya (2020) find that conservative-leaning boards of directors are more likely to dismiss a CEO after misconduct, attributing this result to conservatives' emphasis on personal responsibility and internal attribution and their strong tendencies to manage threat. These tendencies make conservative boards less tolerant of norm violation and more strongly reactive to a CEO who engaged in financial misconduct.

Briscoe and Joshi (2017) build on the distinction between liberals and conservatives in their attributional tendencies and their different perspectives about equality to examine the effect of political ideology of managers on gender gap in performance-based pay. They show that the male-female gender gap in performance-based pay is lower in law firms led by liberal supervisors than in firms with conservative supervisors. Carnahan and Greenwood (2018) investigated the effect of manager political ideology on the hiring and promotion of females, drawing on liberals' and conservatives' different views about equality, gender roles in society, and leadership traits. Their results demonstrate that liberal managers of law firms, specifically male managers, are more likely to hire, select in work teams, and promote females.

My review of literature (summarized in Table 1) reveals that, while political ideology has been shown to impact a wide range of decisions and strategies, we still do not have a complete understanding about how it shapes innovation[5]. The lack of research integrating innovation and political ideology was also highlighted by Swigart et al., (2020) in their most recent review of the literature in the field. Although innovation is a critical determinant of competitive advantage, firms vary with respect to the amount of resources they invest in innovation and the extent to which they integrate innovation into their strategies. So, exploring the antecedents of such variation has been the focus of researchers across disciplines. Specifically, CEOs have been shown to be influential actors in shaping innovation (Nadkarni & Chen, 2014; Tang et al., 2015). As CEOs' political ideologies lead them to prefer certain decisions, they may also impact how much CEOs emphasize innovation as a route to growth and competitive advantage.

The following chapter elaborates on my theory related to how CEO political ideology influences innovation outcomes and strategies.

[5] Kashmiri and Mahajan (2017), published in the Journal of Marketing Research, showed that firms with liberal CEOs exhibit a higher rate of new product introductions (NPIs). My study extends their research in several ways. First, they specifically focused on NPIs, but my study considers a wider range of innovation strategies and outcomes and provides a richer picture of the effect of political ideology on innovation. Furthermore, their sample included 421 publicly listed firms that are tracked from 2006 to 2010. My main sample includes S&P1500 firms and I track them from 1992 to 2014. The sample of my study spans a longer time period, and by focusing on S&P 1500 covers a wider set of firms that enhances the generalizability of my findings.

Table 1. A Summary of Research on Political Ideology and Organizational Outcomes

Study	PI measure	Outcome of interest	Mechanism	Boundary conditions
Hong & Kostovetsky (2012)	- TMT liberalism	- Investment in socially irresponsible firms (-) - Fund performance	- Stakeholder orientation of liberals vs shareholder orientation of conservatives	-
Hutton et al., (2014)	- TMT conservatism - CEO conservatism	Financial policies: - Corporate debt (-) - Capital and R&D expenditure (-) - Risky investments (-) - Profitability (+)	- Stronger need of conservatives to manage threat and avoid uncertainty	-
Christensen et al., (2015)	- TMT conservatism - CEO conservatism	- Tax avoidance (-) - New TMT conservatism (+) - New CEO conservatism (+)	- Stronger need of conservatives to manage threat and avoid uncertainty - Homophily principle	- TMT entrenchment (+)
Francis et al., (2016)	- CEO liberalism	- Tax Sheltering (-)	- Liberals values about distribution of wealth	- CEO equity compensation (-) - CEO entrenchment (-) - Local community liberalism (+)
Elnahas & Kim (2017)	- CEO conservatism	- M&A frequency (-) - Method of payment - Type of target (public vs private) - Short-term value following M&A (None) - Long-term value following M&A (+)	- Stronger need of conservatives to manage threat and avoid uncertainty	-
DeVault & Sias (2017)	Organizational liberalism	- Security characteristics: {size (-), age (-), volatility (+), profitability (-), dividend paying (-) and lottery-type securities (+)} - Portfolio decisions: {entry trades (+), exit trades (+), change in total equity holdings (+)}	- Stronger need of conservatives to manage threat and avoid uncertainty	-
Gupta et al., (2018)	- CEO liberalism	- Even handedness in capital allocation (+) - Firm value (+)	- Liberals preference for equality (egalitarianism) and conservatives preference for hierarchy (proportionality)	- Organizational liberalism (+) - CEO equity-based pay (+) - CEO shareholding (+)
Gupta et al., (2019)	- CEO conservatism	- Downsizing	- Stakeholder orientation of liberals vs shareholder orientation of conservatives	- CEO Extraversion (+)

Market Strategies

(Table 1 cont'd.)

Non-Market Strategies

Study	PI measure	Outcome of interest	Mechanism	Boundary conditions
Chin et al., (2013)	- CEO liberalism	- CSR (+)	- Stakeholder orientation of liberals vs shareholder orientation of conservatives	- CEO power (+) - Financial performance (-)
Briscoe et al., (2014)	- CEO liberalism	- Receptivity to LGBTQ activists (+)	- Liberals embracing values of equality, diversity and human rights.	- Financial Performance (-) - CEO power(+) - Phase of the movement
DiGiuli & Kostovetsky (2014)	- CEO liberalism - Founder liberalism - board members liberalism - local community liberalism	- CSR (+)	- Stakeholder orientation of liberals vs shareholder orientation of conservatives	-
Hutton et al., (2015)	- TMT liberalism - Firm liberalism - Local community liberalism	Litigation types: - civil rights, labor, and environment (-) - securities fraud and intellectual property rights violations. (+)	- liberal values of equal rights, labor rights, and environmental protection vs conservative values of free market, property right and limited government	-
Gupta et al., (2016)	- Organizational liberalism	- CSR (+)	- Stakeholder orientation of liberals vs shareholder orientation of conservatives	- Prevalence of CSR practices in industry (-) - Human capital intensity of firm (+) - CEO tenure (+)
Unsal et al., (2016)	- CEO conservatism	- lobbying expenditure - number of bills and issues lobbied for - number of lobbyists hired - Firm performance	- Stronger need of conservatives to manage threat and avoid uncertainty	-
Gupta et al., (2018)	- CEO liberalism	- CSR (+)	- Stakeholder orientation of liberals vs shareholder orientation of conservatives	- CEO Narcissism (+) - CEO Extraversion (+)
Gupta & Briscoe (2020)	- Organizational liberalism	- Receptivity to social activists (+)	- Stakeholder orientation of liberals vs shareholder orientation of conservatives	- organizational members' spatial proximity to decision makers (+) - incongruence between the organization and community ideology (+) - incongruence between the organization and industry ideology (+)

(Table 1 cont'd.)

Governance Decisions

Study	PI measure	Outcome of interest	Mechanism	Boundary conditions
Briscoe & Joshi (2017)	- Liberal partnering supervisors in law firms	- Gender gap in performance-based pay (-)	- External attribution tendency of liberals vs internal attribution tendency of conservatives	- Employee seniority (+)
Carnahan & Greenwood (2018)	- Liberal managers in law firms	- Hiring females - Selecting females as team members - Females promotion	- Liberals preference for equality (egalitarianism) and conservative preference for hierarchy (proportionality)	- Male managers (+)
Chin & Semadeni (2017)	- CEO liberalism	- vertical pay dispersion between CEO and TMT (ns) - horizontal pay dispersion among TMT (+)	- Liberals preference for equality (egalitarianism) and conservatives' preference for hierarchy (proportionality)	- liberalism of compensation committee
Gupta & Wowak (2017)	- Board conservatism	- CEO pay (+)	- External attribution tendency of liberals vs internal attribution tendency of conservatives	- Conservatism of compensation committee (+) - financial performance (+)
Kim et al., (2013)	- Diversity of board members political ideology	- New director's political ideology - Firm performance (+) - Agency costs (-)	- Homophily principle	-
Shi, Connelly, Mackey & Gupta (2019)	- Board conservatism	- CEO performance-based pay	- External attribution tendency of liberals vs internal attribution tendency of conservatives	-
Park et al., (2020)	- Board conservatism	- CEO dismissal after misconduct (+)	- External attribution tendency of liberals vs internal attribution tendency of conservatives	-
Graffin et al., (2020)	- New CEO conservatism	- CEO initial performance-based pay (-)	- Stronger need of conservatives to manage threat and avoid uncertainty	-

CHAPTER 3. THEORY AND HYPOTHESES DEVELOPMENT

CEOs and Innovation

As the top leader who sets the general direction of a firm, a CEO has a profound role in shaping innovation trajectory (Berger et al., 2008). CEOs influence innovation through a wide array of direct and indirect levers (Crossan & Apaydin, 2010). For example, they may set explicit objectives and strategies for innovation or bring novel ideas and opportunities to the attention of other TMT members (Van de Ven, 1986). They also may make decisions about innovation proposals, control the amount of resources allocated to innovation projects, and coordinate the implementation of such projects (Augier & Teece, 2009; Van de Ven, 1986). CEOs further influence innovation by playing a role in designing organizational structure and developing and maintaining an effective organizational culture (Berson, Oreg & Dvir, 2008). Research shows that the extent to which CEOs prioritize innovation is a function of their personal orientations in terms of experiences, cognitions, personalities, and values (Crossan & Apaydin, 2010; Hambrick & Mason, 1984).[6] For example, existing research shows that younger CEOs and those with engineering/R&D and sales/marketing backgrounds tend to make more investments in innovation than more senior CEOs and those with legal or production backgrounds (Barker & Mueller, 2002). Similarly, overconfidence (Galasso & Simcoe, 2011; Hirshleifer, Low & Teoh, 2012; Tang et al., 2015), temporal orientation (Nadkarni & Chen, 2014; Yadav, Prabhu, & Chandy, 2007) sensation-seeking (Sunder, Sunder & Zhang, 2017), as well as humility and

[6] There are also several attributes of CEOs' position (e.g., power, tenure, insider vs outsider) and components of corporate governance (e.g., CEO compensation) that have implications for a firm's innovation (He & Tian, 2018). Because those attributes are beyond the scope of my study, their effect on innovation is not reviewed here.

narcissism (Zhang, Ou, Tsui, & Wang, 2017) are among cognitive and personality traits that are shown to influence CEO attitudes toward innovation.[7]

In the section that follows, I will present my theory about the influence of CEO political ideology in terms of liberal-conservative orientation on several aspects of a firm's innovation.

CEO Political Ideology and Innovation

CEOs bring their political ideology to the C-suites (Cohen et al., 2019; Francia et al., 2005). Those deeply held beliefs that guide CEOs when making strategic decisions (Briscoe et al., 2014; Chin et al., 2013; Gupta et al., 2018) and likely to influence their decisions about innovation.

Effect on the quantity of innovations

Innovation has two core aspects that make it amenable to be influenced by a CEO's political ideology: 1) newness and 2) riskiness. First, the essence of innovation is *newness* (Gopalakrishnan & Damanpour, 1997; Gupta, Tesluk, & Taylor, 2007) because it involves creating, accepting, and implementing new ideas related to processes, products, and technologies (Thompson, 1965). In a content analysis of 60 definitions of innovation, Baregheh, Rowley, & Sambrook (2009) concluded that "*new*" is the attribute most used by researchers across disciplines to describe innovation. To successfully innovate, firms must constantly explore new opportunities and experiment with new ideas (Dyer, Gregersen, & Christensen, 2011).

As discussed in the previous chapter, liberal orientation tends to be associated with openness to new experiences (Carney et al., 2008; Gerber et al., 2011). This trait characterizes individuals who are imaginative, curious, and amenable to new ideas, experiences, and unconventional perspectives (McCrae, 1987; McCrae & John, 1992). Open individuals are

[7] A brief summary of research on the effects of CEOs' personal orientations on innovation is provided in the Appendix (table A.1).

interested in finding new ways of doing things and tend to make change in the existing orders (McCrae, 1987). By contrast, conservatives tend to be low in openness and high in conscientiousness (Carney et al., 2008; Gerber et al., 2011). They prefer the familiar, routine, and tried to the unfamiliar, novel and new (Costa, McCrae, & Dye, 1991; Jost et al., 2003). Conservatives are also less likely to favor changing the status quo, coming up with new ways of doing things, or soliciting new information (Feist, 1998). These differences make it likely that liberal CEOs, more than their conservative counterparts, favor generating and experimenting with new ideas to develop novel technology and new products.

Second, innovation is *risky*. The eventual outcome of innovation is highly uncertain; while some innovation projects end in success, a great number of them fail during the process. Costs associated with innovation is the issue that makes such uncertainty even more hazardous. Not only it usually takes a long time for an inventor to find a new idea and develop it to a new product or technology, but this process most often requires making substantial financial investments. For example, a recent study (Wouters, McKee & Luyten, 2020) estimated that between 2009 and 2018 the mean investment that biopharma companies made in R&D to develop new medicines was $1336 million, with a median investment of $985 million. As another example, in 2012 the average R&D costs for launching a new product in the consumer-packaged goods industry was about $71 million (Cecere, 2013). Added to these costs is the opportunity cost of lost returns due to diverting resources from activities with potential for short-term payoff and allocating them to innovation projects instead. In addition, pursuing innovation may jeopardize CEOs' career and wealth if the failure of such efforts is attributed to their leadership capabilities (Meindl, Ehrlich, & Dukerich, 1985).

As previously discussed, conservatives and liberals tend to be different in their need to manage uncertainty and threat, with conservatives scoring higher with respect to such needs. This tendency makes conservatives strive to increase the predictability of events and enhance security. Conservatives are also more attuned to negative events and try to mitigate their possibility by avoiding unknowns and remaining loyal to the tried and true (Hibbing et al., 2014). Research shows that, even when thinking about the advantageous and disadvantageous of deviation from known approaches, conservatives tend to see the potential drawbacks more damaging than they see the potential benefits pleasant (Joel, Burton & Plaks, 2014). This evidence further demonstrates conservatives' fearfulness of negative outcomes. Conversely, liberals tend to have a lower need to reduce uncertainty and threat, making them more willing to explore the unknown and take risks (Jost et al., 2003; Jost et al., 2017). Like in any decision that involves risk, a person who focuses on the bright side and potential benefits is more likely to take a risk than one who focuses on the dark side and the potential threat. Therefore, liberal CEOs are more likely to look at the bright side of innovation as a strategy that brings about growth and profitability. Conservative CEOs, on the other hand, are more likely to look at the dark side of innovation as a costly strategy that may possibly jeopardize resources and profitability.

Considering the distinction between liberals and conservatives with respect to attitudes toward new experiences and risk-taking, I expect that firms with liberal CEOs develop more innovations than firms with conservative CEOs.

Accordingly, I hypothesize:

Hypothesis 1: CEO political liberalism is positively associated with the quantity of innovations.

Effect on the quality of innovations: breakthroughs vs failures

Innovations vary with respect to the value they create for firms and the impact they have on markets and technology. On the one hand, breakthrough innovations are high-quality innovations that create considerable firm and social value (Hall, Jaffe, & Trajtenberg, 2005) by challenging the existing technological and competitive order, shaping new trajectories, and allowing firms to create new market opportunities (Phene, Fladmoe-Lindquist, & Marsh, 2006). Such innovations can thus be important sources of competitive advantage and positively influence a firm's long-term survival. On the other hand, failures are low-quality innovations that create little or no value for the innovative firm (Lee, Kim, & Bae, 2020; Singh & Fleming, 2020).

Research shows that breakthrough and failure innovations partly result from undertaking high-risk R&D projects (Cabral, 2003; Conti, 2014; Lee et al., 2020). In general, taking more risk increases the likelihood of both favorable and unfavorable outcomes (March & Shapira, 1987; Sanders & Hambrick, 2007), so high-risk R&D increases the variance in innovation outcomes and the likelihood of developing innovations with extreme quality. High-risk R&D can obviously be a double-edged sword for firms.

The distinctive values and psychological needs of liberals and conservatives is likely to influence the quality of innovations developed under their leadership. Liberal CEOs with higher tendencies to try out new things and enjoy novelty, as well as being willing to take more risks, are more likely to undertake high-risk R&D projects, while the uncertainty and threat-avoidant attributes of conservatives make them more cautious of launching R&D projects that may be end up producing negative results. Thus, conservative CEOs are more likely to opt for committing resources to safer R&D projects.

Considering the predicted differences between liberal and conservative CEOs' with respect to the riskiness of R&D projects they are willing to pursue, I suggest the following:

Hypothesis 2: CEO political liberalism is positively associated with breakthrough innovations.

Hypothesis 3: CEO political liberalism is positively associated with failure innovations.

Effect on the strategy of innovation: exploration vs exploitation

Firms follow different directions in developing innovation, some pursue "exploration of new possibilities" while others follow "exploitation of old certainties" (March, 1991:71). Put differently, firms' innovation strategy varies on an explorative-exploitative continuum (Lavie, Stettner & Tushman, 2010; Manso, 2011).[8] Exploratory innovation strategy is different from exploitative strategy in a number of respects. First, an exploratory innovation strategy can involve experimentation, a distant search for new knowledge beyond a firm's current knowledge base, and a shift to a different technological trajectory (Benner & Tushman, 2002; 2003; Levinthal & March, 1993). Conversely, an exploitative innovation strategy comprises a local search in the proximity of the existing knowledge and building on an existing technological trajectory (Benner & Tushman, 2002; 2003; Levinthal & March, 1993). Second, exploratory innovations usually take a longer time to develop and pay off, require a large amount of resources, and are associated with greater uncertainty and higher likelihood of failure (March, 1991). In contrast, exploitative innovations are more proximate and predictable, are less resource

[8] In his seminal paper, March (1991) conceptualizes exploration and exploitation as a unidimensional construct. He believes exploration and exploitation are fundamentally incompatible for several reasons:1) because they compete for scarce resources, allocating resources to one strategy leaves fewer resources for another, 2) both are self-reinforcing and initiating one may lead to continuation of its pursuit and 3) the mindset and organizational routines needed for each are fundamentally different. While a considerable body of research has followed March's conceptualization, there are a group of studies that model exploration and exploitation as orthogonal constructs (e.g., Katila & Ahuja, 2002; Nerkar, 2003) that can be pursued simultaneously (ambidextrously). In my study, I follow March (1991) and consider exploration-exploitation a continuous construct.

intensive, and are associated with higher chances of success (March, 1991). Moreover, exploratory innovation leads to building new capabilities, offering radically new products, and entering to or creating new markets (He & Wong, 2004; March, 1991), while exploitative innovation results in re-using and fine-tuning current capabilities, refinement and extension of existing products, and meeting the demand of existing markets (Benner & Tushman, 2002; 2003; March, 1991).

CEOs set the strategy of innovation by making strategic decisions with respect to the amount of R&D expenditures or the priority of different innovation projects (Custódio, Ferreira, Matosc, 2019; Galasso & Simcoe, 2011). As discussed earlier, exploratory innovations can involve recombination of new knowledge unfamiliar to the firm and a great deal of uncertainty about the process and potential outcomes. Because liberals tend to be open to new experiences and enjoy the discovery of novelty, they are likely to be more willing and able to think about ideas that challenge the status quo (McCrae, 1987; McCrae & John, 1992). Exploratory innovations are likely to be more stimulating for liberals than exploitative innovations. Moreover, the lower need to avoid uncertainty and the lower fear of failure associated with liberal orientation further reinforces their novelty-seeking and make them more tolerant of the risk involved in exploratory innovations. Conversely, conservatives tend to not favor novelty and prefer familiarity and predictability. Furthermore, relatively risk-averse conservatives tend to choose the safer option (Elnahas, & Kim, 2017), and the degree of uncertainty and high risk of failure associated with exploratory innovations is likely to exceed conservative CEOs' risk tolerance.

Consequently, I expect liberal CEOs to be more willing to follow an exploratory innovation strategy, and equivalently conservative CEOs to be more willing to pursue an exploitative innovation strategy.

Formally, I propose that:

Hypothesis 4: CEO political liberalism is positively associated with exploratory innovations.

Effect on the strategy of innovation: basic vs applied research

A critical source of firms' innovation is their research endeavors, because through research firms create knowledge that will be utilized to develop new products and technology (Arrow 1962; Nelson, 1959). Research activities can be broadly categorized as either basic or applied. According to National Science Foundation (NSF) basic research involves a "systematic study to gain more comprehensive knowledge or understanding of the subject under study without specific applications in mind," while applied research involves a "systematic study to gain knowledge or understanding to meet a specific, recognized need." In other words, basic research is early stage research that seeks general advancement of knowledge with no specific commercial objectives, while applied research seeks more specific knowledge creation with explicit commercial applications.

Basic research initiatives are more likely than applied research to result in revolutionary technological advances and open new trajectories of research (Aghion & Howitt, 1996; Nelson, 1959). This is because basic research not tied to a specific application allows the researcher to experiment and change the direction of research over time, in turn increasing the likelihood of groundbreaking discoveries (Nelson, 1959). Basic research fuels a firm's innovation by extending its knowledge stock and increasing its awareness of technological advances (Henard &

McFadyen, 2005). Such knowledge serves as a key input to applied research projects aiming at developing new products/technology (Czarnitzki & Thorwarth, 2012), so basic research is an essential component of a firm's innovation and success (Griliches, 1986; Mansfield, 1980).

The output of basic research does not have immediate and specific practical application and is usually in the form of knowledge with broad application. Such knowledge has the potential to create value if it is assimilated and exploited in other more applied research projects. A firm that invests in basic research may not be able to capture the full value created by such research if it lacks the necessary resources or capabilities (Rosenberg, 1990). Therefore, basic research is difficult to appropriate (Trajtenberg et al., 1992). A factor that exacerbates the appropriability problem is the nature of knowledge as a public good that when produced becomes freely available to everyone (Rosenberg, 1990). Research shows that basic research spills over within the innovative firm's industry as well as across industries (Czarnitzki & Thorwarth, 2012), so it is believed that the social returns of basic research tend to be higher than its private returns (Rosenberg, 1990). Furthermore, firms, including rivals, that did not make any contribution to the knowledge production process may free ride on a firm's innovative endeavors and exploit the new knowledge to their benefit. Adding to this dilemma is the fact that the output of a basic research project is not always patentable (Rosenberg, 1990). Because of these characteristics, a profit-maximizing business may be reluctant to allocate resources to basic research because the expected private revenue produced by such efforts may not exceed their costs. Thus, motives other than profit maximization may be required to push firms toward undertaking basic research (Nelson, 1959). I suggest that a CEO's political ideology is likely to be influential in a firm's decision to pursue basic research.

Conservatives place high emphasis on ownership rights and believe that shareholders' claims precede all others and resources need to be efficiently allocated to maximize shareholder wealth (Tetlock, 2000). Conservative CEOs are therefore less likely to favor shifting resources to research endeavors that do not promise clear practical benefits and whose returns are not completely appropriable. Such CEOs are less likely to favor advancement of knowledge without tangible applications and benefits for their own firms and shareholders. The fact that other firms, specifically rivals, may also benefit from investments an innovative firm made in basic research adds to the unfavourability of such research for conservatives. On the other hand, liberal CEOs take a broader view about the purpose and role of firms within a society that is reflected in their attempts to maintain balance among the claims of multiple stakeholders (Briscoe et al., 2014; Chin et al., 2013). Liberals are also likely to be more motivated toward exploring and trying out new things, making them more likely to favor knowledge creation and advancement, and their stakeholder model of corporate governance also makes them perceive the social benefits of conducting basic research more favorably than conservatives. Liberal CEOs are therefore expected to envision more promising consequences from undertaking basic research than conservative CEOs. Accordingly, I make the following prediction:

Hypothesis 5: CEO political liberalism is positively associated with a firm's engagement in basic research.

Effects on gender diversity of inventors

Over the past several years, the number of females in Science, Technology, Engineering and Mathematics (STEM) fields has grown. For example, in the U.S. the number of women granted STEM degrees increased by 48% between 2008 and 2016 (Duffin, 2019). Despite these great strides, there is still a remarkable universal gender gap in STEM in an array of aspects such

as workforce participation, salary and the distribution of positions, resources, and rewards (Hoisl & Mariani, 2017; Whittington, 2018). Women are particularly under-represented in inventive jobs (Milli, et al., 2016); in 2016, only 21% of U.S. patents listed at least one female inventor (USPTO, 2019) and women filled only 29.3% of R&D jobs worldwide (UNESCO, 2019). Moreover, research shows that female scientists obtain fewer patents than men (Naldi, Luzi,Valente, Parenti, 2004; Whittington, 2018) and are less likely to engage in commercial activities such as licensing (Duque et al., 2005), consulting (Gaughan & Corley, 2010), and serving on scientific advisory boards (Ding et al., 2013).

Such a gender gap is not a matter of work quality, because research has demonstrated that the quality of female inventions is the same or better than that of their male counterparts (Whittington & Smith-Doerr, 2005). Interviews with female scientists show that in general women receive fewer invitations for collaboration in commercial activities and feel less sought by industry (Murray & Graham, 2007). This disparity in representation of females in inventive jobs may partly stem from gender biases and stereotypes that persist in the society (Correll, Benard, & Paik, 2007; Haines, Deaux, & Lofaro, 2016; Hoisl & Mariani, 2017; Long & Fox, 1995).

In the context of inventive jobs, the following biases may underlie the observed underrepresentation of women. First, innovation by nature is associated with considerable risk. Not only the process of research is highly uncertain, but the final invention may not result in a marketable product. The more novel the invention idea and the more explorative the process, the higher the risk of undertaking the innovation project. Since women are shown to be generally less risk taking than men (Croson & Gneezy, 2009; Palvia, Vahamaa, & Vahamaa, 2015), female scientists may be perceived as unfit for jobs that require high risk-taking propensity. It may also

be perceived that if a female inventor is hired, she may prefer to do more routine and administrative R&D tasks rather than engage in cutting-edge and challenging projects. Second, innovation requires constant generation of new ideas and experimentation, requiring an inventor to stay up to date or even ahead of the latest knowledge and technological advances in his/her field of research. The challenging process of innovation also requires significant commitment of time and energy to a project to achieve the expected results, but existing views about the family-oriented role of females may create a hurdle for female inventors in exhibiting their potential. It may be perceived that family commitments decrease women's productivity because they need to divide their energy between work and family (Becker, 1985). Thus, some employers may believe that these preferences may make female scientists unable to keep their knowledge and skills current and devote enough time and energy to innovation projects. Such implicit assumptions may make employers reluctant to hire female inventors.

As top decision-makers, CEOs have substantial influence in managing diversity in their firms, and their diversity-related decisions are likely to be highly influenced by their own values (Ng & Sears, 2012; 2020). Because liberal and conservative CEOs have dissimilar attitudes toward gender stereotypes, gender roles in the family, and gender inequality, I suggest that they also may have different views about the appointment of female scientists.

First, conservatives are more likely than liberals to adopt gender stereotypes (Jost et al., 2009). According to research in social-cognition, people adhere to stereotypes to enact order and structure to the social world and conserve their mental resources (Moskowitz, 2005). Because conservative orientation is associated with a stronger need to avoid uncertainty and achieve order, structure, and closure (Jost et al. 2003; Jost et al., 2017), stereotyping attitudes are more appealing to conservatives than to liberals who tend to have lower levels of such needs (Jost et

al., 2009). As a result, conservative CEOs are more likely to perceive the gender of females as a proxy for their risk-aversion and consequently their unsuitability for the job. The lower likelihood of adherence to stereotypes makes liberal CEOs less prone to perceive a scientist's gender as an indicator of congruity/incongruity with the job. Second, conservatives in general tend to hold a more traditional view of family roles and gender norms (Jost et al., 2009), believing that women's priorities are looking after the family and raising children, not working outside home (Bolzendahl & Myers, 2004; Davis & Greenstein, 2009). Conversely, liberals often hold non-traditional views about the role of women in the family and even may perceive women's working inside home as an indicator of inequality (Bolzendahl & Myers, 2004; Davis & Greenstein, 2009). Because liberals are less likely to believe that a women's job is looking after home and family, such CEOs are expected to be less concerned that females may miss work or have lower productivity due to family commitments.

Conservatives and liberals also have distinct attitudes toward equality and social change (Jost et al., 2003, Jost et al., 2009). While conservatives advocate for stability and hierarchy, liberals prefer social change and equality (Jost et al., 2003, Jost et al., 2009). Under-representation of females in scientific jobs is likely to be perceived by liberal CEOs as an instance of injustice because this situation may deprive them of the opportunity to demonstrate their capabilities (Ridgeway & Smith-Lovin, 1999). Therefore, liberals are more likely to believe that such social problem should be addressed, suggesting that liberal CEOs are more likely than conservative CEOs to evaluate female job candidates more positively and be more willing to employ them.

Although CEOs may not be directly involved in the process of selecting and hiring inventors, their diversity preferences may influence this process. CEOs set the general principles

of human resource management, including those related to gender equality that become the basis for policies and practices implemented by lower-level managers (Steffensen, Parker, Wang, & Ferris, 2019). CEOs may also explicitly engage in pro-diversity behavior or communicate their own preferences about gender equality to other TMT members (Ng & Sears, 2020). Perception of a CEO's commitment to equality make it more likely that TMT and other managers factor it into their selection decisions (Chadwick, Super, & Kwon, 2015; Fenton-O'Creevy, 2001). Therefore, the political ideology of CEOs can influence the degree of representation of female scientists in their firms.

Thus, I hypothesize:

Hypothesis 6: CEO political liberalism is positively associated with female inventors' representation in a firm.

The political ideology of CEOs is likely to not only influence the overall representation of female scientists in firms, but females' presence in innovation teams. As discussed earlier, liberal CEOs are more likely than their conservative counterparts to believe that organizations should act to resolve inequality as a social problem (Briscoe et al., 2014; Chin et al., 2013), so they are more likely to include gender equality preferences in their general principles and communicate them to other TMT members so that such principles will be integrated into their firm's policies and practices. Moreover, liberal CEOs may encourage equality values by shaping an organizational climate that illuminates for other organizational members precisely what behaviors are acceptable. As a result, it would be expected that the perception of a CEO's view about female scientists and their commitment to gender equality would cause managers and employees in a firm led by a liberal CEO to have a more positive evaluation of female inventors and a stronger adherence to mitigation of the likelihood of inequality in their decisions. In such a

context, those individuals that do not necessarily adhere to the value of gender equality are likely to behave in accordance to the prevailing values encouraged by the CEO in order to behave appropriately and avoid possible undesirable consequences for themselves (March & Olsen, 2006). Therefore, in a firm led by a liberal CEO, female scientists are more likely to be selected for participation in innovation projects because in such firms there is a positive perception of female scientists' competence and enhanced sensitivity about provision of equal opportunities for females.

As such, I hypothesize:

Hypothesis 7: CEO political liberalism is positively associated with female inventors' representation in innovation teams.

CHAPTER 4. METHODOLOGY

Sample

I began with all CEOs who had served in firms listed in the S&P1500 (available on ExecuComp) during 1992-2014, which included 7455 CEOs across 3733 firms. S&P1500 as the main sample fit the purpose of my study for several reasons. First, the S&P1500 covers approximately 90% of the United States market capitalization and involves an array of small, midsize, and large public companies across different industries and states, thus supporting the generalizability of the findings. Second, because of the visibility of S&P1500 firms, data about their CEOs are readily available, facilitating the measurement of CEO-related variables. I chose 1992 as the starting year because this is the first year that ExecuComp data is available. I chose 2014 as the end point because the main source I used to measure CEO political ideology is available up to then and the dataset I used to match ExecuComp firms with patent data is available up to 2015. Following prior research (Custódio et al., 2019; Galasso & Simcoe, 2011; Hirshleifer et al., 2012; Lee et al., 2020; Sunder et al., 2017), I excluded financial (SIC codes 6000–6999) and transportation and utilities firms (SIC codes 4000–4999) from my sample because they are less likely to have significant patenting activity. I also excluded all CEOs for whom I found no donation to either Democratic and/or Republican parties between 1992 to 2014. I also considered only those firms listed in Execucomp that match with the United States Patent and Trademark Office (USPTO) database. In other words, I only included firms in the intersection of the USPTO and the S&P1500[9]. Finally, I excluded companies incorporated outside the U.S.

[9] Previous studies usually assigned zero to those firms for which no match is found in patent database. In other words, they assigned zero patents to a firm-year observation either because the focal firm was not found in patent database or had zero patent applications in the focal year. As underscored by some recent studies (Balsmeier, Fleming, & Manso, 2017), this operationalization increases the measurement error although it leads to a larger sample size. In my study, to have a more accurate sample, I excluded not-matched firms.

Imposing these screens resulted in a final sample size of 9776 firm-year that covers 1544 CEOs across 959 firms and 39 different industries (at two digits SIC codes).

Data

I used patent data obtained from USPTO's PatentsView database to measure innovation variables[10]. This platform is built on a newly developed database that longitudinally links inventors, their organizations, their locations, and their overall patenting activity. It uses data derived from USPTO bulk data files that covers all patents granted from 1976 to the most recent update. I matched each assignee's id of patent data (the time-invariant identifier provided by USPTO to firms) with Compustat's company unique identifier code (GVKEY) following the name-matching algorithm and dataset made publicly available by Arora, Belenzon, and Sheer (2017)[11]. Using Arora et al., (2017)'s dataset, Compustat firms can be matched with patent data produced between 1980 and 2015. This procedure resulted in a matched list of GVKEYs and assignee ids that I then used to collect the required patent data for each firm in my sample. I matched patents to firm-year observations using patents' filing (application) dates. As previously mentioned, in my final sample I included only those GVKEYs for which I could find a match on the PatentsView database. While some prior studies assigned zero patents to those firms not matched with patent data, this practice is likely to increase measurement error (Balsmeier, et al., 2017). I also used the dataset made publicly available by Marx and Fuegi (2020)[12] to measure the *Citations to science* variable. This dataset contains approximately 22 million citations to scientific papers by both U.S. patents (from 1947 to 2018) and non-U.S. patents (from 1782 to 2018).

[10] This data is available on http://www.patentsview.org/download.

[11] This database is available on https://zenodo.org/record/3594743#.Xvt4Zm1KjIX

[12] This dataset is available on https://zenodo.org/record/3755799#.Xw3a_G1KjIV

To measure CEO political ideology, I used individuals' listed donations to Democratic and Republican parties. I obtained data about such donations from Bonica's 2016 Database on Ideology, Money in Politics and Elections (DIME)[13] that includes data on political donations to candidates, party committees, and political action committees (PACs) between 1979 and 2014. This dataset contains more than 130 million political contributions made by organizations and individuals collected from Federal Election Commission (FEC) filings.

I obtained financial data and information on firm locations from Compustat, and institutional ownership data from the Thomson-Reuters Institutional Holdings (13F) database. While I obtained most CEO data from ExecuComp, I accessed data on CEO Vega from the updated version of the database made available by Coles, Daniel, and Naveen (2006). This dataset includes data on CEO Vega between 1992 and 2014[14].

Measures

Dependent variables

Quantity of innovations. I measured the quantity of innovations as the *number of patents* filed by a firm to USPTO in each sample-year (Custódio et al., 2019; Galasso & Simcoe, 2011; Sunder et al., 2017). A patent for an invention is the grant of property rights to its inventor to exclude/stop others from making, using, selling or importing the invention for a limited time (20 years) in exchange for publishing and enabling public disclosure of it. Patents are extensively used in literature as a measure of a firm's innovation-related activities (Ahuja, 2000).

Breakthrough innovations. Breakthroughs are high-quality innovations. Following the innovation literature (Lahiri, 2010), to determine the quality of innovation I used the number of

[13] This dataset is available on https://data.stanford.edu/dime

[14] This dataset is available on https://sites.temple.edu/lnaveen/data/

forward citations (citations made by future patents to a given patent) that a patent received in subsequent years after being filed. Patent citations are a credible measure of innovation quality for several reasons (Hall, Jaffe, & Trajtenberg, 2005). First, when firms cite a patent, it reveals an intent to invest in further development of the innovation/knowledge disclosed by that patent, a signal that the cited patent is technologically/economically important. Since citations accrue over time when the uncertainty about the value of an innovation is reduced, receiving citations years after being granted is a signal of a patent's value. Consistent with these arguments, research shows that the number of citations a patent receives can positively affect a firm's value (Hall, et al., 2005; Trajtenberg, 1990). To measure breakthrough innovations, I divided the number of forward citations received (up to year 2019) by each patent applied by a firm in a given year by the average of all forward citations received by all patents filed in the same technological class in that year (Azoulay, GraffZivin, & Manso, 2011). I categorized those patents in the top 1 percentile of the received citations as breakthrough innovations and considered the number of breakthrough innovations filed by a firm in each sample year for testing my models.

Failure innovations. Failures are low-quality innovations. Using the number of citations as the proxy of a patent's quality (Lahiri, 2010), I measured failures as those patents that received no forward citations (zero citations) in subsequent years (up to 2019) after being filed (Balsmeier et al., 2017; Singh & Fleming, 2010).

Exploratory innovations. I measured exploratory innovations in two different ways. First, as a basis for determining whether a patent is exploratory, I focused on the extent to which a patent builds on knowledge that is unfamiliar/new to a firm (Benner & Tushman, 2002; 2003). To this end, I examined backward citations of a patent. When filing a patent to USPTO, the applicant is obliged to report prior art (i.e., references) on which the patent relied. After a patent

is filed, an examiner, an expert in the relevant technology domain, further explores the prior art relevant to the patent and adds the required additional references. This list makes up the backward citations made by a patent. I classified a backward citation as representing *new knowledge* if it is neither a self-citation (citation to a patent owned by the focal firm) nor a repeated citation (citation to a patent that is already cited by the focal firm's previous patents).[15] I then defined a given patent as an exploratory patent if more than 90% of its backward citations represent *new knowledge* (Lee et al., 2020). I used the total number of such patents filed by a firm in each sample year for hypothesis testing and gathered them under the title of *new knowledge*. As the second measure of explorative innovation, I focused on the extent to which a firm explores in new technological domains (*new technology*). To this end, I examined the technology class of patents filed by a firm in each year and coded a patent's technology class as 1 if the focal firm had no previous patents in that class within the last 5 years (Conti, 2014; Lee et al., 2020). I used the total number of *new technology* classes a firm had during each sample-year for hypothesis testing.

Engagement in basic research. I used two proxies to operationalize this variable.[16] The first proxy was the number of backward citations made by a firm's patents to scientific papers (*Citations to science*). Backward citations listed on a patent can be made either to other patents or to none-patent sources. While patents tend to represent more applied innovations, scientific papers include more basic and non-commercial knowledge (Marx & Fuegi, 2020). In the U.S.,

[15] In determining whether a backward citation is a self-citation and/or a repeated citation, I considered the exact day of patent application rather than the year of application. This way, the backward citations of a given patent were examined in relation to the pool of patents filed/cited by the focal firm up to the day before the day in which it is filed. This more stringent operationalization of exploratory innovation more accurately represents the newness of knowledge involved in a patent.

[16] While a better way to operationalize, basic research would be to examine the composition of firms' R&D expenditures, such data are not readily available from databases such as Compustat and would require surveys and/or interviews.

approximately half of the basic research (48%) is performed by higher-education institutions (Khan, Robbins, & Okrent, 2020) and their results are usually published in scientific papers. A patent's citations to scientific papers tends to show the extent to which it relies on basic rather than applied research (McMillan, Narin, & Deeds, 2000). Furthermore, to build on basic research described in scientific papers, a firm itself would need to have some capability/prior investments in conducting basic research (Rosenberg, 1990); otherwise, the firm most likely cannot exploit the new knowledge or appreciate the value of such knowledge in the first place (Cohen & Levinthal, 1990; Henard & Ann McFadyen, 2005). Thus, the extent to which a firm cites scientific papers could serve as a proxy of how close to basic research is its approach to innovation. Marx and Fuegi (2020) developed a dataset that includes up to 93% of backward citations to scientific papers made by filed patents. Using this dataset, I identified the backward citations to scientific papers and used the total number of such citations made by patents filed by the firms in each sample year for hypothesis testing. The second proxy I used to operationalize a firm's approach to basic research is the number of its patents funded by the government. The U.S. government has provided most funds allocated to basic research since World War II (Nelson, 1959; Rosenberg, 1990). For example, in 2017 the federal government was the largest funder of basic research, providing nearly 42% of such funding (Khan et al., 2020). The PatentsView database provides a list of patents funded by government agencies such as the Department of Energy, the National Science Foundation, the Department of Defense, the National Institute of Health, etc. I used this list and identified all patents filed by a firm in a sample year funded by the government, then used the total number of such patents in the hypothesis-testing models.

Female inventors' representation in firms. Each patent lists all the inventors that contributed to its development and the PatentsView database has recently begun providing information about inventor gender.[17] Using this data, I first identified the gender of all inventors listed in patents filed by a firm in a sample-year, then divided the total number of female inventors by the total number of inventors in each sample year and entered the resulting ratios in the hypothesis-testing models.

Female inventor representation in innovation teams. I defined innovation teams as those inventors listed on a given patent. For each team (each patent), after identifying the gender of inventors, I calculated the ratio of female inventors, then averaged this ratio for all patents filed by a firm in a given year and entered the resulting ratios in the hypothesis-testing models.

Independent variable

CEO liberalism. Following previous studies (Chin et al., 2013, Gupta et al., 2018), I used individual donations to Democratic and Republican parties to measure CEO political ideology. Individual personal donations to candidates and parties account for a significant portion of money in American politics; for example, in 2008 individual donations accounted for over 90 percent of all campaign contributions (Fremeth, Kelleher Richter & Schaufele, 2013). The share of Americans who donate to political candidates is also increasing; while in 1992 only 6% of Americans reported making political donations, this number rose to 12% in 2016 (Hughes, 2017).

Political science research shows that individual donations to political parties tend to be ideologically motivated (Ansolabehere, deFigueiredo, & Snyder, 2003), and it is widely accepted that people with liberal values generally support Democrats and conservative-oriented

[17] The methodology used by USPTO to identify inventors' gender is accessible in the following link: http://data.patentsview.org/documents/On-line+Appendix+-+Gender+Attribution+of+USPTO+Inventors.pdf

individuals favor Republicans (Levendusky, 2009; McCarty, Poole, & Rosenthal, 1984). Donations to Democratic and Republican parties have therefore been extensively used in the literature as a proxy for measuring individual political ideology.

In calculating this variable, I considered political ideology to be time-invariant, an operationalization consistent with research in political psychology showing that when individuals reach adulthood their political ideology remains stable (Jost, 2006; Sears & Funk, 1999). Moreover, recent studies on executives' political ideology provide further evidence about the consistency of executives' ideological orientation (and contributions) over time (Chin et al., 2013; Christensen et al., 2015, Gupta & Wowak, 2017). The dataset of S&P1500 CEOs' political ideology I developed in this study is, to my knowledge, the most comprehensive dataset (in terms of the number of CEOs and the variety of firms covered) developed so far in this research stream. I tracked the donations made by all S&P1500 CEOs (7455 CEOs) from 1992 to 2014, 12 election cycles. Considering donations over such a long period increases the reliability of the measurement of CEO political ideology.

To find political contributions made by sample CEOs, I matched the self-reported first name, middle name, last name, employer name, job title and locations on the Bonica dataset to CEO data in Execucomp. I then manually inspected all the matched records and disregarded ambiguous or incorrect matches, finding as a result a total of 174,694 donations made by 4470 CEOs who lead S&P1500 companies from 1992 to 2014. Over these 12 cycles, among those CEOs that made political donations, about 9% donated exclusively to Democrats and 23% donated exclusively to Republicans while the rest donated to both parties. Following prior studies (Chin et al., 2013, Gupta et al., 2018), I measured CEO liberalism using an index of four indicators of political liberalism: 1) proportion of the number of donations to the Democratic

Party to the number of donations to both parties, (2) proportion of the number of years the individual donated to the Democratic Party to the number of years he or she donated to either party, (3) proportion of the amount of donations to the Democratic Party to the amount of donations to both parties, and (4) proportion of the number of unique recipients of the Democratic Party to the total number of unique political donation recipients of both parties. These four measures had similar mean and standard deviations and they exhibited high reliability ($\alpha = 0.98$), and I averaged them to compute a composite index of CEO liberalism ranging from 0 (highly conservative) to 1 (highly liberal).

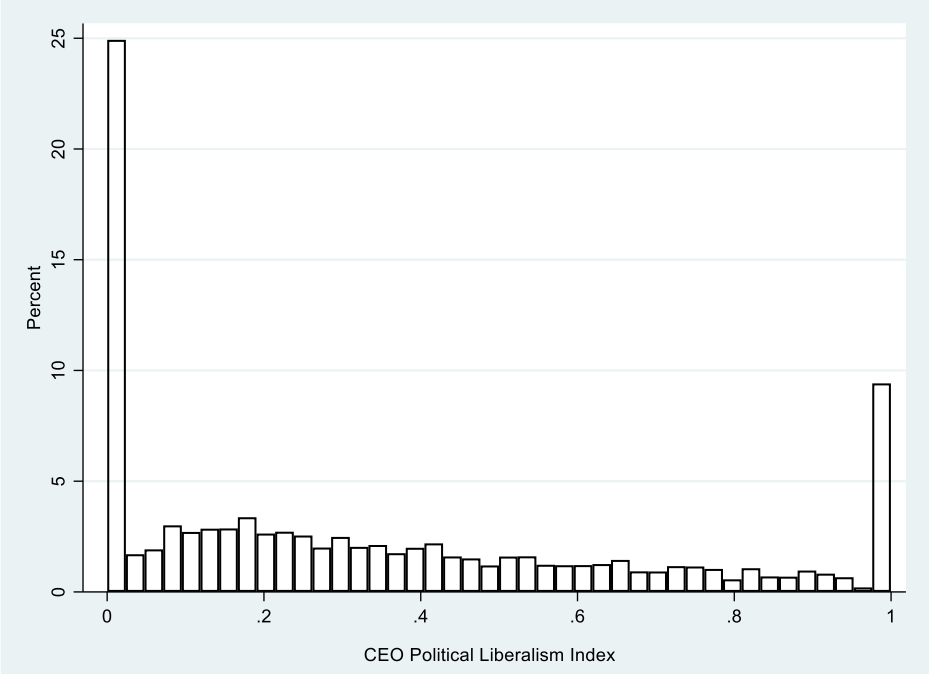

Figure 2.The Distribution of CEO Liberalism Scores

The mean CEO liberalism score in the full sample was 0.363 with a standard deviation of 0.316, showing that CEOs in the sample are more likely to be conservative-leaning (Figure 2) although their political orientations do vary. More precisely, about 31.34% of the CEOs were liberal-leaning (score above 0.5), 68.25% were conservative-leaning (score below 0.5), and 0.41% were moderate (score equal to 0.5).

Among the notable strongly liberal CEOs in the sample were Ursula M. Burns of Xerox, John Warnock of Adobe, and James D. Sinegal of Costco, while among the notable strongly-conservative CEOs were Rex W. Tillerson of Exxon Mobile, Daniel E. Evans of Bob Evans Farms, and James A. Skinner of McDonald's.

I tracked the composition of the political ideologies of S&P1500 CEO over the years from 1992 to 2014. As shown in Figure 3, while the proportion of liberal-oriented CEOs has been slowly growing in the years approaching 2014, conservative-leaning CEOs predominately filled the top leadership positions in S&P1500 firms.

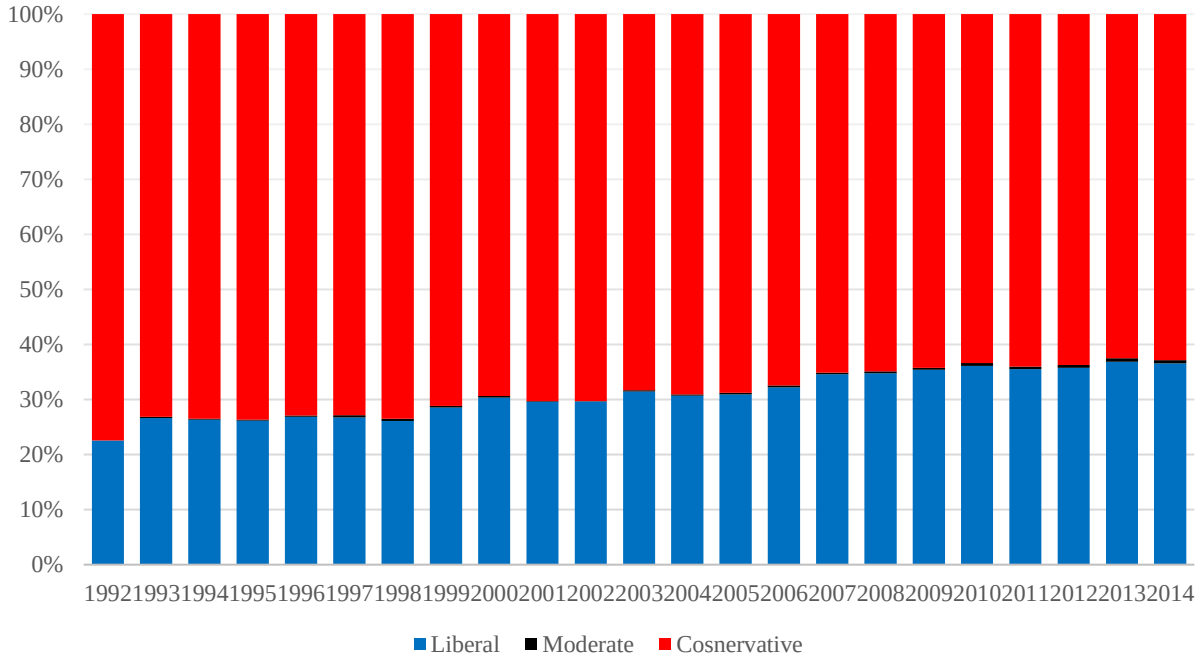

Figure 3. Trends in the Composition of the Political Ideology of S&P1500 CEOs from 1992 to 2014

I also examined the ideological composition of S&P1500 CEOs who led firms in high-tech and non-high-tech industries between 1992 and 2014. Innovation has a pivotal role in the success of firms in high-tech industries and it is interesting to examine the ideological composition of their CEOs and compare it to that of non-tech industries. Following prior research (Tang et al., 2015), I considered the following six three-digit SIC codes representing

high-tech industries: 283 (drugs), 357 (office, computing, and accounting machines), 366 (communication equipment), 367 (electronic components and accessories), 481 (telephone communication services), and 737 (computer and data processing services). The results are shown in Figure 4 and Figure 5. Overall, while conservative CEOs dominated both groups of industries, interestingly, the proportion of liberals and moderate CEOs was higher in high-tech industries than in non-high-tech industries.

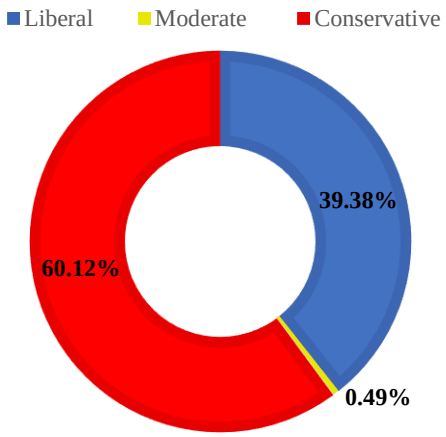

Figure 4.The Composition of the Political Ideology of S&P1500 CEOs Active in High-Tech Industries.

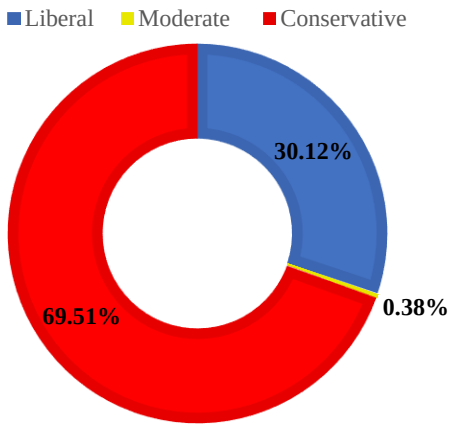

Figure 5.The Composition of the Political Ideology of S&P1500 CEOs Active in Non-High-Tech Industries.

I examined the distribution of S&P1500 CEOs across different states. As shown in Figure 6, in most states conservative CEOs dominated the leadership of S&P1500 firms over the years from 1992 to 2014, the exceptions being states such as Massachusetts, Hawaii, and New York. Interestingly, these states are among the most strongly liberal states according to Gallup's most recent (Jones, 2019) and previous ratings (Jones, 2009) of the political bent of U.S. states. However, there is no evidence of prevalence of liberal CEOs in other strongly liberal states such as Connecticut, Delaware, California, and Illinois.

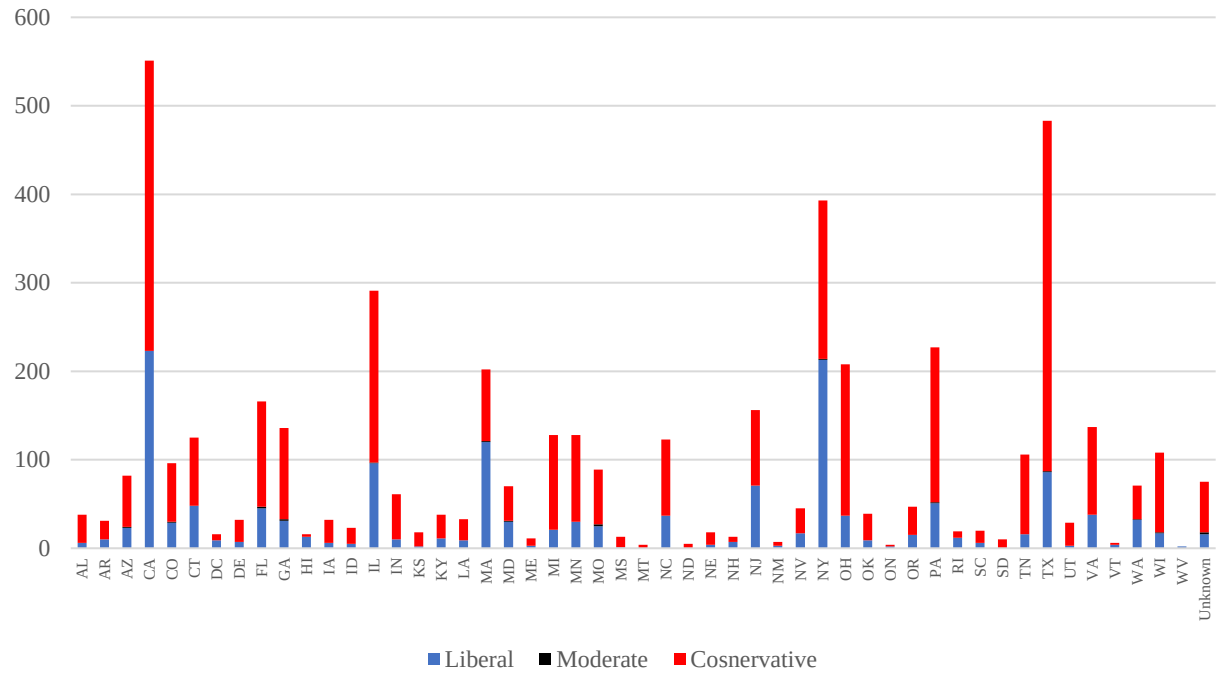

Figure 6. The Composition of the Political Ideology of S&P1500 CEOs Across Different States.

Control variables

I controlled for several variables at the firm, the CEO and environmental levels, to rule out alternative explanations of the proposed relationships. At the firm level, I controlled for *firm performance* (measured by ROA) as performance is shown to influence innovation (Bowen, Rostami, & Steel, 2010), *firm size* (measured by the log of the number of employees) because firm size has been shown to influence innovation outcomes (Camisón-Zornoza, Lapiedra-Alcamí, Segarra-Ciprés, & Boronat-Navarro, 2004), and R&D *intensity* (measured by the ratio of R&D investment to total assets) to account for the intensity of R&D efforts that impact innovation outcomes. Following prior studies, I assigned a zero to firms with missing R&D expenditure in each sample-year (Sunder et al., 2017; Tang et al., 2015).[18]

Further, I controlled for *Tobin's Q* (measured by market-to-book ratio) because firms with more growth opportunities focus more on innovation (Sheikh, 2012). I also controlled for

[18] As I discussed in the robustness check, excluding firms with missing R&D did not change the results.

leverage (measured by debt-to-assets ratio) because financially distressed firms could reduce their investments in innovation and therefore have reduced innovation outcomes (Bhagat & Welch, 1995). I also controlled for *institutional ownership* (measured by the total shares owned by institutional owners) because institutional ownership has been shown to be associated with innovation (Aghion, Van Reenen, & Zingales, 2013). I also controlled for several CEO-level variables. CEOs are not unconstrained in exercising their personal preferences in business decisions and how much power they possess to influence firms' outcomes varies. To account for CEO power and influence, I controlled for several sources of power widely used in previous studies (Finkelstein, 1992; Pollock, Fischer & Wade, 2002). I controlled for *CEO tenure* (measured as the number of years since the CEO was appointed to this position); *CEO duality* (coded 1 if the CEO is also chairman of the board and 0 if not) and *CEO stock ownership* (measured as the percentage of total shares owned by the CEO). I also included two controls to account for factors that might influence a CEO's risk-taking. First, to capture the risk-taking effect of CEO incentives I included *CEO Vega* (measured as the change in the dollar value of a CEO's option holdings for a 1% change in stock-return volatility) (Coles et al., 2006; Core & Guay, 2002). Second, I controlled for *CEO age* to account for differences in CEOs' motive towards taking risk that may arise because of the stage of their career (Matta & Beamish, 2008). Because including CEO age in the models increased variance inflation factors (VIF), I entered quantiles of CEO age in the hypotheses-testing models. When explaining hypotheses 6 and 7 related to female inventors, I controlled for *Female CEO* (coded 1 if the CEO is female and 0 if not) and *female representation in TMT* (measured as the number of female executives divided by the total number of executives in TMT). Including these variables in the model rules out the possibility that the representation of female inventors is due to the natural tendency of female

executives (female CEO or female TMTs) to evaluate female inventors more favorably in their hiring decisions (Tajfel & Turner, 1979). I considered all executives reported in ExecuComp as members of a firm's TMT (Dezsö, Ross, & Uribe, 2016; Dezsö & Ross, 2012). The average TMT size in my sample is 4.8 with a standard deviation of 1.34. This size is in accordance with prior research reporting TMT sizes of between three and seven executives (Carpenter & Sanders, 2002).

I also controlled for the effects of time and industry by including industry (two-digit SIC codes) and year dummies in the models.

Estimation Method

My data represented an unbalanced panel of 959 firms over 23 years (n=9776 firm-years) with majority of my dependent variables measured by count data. While models such as Poisson regression can be useful when the dependent variable is count data, Poisson models assume that the mean and variance of the distribution are equal. Since my data exhibited overdispersion (variances of the dependent variables are greater than their means), I did not use Poisson regression (Fleming, 2001). Instead, I used Random-effect Ordinary Least Square (OLS) regression to test the models and I repeated my analyses with a Random-effect Negative Binomial model[19]. I did not use a fixed-effect model because the main independent variable in my models (i.e., CEO liberalism) is time-invariant. I used the xtreg command in Stata 16.0 with robust standard errors clustered at the firm level to test all the OLS regression models. Because the patent data is highly skewed, with numerous firms having zero patents in each year, following previous studies (Balsmeier et al., 2017; Custódio et al., 2019; Hirshleifer et al., 2012),

[19] As shown in table A.2 in the appendix, although for a few lags and dependent variables the negative binomial regressions did not converge, generally I found consistent results between OLS and Negative Binomial models.

I added all patent-based dependent variables by one and log transformed them before entering them to the models. With this operationalization I kept the firm-years with zero patents.

In general, there is a time lag from the start of an innovation project to when the corresponding patent is filed (Galasso & Simcoe, 2011). This time lag may vary by industry, with some industries (e.g. pharmaceuticals) taking a relatively long time while others (e.g. software development) may have quite short lags. This lag may also vary by the nature of particular innovation projects; exploratory innovations usually take longer time than exploitative ones (March, 1991). In fact, it is expected that CEO preferences and other explanatory variables need some time to become visible in the patent data (Balsmeier & Buchwald, 2015; Cummings & Knott, 2017). While there has been no research on this average time-lag (Galasso & Simcoe, 2011), studies in the innovation literature have used different lags in testing regression models. In this study, I used one, two, and three-year lags in testing all the hypotheses (Balsmeier & Buchwald, 2014; Cho & Kim, 2017; Hirshleifer et al., 2012; Islam & Zein, 2020). Using a lagged structure also resolve the simultaneity bias issues in my models.

Results

As several dependent and explanatory variables in this study are transformed, I first report the descriptive statistics of them before transformation. As shown in Table 2, the average number of patent applications by firms was 78.4 per year. Also, the average firm filed 2 breakthrough and 13.7 failure patents while the breakthrough range was from 0 to 115 and the failure range was from 0 to 2823. These patterns provide additional evidence that innovation is risky and that even those innovation projects that lead to granted patents may eventually fail to create value for the firm. On average, 3 patent applications were in new technological classes and 14.9 patents relied on knowledge new to the firm. Furthermore, an average firm had 1.3 patents funded by the

government during the sample period. The average firm in the sample had 20.6 (in thousands) employees and was led by a 56-year-old CEO.

Table 2. Descriptive Statistics of Variables Before Transformation

Variables	Observations	Mean	St.Dev	Min	Max
Number of patents	9,776	78.391	273.841	0	8731
Breakthroughs	9,776	2.066	6.785	0	115
Failures	9,776	13.725	66.418	0	2823
New knowledge	9,776	14.977	40.921	0	583
New technology	9,776	3.029	4.106	0	42
Citations to science	9,776	455.532	2366.241	0	99148
Government funded	9,776	1.305	9.299	0	368
CEO age	9,374	56	7.4	29	96
Firm size (employees in 1000)	9,688	20.61	44.81	0	745

Table 3 provides descriptive statistics (transformed and non-transformed) and Table 4 shows correlations among all variables. The average CEO had been in the office for 8.1 years and owns 3.4% of the firm's stock. As reported in Table 3, females on average accounted for a small number of inventors in the sample firms. Also, average CEO liberalism in the final sample was 0.348, reflecting a lean toward conservatism. As shown in Table 4, CEO liberalism has a positive correlation with breakthroughs, proxies representing the pursuit of basic research (government funded and citations to science), and measures of female inventors' representation. However, CEO liberalism had negative correlations with the number of patents, failures, and the two measures of exploratory innovation (new knowledge and new technology). There is a positive correlation between R&D intensity and the number of patents, consistent with the fact that R&D provides input to the innovation process and patents are the outputs of this process (Artz, Norman, Hatfield, & Cardinal, 2010). The positive association between measures of

exploratory innovations and breakthroughs and failures also demonstrate that pursuing a strategy of exploration that involves more risky innovation projects increases the likelihood of developing both high-quality and low-quality innovations (Balsmeier et al., 2017; Lee et al., 2020). Overall, the correlations among independent and control variables are mostly low to moderate, mitigating the issue of multi-collinearity. I further checked for multi-collinearity in regression models by calculating VIFs for individual variables and full models. All VIFs were lower than 10 and revealed no serious multi-collinearity concerns (Kennedy, 2008).

Table 3. Descriptive Statistics of all Variables

Variables*	Observations	Mean	St.Dev	Min	Max
Number of patents	9,776	2.477	1.894	0	9.075
Breakthroughs	9,776	.484	.861	0	4.754
Failures	9,776	1.039	1.407	0	7.946
New knowledge	9,776	1.507	1.427	0	6.365
New technology	9,776	.986	.881	0	3.761
Citations to science	9,776	2.614	2.653	0	11.504
Government funded	9,776	.207	.653	0	5.911
Female inventors in firm	8,025	.16	.137	0	1
Female inventors in teams	7,992	.138	.121	0	1
R&D intensity	9,740	.06	.121	0	8.497
Leverage	9,692	.173	.164	0	1.705
Firm size	9,687	1.807	1.656	-5.809	6.613
Firm performance (ROA in 1000)	9,754	.0003	0.018	-.0765	1.743
Tobin's Q	9,473	1.612	2.751	0	104.102
Institutional ownership (in billion)	9,776	14.655	45.779	0	590.341
CEO Vega (in 1000)	9,203	.183	.398	0	11.262
CEO age *	9,374	2.573	1.094	1	4
CEO duality	9,776	.653	.476	0	1
CEO tenure	9,732	8.14	7.924	0	61
CEO ownership	5,825	3.424	7.351	0	100
CEO liberalism	9,776	.348	.334	0	1

All patent-based variables are added by one and log transformed.
Quantiles of CEO age

Table 4. Correlations Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variables:									
(1) Number of patents	1								
(2) Breakthroughs	0.733*	1							
(3) Failures	0.787*	0.613*	1						
(4) New knowledge	0.905*	0.659*	0.696*	1					
(5) New technology	0.810*	0.566*	0.522*	0.821*	1				
(6) Citations to science	0.810*	0.675*	0.720*	0.670*	0.570*	1			
(7) Government funded	0.480*	0.467*	0.499*	0.490*	0.396*	0.444*	1		
(8) Female inventors in firm	0.155*	0.148*	0.276*	0.056*	-0.042*	0.333*	0.057*	1	
(9) Female inventors in teams	0.176*	0.167*	0.294*	0.065*	-0.032*	0.364*	0.070*	0.934*	1
Control variables:									
(10) R&D intensity	0.027*	0.051*	0.008	0.012	-0.035*	0.140*	-0.014	0.153*	0.152*
(11) Leverage	-0.014	-0.056*	0.008	-0.033*	-0.008	-0.046*	0.001	0.021	0.038*
(12) Firm size	0.531*	0.388*	0.492*	0.544*	0.465*	0.320*	0.354*	0.031*	0.042*
(13) Firm performance	-0.008	-0.002	-0.005	-0.005	-0.006	-0.007	-0.002	0.009	0.018
(14) Tobin's Q	0.027*	0.076*	-0.026*	-0.001	0.005	0.113*	-0.034*	0.069*	0.069*
(15) Institutional ownership	0.368*	0.392*	0.478*	0.320*	0.186*	0.377*	0.255*	0.172*	0.188*
(16) CEO Vega	0.277*	0.261*	0.344*	0.246*	0.167*	0.274*	0.216*	0.154*	0.164*
(17) CEO age	0.004	-0.037*	0.011	0.011	0.025*	-0.038*	0.012	-0.040*	-0.046*
(18) CEO duality	0.093*	0.066*	0.063*	0.108*	0.123*	0.051*	0.093*	-0.021	-0.013
(19) CEO tenure	-0.127*	-0.083*	-0.122*	-0.116*	-0.107*	-0.098*	-0.087*	-0.02	-0.030*
(20) CEO ownership	-0.073*	-0.012	-0.145*	-0.027*	0.003	-0.090*	-0.054*	-0.080*	-0.088*
Independent variable:									
(21) CEO liberalism	-0.049*	0.014	-0.008	-0.061*	-0.075*	0.059*	0.033*	0.081*	0.091*

* shows significance at the 0.05 level

(Table 4 cont'd.)

Variables	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Control variables:												
(10) R&D intensity	1											
(11) Leverage	-0.098*	1										
(12) Firm size	-0.303*	0.173*	1									
(13) Firm performance	-0.036*	0.074*	-0.025*	1								
(14) Tobin's Q	0.213*	-0.109*	-0.163*	0.007	1							
(15) Institutional ownership	-0.004	-0.024*	0.330*	0.002	0.037*	1						
(16) CEO Vega	-0.026*	0.008	0.323*	-0	0.067*	0.374*	1					
(17) CEO age	-0.091*	0.091*	0.125*	0	-0.092*	0.016	0.02	1				
(18) CEO duality	-0.085*	0.065*	0.226*	-0.01	-0.050*	0.009	0.070*	0.251*	1			
(19) CEO tenure	0.035*	-0.105*	-0.153*	-0.01	0.020*	-0.036*	0.033*	0.340*	0.188*	1		
(20) CEO ownership	-0.013	-0.117*	-0.063*	-0.01	0.069*	-0.037*	0.025	0.083*	0.102*	0.395*	1	
Independent variable:												
(21) CEO liberalism	0.082*	-0.035*	-0.138*	0.014	0.038*	0.012	0.048*	-0.074*	-0.092*	0.074*	0.097*	1

* shows significance at the 0.05 level

Table 5 through Table 17 report the results of testing the study's hypotheses. Each table presents separate models (control and full models) for one, two and three-year lags.

Hypothesis 1 predicts that CEO liberalism is positively associated with the quantity of innovations developed by a firm, and Table 5 shows the results of testing this hypothesis. I entered control variables into models 1, 3, and 5 and tested the hypothesized relationship in models 2, 4, and 6. While all coefficients are in line with the hypothesis (β_2=0.052, β_4=0.060, β_6=0.055) none are statistically significant (p_2= 0.667, p_4= 0.608, p_6= 0.668). The results do not support Hypothesis 1, that CEO liberalism (conservatism) is positively (negatively) associated with the number of patent applications by a firm. Control variables show some interesting results. In line with prior research (Galasso & Simcoe, 2011; Tang et al., 2015), R&D intensity has a positive effect (and statistically significant for two and three-year lags) on the number of patents. I found that larger firms (measured with the log of the number of employees) and those with higher growth opportunities (measured by Tobins'Q) tend to file more patents. Confirming prior research (Aghion et al., 2013), firms with institutional owners file more patents. Among CEO-related controls, CEO age and CEO tenure have a negative effect on patenting activities of firms. These results correspond with previous research (Cho & Kim, 2017; Heyden, Reimer, & Van Doorn, 2017) showing that seasoned CEOs have lower incentive to pursue innovation because of the risk associated with it and the fact that they might not be able to personally benefit from the results of such projects that mostly pay off in the long term.

Table 5. The Effect of CEO Liberalism on the Number of Patents

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	0.697	0.696	0.703+	0.701+	0.616*	0.617*
	(0.439)	(0.439)	(0.394)	(0.394)	(0.289)	(0.289)
Leverage	-0.042	-0.043	-0.195	-0.195	-0.269	-0.269
	(0.151)	(0.151)	(0.170)	(0.170)	(0.170)	(0.170)
Firm size	0.471**	0.472**	0.449**	0.449**	0.414**	0.415**
	(0.038)	(0.038)	(0.039)	(0.040)	(0.040)	(0.040)
Firm performance (ROA)	0.017	0.016	0.312**	0.311**	-0.280**	-0.281**
	(0.110)	(0.110)	(0.069)	(0.069)	(0.065)	(0.065)
Tobin's Q	0.015+	0.015+	0.015+	0.015+	0.019*	0.020*
	(0.009)	(0.009)	(0.008)	(0.008)	(0.009)	(0.009)
Institutional ownership	0.070**	0.070**	0.064**	0.065**	0.060**	0.060**
	(0.018)	(0.018)	(0.018)	(0.017)	(0.019)	(0.019)
CEO Vega	0.076	0.077	0.041	0.042	0.020	0.021
	(0.074)	(0.074)	(0.064)	(0.064)	(0.064)	(0.064)
CEO age	-0.015	-0.014	-0.023	-0.022	-0.047+	-0.046+
	(0.025)	(0.025)	(0.026)	(0.026)	(0.027)	(0.027)
CEO duality	-0.061	-0.059	-0.076	-0.074	-0.089	-0.087
	(0.054)	(0.055)	(0.061)	(0.060)	(0.065)	(0.064)
CEO tenure	-0.008*	-0.008*	-0.009*	-0.009*	-0.007	-0.008+
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
CEO stockownership	0.003	0.003	0.004	0.004	0.002	0.002
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
CEO liberalism		0.052		0.060		0.055
		(0.120)		(0.118)		(0.129)
Constant	0.938	0.924	0.517	0.500	0.755	0.741
	(1.214)	(1.215)	(1.218)	(1.219)	(1.218)	(1.217)
Observations	4736	4736	4262	4262	3797	3797
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.252	0.252	0.251	0.251	0.235	0.234
Between R-squared	0.392	0.393	0.373	0.374	0.359	0.361
Overall R-squared	0.395	0.396	0.379	0.380	0.367	0.368

Standard errors in parentheses.
(+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

In Hypothesis 2, I suggested that CEO liberalism is positively associated with breakthrough innovations. The results of testing this hypothesis is reported in Table 6 and by models 2, 4, and 6. Consistent with Hypothesis 2, I found a positive and marginally significant relationship between CEO liberalism and breakthrough innovations with one-year lag (β_2=0.104, p_2= 0.051) and a positive and significant relationship with two-year lag (β_4= 0.107, p_4= 0.041). However, I found a positive and insignificant (β_6= 0.084, p_6= 0.111) relationship between these variables when considering a three-year lag. It seems that the effect of CEO liberalism phases out as the time lag increases. It may be that not only is the development of breakthrough innovations occasional, but also after introducing a breakthrough the innovative firm may tend to shift its focus to exploiting the new opportunities provided by it rather than the exploration that lead to the new breakthrough. These results provide evidence supporting Hypothesis 2, that a liberal CEO increases breakthrough innovation by around 11% (calculated as $1-e^{0.107}$).

Hypothesis 3 examines the relationship between CEO liberalism and failure innovations. As shown by models 2, 4, and 6 in Table 7, the association is in the hypothesized direction but not statistically significant in any of the models (β_2= 0.021, p_2= 0.839; β_4=0.072, p_4= 0.460; β_6=0.059, p_6= 0.546) models, thus, Hypothesis 3 is not supported. Interestingly, according to the results of Hypotheses 2 and 3, while CEO liberalism is associated with high-quality innovations, it has no influence on low-quality innovations. A more detailed discussion of these results will be provided in chapter 5.

Table 6. The Effect of CEO Liberalism on the Quality of Innovations-Breakthroughs

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	0.343*	0.339*	0.261+	0.257+	0.306*	0.304*
	(0.153)	(0.153)	(0.155)	(0.154)	(0.155)	(0.155)
Leverage	-0.001	-0.002	-0.022	-0.022	0.027	0.027
	(0.084)	(0.085)	(0.079)	(0.079)	(0.093)	(0.094)
Firm size	0.110**	0.111**	0.103**	0.104**	0.090**	0.091**
	(0.017)	(0.017)	(0.018)	(0.018)	(0.019)	(0.019)
Firm performance (ROA)	-0.071+	-0.075+	-0.070*	-0.075*	-0.022	-0.027
	(0.043)	(0.043)	(0.032)	(0.032)	(0.036)	(0.036)
Tobin's Q	0.008	0.008	0.011**	0.011**	0.015**	0.015**
	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)
Institutional ownership	0.036**	0.036**	0.033**	0.033**	0.027**	0.027**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)
CEO Vega	0.039	0.040	-0.011	-0.011	-0.011	-0.010
	(0.057)	(0.057)	(0.038)	(0.038)	(0.038)	(0.038)
CEO age	-0.003	-0.001	0.002	0.004	-0.012	-0.010
	(0.012)	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)
CEO duality	0.012	0.016	0.021	0.025	0.016	0.020
	(0.024)	(0.024)	(0.028)	(0.028)	(0.031)	(0.031)
CEO tenure	-0.001	-0.001	-0.001	-0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CEO stockownership	0.001	0.001	0.001	0.001	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
CEO liberalism		0.104+		0.107*		0.084
		(0.053)		(0.053)		(0.053)
Constant	0.171	0.143	-0.049	-0.079	0.046	0.025
	(0.525)	(0.523)	(0.530)	(0.529)	(0.507)	(0.506)
Observations	4729	4729	4250	4250	3781	3781
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.076	0.077	0.067	0.068	0.052	0.052
Between R-squared	0.281	0.284	0.262	0.266	0.235	0.240
Overall R-squared	0.222	0.227	0.206	0.212	0.201	0.207

Standard errors in parentheses.
($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Table 7. The Effect of CEO Liberalism on the Quality of Innovations-Failures

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	0.649**	0.649**	0.642*	0.641*	0.466+	0.468+
	(0.234)	(0.235)	(0.250)	(0.251)	(0.251)	(0.252)
Leverage	-0.124	-0.124	-0.212	-0.212	-0.230+	-0.230+
	(0.129)	(0.129)	(0.138)	(0.138)	(0.129)	(0.129)
Firm size	0.317**	0.317**	0.340**	0.341**	0.337**	0.338**
	(0.030)	(0.030)	(0.030)	(0.030)	(0.032)	(0.032)
Firm performance (ROA)	-0.060	-0.060	-0.157*	-0.160*	-0.212**	-0.214**
	(0.083)	(0.083)	(0.062)	(0.062)	(0.062)	(0.062)
Tobin's Q	0.001	0.001	0.003	0.004	0.010	0.010
	(0.004)	(0.004)	(0.005)	(0.005)	(0.007)	(0.007)
Institutional ownership	0.103**	0.103**	0.099**	0.099**	0.092**	0.092**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)
CEO Vega	0.176*	0.176*	0.170*	0.171*	0.168+	0.168+
	(0.084)	(0.084)	(0.080)	(0.080)	(0.089)	(0.089)
CEO age	-0.028	-0.027	-0.019	-0.017	-0.026	-0.024
	(0.024)	(0.025)	(0.024)	(0.024)	(0.025)	(0.025)
CEO duality	-0.051	-0.050	-0.087+	-0.084+	-0.066	-0.063
	(0.048)	(0.048)	(0.051)	(0.051)	(0.053)	(0.053)
CEO tenure	-0.011**	-0.011**	-0.011**	-0.011**	-0.012**	-0.013**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
CEO stockownership	0.001	0.001	0.002	0.002	0.001	0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)
CEO liberalism		0.021		0.072		0.059
		(0.102)		(0.098)		(0.097)
Constant	0.508	0.502	0.207	0.187	0.109	0.094
	(0.847)	(0.848)	(0.863)	(0.863)	(0.790)	(0.790)
Observations	4729	4729	4250	4250	3781	3781
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.405	0.405	0.392	0.392	0.368	0.368
Between R-squared	0.585	0.586	0.577	0.579	0.547	0.549
Overall R-squared	0.535	0.535	0.511	0.512	0.479	0.480

Standard errors in parentheses.
($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Hypothesis 4 predicts that CEO liberalism is positively associated with exploratory innovations, and the result of testing this hypothesis is reported in Table 8 and Table 9. As shown by Models 2, 4, and 6 test the effect of CEO liberalism on the first measure of exploratory innovation (the number of patents that built on new knowledge). As shown in Table 8, the association of CEO liberalism with new knowledge is positive and in accordance with the hypothesis in all three models (β_2= 0.050, β_4=0.083, β_6=0.121), but this effect is not statistically significant (p_2= 0.492, p_4= 0.268, p_6= 0.148).

As reported in Table 9, I tested models 2, 4, and 6 with the second measure of exploratory innovation (the number of new technological domains a firm enters each year). Again, the effect of CEO liberalism on new technology is consistent with the hypothesized direction (β_2= 0.092, β_4=0.050, β_6=0.059). This effect is significant in the model with a one-year lag (p_2= 0.029) but not significant in the other two models (p_4= 0.288, p_6= 0.254), so I found support for Hypothesis 3. Having a liberal CEO increases exploring new technological domains by about 10%.

Table 8. The Effect of CEO Liberalism on Exploratory Innovations-New Knowledge

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
R&D intensity	0.554*	0.552*	0.590*	0.587*	0.330	0.330
	(0.245)	(0.245)	(0.253)	(0.253)	(0.235)	(0.235)
Leverage	-0.157	-0.157	-0.310*	-0.310*	-0.224+	-0.224+
	(0.119)	(0.119)	(0.132)	(0.132)	(0.119)	(0.120)
Firm size	0.364**	0.365**	0.344**	0.345**	0.317**	0.319**
	(0.027)	(0.027)	(0.028)	(0.028)	(0.028)	(0.028)
Firm performance (ROA)	0.326**	0.324**	-0.106	-0.109+	-0.101+	-0.106+
	(0.081)	(0.082)	(0.066)	(0.066)	(0.057)	(0.057)
Tobin's Q	0.009	0.009	0.006	0.007	0.011**	0.012**
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
Institutional ownership	0.049**	0.049**	0.047**	0.047**	0.040**	0.040**
	(0.014)	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)
CEO Vega	0.076	0.076	0.027	0.027	0.030	0.031
	(0.056)	(0.056)	(0.054)	(0.055)	(0.049)	(0.050)
CEO age	-0.031+	-0.030	-0.037+	-0.035+	-0.041*	-0.038+
	(0.019)	(0.019)	(0.020)	(0.020)	(0.021)	(0.021)
CEO duality	0.006	0.008	0.009	0.012	-0.025	-0.019
	(0.041)	(0.041)	(0.043)	(0.043)	(0.048)	(0.048)
CEO tenure	-0.001	-0.001	-0.001	-0.002	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
CEO stockownership	0.001	0.001	0.003	0.003	0.003	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
CEO liberalism		0.050		0.083		0.121
		(0.072)		(0.075)		(0.084)
Constant	-0.149	-0.163	-0.309	-0.332	0.270	0.240
	(0.473)	(0.475)	(0.487)	(0.487)	(0.377)	(0.377)
Observations	4729	4729	4250	4250	3781	3781
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.264	0.264	0.266	0.266	0.260	0.259
Between R-squared	0.413	0.415	0.391	0.393	0.364	0.368
Overall R-squared	0.420	0.421	0.404	0.406	0.389	0.393

Standard errors in parentheses.
($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Table 9. The Effect of CEO Liberalism on Exploratory Innovations-New Technology

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	0.368*	0.362*	0.395*	0.392*	0.131	0.130
	(0.183)	(0.182)	(0.178)	(0.177)	(0.148)	(0.148)
Leverage	-0.163*	-0.164*	-0.157*	-0.158*	-0.133	-0.134
	(0.078)	(0.078)	(0.078)	(0.078)	(0.090)	(0.090)
Firm size	0.187**	0.189**	0.169**	0.170**	0.154**	0.155**
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Firm performance (ROA)	0.292**	0.286**	0.328**	0.324**	-0.011	-0.015
	(0.062)	(0.062)	(0.051)	(0.051)	(0.059)	(0.059)
Tobin's Q	0.016**	0.017**	0.010*	0.010*	0.014**	0.014**
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Institutional ownership	0.011*	0.011+	0.010*	0.010*	0.008+	0.007+
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
CEO Vega	0.041	0.042	0.021	0.021	0.004	0.004
	(0.051)	(0.051)	(0.041)	(0.041)	(0.038)	(0.038)
CEO age	0.005	0.007	-0.018	-0.017	-0.015	-0.013
	(0.013)	(0.013)	(0.014)	(0.014)	(0.015)	(0.015)
CEO duality	-0.006	-0.002	0.012	0.014	-0.024	-0.021
	(0.029)	(0.029)	(0.031)	(0.031)	(0.033)	(0.033)
CEO tenure	-0.003+	-0.004*	-0.003	-0.003	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CEO stockownership	0.000	0.000	0.002	0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CEO liberalism		0.092*		0.050		0.059
		(0.042)		(0.047)		(0.052)
Constant	0.076	0.050	0.177	0.162	0.043	0.029
	(0.320)	(0.321)	(0.329)	(0.331)	(0.263)	(0.262)
Observations	4729	4729	4250	4250	3781	3781
Year fixed effects	YES	YES	Yes	Yes	Yes	Yes
Industry fixed effects	YES	YES	Yes	Yes	Yes	Yes
Robust standard errors	YES	YES	Yes	Yes	Yes	Yes
Within R-squared	0.243	0.244	0.249	0.249	0.250	0.250
Between R-squared	0.269	0.271	0.225	0.226	0.233	0.235
Overall R-squared	0.295	0.295	0.284	0.284	0.293	0.294

Standard errors in parentheses.
(+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Hypothesis 5 examines the association of CEO liberalism with firms' engagement with basic research in their innovation efforts. The results of testing this hypothesis are shown in Table 10 and Table 11. Models 2, 4, and 6 in Table 10 show the results of testing the relationship between CEO liberalism and citations to science. While the coefficients for all models are in the predicted direction, none of them are statistically significant (β_2= 0.161, p_2= 0.456; β_4=0.069, p_4= 0.732; β_6=0.059, p_6=0.765).

Models 2, 4, and 6 in Table 11 report the results of testing the association between CEO liberalism and innovations funded by the government. As shown in the table, there is a marginally-significant relationship between these variables when considering a two-year lag (β_4=0.051, p_4=0.069) but this relationship is not significant for one-year (β_2=.041, p_2=0.267) or three-year lags (β_6=.028, p_6=0.231) although these effects are in the hypothesized direction, so Hypothesis 5 is marginally supported, i.e., having a liberal CEO increases the development of government funded innovations by about 5.23%. Examination of control variables shown in Table 10 and Table 11 also reveals interesting patterns. Firm size has a positive and statistically significant association with both measures. The coefficient of firm size is higher for citations to science than developing innovations funded by the government. These results provide evidence that larger firms usually have more resources to commit to basic research projects that take a long time to develop and pay off. Furthermore, such firms are more likely to have a more diverse range of products and processes that make them confident that they will be able to benefit from the results of basic research in some of their business areas (Rosenberg, 1990). Institutional ownership is found to be positively related to engagement in basic research. The negative and statistically-significant relationship between ROA and government-funded innovations shown in

Table 11 provides evidence that underperforming firms may tend to find external sources to fund their innovation endeavors.

Table 10. The Effect of CEO Liberalism on Engagement in Basic Research-Citations to Science

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	1.059	1.061	1.472+	1.475+	1.259*	1.268*
	(0.812)	(0.812)	(0.799)	(0.799)	(0.640)	(0.640)
Leverage	-0.020	-0.022	-0.172	-0.172	-0.267	-0.268
	(0.226)	(0.227)	(0.252)	(0.252)	(0.245)	(0.245)
Firm size	0.421**	0.423**	0.396**	0.397**	0.365**	0.367**
	(0.058)	(0.058)	(0.058)	(0.059)	(0.058)	(0.058)
Firm performance (ROA)	2.296**	2.292**	1.710**	1.708**	-0.390*	-0.393*
	(0.168)	(0.168)	(0.093)	(0.093)	(0.162)	(0.162)
Tobin's Q	0.036**	0.037**	0.044**	0.045**	0.041*	0.042*
	(0.014)	(0.014)	(0.015)	(0.015)	(0.020)	(0.020)
Institutional ownership	0.100**	0.100**	0.092**	0.092**	0.089**	0.090**
	(0.025)	(0.025)	(0.024)	(0.024)	(0.027)	(0.027)
CEO Vega	0.032	0.034	-0.009	-0.009	-0.032	-0.031
	(0.114)	(0.115)	(0.094)	(0.095)	(0.086)	(0.086)
CEO age	0.004	0.008	-0.034	-0.032	-0.043	-0.042
	(0.038)	(0.039)	(0.038)	(0.039)	(0.040)	(0.041)
CEO duality	-0.060	-0.054	-0.050	-0.047	-0.047	-0.044
	(0.083)	(0.083)	(0.087)	(0.087)	(0.085)	(0.084)
CEO tenure	-0.013+	-0.013*	-0.006	-0.006	-0.005	-0.005
	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
CEO stockownership	0.006	0.006	0.001	0.001	-0.004	-0.004
	(0.010)	(0.010)	(0.009)	(0.009)	(0.008)	(0.008)
CEO liberalism		0.161		0.069		0.059
		(0.216)		(0.201)		(0.198)
Constant	2.776	2.732	1.993	1.974	1.288	1.273
	(1.996)	(1.998)	(1.998)	(1.999)	(2.091)	(2.089)
Observations	4729	4729	4250	4250	3781	3781
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.105	0.104	0.095	0.095	0.082	0.081
Between R-squared	0.356	0.360	0.350	0.352	0.338	0.341
Overall R-squared	0.325	0.328	0.321	0.323	0.304	0.306

Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Table 11. The Effect of CEO Liberalism on Engagement in Basic Research-Government Funded Innovations

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	0.014	0.014	-0.104	-0.105	-0.048	-0.048
	(0.059)	(0.059)	(0.066)	(0.065)	(0.057)	(0.057)
Leverage	0.005	0.005	0.012	0.011	0.002	0.002
	(0.037)	(0.037)	(0.036)	(0.036)	(0.031)	(0.031)
Firm size	0.053**	0.054**	0.044*	0.045*	0.037*	0.037*
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Firm performance (ROA)	-0.053+	-0.054+	-0.063**	-0.064**	-0.071**	-0.072**
	(0.030)	(0.030)	(0.024)	(0.024)	(0.024)	(0.024)
Tobin's Q	0.001	0.001	-0.000	-0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional ownership	0.026*	0.026*	0.028*	0.028*	0.024	0.024
	(0.012)	(0.012)	(0.014)	(0.013)	(0.015)	(0.015)
CEO Vega	0.078**	0.078**	0.060*	0.061*	0.074+	0.074+
	(0.030)	(0.030)	(0.030)	(0.030)	(0.042)	(0.042)
CEO age	0.011	0.012	0.001	0.003	0.005	0.005
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
CEO duality	-0.011	-0.009	0.010	0.012	-0.005	-0.004
	(0.025)	(0.025)	(0.028)	(0.028)	(0.026)	(0.026)
CEO tenure	-0.002	-0.002	-0.002	-0.002	-0.001	-0.001
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
CEO stockownership	0.002	0.002	0.002*	0.002*	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO liberalism		0.041		0.051+		0.028
		(0.037)		(0.028)		(0.023)
Constant	-0.146+	-0.157+	-0.068	-0.082	-0.110	-0.117
	(0.078)	(0.081)	(0.112)	(0.113)	(0.123)	(0.124)
Observations	4729	4729	4250	4250	3781	3781
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.078	0.077	0.077	0.077	0.070	0.069
Between R-squared	0.264	0.269	0.253	0.258	0.238	0.242
Overall R-squared	0.194	0.198	0.175	0.181	0.148	0.151

Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Hypothesis 6 predicts a positive relationship between CEO liberalism and representation of female inventors in firms. The results of testing this hypothesis is reported in Table 12 and in models 2, 4, and 6. Consistent with the hypothesis, the coefficients of female inventors in firm are positive in all models (β_2=0.016, p_2= 0.114; β_4=0.014, p_4= 0.184) and is statistically significant in the model for a three-year lag (β_6=0.027, p_6=0.016), so Hypothesis 6 is supported. These results show that more time is needed for CEO liberalism to influence the presence of females in firms, possibly because the institutionalization of CEO values in human resource policies and practices to influence selection and hiring decisions takes some time. Presence of a liberal CEO increases the ratio of female inventors by 2.7%.

Hypothesis 7 suggests that CEO liberalism positively impacts the representation of female inventors in innovation teams. As shown in Table 13, consistent with this hypothesis, the coefficients for all models are positive (β_2=0.018, β_4=0.016, β_6=0.026). This relationship is statistically significant for models with one (p_2= 0.036) and three-year lags (p_6= 0.008) and is marginally significant for the model with two-year lag (p_4= 0.075). Thus, Hypothesis 7 is supported. The existence of a liberal CEO increases the ratio of female inventors in innovation firms by about 1.6% to 2.6%.

These results indicate that it takes longer for CEO liberalism to influence the representation of females in a firm than in innovation teams, possibly because of the longer time needed to recruit and hire employees. However, the influence of CEO liberalism in reducing inequality in provision of opportunity for female employees tend to be more immediate.

Table 12. The Effect of CEO Liberalism on the Representation of Female Inventors in Firm

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	0.125**	0.124**	0.162**	0.161**	0.089	0.087
	(0.043)	(0.043)	(0.060)	(0.060)	(0.082)	(0.081)
Leverage	0.009	0.009	-0.004	-0.004	0.011	0.011
	(0.020)	(0.020)	(0.016)	(0.016)	(0.018)	(0.018)
Firm size	0.009*	0.009*	0.010**	0.010**	0.004	0.005+
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Firm performance (ROA)	0.278**	0.277**	0.459**	0.456**	-5.550*	-5.574*
	(0.019)	(0.019)	(0.021)	(0.021)	(2.500)	(2.509)
Tobin's Q	0.001+	0.001+	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional ownership	0.002**	0.002**	0.002**	0.002**	0.002**	0.002**
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
CEO Vega	0.004	0.004	0.006	0.006	0.001	0.001
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
CEO age	-0.006+	-0.006+	-0.001	-0.001	-0.005	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
CEO duality	-0.004	-0.003	-0.001	-0.001	0.007	0.008
	(0.006)	(0.007)	(0.007)	(0.008)	(0.007)	(0.007)
CEO tenure	0.000	0.000	-0.001+	-0.001*	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CEO ownership	0.000	0.000	0.001	0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female CEO	0.006	0.005	0.006	0.005	0.017	0.015
	(0.017)	(0.017)	(0.020)	(0.021)	(0.023)	(0.024)
Female on TMT	0.043	0.043	-0.017	-0.017	-0.045	-0.045
	(0.028)	(0.028)	(0.028)	(0.028)	(0.029)	(0.029)
CEO liberalism		0.016		0.014		0.027*
		(0.010)		(0.011)		(0.011)
Constant	0.144**	0.141**	-0.004	-0.006	0.081**	0.073**
	(0.028)	(0.029)	(0.056)	(0.055)	(0.019)	(0.020)
Observations	3691	3691	3273	3273	2861	2861
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.070	0.070	0.065	0.066	0.059	0.061
Between R-squared	0.324	0.326	0.329	0.330	0.267	0.270
Overall R-squared	0.224	0.225	0.209	0.210	0.201	0.202

Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Table 13. The Effect of CEO Liberalism on the Representation of Female Inventors in Innovation Teams

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	0.106*	0.105*	0.098*	0.097*	-0.005	-0.006
	(0.043)	(0.043)	(0.041)	(0.041)	(0.050)	(0.049)
Leverage	0.032	0.032+	0.015	0.016	0.021	0.022
	(0.020)	(0.019)	(0.014)	(0.015)	(0.016)	(0.016)
Firm size	0.008*	0.009**	0.010**	0.010**	0.006*	0.006*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Firm performance (ROA)	0.272**	0.270**	0.460**	0.457**	-5.052*	-5.100*
	(0.019)	(0.019)	(0.019)	(0.019)	(2.081)	(2.018)
Tobin's Q	0.001+	0.001+	0.001	0.001	0.001+	0.001+
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional ownership	0.002**	0.002**	0.002**	0.002**	0.002**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO Vega	0.002	0.002	0.001	0.001	-0.001	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
CEO age	-0.004	-0.004	0.000	0.000	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
CEO duality	0.001	0.001	-0.001	0.000	0.002	0.004
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
CEO tenure	0.000	0.000	-0.001*	-0.001*	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CEO ownership	0.000	0.000	0.001	0.001	-0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female CEO	0.017	0.015	0.020	0.019	0.018	0.016
	(0.019)	(0.019)	(0.021)	(0.021)	(0.025)	(0.024)
Female on TMT	0.025	0.025	-0.006	-0.007	-0.021	-0.021
	(0.024)	(0.024)	(0.025)	(0.025)	(0.025)	(0.025)
CEO liberalism		0.018*		0.016+		0.026**
		(0.009)		(0.009)		(0.010)
Constant	0.030	0.025	-0.048*	-0.052*	-0.000	-0.008
	(0.034)	(0.035)	(0.022)	(0.022)	(0.023)	(0.023)
Observations	3764	3764	3367	3367	2953	2953
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.064	0.064	0.069	0.070	0.064	0.066
Between R-squared	0.329	0.333	0.347	0.348	0.288	0.290
Overall R-squared	0.239	0.241	0.231	0.232	0.219	0.222

Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.010$)

Robustness Checks and Additional Analyses

To further establish the robustness of the empirical results, I conducted several robustness checks. First, to ensure that the obtained results are not driven by including firms with missing R&D expenditures, I excluded firms with no R&D expenditures reported in the Compustat database and retested the hypotheses. As reported in Table 14, that replicates Table 5 through Table 13, the overall results remained the same. I found support for Hypotheses 2, 6, and 7, marginal support for Hypothesis 4 and 5, and no support for Hypotheses 1 and 3.

Second, I conducted some robustness analyses for testing the relationships between CEO liberalism and some of the dependent variables including breakthroughs and failures and measures of gender diversity of inventors. I also examined the effect of CEO liberalism on R&D intensity.

In the following I will provide the rationale and results of these analyses.

Table 14. Robustness Checks: Excluding Firms with Missing R&D Expenditures

	Number of patents			Breakthroughs		
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
R&D intensity	0.632	0.631+	0.631*	0.303*	0.216	0.260
	(0.400)	(0.365)	(0.308)	(0.152)	(0.156)	(0.158)
Leverage	-0.005	-0.177	-0.243	0.007	-0.017	0.028
	(0.166)	(0.185)	(0.184)	(0.095)	(0.088)	(0.104)
Firm size	0.498**	0.471**	0.438**	0.121**	0.114**	0.097**
	(0.039)	(0.041)	(0.042)	(0.019)	(0.020)	(0.021)
Firm performance (ROA)	-19.805*	-17.362*	4.667	-4.886	-4.349	-1.163
	(8.287)	(7.371)	(15.112)	(3.158)	(3.931)	(4.030)
Tobin's Q	0.014	0.014+	0.019*	0.008	0.011**	0.015**
	(0.009)	(0.008)	(0.009)	(0.005)	(0.004)	(0.003)
Institutional ownership	0.066**	0.061**	0.058**	0.035**	0.031**	0.025**
	(0.017)	(0.017)	(0.018)	(0.008)	(0.008)	(0.007)
CEO Vega	0.079	0.050	0.023	0.041	-0.011	-0.010
	(0.073)	(0.084)	(0.093)	(0.060)	(0.050)	(0.055)
CEO age	-0.014	-0.025	-0.058*	0.005	0.008	-0.008
	(0.027)	(0.028)	(0.029)	(0.013)	(0.014)	(0.015)
CEO duality	-0.041	-0.073	-0.083	0.016	0.028	0.021
	(0.054)	(0.060)	(0.067)	(0.025)	(0.029)	(0.031)
CEO tenure	-0.010*	-0.011*	-0.009+	-0.002	-0.002	0.000
	(0.004)	(0.004)	(0.005)	(0.002)	(0.002)	(0.002)
CEO ownership	0.009	0.009	0.009	0.003	0.003	0.001
	(0.006)	(0.006)	(0.007)	(0.002)	(0.003)	(0.002)
CEO liberalism	0.025	0.022	0.043	0.116*	0.122*	0.096+
	(0.121)	(0.116)	(0.129)	(0.053)	(0.050)	(0.053)
Constant	2.163*	1.647	1.649	0.483	0.285	0.353
	(0.877)	(1.104)	(1.320)	(0.582)	(0.583)	(0.594)
Observations	4333	3887	3450	4325	3872	3432
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.262	0.260	0.243	0.078	0.069	0.052
Between R-squared	0.390	0.383	0.361	0.286	0.279	0.242
Overall R-squared	0.398	0.382	0.363	0.229	0.214	0.204

Models with only control variables are not reported in this table.
Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

(Table 14 cont'd.)

	Failures			New knowledge			New technology		
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
R&D intensity	0.669**	0.667**	0.495+	0.504*	0.539*	0.298	0.335+	0.321*	0.122
	(0.226)	(0.245)	(0.258)	(0.232)	(0.233)	(0.237)	(0.176)	(0.162)	(0.165)
Leverage	-0.100	-0.238	-0.277*	-0.154	-0.331*	-0.243+	-0.198*	-0.190*	-0.158+
	(0.141)	(0.151)	(0.140)	(0.133)	(0.144)	(0.128)	(0.085)	(0.081)	(0.094)
Firm size	0.361**	0.383**	0.377**	0.391**	0.371**	0.348**	0.200**	0.179**	0.162**
	(0.031)	(0.031)	(0.032)	(0.028)	(0.028)	(0.029)	(0.015)	(0.015)	(0.016)
Firm performance (ROA)	-14.277*	-15.398*	-10.850	-10.481	-15.347*	-7.441	-9.197*	-10.587**	3.897
	(6.395)	(6.540)	(10.935)	(8.363)	(6.886)	(9.254)	(4.473)	(3.761)	(9.013)
Tobin's Q	0.003	0.005	0.011	0.009	0.007	0.011**	0.015**	0.009+	0.014**
	(0.004)	(0.005)	(0.008)	(0.006)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)
Institutional ownership	0.099**	0.093**	0.084**	0.046**	0.042**	0.037**	0.009	0.008	0.007
	(0.017)	(0.016)	(0.016)	(0.014)	(0.012)	(0.013)	(0.006)	(0.005)	(0.005)
CEO Vega	0.159+	0.207+	0.255**	0.081	0.069	0.040	0.043	0.022	-0.031
	(0.082)	(0.106)	(0.095)	(0.057)	(0.066)	(0.070)	(0.051)	(0.053)	(0.048)
CEO age	-0.027	-0.017	-0.030	-0.026	-0.032	-0.041+	0.006	-0.019	-0.015
	(0.025)	(0.025)	(0.026)	(0.020)	(0.021)	(0.021)	(0.014)	(0.015)	(0.016)
CEO duality	-0.063	-0.097+	-0.071	0.010	0.000	-0.021	0.003	0.014	-0.020
	(0.049)	(0.052)	(0.055)	(0.042)	(0.045)	(0.051)	(0.031)	(0.032)	(0.036)
CEO tenure	-0.011**	-0.012**	-0.012**	-0.002	-0.003	-0.003	-0.004*	-0.004+	-0.002
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)
CEO ownership	0.007	0.008*	0.008*	0.003	0.005	0.005	-0.000	0.003	-0.002
	(0.004)	(0.003)	(0.004)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
CEO liberalism	-0.017	0.037	0.035	0.065	0.096	0.137	0.086+	0.049	0.061
	(0.101)	(0.095)	(0.095)	(0.074)	(0.076)	(0.087)	(0.044)	(0.048)	(0.055)
Constant	1.430**	1.058	0.908	0.321	0.136	0.653*	0.338	0.553**	0.230
	(0.427)	(0.652)	(0.623)	(0.325)	(0.391)	(0.294)	(0.285)	(0.214)	(0.280)
Observations	4325	3872	3432	4325	3872	3432	4325	3872	3432
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.413	0.399	0.376	0.276	0.280	0.271	0.253	0.257	0.253
Between R-squared	0.598	0.599	0.563	0.417	0.403	0.380	0.268	0.235	0.242
Overall R-squared	0.552	0.530	0.496	0.433	0.421	0.406	0.300	0.289	0.296

Models with only control variables are not reported in this table.
Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)
(Table 14 cont'd.)

Variables	Citations to science			Government funded		
	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15
R&D intensity	0.945	1.390+	1.308*	0.004	-0.122	-0.065
	(0.747)	(0.781)	(0.634)	(0.066)	(0.083)	(0.070)
Leverage	0.063	-0.077	-0.214	0.002	0.008	-0.003
	(0.251)	(0.276)	(0.270)	(0.040)	(0.039)	(0.033)
Firm size	0.458**	0.423**	0.389**	0.063**	0.053**	0.043*
	(0.062)	(0.063)	(0.064)	(0.019)	(0.019)	(0.019)
Firm performance (ROA)	-29.031**	-13.053	30.304	-5.335*	-5.580*	-5.365+
	(7.284)	(10.438)	(33.938)	(2.568)	(2.755)	(2.749)
Tobin's Q	0.039**	0.045**	0.042*	0.001	0.000	0.001
	(0.014)	(0.016)	(0.019)	(0.001)	(0.001)	(0.001)
Institutional ownership	0.096**	0.088**	0.088**	0.025*	0.026*	0.022
	(0.023)	(0.023)	(0.027)	(0.012)	(0.013)	(0.014)
CEO Vega	0.032	0.013	-0.027	0.086**	0.091**	0.121**
	(0.120)	(0.129)	(0.123)	(0.029)	(0.026)	(0.044)
CEO age	0.006	-0.036	-0.051	0.011	0.002	0.005
	(0.042)	(0.042)	(0.045)	(0.010)	(0.010)	(0.011)
CEO duality	-0.060	-0.037	-0.066	-0.021	0.006	-0.008
	(0.087)	(0.090)	(0.087)	(0.027)	(0.029)	(0.027)
CEO tenure	-0.012	-0.008	-0.006	-0.002	-0.002	-0.002
	(0.007)	(0.007)	(0.007)	(0.002)	(0.002)	(0.002)
CEO ownership	0.009	0.004	0.001	0.001	0.002+	0.001
	(0.011)	(0.009)	(0.009)	(0.001)	(0.001)	(0.001)
CEO liberalism	0.184	0.101	0.075	0.023	0.051+	0.034
	(0.230)	(0.212)	(0.209)	(0.028)	(0.029)	(0.025)
Constant	4.630**	3.859*	2.538	-0.083	-0.008	-0.067
	(1.562)	(1.688)	(2.475)	(0.064)	(0.097)	(0.124)
Observations	4325	3872	3432	4325	3872	3432
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.101	0.092	0.086	0.083	0.082	0.077
Between R-squared	0.363	0.359	0.339	0.276	0.271	0.256
Overall R-squared	0.331	0.326	0.303	0.206	0.192	0.166

Models with only control variables are not reported in this table.
Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)
(Table 14 cont'd.)

Variables	Female inventors in firm			Female inventors in teams		
	Model 16	Model 17	Model 18	Model 19	Model 20	Model 21
R&D intensity	0.132**	0.153**	0.079	0.122**	0.091*	-0.023
	(0.043)	(0.057)	(0.083)	(0.043)	(0.042)	(0.049)
Leverage	-0.003	-0.005	0.010	0.025	0.021	0.028+
	(0.018)	(0.017)	(0.018)	(0.017)	(0.015)	(0.016)
Firm size	0.012**	0.010**	0.004	0.011**	0.010**	0.005+
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Firm performance (ROA)	-0.818	0.061	-6.067*	0.899	1.419+	-5.416**
	(2.613)	(2.026)	(2.506)	(1.293)	(0.837)	(1.882)
Tobin's Q	0.001	0.001	0.001	0.001+	0.001	0.001+
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional ownership	0.001**	0.002**	0.002**	0.002**	0.002**	0.002**
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
CEO Vega	0.003	0.010*	0.005	0.004	0.002	0.001
	(0.003)	(0.004)	(0.006)	(0.004)	(0.004)	(0.006)
CEO age	-0.007*	-0.003	-0.004	-0.005+	-0.001	-0.004
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
CEO duality	0.001	0.002	0.013+	0.006	0.002	0.007
	(0.007)	(0.008)	(0.007)	(0.006)	(0.007)	(0.007)
CEO tenure	0.000	-0.001+	-0.000	0.000	-0.001+	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CEO ownership	0.001	0.002	-0.000	0.001	0.002+	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female CEO	0.005	0.005	0.013	0.018	0.021	0.014
	(0.018)	(0.021)	(0.024)	(0.019)	(0.021)	(0.024)
Female on TMT	0.041	-0.008	-0.040	0.020	-0.003	-0.017
	(0.028)	(0.028)	(0.031)	(0.024)	(0.025)	(0.026)
CEO liberalism	0.015	0.016	0.029**	0.017*	0.017+	0.027**
	(0.010)	(0.010)	(0.011)	(0.009)	(0.009)	(0.010)
Constant	0.141**	0.002	0.077**	0.025	-0.046*	-0.005
	(0.029)	(0.053)	(0.019)	(0.035)	(0.019)	(0.023)
Observations	3469	3069	2676	3541	3161	2766
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.068	0.061	0.056	0.065	0.066	0.064
Between R-squared	0.306	0.309	0.272	0.308	0.290	0.267
Overall R-squared	0.219	0.204	0.204	0.234	0.221	0.219

Models with only control variables are not reported in this table.
Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Alternative measures of breakthrough and failure innovations

As previously mentioned, I measured breakthroughs and failures using forward citations up to 2019 received by patents after their application date. Because citations are accrued over time, patents filed earlier have a higher chance of obtaining forward citations and patents filed near the ending year of the sample have less time/chance to obtain forward citations. As a result, forward citations suffer from a time-truncation bias. To rule out the possibility that the results reported in Table 6 and Table 7 are influenced by this truncation problem, I tried alternative operationalizations of breakthroughs and failures. In these alternative measures I considered a five-year window from the date a patent is filed and counted the number of forward citations at the end of the fifth year (Lahriri, 2010). I tested Hypotheses 2 and 3 with these measures and the results are reported in Table 15.

Models 2, 4, and 6 tested the effect of CEO liberalism on breakthrough innovations with the new operationalization. As shown in the table, the relationships are positive and significant for both a two-year lag (β_4= 0.111, p_4=0.048) and a three-year lag (β_6= 0.111, p_6= 0.041). I also found a marginally significant effect for one-year lag (β_2= 0.093, p_2= 0.076). These results show that a liberal CEO increases breakthrough innovation from about 9.75% to 11.74%.

The results of models 8, 10, and 12 show that the association between CEO liberalism and failures are in the hypothesized direction but not significant (β_8=0.018, p_8=0.870; β_{10}=0.028, p_{10}= 0.802; β_{12}=0.023, p_{12}=0.846).

These results provide further support for the results reported in Table 6 and Table 7. CEO liberalism is positively and significantly related to breakthrough innovations and has a positive but not statistically significant association with failures.

Table 15. Robustness Checks: Testing for Alternative Measures of Breakthroughs (Models 1 To 6) and Failures (Models 7 To 12)

	Breakthroughs						**Failures**					
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**
R&D intensity	0.247*	0.242*	0.297+	0.293+	0.283+	0.282+	0.628	0.628	0.740*	0.739+	0.613*	0.614*
	(0.116)	(0.115)	(1.92)	(1.91)	(1.85)	(1.84)	(0.398)	(0.398)	(1.96)	(1.96)	(2.40)	(2.40)
Leverage	-0.056	-0.057	-0.091	-0.091	-0.066	-0.066	-0.023	-0.023	-0.164	-0.164	-0.231	-0.231
	(0.067)	(0.067)	(1.26)	(1.27)	(0.79)	(0.79)	(0.138)	(0.138)	(1.07)	(1.07)	(1.56)	(1.55)
Firm size	0.120**	0.121**	0.108**	0.109**	0.097**	0.099**	0.428**	0.429**	0.413**	0.413**	0.386**	0.387**
	(0.016)	(0.016)	(6.16)	(6.25)	(5.08)	(5.18)	(0.033)	(0.033)	(12.00)	(11.94)	(11.14)	(11.08)
Firm performance	-0.027	-0.031	-0.047	-0.053+	0.014	0.008	-0.187	-0.187	-0.167**	-0.167**	-0.175**	-0.175**
	(0.038)	(0.038)	(0.032)	(0.032)	(0.036)	(0.037)	(0.119)	(0.119)	(0.054)	(0.054)	(0.052)	(0.052)
Tobin's Q	0.007	0.007	0.005	0.006	0.012*	0.012*	0.013+	0.013+	0.014*	0.014*	0.018*	0.018*
	(0.005)	(0.005)	(0.83)	(0.89)	(2.17)	(2.23)	(0.007)	(0.007)	(2.35)	(2.35)	(2.29)	(2.29)
Institutional ownership	0.037**	0.037**	0.032**	0.032**	0.025**	0.025**	0.063**	0.063**	0.058**	0.058**	0.056**	0.056**
	(0.009)	(0.009)	(0.008)	(0.008)	(0.007)	(0.007)	(0.017)	(0.016)	(0.016)	(0.016)	(0.018)	(0.018)
CEO Vega	-0.001	-0.001	-0.042	-0.042	-0.049	-0.048	0.051	0.051	0.015	0.015	-0.039	-0.039
	(0.062)	(0.062)	(0.041)	(0.042)	(0.045)	(0.045)	(0.058)	(0.058)	(0.058)	(0.058)	(0.063)	(0.063)
CEO age	-0.011	-0.009	-0.002	0.001	-0.006	-0.003	-0.011	-0.011	-0.021	-0.020	-0.047*	-0.047*
	(0.011)	(0.012)	(0.14)	(0.09)	(0.48)	(0.27)	(0.022)	(0.022)	(0.93)	(0.88)	(2.02)	(1.97)
CEO duality	0.016	0.020	0.018	0.022	-0.004	0.001	-0.042	-0.041	-0.083	-0.082	-0.061	-0.059
	(0.024)	(0.024)	(0.63)	(0.80)	(0.13)	(0.03)	(0.050)	(0.050)	(1.52)	(1.51)	(1.00)	(0.99)
CEO tenure	-0.001	-0.001	0.000	0.000	0.002	0.001	-0.007*	-0.007*	-0.008*	-0.008*	-0.006	-0.006
	(0.002)	(0.002)	(0.15)	(0.01)	(0.70)	(0.58)	(0.003)	(0.003)	(2.22)	(2.23)	(1.47)	(1.48)
CEO ownership	0.000	0.000	-0.001	-0.001	-0.002	-0.002	0.004	0.004	0.005	0.005	0.002	0.002
	(0.004)	(0.004)	(0.20)	(0.20)	(0.49)	(0.51)	(0.007)	(0.007)	(0.79)	(0.80)	(0.29)	(0.29)
CEO liberalism		0.093+		0.111*		0.111*		0.018		0.028		0.023
		(0.053)		(1.98)		(2.04)		(0.108)		(0.25)		(0.19)
Constant	0.294	0.269	-0.031	-0.062	0.125	0.098	0.896	0.892	0.624	0.617	0.688	0.682
	(0.515)	(0.515)	(0.06)	(0.12)	(0.24)	(0.19)	(1.041)	(1.041)	(0.58)	(0.58)	(0.64)	(0.64)
Observations	4729	4729	4250	4250	3781	3781	4729	4729	4250	4250	3781	3781
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.076	0.077	0.067	0.068	0.049	0.049	0.245	0.244	0.262	0.262	0.262	0.262
Between R-squared	0.297	0.301	0.261	0.266	0.234	0.243	0.391	0.392	0.373	0.374	0.360	0.361
Overall R-squared	0.234	0.240	0.212	0.219	0.200	0.210	0.403	0.403	0.390	0.390	0.378	0.379

Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

Alternative explanations for the gender diversity of inventors

As discussed above, CEO liberalism has a positive relationship with measures of gender diversity of inventors (representation of female inventors in firms and innovation teams). To further test the robustness of these results, I tested the models by including state fixed effects. This control rules out the possibility that the observed effect of CEO liberalism on inventors' gender diversity is the result of the omitted variable of location. For example, it is likely that both CEO liberalism and the presence of female inventors are affected by the liberal ideology of the state where a firm is located. Also, location is likely to explain representation of female scientists because some locations may be more attractive for innovation activities of these scientists (Delgado, Mariani, & Murray, 2019). The result of including the state fixed effect is reported in Table 16. As shown in models 1 through 6, after addition of this control the effect of CEO liberalism on all measures of gender diversity of inventors is still marginally significant in models with a three-year lag (β_3=0.023, p_3=0.060; β_6=0.018, p_6=0.075). These results provide further support for hypotheses 6 and 7, i.e., that CEO liberalism is positively associated with representation of female inventors in firms and innovation teams.

Table 16. Robustness Checks: Controlling for State to Predict the Effect of CEO Liberalism on Inventors' Gender Diversity

Variables	Female inventors in firm			Female inventors in teams		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D intensity	0.089*	0.114+	0.047	0.072+	0.053	-0.057
	(0.039)	(0.059)	(0.085)	(0.040)	(0.040)	(0.046)
Leverage	0.009	-0.000	0.019	0.032+	0.018	0.026+
	(0.019)	(0.016)	(0.018)	(0.018)	(0.014)	(0.015)
Firm size	0.013**	0.014**	0.008**	0.012**	0.013**	0.010**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Firm performance	0.270**	0.484**	-6.420*	0.258**	0.487**	-5.402**
	(0.046)	(0.030)	(2.814)	(0.047)	(0.026)	(1.695)
Tobin's Q	0.001	0.001	0.001	0.001+	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional ownership	0.001	0.001*	0.002**	0.001*	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO Vega	0.004	0.005	0.000	0.001	-0.000	-0.002
	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
CEO age	-0.005	-0.000	-0.003	-0.003	0.001	-0.001
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
CEO duality	-0.003	-0.001	0.008	0.002	-0.000	0.003
	(0.007)	(0.008)	(0.007)	(0.006)	(0.006)	(0.007)
CEO tenure	0.000	-0.001*	-0.000	-0.000	-0.001**	-0.001+
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CEO ownership	0.000	0.001	-0.000	0.000	0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO gender	0.003	-0.000	0.015	0.011	0.010	0.011
	(0.020)	(0.023)	(0.026)	(0.021)	(0.024)	(0.028)
Female on TMT	0.043	-0.019	-0.052+	0.024	-0.011	-0.027
	(0.029)	(0.028)	(0.029)	(0.024)	(0.024)	(0.025)
CEO liberalism	0.009	0.009	0.023+	0.011	0.008	0.018+
	(0.010)	(0.011)	(0.012)	(0.009)	(0.009)	(0.010)
Observations	3686	3269	2858	3759	3363	2950
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.071	0.068	0.063	0.065	0.072	0.069
Between R-squared	0.374	0.379	0.343	0.376	0.407	0.355
Overall R-squared	0.250	0.237	0.219	0.265	0.266	0.256

Models with only control variables are not shown in this table.
Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

The effect of CEO liberalism on firms' investment in innovation

One important factor that influences the innovation activities of firms is the amount of investment they make in R&D. In fact, R&D investment provides the input required by the innovation process and influences outputs such as the number of patents and/or new products developed (Galasso & Simcoe, 2011; Hirshleifer et al., 2012). The results from testing Hypothesis 1 did not provide evidence of a significant relationship between CEO liberalism and the number of patents developed by a firm, so these results show that the political ideology of CEOs does not tend to influence the outputs of innovation in firms. As additional analysis and to further deepen our understanding about the effect of CEO political ideology on innovation, I also tested the effect of CEO liberalism on R&D. I expected that liberal CEOs when compared to their conservative counterparts assign more priority to R&D and make greater investments in it, because their higher propensity to taking risks and exploring new knowledge domains make liberal CEOs more likely to shift scarce time and money to projects that not only deplete current earnings and pay off in the long-term, but also are associated with high risk of failure. Therefore, my hypothesis is that CEO liberalism is positively associated with R&D.

Following prior research (Hirshleifer et al., 2012), I operationalized R&D by *R&D intensity*, measured by dividing R&D expenditures by total assets. This measure also shows the relative importance that firms ascribe to R&D. Table 17 reports the results of testing this hypothesis. I tested this effect on the full sample[20] in model 2 and on the sample of firms without missing R&D expenditures on Compustat in model 4. I tested the effect of CEO liberalism on R&D by considering only a one-year lag because, in contrast to the effects of patents, the effect of CEO preferences on the amount of money to invest in R&D is more immediate (Galasso &

[20] When considering R&D intensity as the dependent variable, I relaxed the restriction that to be included in the sample S&P1500 firms should match patent data.

Simcoe, 2011). As shown in the table, although the coefficients in models are positive and in the hypothesized direction, they are not statistically significant (β_1=0.006, p_1= 0.165; β_4=0.004, p_4=0.510), so the results do not conform to the hypothesis that liberal CEOs intensify R&D efforts in their firms. The results shown in Table 17 show that institutional ownership has a positive and significant effect on R&D intensity and smaller firms make more investments in R&D. Among CEO-level controls, CEO stock ownership negatively affects R&D. This effect is consistent with prior research showing that owning more shares decreases CEOs' risk-taking propensity (Sanders, 2001).

Table 17. The Effect of CEO Liberalism on R&D Intensity

	Including firms with missing R&D		Excluding firms with missing R&D	
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Leverage	-0.001	-0.001	0.011	0.011
	(0.012)	(0.012)	(0.021)	(0.021)
Firm size	-0.014**	-0.014**	-0.019**	-0.019**
	(0.003)	(0.003)	(0.004)	(0.005)
Firm performance (ROA)	-0.090+	-0.091*	-9.028**	-9.012**
	(0.046)	(0.046)	(1.977)	(1.981)
Tobin's Q	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Institutional ownership	0.001**	0.001**	0.002*	0.002*
	(0.000)	(0.000)	(0.001)	(0.001)
CEO Vega	0.004	0.004	0.007	0.007
	(0.004)	(0.004)	(0.005)	(0.005)
CEO age	-0.001	-0.001	-0.002	-0.002
	(0.001)	(0.001)	(0.002)	(0.002)
CEO duality	-0.001	-0.001	0.000	0.000
	(0.003)	(0.003)	(0.005)	(0.004)
CEO tenure	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
CEO stockownership	-0.001**	-0.001**	-0.001*	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
CEO liberalism		0.006		0.004
		(0.004)		(0.007)
Constant	0.078**	0.076**	0.106**	0.105**
	(0.015)	(0.015)	(0.024)	(0.024)
Observations	9516	9516	6198	6198
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Robust standard errors	Yes	Yes	Yes	Yes
Within R-squared	0.002	0.002	0.004	0.004
Between R-squared	0.280	0.281	0.335	0.336
Overall R-squared	0.142	0.143	0.165	0.165

Standard errors in parentheses. ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)

CHAPTER 5. DISCUSSION

My primary goal in this dissertation was to examine the role of CEOs' liberal or conservative orientation in shaping firms' innovation. I grounded my arguments on the tenets of upper-echelon theory related to the role of executives' orientations in shaping their decisions (Hambrick & Mason, 1984) and the body of research in political psychology that provides ample evidence regarding the different values and psychological needs of liberals and conservatives (Jost et al., 2003; Jost et al., 2017). Using a sample of S&P1500 CEOs from 1992 to 2014, I found that firms' innovation outcomes and strategies are in part a reflection of their CEOs' political ideologies. My results specifically show that CEO liberalism increases breakthrough innovations and is associated with exploration in new technology domains as well as pursuit of basic research. I also found that CEO liberalism shapes inventor-staffing strategy by decreasing the gap with respect to the presence of female inventors in the firm and in innovation teams. Contrary to my predictions, I did not find evidence that CEO liberalism increases the amount of R&D investment nor the number of innovations developed by firms, and the results also do not support the existence of an association between CEO liberalism and the number of failure innovations.

Theoretical Implications and Future Research

My study makes important contributions to several areas of research and suggests opportunities for future research:

CEO political ideology literature

My study extends the growing line of research on the consequences of CEOs' ideological beliefs by demonstrating that such beliefs can shape firms' innovation. The most notable finding of this dissertation is that CEO political ideology is not much consequential for *how much*

(quantity) firms innovate but is influential on *how* (strategy) they innovate. The finding that CEO political ideology neither influences the amount of R&D investments nor the number of innovations is interesting, considering the substantial body of research that shows liberals and conservatives have different attitudes toward uncertainty and new experiences (Carney et al., 2008; Jost et al., 2003). These attributes have been shown in several previous studies to have a substantial influence on the degree to which a CEO prioritizes innovation (Lee et al., 2020; Sunder et al., 2017). This result suggests that although the viewpoints of liberals and conservatives may diverge over a wide range of societal and organizational domains, CEOs with different ideological orientations tend to come to agreement about the importance of innovation as a key driver of competitive advantage and long-term success (Schumpeter, 1942). The finding that CEO ideology does not impact R&D investment is inconsistent with prior research (Hutton et al., 2014) that showed a negative (positive) association between CEO conservatism (liberalism) and R&D. I speculate that this inconsistency may result partly from the fact that Hutton and colleagues used a different operationalization of CEO conservativism. To measure political ideology, they examined political donations in each cycle and coded CEO conservatism as 1 if all donations he/she made were directed to Republicans and zero otherwise, then calculated their conservatism index by taking the average of this variable across all years in which the CEO made donations. In contrast, my CEO liberalism index (Chin et al., 2013; Briscoe et al., 2014) considers donations to both parties and takes into account behavioral commitment (number of donations), financial commitment (amount of donations), persistence of commitment (number of years) and scope of commitment (count of distinct recipients). The correlation between the index of CEO liberalism in my study and their measure of CEO conservativism is -0.46. Another reason for this inconsistency could be the fact that Hutton et al.

(2014) considered a limited number of controls, mostly at the firm level[21] while my hypothesis testing models involved a more comprehensive set of variables at the CEO, firm and environmental levels.

Another contribution of my study is the finding that CEO political ideology is a critical determinant of a firm's innovation trajectory. On one hand, liberal CEOs lead firms toward a departure from firms' existing technology and exploration in new technology domains, encouraging research endeavors that enhance fundamental understating about phenomena, with benefits that go beyond the focal firms. Such innovation trajectory is uncertain and long-term but, as my findings also demonstrated, is more likely to result in breakthrough innovations that revolutionize current markets and technologies. On the other hand, my results show that more conservative CEOs direct firms towards incrementally improving and refining current technology. They tend to encourage research endeavors that are more certain and have more proximate practical results for their firms. These results are consistent with prior research showing that conservative CEOs establish more certain and less risky policies (Christensen et al., 2015; Hutton et al., 2014). Conservative CEOs' innovation strategy is more predictable and generates results in the short term, but it is less likely to bring about breakthroughs, and such strategies may lead to inertia and impede firms' adaptation to environmental changes (Levinthal, 1991). Future research can explore the consequences of different strategic-direction pursuits by liberal and conservative CEOs on firms' flexibility and adaptation capability.

While risky and exploratory strategies increase the risk of failure, contrary to my predictions I found no evidence that firms with liberal CEOs develop more failure innovations. One explanation for this finding could be existence of other factors that offset the danger of

[21] Hutton et al., (2014) controlled for Tobin's Q, firm size, leverage and earning performance and included year and industry fixed effects.

R&D project riskiness undertaken by firms with liberal CEOs. One possible factor could be the diversity of inventors in firms led by liberal CEOs that not only increases the amount of available information, knowledge, and skills (Jehn, Northcraft, & Neale, 1999) but enhances the range of thinking styles and perspectives that contribute to the research process, potentially improving information processing and decision-making quality (Van Knippenberg, De Dreu, & Homan, 2004). Prior research consistently shows that greater diversity in innovation teams increases innovation quality (Díaz-García, González-Moreno, & Sáez-Martínez, 2013; Garcia Martinez, Zouaghi, & Garcia Marco, 2017). As the two last hypotheses of this study demonstrate, the existence of a liberal CEO tends to increase the presence and participation of female scientists. The increased diversity in innovation teams in such firms is likely to translate into enhanced innovation quality. Another possible factor for the null finding on the effect of liberal CEOs on failure innovations could be the quality of inventors working in such firms. Research shows that high-quality (star) inventors actively seek out employers with promising working conditions (Moretti & Wilson, 2017), and it is likely that the policies and practices established by liberal CEOs that encourage equality (Carnahan & Greenwood, 2018; Chin & Semadeni, 2017), diversity (Chin et al., 2013), and less performance-based pay (Gupta & Wowak, 2017), along with their own openness and receptivity to new ideas, may make such firms more favorable workplaces for star inventors whose presence reduces the likelihood of developing low-quality (failure) innovations (Hohberger, 2016). Future research could explore these and other factors that help liberal CEOs avoid failure trap while pursuing risky innovation projects.

Innovation literature

My study also has several implications for innovation literature. First, it shows that CEO liberalism is a strong predictor of breakthrough innovation. Breakthroughs have a key role in

changing technological trajectories and disrupting current markets. This type of innovation can provide firms with a unique competitive advantage and serve as a significant source of value both for firms and the broader society (Hall et al., 2005). Therefore, understanding the determinants of breakthroughs is important from both theoretical and practical standpoints (Ahuja & Lampert, 2001) and has long been a central inquiry in innovation literature (Kaplan & Vakili, 2015; Phene et al., 2006). Only a few studies to date have examined CEO-related antecedents of breakthroughs (Cho & Kim, 2017; Lee et al., 2020) and my study is the first that points to CEOs' deeply held ideological beliefs as a key determinant of such innovations.

My second contribution to innovation literature is establishing CEO ideological orientation as a determinant of the choice between exploration and exploitation. Since these concepts were introduced by March (1991), several studies have explored factors that determine the choice between them (Wilden et al., 2018; Lavie et al., 2010). While March's propositions were inherently behavioral, subsequent studies mostly neglected the behavioral and psychological determinants of exploration vs exploitation (Wilden et al., 2018). Particularly, the role of behavioral tendencies of CEOs in these strategies has not been studied. I advanced this literature stream by theorizing and empirically showing that the innovation endeavors of firms led by liberal CEOs are more likely to explore new technological domains.

My study makes an additional contribution to innovation literature by helping to answer the question "*why do firms do basic research*?" Basic research is conducted to discover new knowledge and, contrary to applied research, is often undertaken without specific commercial applications in mind. It involves highly uncertain and long-term research endeavors the benefits of which are often not completely appropriable by the firm undertaking it (Rosenberg, 1990), making businesses usually reluctant to pursue such research. I provided evidence for my

prediction that, due to their inherent curiosity and broad perspectives about the role of businesses in the society, liberal CEOs are more likely to encourage the pursuit of basic research. To my knowledge, this study is the first that shows the role of CEOs in a firm's tendency to conduct basic research.

Gender diversity literature

This study has important implications for the literature stream related to gender diversity in the workplace, specifically in innovative jobs. While prior research provides ample evidence that gender diversity in innovation teams enhances innovation capability and performance (Díaz-García et al., 2013; Garcia Martinez et al., 2017; Xie, Zhou, Zong, & Lu, 2020), there is still a significant gap both in academia and industry with respect to the presence of females in innovative jobs and related commercial activities (Whittington, 2018). Although research on the antecedents of this gap in the industry sector is very limited, there is some evidence that firms are often not welcoming towards female scientists (Murray & Graham, 2007). My study demonstrates the role of CEO liberalism in welcoming the presence of female inventors in firms, even after controlling for several possible antecedents related to firm, industry, and location. I also found that in firms led by liberal CEOs, females participate in innovation teams in higher proportions, providing more evidence about the confidence in the capabilities of female scientists that exists in such firms. These results are also consistent with prior research on the impact of liberal orientation of decision-makers on gender equality (Briscoe & Joshi 2017; Carnahan & Greenwood, 2018; Chin et al., 2013). While a group of these studies focused on supervisors/managers' political ideology (Briscoe & Joshi 2017; Carnahan & Greenwood, 2018) and others studied it indirectly through CSR efforts (Chin et al., 2013), my study provides both

theory and evidence that the political ideology of CEOs as the top leader of firms decreases the gender gap in the hiring and selection of highly-skilled human capital.

Additional opportunities for future research

In addition to the ideas for future research presented above, my dissertation suggests several other lines of future inquiry:

First, while my study focused on the effect of CEO ideology, future research may examine the implication of the political orientation of the entire TMT with respect to a firm's innovation. This would be an important inquiry because TMTs are the most influential executives of firms, with a substantial role in determining firms' strategies, including innovation (Hambrick, 2015; Heyden et al., 2017; Kor, 2006). Another interesting research question that could guide future research is the role of board members' political ideology. While the board of directors has been shown to have a role in shaping firms' innovation (Balsmeier et al., 2017; Bravo & Reguera-Alvarado, 2017), we still do not know whether their political ideologies impact innovation. It would be specifically interesting to study the joint effect of CEO and TMT/board ideologies to examine whether they have complementary or substitutive effects on innovation.

A second potentially fruitful avenue for future research pertains to delving deeper into the effect of CEOs' political ideology on the management of high skilled human capital. In this study, I took the first step by showing that CEO liberalism tends to increase the presence of female scientists, and future research could consider whether the different values of liberal and conservative CEOs have implications with respect to the type of human capital that firms attract and retain (Schneider, 1987). Specifically, researchers could examine the presence of star inventors in firms led by liberal vs conservative CEOs. Star inventors are a small number of highly influential scientists that develop a large proportion of knowledge and have a remarkable

impact on the technological progress (Zucker, Darby, & Torero, 2002). They can account for a substantial portion of a firm's innovation capabilities and intellectual capital and can provide firms with a myriad of advantages such as enhanced innovation productivity and transfer of knowledge to other inventors (Azoulay et al., 2011; Kehoe & Tzabbar, 2015; Zucker & Darby, 1997). Star inventors are therefore an important resource for any firm and investigating the determinants of their presence in firms has important theoretical and practical implications. As mentioned earlier, it is likely that the inherent motivation of liberal CEOs to explore and exhibit receptivity towards new ideas as well as the nature of their policies (promoting diversity, equality, less performance-based pay, etc.) may attract and retain star inventors (Schneider, 1987). As another opportunity for future research, researchers could examine the intersection of CEO political ideology and inventors' mobility. Inventors are key talents whose human capital serves as an important source of competitive advantage for firms. Firms make substantial investments to hire and retain such highly skilled human capital and losing them can be a major cost. Moreover, the mobility of inventors has been shown to be a prominent source of knowledge dissemination and spillover between firms (Arrow, 1962; Song, Almeida, & Wu, 2003). The fact that leaving inventors may join rival firms and transfer their valuable skills and technological knowledge to them makes losing them even more costly. As a result, understanding the antecedents of inventor mobility has been a central research inquiry with implications for both research and practice. Future research can examine whether the different attitudes of liberal and conservative CEOs towards novel ideas and the different human resource management policies they establish are among factors that inventors consider when deciding about taking employment in a firm.

Finally, most studies on the implications of CEO political ideology (including this study) have conceptualized CEO ideology as a set of values and orientations that shape their decisions (Swigart et al., 2020). I suggest that political ideology also can be considered as a dimension of CEO human capital (i.e., knowledge, skills, ability and other characteristics). Such conceptualization can open fruitful lines of research. For example, future studies could integrate the literature on political ideology and CEO-organization fit (Finkelstein, Hambrick, & Cannella, 2009). CEOs may have a repertoire of human capital that make them suited for one context but not for another (Chen & Hambrick, 2012; Finkelstein et al., 2009), and it seems likely that, due to their different preferences, conservative or liberal CEOs can deliver better performance in specific contexts. For example, research demonstrates that exploratory innovation is more effective in dynamic environments while exploitative innovation is more beneficial in competitive environments (Jansen, et al., 2006). Given the results of my study showing the different innovation strategies that liberal and conservative CEOs prefer to pursue, researchers can examine the performance differences of firms led by liberal vs conservative CEOs in these contexts.

Practical Implications

From a practical standpoint, my dissertation has special implications for the board of directors. One major responsibility of board members is selecting a CEO, and the results of my study have potential to inform this decision. I provide evidence that liberal and conservative CEOs have different preferences about the direction and trajectory of research efforts and innovation, and these different trajectories are likely to have implications for firms' competitive advantages and performance as well as for their flexibility and adaptation. Unlike other traits of CEOs such as personality, their political orientation is observable before they take office, thus

when selecting a CEO, a board of directors should carefully examine the fit between the desired direction and the contextual conditions of the firm and an incoming CEO's political ideology and select a CEO whose preferences are in alignment with the firm's specific circumstances.

Limitations

As with any empirical research study, my study has limitations that require some refinements and extensions. First, although using donations to political parties to operationalize political ideology is a well-established approach in the literature, it is certainly not a precise approach for measuring an individual's complex psychological attitudes. Future research can benefit from more precise methods such as surveys and interviews as well as textual analysis of executives' statements for measuring their political ideology.

Moreover, although patents are a widely-accepted proxy of innovation used in the innovation literature (Sunder et al., 2017), there is a limitation to using them because, for example, not all innovations are patented or can be patented (Hall, Helmers, Mogers, Sena & 2014). Firms may also prefer to use other means of protecting their intellectual property (e.g., trademarks, copyrights, trade secrets, etc.). Future research can benefit from other measurement approaches such as text-based techniques (Bellstam, Bhagat, & Cookson, 2020) that do not have the limitations represented by patents.

Furthermore, I acknowledge that alternative explanations might exist for my findings. To rule out such explanations I included a set of control variables related to CEO, firm and the environment and used a lagged design in which the independent (CEO liberalism) and control variables precede the dependent variables to eliminate the possibility of recursive relationships between independent and dependent variables. However, it is possible that CEOs do not volitionally act on their ideology but are selected and attracted to firms that fit their values

(Schneider, 1987). Therefore, the results I have obtained so far may be because of the propensity of firms with specific attributes (certain innovation outcomes and strategies) to hire liberal CEOs and/or the tendency of liberals to lead such firms and not because of the CEOs' liberal values and preferences. Therefore, future research needs to account for this endogenous matching.

Finally, my measurement of basic research can certainly be improved on in future research. Because it is almost impossible to measure the fraction of R&D endeavors devoted to basic and applied research using archival data, I considered the number of citations to scientific papers and the number of government-funded innovations as proxies for basic research endeavors. Another approach to operationalizing basic research could be focusing on scientific papers published by a firm and grouping them into basic or applied categories considering the nature of the journals in which they are published (Lim, 2000). Future research could benefit from this approach or other more precise measurements of basic research.

Conclusion

The purpose of this dissertation was to examine the influence of CEO political ideology for firm innovation. Specifically, it aimed to assess how the political ideology of CEOs impacts the outcomes of innovation and how it impacts the strategies of innovation in firms. I showed that CEOs' liberal or conservative orientation is influential for the direction and trajectory of firms' innovation and the quality of innovations they develop while it does not impact the quantity of their innovations.

APPENDIX A. SUPPLEMENTARY MATERIAL

Table A.1. Review of Research on CEO Characteristics and Innovation

Study (s)	CEO attribute	Key findings
Yadav, Prabhu & Chandy (2007)	Attention	CEOs that focus their attention on future and on external entities foster innovation in their firms.
Nadkarni & Chen (2014)	Temporal focus	When a CEO's temporal focus (past, present, future) is consistent with the demand of the environment, it enhances the rate of NPIs. For instance, in stable environments, CEOs with past temporal focus and those with present focus enhance the rate of NPIs.
Miller, Kets De Vries & Toulouse (1982) - Miller & Toulouse (1986)	Locus of control	CEOs with internal locus of control pursue more product and service innovations and introduce new products more frequently. CEOs with such personality trait also place greater emphasis on R&D and change their product line more dramatically.
Galasso and Simcoe (2011)	Overconfidence	Because an overconfident CEO underestimates the likelihood of failure, he/she is more likely to innovate. And CEOs' overconfidence is associated with higher innovations quality specifically when they have more discretion and when competition is more intense.
Hirshleifer, Low & Teoh (2012)	Overconfidence	overconfident CEOs invest more in research and development (R&D) and for a given R&D expenditure they generate more innovation outputs (more patents and patent citation counts). This effect is stronger in more innovative industries.
Tang, Li & Yang, 2015	Hubris	hubristic CEOs foster firms' innovation but their effect on innovation is weaker in in more munificent and complex environments.
Sunder, Sunder & Zhang (2017)	Sensation seeking	Firms with pilot CEOs (who are high in sensation seeking) have higher number of patent applications, their patents are of higher quality and are more diverse and original. Further, market reacts more favorably to patents created by pilot CEOs.
Zhang, Ou, Tsui & Wang (2017)	Humility & narcissism	CEOs who are both humble and narcissistic foster innovation. Because such CEOs tend to exploit the existing knowledge and explore new knowledge at the same time.
Barker & Mueller (2002)	- Prior experiences - Demographics	Younger CEOs and those with prior experiences in R&D/engineering and those who worked in sales/marketing spend more on R&D. However, CEOs with prior career in legal or production/operations areas tend to invest less in R&D.
Custódio, Ferreira & Matos (2019)	Generalist vs specialist	Generalist CEOs are those whose human capital is not firm-specific and is transferable across different firms and industries. Firms with generalist CEOs have higher innovation productivity (measured by the number of patents and the number of patent citations). Additionally, generalist CEOs engage more in exploratory innovation than exploitative innovation.
Berson, Oreg & Dvir (2008)	Self-Directive, Supportive & Benevolent Values	CEOs with self-directive values promote innovation-oriented culture in their firm and consequently enhance sales growth.
Kashmiri & Mahajan (2017)	Political Ideology	Firms with more liberal CEOs have higher rate of NPIs. When CEOs have greater equity-based compensation, when marketing department has higher influence over TMT and when the economy is growing the association between CEOs' liberalism and rate of NPIs is weaker. But CEO power enhances the effect of political ideology on NPI.

Table A.2. Negative Binomial Regressions Predicting the Effect of CEO Liberalism on Innovation Outcomes and Strategies

	Number of patents			Breakthroughs			New knowledge[1]		New technology			Citation to science			Government funded [2]	
	Model 1	Model 2	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16	Model 17
R&D intensity	0.824**	0.630**	0.336	2.460**	2.170**	2.321**	0.864**	0.910**	0.910**	0.918**	0.644+	0.919**	0.944**	0.681**	-2.415	-1.031
	(0.223)	(0.234)	(0.262)	(0.536)	(0.585)	(0.609)	(0.315)	(0.339)	(0.321)	(0.340)	(0.369)	(0.199)	(0.214)	(0.260)	(1.560)	(1.426)
Leverage	-0.085	-0.327**	-0.251*	-0.010	-0.099	0.021	-0.280*	-0.528**	-0.310*	-0.333*	-0.288+	-0.161	-0.346*	-0.259+	-0.344	-0.520
	(0.099)	(0.105)	(0.112)	(0.209)	(0.229)	(0.235)	(0.127)	(0.135)	(0.131)	(0.139)	(0.151)	(0.143)	(0.151)	(0.156)	(0.610)	(0.652)
Firm size	0.348**	0.341**	0.321**	0.486**	0.440**	0.406**	0.462**	0.462**	0.357**	0.336**	0.323**	0.320**	0.309**	0.286**	0.535**	0.532**
	(0.020)	(0.021)	(0.024)	(0.044)	(0.046)	(0.050)	(0.023)	(0.024)	(0.023)	(0.025)	(0.026)	(0.023)	(0.024)	(0.026)	(0.079)	(0.081)
ROA	0.487	1.124	-1.090	-0.600	-1.256	-1.015	1.679*	-26.892+	1.229+	1.438+	0.035	2.007**	3.097**	-0.514	-173.560	-172.588
	(0.682)	(0.794)	(2.327)	(6.090)	(9.020)	(7.596)	(0.797)	(15.469)	(0.665)	(0.742)	(1.955)	(0.598)	(0.935)	(1.837)	(112.017)	(121.727)
Tobin's Q	0.010*	0.010**	0.013**	0.018**	0.020**	0.021**	0.001	0.002	0.017**	0.009+	0.018**	0.030**	0.032**	0.028**	-0.049	0.004
	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.005)	(0.005)	(0.006)	(0.004)	(0.004)	(0.004)	(0.045)	(0.038)
Institutional ownership	0.033**	0.028**	0.022**	0.025**	0.016**	0.017**	0.023**	0.024**	0.019**	0.018**	0.013**	0.044**	0.039**	0.033**	0.032*	0.045**
	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.014)	(0.016)
CEO Vega	0.031	0.045+	0.071+	0.074+	0.039	0.059	0.054*	0.060*	0.053	0.039	0.044	0.006	0.017	0.054	0.069	0.025
	(0.022)	(0.024)	(0.030)	(0.042)	(0.052)	(0.061)	(0.025)	(0.027)	(0.035)	(0.038)	(0.043)	(0.031)	(0.035)	(0.043)	(0.077)	(0.115)
CEO age	-0.029+	-0.009	-0.008	0.006	0.029	0.007	-0.041*	-0.019	0.023	-0.015	-0.002	0.003	0.001	-0.037	0.041	-0.007
	(0.016)	(0.017)	(0.019)	(0.037)	(0.040)	(0.044)	(0.019)	(0.021)	(0.021)	(0.023)	(0.025)	(0.022)	(0.024)	(0.025)	(0.077)	(0.086)
CEO duality	-0.058+	-0.082*	-0.120**	0.040	0.067	0.085	-0.006	-0.031	-0.003	-0.010	-0.093+	-0.113*	-0.066	-0.083	0.168	0.184
	(0.035)	(0.036)	(0.039)	(0.083)	(0.089)	(0.096)	(0.043)	(0.045)	(0.046)	(0.049)	(0.053)	(0.050)	(0.053)	(0.058)	(0.178)	(0.195)
CEO tenure	-0.009**	-0.012**	-0.012**	-0.009	-0.012*	-0.008	-0.003	-0.007*	-0.009**	-0.009**	-0.008*	-0.012**	-0.012**	-0.009*	-0.011	-0.009
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)	(0.007)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)	(0.012)	(0.013)
CEO ownership	0.003	0.004	0.004	0.003	0.002	-0.004	-0.002	0.003	0.001	0.006	-0.001	-0.004	-0.006	-0.012**	0.007	-0.019
	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)	(0.008)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.017)	(0.020)
CEO liberalism	0.022	0.059	0.066	0.545**	0.558**	0.605**	-0.026	0.020	0.183*	0.068	0.087	0.102	0.112	0.084	1.051**	0.772*
	(0.058)	(0.062)	(0.069)	(0.142)	(0.153)	(0.170)	(0.069)	(0.075)	(0.074)	(0.081)	(0.089)	(0.071)	(0.077)	(0.083)	(0.289)	(0.300)
Constant	-1.049	-0.038	-1.584	0.806	-0.232	0.961	-0.471	-0.717	0.450	0.902	-0.432	-1.726*	-1.684+	-2.460*	-1.350	-22.457
	(0.702)	(1.019)	(1.153)	(1.114)	(1.279)	(1.266)	(0.773)	(0.815)	(0.665)	(0.704)	(0.969)	(0.707)	(0.876)	(1.161)	(2.167)	(30032.32)
Observations	4736	4262	3,797	4729	4250	3781	4729	4250	4729	4250	3781	4729	4250	3781	4250	3781
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Models including only control variables are not shown in this table.
Standard errors in parentheses (+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$)
1-Models with 1- and 2-year lags are reported.
2-Models with 2- and 3-year lags are reported.

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VITA

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