# Managerial political preferences and corporate innovation strategies


Jian Wang
School of Business Administration
Institute of Behavioral and Service Operations Management
Northeastern University
Shenyang 110167, China
Email: jwang@mail.neu.edu.cn

Yanhuang Huang
Institute of Behavioral and Service Operations Management
Northeastern University
Shenyang 110167, China
Email: 2010434@stu.neu.edu.cn

Yunbi An
Odette School of Business
University of Windsor
Windsor, Ontario, Canada N9B 3P4
Email: yunbi@uwindsor.ca

Hongrui Feng
Business Administration Division
Pepperdine University
Malibu, CA, 90263, USA
Email: Hongrui.Feng@pepperdine.edu



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## Abstract

This paper investigates the role of managerial personal political preferences in shaping firm innovation strategies. Using a text-based methodology, we classify firm innovations as less risky process innovations and more risky non-process innovations that focus on long-term value. We find that firms led by Republican-leaning managers tend to engage more in process innovations than non-process innovations. We further show that firms led by Republican-leaning managers invest less in tangible assets and employ less debt financing, thereby exhibiting a greater preference for process innovations. In addition, managerial discretion, including ideological homogeneity with the board and industry environmental uncertainty, enables Republican managers to better act on their own personal preferences, thus strengthening the relationship between managerial political ideology and process innovation. Furthermore, the relationship is stronger for firms in higher labor-cost industries, as well as for firms with greater analyst coverage, more transient institutional investors, longer managerial tenures, and higher managerial compensation.



Keywords: Top management team, political preference; innovation horizon; managerial conservatism; short-termism

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## 1. Introduction

Several studies document empirical evidence that the risk attitudes of managers influence corporate innovation within the agency framework, and conclude that innovation at the firm level is constrained by managerial conservatism (Duong et al., 2021; Hsu et al., 2017; Lu & Wang, 2018). Managerial conservatism is a "hidden, silent killer" that is very difficult to observe but can't be ignored when it comes to investment decisions, because managers have the power to decide whether to invest in routine projects or risky innovative projects. Innovation at the firm level is constrained by an agency problem that arises from the discrepant attitudes toward risk between the managers of a company and its shareholders. Within this framework, conservative managers tend to prefer projects with less volatile cash flows, fear losses, value financial and job security, and have greater aversion to ambiguity and uncertainty (Christensen et al., 2015; Chin et al., 2013; Hutton et al., 2014). Therefore, compared to non-conservative managers, conservative managers prioritize short-term success and have lower incentives to innovate, as innovation is generally a long-term, highly risky endeavor.

Prior literature used to directly test the relationship between managerial conservatism and innovation performance, focusing on the number of patents and citations (Guan et al., 2021; Laux & Ray, 2020; Lu & Wang 2018). However, not all innovations are at the same level of risk-taking. The term innovation has been conceptualized in various ways including the classic Schumpeterian view of innovation as creative destruction (Schumpeter, 1934) as well as recent conceptualizations as incremental vs. radical, explorative or exploitative (He & Wong, 2004; Jansen et al., 2006; Manso, 2011). Most recent literature on innovation and corporate governance classifies innovation as process and product (non-process) innovation (Adner & Levinthal, 2001; Akcigit & Kerr, 2018; Bena et al., 2022; Qiu et al., 2024). In general, process innovations are closely related to labor-saving production method (technology) inventions and designed with reduction of production costs in mind, while non-process or product innovation refers to new products or goods that did not exist before (Cohen & Klepper, 1996; Bena & Simintzi, 2019; Bena et al., 2022). As such, we can argue that process innovations are less risky and more likely to generate earnings in the short term, while non-process or new product claims are presumed to be riskier with payoffs likely to be longer-term and outcomes highly uncertain. It is expected that conservative managers may promote process innovation, while inhibiting non-process innovation, out of concerns of short-term performance and corporate risk. There is a lack of understanding of the innovation strategies adopted by firms with conservative managers, due to their risk-taking tendencies and career concerns.

In most previous studies, conservatism is viewed as an exogenous variable. Some recent studies examine the drivers of managerial conservatism, documenting risk-taking propensity of managers from the perspectives of personal characteristics such as overconfident, tenure and age, board independence, and auditor monitoring, among others, from the upper echelon perspective (Bantel & Jackson, 1989; Coles et al., 2006; Hirshleifer et al., 2012; Liu et al., 2012; Cain & Mckeon, 2016; Lu & Wang, 2018). A growing body of literature sheds light on political orientation as a unique proxy of executives' personal conservatism, documenting how managers' personal political orientation influences firm strategic decision making (Hong & Kostovetsky, 2012; Chin et al., 2013; Hutton et al., 2014; Christensen et al., 2015). Political orientation, representing an ex ante measure of an executive's attitude toward risk, may be cleaner than other demographic proxies, such as age and tenure, and may also help assess an executive's propensity for undertaking risk before they are hired.

Many studies identify political ideology along the liberal-conservative or left-right continuum, and argue that individuals with Republicanism orientation are more conservative in financial policies, more risk-averse in capital investment, and pursue near-term earnings. For example, Hutton et al. (2014) document that Republican managers are likely to choose smaller and safer bets, which are associated with lower levels of investment in tangible assets and R&D. Christensen et al. (2015) demonstrate that firms with top executives leaning toward the Republican Party actually engage in less tax avoidance than firms with executives leaning toward the Democratic Party. Elnahas & Kim (2017) find that Republican CEOs are less likely to engage in merge and acquisition (M&A) due to high information asymmetry in M&A activities. Collectively, political ideology can act as an intrinsic motivation of encouraging managerial conservatism, and further influence firm strategies making. However, little efforts in prior research are devoted to the effects of managerial political preference on the direction and mode of innovation.

Based on the upper echelons perspective (Hambrick & Mason, 1984) with the behavioral agency theory (Pepper & Gore, 2015; Wiseman & Gomez-Mejia, 1998), this paper aims to investigate the effects of managerial political preference on firms' innovation strategies with different implications for firm short-term performance and corporate risk. From the perspectives of risk aversion and short-termism, we further investigate the role of conservative managers' investment and financing behaviors in explaining their decision-making about innovation strategies. We also intend to understand how managerial discretion, such as ideological homogeneity between boards and managers as well as industry environmental uncertainty, enable managers to better act on their own personal preferences, thus influencing the relationship between managerial political ideology and process innovation.

We follow Bena and Simintzi (2019) and Bena et al. (2022) to identify process and non-process innovations. Specifically, we extract the information that can distinguish process innovation from non-process innovation from the texts of patent grants, relying on the critical defining "book" and the list of specific "claims", which define the subject matter protected by a patent and the scope of protection conferred in technical terms. We measure a firm's patented process innovation output based on the ratios of the claim number contained in process patents filed by each firm in a given year to the total claims and citation-weighted counts of process patents to the total patent numbers to account for patent quality.[1]

To measure the political preference of a firm's top management team (hereafter TMT), we consider top five compensated executives as a whole. This is because

[1] Citations are for entire patents and not for individual claims; thus, we follow Bena et al., (2022) to define process and non-process patents. See Section 3 for details.

upper echelons scholars suggest that organizational outcomes can be better understood when TMT members are considered together (Chin et al., 2013; Hutton et al., 2014). Firstly, we examine individual donations to the two major parties (republican and democratic) in the US relying on political contribution data from the Federal Election Commission (FEC). Secondly, we calculate a cycle-specific political orientation measure during a 2-year election cycle and use the mean of all election cycles to mitigate strategic donation timing effect (Lee et al., 2014; Christensen et al., 2015). Finally, we calculate TMT republicanism by assigning weights that vary inversely with executive salary ranks.

Our main results show that firms led by Republican top managers tend to have more process claims and citation-weighted process patents,[2] indicating that the conservative political preference of TMT enhances firm process innovation output. Thus, there is evidence that conservative top managers engage in less risky investment and pursue short-term profitability, leading to more firm process innovations that are safer and can generate short-term profits. We include the three-year lagged innovation variable in our baseline model and still find a positive relation between TMT republicanism and process innovation. We re-estimate the model using the instrument variable method with TMT turnover as an exogenous shock as well as the difference-in-differences method, and confirm that the results are qualitatively the same as the baseline results.

We then test the mechanisms and moderators of the relationship between

[2] As a robustness check, we also use non-process claim number and citation-weighted non-process patent as our main dependent variable, and the coefficient of TMT republicanism is not statistically significant.

managerial political preference and process innovation. Managerial conservatism leads to conservative investment and capital structures, which in turn impact their innovation strategy decisions. First, Republican-oriented managers are prone to cut long-term risky investment to meet short-term performance targets at the expense of long-term fundamental values (Porter, 1992; Gopalan et al., 2014; Hutton et al., 2014; Edmans et al., 2017). It is challenging for firms with less tangible asset investment to increase productivity and issue contract guarantees for external capital, which leads such companies to prefer process innovation that can improve productivity and achieve short-term success (Elnahas et al., 2023; Hutton et al., 2014). Second, firms led by more conservative managers adopt lower levels of corporate debt, and thus face strict financial constraints (Lu & Wang, 2018; Thadden, 1995). Debt and equity financing have different implications for corporate risk, profitability, and growth, and thus the choice of the financing strategy is likely to have an influence over the management's decision to invest in different innovation projects with various levels of risk (Hirshleifer & Thakor, 1992). Firms with Republican-oriented managers are highly risk averse, and tend to engage more in process innovations with lower risk and soft budget constraints (Atanassov, 2015; Borisova & Brown, 2013).

However, it is well known that executives do not always have complete latitude of action (Lieberson & O'Connor, 1972; Hannan & Freeman, 1977). Under conditions of restricted managerial discretion, personal values may become less important, and environmental and organizational factors become more significant in influencing strategy making and firm performance (Finkelstein & Hambrick, 1990). We consider the moderating role of two types of managerial discretion: individual discretion and environmental discretion. Specifically, the two types of managerial discretion cover sources of discretion at both the firm and industry levels. Individual discretion emphasizes the “amplifying influence” of ideology homogeneity, and the latter represents the latitude of individual action under specific industrial conditions. We also employ a set of other cross-sectional analyses based on industry-level, firm-level and individual characteristics, such as the industrial labor cost, institutional shareholders, and TMT tenure and compensation, to further test the relationship between the top management team ideology and firm innovation strategy. We show that the effects of managerial conservatism on process innovations are particularly pronounced for firms with higher industrial labor-costs, higher analyst coverage levels, more transient institutional investors, as well as longer TMT tenure and higher salary compensation.

This paper makes two important contributions to prior literature. First, we contribute to the literature on managerial political preference and managerial decision-making by providing greater granularity into the type of innovation led by different political leaning top executives. Previous studies have focused more on the impact of political preferences on other corporate decision-makings, such as social governance, tax avoidance, dividend payouts, as well as merger and acquisitions, among others (Bhandari & Golden, 2021; Elnahas & Kim, 2017; Gupta et al., 2021). More specifically, some research focuses on the influence of CEO political ideology on R&D expenditure. The basic idea is that the Republican-leaning managers will choose more conservative financial policies and avoid taking risky investments, so they will cut R&D spending (Christensen et al., 2015; Hutton et al., 2014). A more general chain based on this idea is to study the hindering effect of managerial conservatism on innovation performance (Houston & Karim, 2021; Lu & Wang, 2018; Zhang, 2024). Our study extends this growing line of research on the consequences of managerial ideological beliefs by demonstrating that such beliefs can shape firms' innovation strategies.

Second, our paper also contributes to prior literature on managerial conservatism and firm innovation. We incorporate managerial political ideology into the research framework, showing that it is an endogenous driver of managerial conservatism, thereby serving as a critical determinant of a firm's innovation trajectory. While many studies are conducted to improve our understanding of the factors underlying different innovation strategies, such as the determinants of corporate choice between exploratory and exploitative innovation strategies, mostly neglect the behavioral and psychological determinants (Cohen & Levinthal, 1994; Lavie et al., 2010; McGrath, 2001; Wilden et al., 2018). Only a few studies have examined the relationship between CEO-related antecedents of breakthroughs and innovation strategies (Lee et al., 2014). We advance this literature stream by showing that the innovation endeavors of firms led by Republican-oriented managers are more likely to exploit existing technological domains and incrementally improving and refining current technologies, thus fostering process innovations (Bena et al., 2017; Bena et al., 2022). These results complement findings in prior research that Republican-oriented CEOs are more conservative and establish more certain and less risky policies (Chin et al., 2013;

Unsal et al., 2016; Gupta et al., 2019; Elnahas et al., 2023).

The rest of this paper is structured as follows. Section 2 contains literature review and hypothesis development. Section 3 discusses data, variables and research methodology. Section 4 provides the main results, mechanism analyses, and managerial discretion moderating effects. Section 5 presents additional heterogeneity tests based on other firm-level or TMT-level measures. Section 6 concludes this paper.

## 2. Literature Review and Hypotheses Development

Process innovation pertains to the development of new and improved methods or techniques in a firm's production process of manufacturing or delivering existing goods that lead to increased efficiency, productivity, and cost savings (Autor & Dorn, 2013; Eswaran & Gallini, 1996; Scherer, 1982). Prior literature documents that improvements in production methods can be achieved in a relatively short period of time. As noted by Bena et al. (2022), firms can fully take advantage of a higher capital-labor ratio only if they are able to use new production methods that are appropriate for that capital-labor ratio to facilitate production. In contrast, non-process innovation or product innovation generally refers to inventions sold to others, such as new or improved products that the firm aims to sell to either final consumers or other firms. The investment in new product development leads to lower net income and cash flows in the near term as the expenses related to the development are not matched with revenues until later time periods. As a result, while investment in product innovation can help promote firm growth in the long term, it may lead to lower returns in the near term. At the same time, such investment involves high risk of product innovation failure (Aghion et al., 2013; Cohen & Klepper, 1996; Rosenkranz, 2003). Whether to invest in process innovation or product innovation represents a strategic decision of a company. This decision is not only influenced by the firm's internal labor employment, corporate governance or changes in production methods, but also by external factors such as labor market frictions, stakeholders, and institutional ownership (Porter, 1992; Matsumoto, 2002).

Hambrick and Mason's (1984) upper echelons theory asserts that executives inject their experiences and personalities into their strategic decision making, because these observable characteristics of top executives are proxies for their underlying cognitive frames or values. Recent literature focuses more on a unique proxy of executive risk aversion: executives' personal political preferences, and further explains how they influence firm outcomes. Most recent research adopts the liberalism–conservatism spectrum based on personal political donations data to array political ideologies (Jost, Federico, and Napier, 2009; Gupta et al., 2017; Gupta et al., 2018). It is noteworthy that the Republican platform tends to attract more conservative individuals based on the philosophical differences between the major political parties in the US (Hutton et al., 2014; Chin et al., 2021; Gupta et al., 2021). This is consistent with trends shown in the political science literature, which suggest that more conservative people have increasingly been aligning themselves with the Republican Party (Layman et al., 2006; Francis et al., 2016; Barber & Pope, 2019). Thus, political orientation may be an indicator of underlying differences in executive conservatism. Furthermore, considerable research suggests that ideologies tend to be highly stable over time and more or less solidified by adulthood (Chin et al., 2013; Christensen et al., 2015; Chin & Semadeni, 2017; Gupta & Wowak, 2017). Compared to other demographic characteristics, political orientation represents an ex-ante measure of an executive's attitude toward strategic making and may also help assess an executive's propensity for undertaking risk and pursuing long-term profit before they are hired.

Conservative top executives exhibit a risk-aversion attitude and managerial myopia (Abramowitz & Saunders, 2006; Chin et al., 2013; Christensen et al., 2015), and thus act more cautiously in establishing their firm's investing strategies and pursue more near-term outcomes. Political conservatives tend to fear losses, value financial and job security, and have greater aversion to ambiguity and uncertainty than those who are less politically conservative (Elnahas et al., 2023; Hong & Kostovetsky, 2012; Hutton et al., 2014). Accordingly, Republican-leaning managers are likely to favor actions that will lead to higher near-term income and cash flows, potentially through cost take-outs. Given their time horizon, conservative top executives might be more in favor of management contracts that reward short-term performance and thus engage in more process innovative activities.

Since Republican-leaning executives appear to be more conservative when it comes to corporate policies, the behavioral consistency theory, which asserts that individuals tend to behave consistently across situations (Cronqvist et al., 2012; Funder & Colvin, 1991), suggests that this conservatism should also spill over into their firm's innovation activities. Process innovation is potentially less risky than non-process innovation. The near-term and less risky actions undertaken by conservative managers may lead to patent filings and citations that are in line with process innovation. Thus, we conclude that conservative managers tend to adopt less risky corporate policies and maintain a higher level of near-term firm performance, thereby facilitating production methods (Bena & Simintzi, 2019; Manso, 2011). Firms with less risky corporate policies provide relatively stable cash flows and earnings growth, exhibiting higher levels of process innovation relative to non-process innovation. We propose Hypothesis H1 as follows:

H1: All else equal, firms led by top managers who are more Republican-leaning (Democratic-leaning) exhibit a shorter (longer) innovation horizon, and thereby engage more in process innovations than non-process innovations.

We then explore the channels through which Republican managers shape firm innovation horizon. Indeed, a firm's long-term investments (e.g. plant, machinery, transportation equipment, instruments and tools, land, and inventories) relate to its business sustainability. Short-term investment is valuable due to several advantages, such as creating additional revenue and emergency cash reserves, offsetting inflation, diversifying an investment portfolio, and raising flexibility and liquidity in a firm's cash flow (Chen & Chen, 2012; Mulier et al., 2016; Gao et al., 2018). In fact, different investment directions may influence the horizon of innovation policies to a certain extent. Compared to firms led by Democratic-oriented managers, firms led by Republican-oriented managers emphasize short-term investments, because

Republican-oriented managers are more willing to cut long-term risky investment to meet short-term performance targets at the expense of long-term fundamental values (Porter, 1992; Gopalan et al., 2014; Hutton et al., 2014; Edmans et al., 2017). These discussions, together with the fact that process innovation results in short-run earnings (Levinthal & March, 1993; Bena et al., 2022), lead to our first channel hypothesis based on the investment horizon.

Tangible investment such as spending on plants, machines, equipment, which is a typical proxy of long-term investment, is aimed at the expansion of production capacity but is also costly, especially for fixed capital investment that is not easily reversible. Prior research shows that due to the risks associated with capital investments, all else being equal, Republican-leaning managers will choose more safer investments instead of investing in tangible assets (Hong & Kostovetsky, 2012; Hutton et al., 2014; Rice, 2024). On the other hand, compared to investment in financial assets, investment in tangible assets has higher uncertainty and typically takes longer to generate payoffs, which, in the short run, may hurt profitability (Brown & Huang, 2020; Elnahas & Kim, 2017; Giuli & Kostovetsky, 2014). However, the low level of tangible asset investments of firms led by Republican-oriented managers inhibits production scale from expanding. Collectively, conservative managers are more prone to engage in process innovations to raise the marginal productivity of existing physical capital, improve cost efficiency, and compensate for the output decreasing caused by the reduction of production equipment.

Furthermore, Almeida and Campello (2007) note that asset tangibility increases a firm's ability to obtain financing support, because physical assets can reduce contracting problems between firms and the external capital providers. Firms led by Republican-oriented managers have fewer tangible assets, insufficient contract guarantees, and less tolerance for risk-taking, and thereby are more inclined to choose process innovations with a higher likelihood of short-term success. On the other hand, tangible investment by the firm is required for the commercialization of new products generated by the product innovation activities (Wyatt, 2005; Borisova & Brown, 2013; Lim et al., 2020). Therefore, a low level of investment in tangible assets will also reduce the motivation for product innovations. We thus propose the following hypothesis:

H2a: All else equal, firms led by top managers who are more Republican-leaning (Democratic-leaning) invest less in tangible assets, exhibiting a greater preference for process innovations relative to non-process innovations (tangible assets channel).

A growing body of work focuses on the role of debt financing in corporate innovation (Chava et al., 2013; Atanassov, 2015; Geelen et al., 2022). Corporate innovation requires massive investments in research and development (R&D) and human capital, among others. The way this investment is financed remains an important topic of research among scholars in the field of corporate finance and corporate innovation (Chang et al., 2019; Hall and Lerner, 2010). Financing choices are broadly classified into debt and equity financing. Because debt and equity have different implications for corporate risk, profitability, and growth, the choice of the financing strategy is likely to have an influence over the management's decision to invest in different innovation projects with various degrees of risk (Hirshleifer & Thakor, 1992). Given the fiscal conservatism of Republican managers documented in the literature, firms led by more conservative managers adopt lower levels of corporate debt, and thus face more financial constraints (Hutton et al., 2014; Lu & Wang, 2018; Elnahas et al., 2023).

Prior research on the effects of financial resources on innovation or innovation technology types argues that budget constraints will inhibit long-term innovation strategies (Boyabatlı et al., 2016; Kornai, 1986; Kornai et al., 2003). Strong financial commitment is required for the long-term production process and commercialization of new products generated by the product innovation activities (Lach and Rob 1996). Product innovations require larger investment costs and higher financial flexibility to protect them from uncertainty associated with innovative activities and foster the culture of experimentation (Nohria & Gulati, 1996). Therefore, firms with stringent financial constraints will choose less product innovation strategies as response to the tighter capital budget, and more inclined toward process innovation due to its soft budget constraints and lower costs (Levinthal & March, 1993). Therefore, we propose the following hypothesis:

H2b: All else equal, firms led by Republican-oriented (Democratic-leaning) managers employ less debt financing, thus engaging more in process innovation projects relative to non-process innovation projects (debt financing channel).

The effects of personal political ideology on firm financial decision making can vary, depending on the level of managerial discretion in firms. Prior political ideology-related literature documents the moderating role of managerial discretion, a pivotal moderator of upper echelons predictions (Finkelstein & Hambrick, 1990). Managerial discretion exists when there is an absence of constraint and when there is a great deal of means-ends ambiguity, and emanates from environmental conditions (e.g., industry growth), from organizational factors (e.g., a weak board), and from the executive himself or herself (e.g., tolerance for ambiguity) (Finkelstein and Hambrick, 1990). The higher managerial discretion, the better TMT political preference manifests in the organizational outcomes. The individual discretion represents the latitude of objectives, and environmental (industrial) discretion represents the latitude of action (Finkelstein & Hambrick, 1990).

For individual discretion, we consider board of director's ideology. The board fulfills a fiduciary responsibility in approving major decisions, certifying financial results, and monitors and advises TMT decisions (Boivie et al., 2016). Thus, the relationship between TMT ideology and firm decision making may be influenced by the board political preference. Isomorphic pressure in a firm's environment restricts the discretion of its managers, and the less the isomorphic pressure on firms, the greater the managerial discretion (Hambrick, et al., 1996). We thus expect that political preference orientation homogeneity between TMT and board strengthens the association between TMT political preference and firm process innovation, and propose the following hypothesis:

H3a: Ceteris paribus, the positive relation between Republican managers and process innovation is more pronounced in firms with homogeneity between TMT and board political preference.

The contextual conditions can also affect the incorporation of TMTs' values into their decision-making. To understand this, we examine the environment at the industry level, focusing on industrial stability and change. Following the managerial discretion framework proposed by Finkelstein and Hambrick (1990), we expect that the effect of TMT political preference on firms' innovation horizon varies depending upon the industrial environment. In some early work, industries described as highly uncertain are believed to afford executives greater discretion, which in turn moderates TMT political preference effects (Finkelstein & Hambrick, 1990; Doan & Iskandar-Datta, 2020). We can use another moderator of upper echelons predictions, executive job demands, to interpret environmental discretion as well (Arnold & Tafkov, 2019; Griffin et al., 2021). Executives face strong task challenges when the firm is in a more competitive, uncertain, and turbulent industrial environment. The heavy job demands will force managers to take mental shortcuts and fall back on what they have tried or seen work in the past; thus, their choices will reflect their backgrounds and ideologies (Lawrence and Lorsch, 1967; Henderson and Fredrickson, 1996). We thus conjecture that the higher the industry uncertainties or the greater executive job demands, the stronger the relationship between executive characteristics and strategic choices. Therefore, we propose the following hypothesis:

H3b: Ceteris paribus, the positive relation between Republican managers and process innovation is more pronounced in firms belonging to highly competitive industries.

## 3. Data, Variables, and Methodology

### 3.1 Data and Sample

Our sample spans the period from 1992 to 2021, covering 54,764 firm-year observations based on 1,923 publicly traded S&P 1500 firms headquartered in the US that filed at least one patent with the United States Patent and Trademark Office (USPTO) during this period. This sample is used because it contains a wide range of industries with large firms that exhibit substantial variations in the strategies they pursue. Further, large firms tend to be more innovative because of their capacities and resources to invest in innovation. We also require a firm to be traded on NYSE, Amex, or NASDAQ for at least six months in a fiscal year (Fang, Noe, and Tice, 2009). We exclude financial firms (SIC 6000-6999) and utility firms (SIC 4900-4999), following Hutton et al. (2014). Our sample is constructed from several databases. Stock returns and other financial data are from CRSP and Compustat database. The patent claim citation-related data are from KPSS patent database. The data on board of directors are obtained from Boardex and ISS (formerly RiskMetricks) database. The data on institutional shareholdings and turnovers are obtained from the Thomson Reuters CDA/Spectrum database (13F). We winsorize all continuous variables at the 1% and 99% levels to ensure that the regression estimates are not driven by outliers.

### 3.2 Firm Level Process vs. Non-Process Innovation

Following Bena and Simintzi (2019), we first distinguish between process claims and non-process claims based on the full texts of all utility patents awarded by the USPTO to US and international companies, individuals, and other institutions from 1976 to December 2021. The patent texts are parsed to extract the list of patent claims. The legalistic and stilted language used in the drafting of patent claims allows us to accurately distinguish process from non-process claims. For example, process claims always refer to “A method for …” or “A process for …”. We then parse the structured texts of patent grants to identify the section that contains patent claims, and use textual analysis to calculate the measure of process innovation.

Specifically, we use the same bigram lexicon of process claim words as Bena et al. (2022) and measure process innovation using inverse hyperbolic sine of the number of process claims. First, we compute a firm’s process claims by summing the number of process claims contained in all of its patents filed in each year. Similarly, we compute a firm’s non-process claims by summing the number of non-process claims contained in all of its patents filed in each year. We set both variables to zero for firm-year observations with no patents.

Second, we use the number of citations received by each patent to account for the differences in the quality of patents. This measure captures the firm-specific efforts toward process innovation. Since there are no claim-level indicators of quality, we follow Bena et al., (2022) to ensure a clear distinction between process and non-process innovations. Specifically, we focus on patents that contain only process claims (*Process_Patents*) or only non-process claims (*Non-Process_Patents*), but not both. Process patents and non-process patents account for 67.9% of all patents in our data. *C-W_Process_Patents* represents the citations-weighted number of process patents and *C-W_Non-Process_Patents* represents the citations-weighted number of non-process patents filed by a firm in a year (Note that this measure is only conditional on the firm-year observations where a firm has filed at least one patent application). We set both measures to zero for firm-years with no process or no non-process patents.

The dependent variables are *Process_C* (Log(1 + *Process_Patents*)), *Product_C* (Log(1 + *Non-Process_Patents*)), *Process_P* (Log(1 + *C-W_Process_Patents*)), and *Product_P* (Log(1 + *C-W_Non-Process_Patents*)), respectively. To examine process innovation relative to non-process innovation, we also consider ratio variables, *Ratio_C*, defined as the share of process claims in a firm's total number of (process and non-process) claims in each year, and *Ratio_P*, defined as the share of citation-weighted process patents in a firm's total number of citation-weighted (process and non-process) patents in each year.

**3.3 TMT Political Preference**

To assess TMT ideology, we need reliable data on the political ideologies of the individual top managers serving on the TMTs in our S&P 1500 sample firms. We focus on the top five compensated executives from ExecuComp database, given that this method has been accepted as a relevant and meaningful way of identifying TMT members (Carpenter et al., 2004; Bloom et al., 2007; Fredrickson et al., 2010; Hutton, Jiang, and Kumar, 2014). Following prior research, we measure individual ideology by examining his or her donations to the two major parties (Republican and Democratic) in the US (Chin et al., 2013; Hutton et al., 2014; Christensen et al., 2015). We source the political contribution data from the Federal Election Commission (FEC), providing information on both the donation itself (amount, date, recipient name, and recipient party) and the donor (name, address, occupation, employer, and job title), where we can get donations of more than $200 to Republican- and Democratic-affiliated Senate, House, and presidential candidates, and party committees in political campaigns covering the 1992-2021 period.[3] We use direct personal contributions to candidates or party committees rather than the ones through their own company political action committees (PACs), because company PACs usually contribute simultaneously to multiple parties (Cooper, Gulen, and Ovtchinnikov, 2010; Hutton, Jiang, and Kumar, 2014). In fact, we find 92% of PACs contribute to multiple parties. This helps us to more accurately identify the political preference of managers. We use the occupation, name and address to link managers from ExecuComp and donors from FEC. We finally find 126,479 eligible political donations made by 7,662 top managers in our sample.

We then construct our measure of TMT conservatism. Prior research argues and empirically validates that nondonors tend to be ideologically neutral (Rosenstone & Hansen, 1992; Chin et al., 2013). Thus, top managers with no donation records (around 30% of those in our sample) are classified as moderate and assigned a score

[3] https://www.fec.gov/data/browse-data/?tab=bulk-data#bulk-data.

of 0.[4] We first compute a cycle-specific political orientation measure as the difference between his or her contributions to the Republican Party and the Democratic Party divided by the total contributions to both parties during a 2-year election cycle (Lee et al., 2014; Christensen et al., 2015), which is bounded between -1 (strong Democratic) and +1 (strong Republican).[5] We use the mean of all election cycles to identify the political preferences to mitigate the strategic donation timing effect on political ideology,[6] consistent with Hong and Kostovetsky (2012), Hutton, Jiang, and Kumar (2014), and Giuli & Kostovetsky (2014). We treat managerial conservatism as time-invariant, consistent with political psychology research's finding that political ideology remains stable once individuals reach adulthood. The stability of ideology is also evidenced by recent studies showing that executives' political contributions, and specifically the ideological orientations of their contributions, are highly consistent over time (Chin et al., 2013; Hutton et al., 2014; Christensen et al., 2015).

Because we perform our tests at the firm level, we take our measure of political orientation for each executive and aggregate it to the firm level each year. Although each executive's measure of political orientation remains constant during the sample period, this firm-level political orientation variable varies over time as TMT

[4] Our results hold if we exclude nondonor managers from our sample.

[5] As a robustness check, we re-run the analyses using a dummy variable that takes on a value of one when executives are net contributors to the Republican Party (Hong and Kostovetsky, 2012; Hutton et al., 2014) and find generally similar results.

[6] If we simply use donations during the whole sample period to calculate a time-invariant political ideology measure, there may exist some potential timing effects. Specifically, an individual who made a large opportunistic donation to the Republican (Democratic) Party in one election cycle, but made a series of small donations to the Democratic (Republican) Party in all other election cycles, is classified as a Republican (Democratic). The cycle-average measure of political ideology is less likely to be affected by a large opportunistic donation made in a single election cycle and, therefore, is less subject to concerns related to strategic donation timing.

composition in the firm changes. Following Hutton et al. (2014) and Christensen et al. (2015), the weight assigned to each executive varies inversely with his/her salary rank. Specifically, the highest paid executive gets assigned a weight of 1 (usually the CEO), the second highest gets a weight of 1/2 (usually the CFO), the third highest gets a weight of 1/3, and so forth.[7] The final TMT conservatism variable, $TMT\_REP_{k,t}$, is calculated as follows:

$$TMT\_REP_{k,t} = \sum 0.5^{Rank_{c,k,t}-1} w_{c,k,t}, \tag{1}$$

where $Rank_{c,k,t}$ and $w_{c,k,t}$ represent the pay rank and the political preference of individual managers, respectively, of firm $k$ in quarter $t$. $REP_{k,t}$ is aggregated firm level Republican indices.

### 3.4 Control Variables

Following prior literature, we control for a set of firm and industry characteristics (measured in date $t$-1) that are likely to affect firms' process innovation (Aghion et al., 2013; Chin & Semadeni, 2017; Gupta et al, 2019; Bena et al., 2022). At the firm level, we control for firm age, defined as the natural logarithm of the number of years a firm has existed in Compustat (*Log(Age)*); firm size, defined as the natural logarithm of the total assets (*Log(AT)*); *ROA*, defined as annual return on assets; *R&D*, defined as the R&D expenses scaled by total assets; *MTB*, market-to-book ratio, defined as the firm's market value of assets scaled by the book value of total assets; *Capex*, defined as capital expenditures scaled by total assets. In

[7] The results are also robust with regard to the equal-weighted assigning among TMT members when calculating TMT ideology value.

addition, Aghion et al. (2005) argue that product market competition affects innovation and that the effect may be nonlinear. We control for the effect of industry concentration, measured by the *HHI* (Herfindahl-Hirschman Index), which is calculated as the sum of sales revenue scaled by sales for four-digit standard industrial classification (SIC) code. $HHI^2$ is the square of *HHI*. Detailed definitions of all the variables used in our analysis are provided in the Appendix.

At TMT level, we control for *TMT_own* (TMT stock ownership, calculated as the percentage of shares held by TMT members), and *TMT_size* (number of TMT members). At the board level, we control for *Dir_own* (director stock ownership, calculated as the percentage of shares held by independent directors) and *Board_size*, measured as the total number of directors. Following Cooper, Gulen, and Ovtchinnikov (2010), we also classify firms as leaning toward the Democratic Party or Republican Party, based on which party's PACs they contribute more money to. We include *PAC*, which is a binary variable with a value of 1 when the firm contributes more money to Republican than Democratic for the most recent election cycle, and 0 otherwise (Hutton et al., 2014).[8]

**3.5 Methodology**

To test Hypothesis 1, we run the following panel regression model:

[8] We also directly use the same method to construct TMT political ideology following Christensen et al. (2015), for the most recent election cycle. We get similar results. Using corporate PAC contribution records (drawn from opensecrets.org), we construct an alternative continuous variable to reflect the firm's PAC orientation, similar to Chin et al. (2013). Specifically, the four-item donation-based index, PAC Republican orientation, ranges from zero to one; we assigned a score of 0.5 to those companies that had no records of PAC contributions. The last alternative measure used to represent firm political connections through PAC is a binary variable that takes the value of one if the company runs political action committees (PACs), and zero otherwise. When we use these two alternative PACs, the results are similar to our baseline results.

$$y_{i,t} = \alpha + \beta TMT\_REP_{i,t-1} + \gamma X_{i,t-1} + Year\ FE + Firm\ FE + Industry\ Firm + \varepsilon_{i,t}. \quad (2)$$

The dependent variable is one of the variables *Process_C*, *Product_C*, *Process_P*, and *Product_P*, *Ratio_C*, and *Ratio_P*. The independent variable is *TMT_REP*, and the vector $X$ includes a set of lagged control variables. Firm FE/Industry FE is firm/industry fixed effects, which controls for time-invariant firm characteristics or industry fixed effects (based on 4-digit SIC), and the models also include time fixed effects (Year FE). In all regressions, standard errors are clustered by firms.

## 4. Empirical Results

### 4.1 Descriptive Statistics

The summary statistics of all main variables are reported in Table 1. The full sample has 54,764 firm-year observations. The mean of the TMT political preference measure (*TMT_REP*) is 0.499, indicating that the TMTs in our sample are more Republican leaning. The means of process claim number and C-W process patent number are 1.417 and 0.532, respectively; while the means of non-process claim number and C-W non-process patent number are 1.794 and 1.106, respectively, which are consistent with prior studies (Bena et al., 2022). For the average firm in our sample, the share of process claims in total claims is 26.8% over the entire sample period, and the mean of process share in C-W patents is 20.7%. In addition, the statistics of all control variables are similar to the findings in prior literature.

Table 2 shows the correlations of the variables. The share of process patents and citation-weighted patents are observations at time *t*+1 while all other variables are observations at time *t*. The correlation coefficient between *TMT_REP* and *Ratio_C* (*Ratio_P*) is 0.544 (0.627), which is significantly positive at the 1% level. These results are consistent with Hypothesis 1 that firms with Republican managers engage more in process innovations than non-process innovations. The correlations of *TMT_REP* with other firm level financial measures are all significant at the 1% level, which means that TMT republicanism may influence firm capital structure through different investment policies and corporate governance. The correlations between the share of process innovation and other control variables are also statistically significant, which means that both factors in the firm level and TMT level influence firm process innovations.

**4.2 Effects of TMT political preference on process and non-process innovation**

We estimate the panel regression of Equation (2) and report the estimation results in Table 3. Untabulated statistics show that the mean Variance Inflation Factor (VIF) is below 2, suggesting that multicollinearity is not an issue in our setting. The results in columns (1) and (2) show that the coefficients on *TMT_REP* are both significant, indicating that firms with more conservative top managers have higher process claims and C-W process patents outputs. The positive relation is not only statistically significant, but also economically significant. A one standard deviation increase in *TMT_REP* increases process claim numbers by 0.011 or about 0.79%, and increases citation-weighted process patents by 0.009 or about 1.59%. The coefficients of *TMT_REP* in columns (3) and (4) are both insignificantly negative; thus, there is evidence that TMT conservative preference can inhibit firm long-term innovation horizons.[9] We conclude that firms led by more Republican-leaning top managers are prone to engage process innovations relative to product innovations.

We further estimate the effect of the TMT republicanism on the share of process innovation in total innovation, conditional on the firm filing patents in a given year. These results speak to the "intensive margin", namely they provide evidence on whether firms led by Republican-oriented managers shift their innovation efforts towards more process innovation. In columns (5) and (6), we respectively use the share of process claims in a firm's total number of claims (*Ratio_C*) and the share of citation-weighted process patents in a firm's total number of citation-weighted patents (*Ratio_P*) as the dependent variable. We find that firms led by Republican-leaning managers manifest higher level of *Ratio_C* and *Ratio_P*, as the coefficients of *TMT_REP* are both significantly positive. The results are economically important: the share of process claims and C-W process patents increase 10.5 percentage points and 29.9 percentage points depending on the regression, which are 9.52 % and 35.1% of the respective sample mean of dependent variables. Collectively, our findings support Hypothesis 1 that firms led by top managers who are more Republican-leaning (Democratic-leaning) will exhibit a shorter (longer) innovation horizon or a higher (lower) level of process innovation relative to non-process innovation, confirming that conservative managers tend to engage in less risky and near-term profitable innovation activities.

The coefficients on control variables in Table 3 are largely consistent with

[9] We get the similar results to those in Table 3 when we include industries and year fixed effects in our models.

previous findings in the literature. Larger firms have less process claims and less process patent citations. Industry concentration has no significant impacts on process innovation, once firm fixed effects are included. Firm age is positively related to process innovation, implying that younger firms tend to have relatively more process innovations. Intuitively, directors are more tolerant of innovative and risky projects, and thus less likely to monitor managers engaging more process innovations. *ROA* and *MTB* are positively related to the number of process patent claims, and unrelated to citation-weighted process patent counts, while firms with more working capital have less process innovations. To save space, in the following analysis, we focus on the results of regressions with *Ratio_C* or *Ratio_P* as the dependent variable, and do not report the results of the regressions with *Process_C*, *Product_C*, *Process_P*, or *Product_P* as the independent variable.

### 4.3 Robustness Checks

To test the robustness of our results, we re-estimate the regressions with alternative measures of process claims and process patent citations. We first use *Cit_per,* the average citations per patent (rather than total citations) for each firm-year that measures the average importance of patents as an alternative dependent variable. Second, we construct an alternative innovation measure as the number of process patent claims for each firm-year divided by the mean number of patent claims for the same year ($Claim^{time}$). This weighting adjustment corrects for the truncation bias in patent grants. Patents have on average a 2-year lag from the time a patent application is submitted until the time it is granted. Therefore, some patents that have already been applied for may not yet appear in the sample. Patent citations, however, also suffer from truncation bias, because patent citations are received for many years after the patent is granted. Thus, we construct the other proxy, *citation*$^{time}$, similar to *Claim*$^{time}$. Another potential concern is that different industries might have different propensities to cite patents. To address this concern, we construct two modified variables by using the fixed effects method. Specifically, we measure *citation*$^{tech}$ as the number of process patent citations divided by the average count of patent citations in the same cohort (technology class) to which the patent belongs (Hall, Jaffe, and Trajtenberg, 2001), where the technology classes are defined based on the Cooperative Patent Classification (CPC). Similarly, the other modified variable, *citation*$^{tech\text{-}time}$, is measured as the number of process patent citations divided by the average amount of patent citations in the same year-and-technology class. The results are shown in Table 4, and are similar to those in Table 3. All models include both firm and year fixed effects, and the results are qualitatively the same when we use industry and year fixed effects.

We also consider an alternative measure of TMT republicanism, following the research that calculates individual top manager's political ideology within the emerging strategic managerial framework. Specifically, we use these political contribution data to code a new donation-based index measure of conservatism following Chin et al. (2013). This measure ranges from 0 to 1, with a lower value indicating a more liberal orientation and a higher value indicating a more conservative orientation. The untabulated results are consistent with our baseline results, regardless of whether we assign a score of 0.5 (indicating a moderate orientation) to a manager for whom no donation data are found or include only top managers who donate at least once during our sample frame. We also exclude CEO from our TMT republicanism measure and instead create a separate control for CEO republicanism (calculated as described in Section 3.1) to account for potential bias resulting from CEOs attempting to dominate TMTs' financial decisions.[10] The results based on the methods above are consistent with our baseline results. Moreover, we perform a robustness analysis using a time-varying measure of TMT conservatism that reflects only manager donations made during the ten years prior to the focal year (Chin & Semadeni, 2017; Gupta & Wowak, 2017) or the cumulative political ideology of top executives based on the ten years before they became TMT members (from year $t$–10 to $t$–1, where $t$ is the first year of their tenures) following Chin et al. (2013). Following Christensen et al. (2015), we use other two measures: 1) contributions from just the first election cycle in which a manager makes contributions and 2) the average political orientation score for the manager from election cycles before the beginning of a fiscal year. These alternative measures produce results highly similar to the baseline results.

Further, we exclude observations associated with those managers who lack donation data or simultaneously donate to both parties in a particular election cycle. In addition, we use the samples only in even years, because the presidential election and most congressional election are happened in odd years. Lastly, we create a distinct

[10]Only top four compensated executives are included in the TMT after excluding CEO.

measure of TMT republicanism, based on donations by non-CEO employees in TMT with titles of vice president or higher (Hambrick et al., 1996; Hambrick & Cannella, 2004; Gupta et al., 2018). Our findings remain qualitatively the same as the baseline results.[11]

### 4.4 Endogeneity Tests

It is possible that companies in heavily Democratic states prefer to appoint liberal TMTs,[12] and certain industries might also exhibit a preference for liberal over conservative TMTs (Chin et al. 2013).[13] Therefore, the variable *TMT_REP* can be endogenous. In addition, the omitted variables issues, caused by factors that influence both TMT political preference and firm process innovation which are commonly excluded from regression analysis, can also result in potential endogeneity. In this section, we conduct some robustness tests to address endogeneity concerns.

Our first test is to add a three-year lagged variable of *Ratio_C* (*Ratio_P*) as the explanatory variable to our baseline model. This method not only mitigates endogeneity concerns but also accommodates the fact that patent filings take time to be processed and reflect innovation productivity that occurred earlier in time. A three-year forward looking measure of patent filings (lagging the dependent variables by three years) would ensure that we properly account for this time dimension, which

[11] We obtain the data from BoardEx, ExecuComp, Bloomberg, D&B's Reference Book of Corporate Management, Standard and Poor's Registry of Corporations, Directors, and Executives, and company websites.

[12] The headquarters of a firm are located in any of the ten most Democratically oriented states, as rated by Gallup (Jones, 2009). These states are Rhode Island, Massachusetts, Hawaii, Vermont, New York, Connecticut, Maryland, Illinois, and Delaware.

[13] These certain industries include high-tech, natural resources, consumer products, utilities, financial, and other services. For example, high-tech firms, and firms in competitive product markets (Hart, 1983; Karuna, 2007) have to innovate to survive and succeed, and their CEOs thus have greater incentives to take risk and invest in non-process innovation.

addresses the endogeneity concern. The untabulated results are consistent with our baseline results.

We then run the regressions using the instrumental variable method. To this end, we consider three instruments that can influence executive TMT political preference, but are not related to firm innovation. Our first instrument is industry peer conservatism, given the fact that top managers' political ideology will be determined in part by supply-side factors, specifically the aggregate political leanings of the local labor market. We calculate this variable as the average conservatism of all top managers serving on the TMTs of industry peer firms, excluding the focal firm. The second instrument is the average age of managers. Executive age would suggest a pattern where "older executives" are more likely to be Republican (Hutton et al., 2014; Unsal et al., 2016). The third instrument is firm predecessor TMT ideology (Christensen et al., 2015; Gupta et al., 2021), calculated in the same way as the ideology of the current TMT. We also report two specification tests to ensure the validity of the instrument variables: (1) the weak instrument test and (2) the Sargan test for overidentifying restrictions. The highly significant F-statistics indicate that the instruments are valid predictors of *TMT_REP*, while the non-significant Sargan tests (Hill, Griffiths, and Lim, 2008) for overidentifying restrictions indicate that the instruments are exogenous. We first regress our measure of TMT republicanism against one of the three instrumental variables, along with other control variables as described above, and year dummies. Then, we use the predicted *TMT_REP* from the first stage regression as the key explanatory variable in the second stage regressions, where the dependent variables are measures of process innovation. The second stage estimation results of the IV regressions are reported in Table 5.

The results in Table 5 show that the predicted indicators based on different instruments continue to have significantly positive coefficients, which are consistent with our baseline results. After addressing potential endogeneity concerns, the findings continue to show that republican-leaning top managers of a firm still engage in more process innovation.

To address sample selection bias, we employ a difference-in-differences (DID) approach to re-run the regressions. Following Hutton, Jiang and Kumar (2014), we employ the managerial turnover as an exogenous firm-specific shock for *TMT_REP*. We finally collect 3,681 TMT turnovers in our sample period based on data from the 10-K corporate filings of individual firms. "*Treat*" is a dummy variable equals one if firm *i* experiences top manager turnover, and 0 otherwise. "*Time*" is a dummy variable equal to 1 if the year is after TMT turnover for firm *i*, and 0 otherwise. We expect the "*Treat*×*Time*" (DID) estimator to be significantly positive. Firm and year dummies are all included in the regression, the standard errors are clustered at the firm level. Table 6 reports the DID results. As seen in Table 6, the coefficient of *Treat*×*Time* is still significantly positive.

We further employ the cross-sectional change-in-change regression around 3,681 TMT turnovers, because this method can provide a much sharper test of the causal effect of TMT ideology on firm process innovation (Hutton et al., 2014; Chava and

Purnanandam, 2010). We compute the change in each variable as the difference between the value measured after the new TMT member takes office and the value measured when the previous TMT member was in power. We use changed values of all variables to re-estimate the regressions, where Δ denotes a change in the given variable from year $t-1$ to year $t+1$, and $t$ is the year that a new TMT member takes over. Table 7 reports the estimation results. The results are consistent with our main findings, as the coefficient of *△TMT_REP* is still significantly positive based only on the TMT-turnover sample, suggesting that a switch in political ideology to Republican-leaning is associated with an increase in firm process innovation ratio. The magnitude of the effect is even significantly higher than that in the baseline regression.

We also perform a propensity score matching (PSM) analysis to control for observable differences in firm and industry attributes. We first regress *TMT_REP* on three major firm characteristics: firm size, leverage, and ROA. We then match firms led by Republican TMTs with firms led by non-Republican TMTs that have the closest predicted probability within a maximum caliper distance of 1% (Lawrence et al., 2011; Bhandari & Golden, 2021). For our second PSM matching approach, we follow similar procedures and regress *TMT_REP* on all control variables. Both approaches yield similar results to those in Table 3. Collectively, all the results demonstrate the robustness of our main finding.

**4.5 Mechanism Tests**

As discussed in Section 2, TMT political preference may shape firm innovation horizon through different mechanisms. We first investigate the tangible assets channel, based on the 2SLS method. Following Almeida and Campello (2007) and Bhandari and Golden (2021), we include a measure of asset tangibility, calculated as [0.715×receivables + 0.547×inventories + 0.535×PPE + (cash and short-term investments)]/total assets.[14] We then examine the leverage mechanism. The variable of leverage is computed as total debt (long-term debt and debt in current liabilities) divided by book value of total assets (Anderson et al., 2012; Cassell et al., 2012; Tong & Zhang, 2024). All independent variables are lagged by one year. Specifically, we first regress asset tangibility and leverage on *TMT_REP* in the first stage, and get the fitted values. In the second stage, we regress the ratio of process innovation claims and C-W process patents on the predicted values.

Table 8 presents the 2SLS estimation results of the tangible assets channel. All regressions include firm and year fixed effects or industry and year fixed effects. Standard errors are corrected for clustering of observations at the firm level. In the first-stage estimations of Model (1) in Table 8, *TMT_REP* is negatively associated with *Tan*. In the second stage estimation, the coefficient of *Predicted_Tan* is also significantly negative, which further demonstrates the mediating role of short-term investment in the relationship between TMT republicanism and firm process innovation. For the control variables, small, high growth, and high leverage firms tend

[14] We use total net property, plant, and equipment (*PPENT*) or the investment in tangible capital (*INV*) measured as the ratio of capital expenditure (*CAPEX*) to *PPENT* as the alternative mechanism variables of tangible assets (Hutton et al., 2014), and we get the similar regression results to those in Table 5.

to have higher stock return volatility. Firms that are performing poorly in terms of ROA and firms with high cash levels also tend to have higher risks (Opler et al., 1999; Coles et al., 2006; Low, 2009). These findings confirm H2a that Republican-leaning managers tend to engage more in process innovations via less tangible assets investment.

Similarly, the results in Table 9 indicate that the coefficient of *predicted_Lev* is significantly negative in the second-stage regressions, regardless of whether or not firm or industry fixed effects are included. This result confirms Hypothesis H2b that firms led by Republican-leaning TMTs engage in less debt financing, thus manifest shorter innovation horizons. In summary, we show that tangible assets and debt financing serve as two important mechanisms through which TMT political preference shapes firm innovation strategies.

### 4.6 Managerial Discretion and the Impacts of Managerial Political Preference

To shed light on why some managers can better align their strategies with their political ideologies than others, we consider two key sources of managerial discretion that facilitate the infusion of their ideologies into strategic behaviors: individual discretion and environmental discretion.

#### 4.6.1 Individual Discretion

To account for the influence of the board of directors' political ideology, we control for board conservatism using the same multi-item index of aggregate ideology for all non-TMT board members, following Gupta and Wowak (2017). We first calculate individual director cycle-average ideology with equal weight. We obtain board directors data on S&P 1500 companies from the RiskMetrics and Boardex database. Note that the sample is not the same as the one used to obtain baseline results due to the data availability for board directors. Our final sample comprises 29,147 firm-year observations from 9,495 directors.

As shown in Table 10, the coefficient of the interaction term, *TMT_REP*×*Board_REP*, is significantly positive. Thus, the effect of TMT political conservatism on process innovation is greater when the board is also more conservative, which demonstrates the amplifier role of board political preference.

**4.6.2 Environmental Discretion (Executive Job Demands)**

Highly competitive, uncertain, and turbulent industries are particularly taxing, due to large information-processing demands (Galbraith, 1973) and the potential need for quantum changes in a strategy (Hamel and Prahalad, 1994). Such industries are identified as those high-growth, high-growth-volatility, and technology-intensive industries (Hambrick & Cannella, 2004). To examine the role of uncertain industrial environment, we consider three variables as primary indicators of environmental discretion, following Finkelstein and Hambrick (1990). *Industry_growth* is the median rate of sales growth (annualized) between year $t$-1 and $t$. Because industry demand can grow (or shrink) in an unpredictable manner, we also calculate *Industry_instability* as the absolute difference in the industry growth rate from year $t$-2 to $t$ -1 vs. from year $t$-1 to $t$. *R&D_intensity* is the median R&D expenditure/total sales of companies in the industry. We add a new interaction term to our baseline model, by interacting *Industry_growth*, *Industry_instability*, and *R&D_intensity* with *TMT_REP*, respectively.

The results in Table 11 show that all coefficients of the three interaction terms are significantly positive, indicating the positive moderating role of managerial discretion on the relationship between managerial preference and process innovation afforded by uncertain environment. By highlighting individual and industrial boundary conditions for the ideology–strategy relationship, our findings take an important step toward reconciling the equivocal findings on the role of TMT republicanism in driving firm strategies.

## 5. Additional Analyses

### 5.1 Cross-Sectional Analysis of the Effects of Analyses-Labor Costs

Firms' incentives to invent new cost-saving production processes are arguably greater in industries for which labor costs account for a larger fraction of production costs (Bena et al., 2022). We expect that Republican managers are more prone to engage in process innovation when their firms have higher labor costs. To investigate the heterogeneity in the effects of managerial political preference in relation to labor costs, we re-run regressions with an interaction term of a labor cost measure and *TMT_REP*. We consider three methods to measure labor costs. The first on is the extended labor share (the variable *ELS*), defined as a dummy variable that equals one (zero) for firms that have high- (low-) extended labor share, which is computed as the imputed labor expenses divided by the value-added of a firm (Donangelo et al., 2019). The firm-level imputed labor expense is calculated as an industry average labor costs per employee multiplied by the number of employees of a firm.

Following Bena et al. (2022), we use *Labor-CostShr* as the second measure of labor costs, defined as median labor cost share in the firm's three-digit SIC industry. For each firm, dollar labor costs are computed as the Compustat number of employees multiplied by the average wage rate in the firm's industry. The average wage data are obtained from the Quarterly Census of Employment and Wages provided by the US Bureau of Labor Statistics. Next, the dollar labor costs are divided by the firm's cost of goods sold. Last, we compute the median cost share across all firm-years in each three-digit SIC industry. To facilitate the interpretation of the estimated coefficients, *Labor-CostShr* is standardized to have mean zero and standard deviation of one before forming the interaction in the regression.

We use the labor-to-capital ratio dummy as the third alternative variable. A higher Labor-to-Capital ratio in a firm is related to higher labor costs, since it always takes more costs to engage more production method improvements and mitigates the labor market frictions. The variable *Labor-to-Capital* is an indicator that equals one (zero) for firms that have a high- (low-) labor-to-capital ratio, which is computed as the total employment divided by the gross property, plant, and equipment (Knesl, 2019; Qiu, Wan, and Wang, 2024).

We regress process innovation measures on both *TMT_REP* and the interaction term between *TMT_REP* and one of the three labor cost measures (*ELS, Labor-CostShr*, or *Labor-to-Capital*) along with the labor cost measure itself and other control variables as in Table 3. The results in Table 12 show that the coefficients of *TMT_REP×ELS*, *TMT_REP×Labor-CostShr*, and *TMT_REP×Labor-to-Capital* are significantly positive in all models, regardless of whether we measure process innovation using process claims in columns (1) to (3) or citations-weighted process patents in columns (4)-(6). Thus, Republican-leaning top managers lead firms to a larger increase in process innovation in industries for which labor costs account for a larger share of production costs.

**5.2 Analyst Coverage**

Prior research documents the inhibiting effects of analyst coverage on firm innovation, finding that firms covered by a larger number of analysts generate fewer patents and patents with lower impacts (Yu, 2008; He & Tian, 2013; Jiang et al., 2016; Rees & Twedt, 2022). Moreover, some studies show that analysts exert high pressure on managers to meet short-term goals, exacerbating managerial myopia and impeding firms' investment in long-term innovative projects. For example, Benner (2010) finds that analysts are more attentive and positive toward corporate strategies that extend and preserve existing technologies (which are exploitative in nature) than toward strategies that respond directly to a new technology (which are exploratory in nature). Manso (2011) theoretically shows that tolerance for failure is necessary for effectively motivating and nurturing innovation. However, the least thing financial analysts can offer to innovative firms is to tolerate short-term failures, as their job is to forecast near-term earnings and make corresponding stock recommendations. Jia (2017, 2018) finds that firms pursuing an exploration-oriented innovation strategy (as opposed to an exploitation-oriented innovation strategy) are associated with lower analyst coverage. Thus, we hypothesize that the relation between TMT republicanism and process innovation is more pronounced in firms with higher analyst coverage.

To examine how the impacts of managerial political preferences on process innovation vary in firms with different degrees of analyst coverage, we measure analyst coverage (denoted by the variable *Ana_cov*) as the natural logarithm of one plus the number of analysts that issue earnings forecasts for a given firm in year *t* (Hui et al., 2009; He & Tian, 2013). A higher value of *Ana_cov* indicates stronger external monitoring by analysts. Data on the nature of analyst activities are obtained from the IBES database in Wharton Research Data Services.

We split the entire sample into two subsamples based on analyst coverage and re-run the baseline regression for the two subsamples, separately. Table 13 reports the estimation results of the panel regressions. Based on the results, the estimated coefficients on *TMT_REP* are positive and significant at the 1% level in high *Ana_cov* subsample. In the low *Ana_cov* subsample, the coefficients of *TMT_REP* under different model specifications are all significant at the 10% level. Moreover, on average, the magnitudes of estimation results for *TMT_REP* based on the former are nearly doubled compared to those of the latter sample, regardless of whether the dependent variable is *Ratio_C* or *Ratio_P*. These results demonstrate that the relationship between TMT republicanism and firm process innovation is more pronounced when analyst coverage is stronger. Thus, the political preferences of managers play a more important role in shaping a firm's innovation horizon under the pressure of higher analyst following.

### 5.3 Institutional Investor Horizon

Our research complements the burgeoning literature on the governance of innovation. Aghion et al. (2013) find that high institutional ownership is associated with more non-process innovation, due to the career concern of managers. We further assert that transient institutional investors are more myopic and exhibit lower tolerance of innovation project failure, thereby weakening managers' incentives to take risky investment. Thus, we hypothesize that the relation between TMT republicanism and process innovation will be more pronounced in firms with a higher institutional turnover rate.

To examine effects of institutional investors' investment horizons, we first construct a key variable, *InstTO*, to proxy the average institutional horizon for firm $k$, based on the churn rate of portfolios held by institutional owners in the firm. A higher (lower) value of *InstTO* indicates greater (lower) ownership by transient institutional owners. Following Gaspar et al. (2005), we compute institutional investor $i$'s churn rate in quarter $t$ as follows:

$$CR_{i,t} = \frac{\sum abs(N_{j,i,t}P_{j,t} - N_{j,i,t-1}P_{j,t-1} - N_{j,i,t-1}\Delta P_{j,t1})}{\sum 0.5\times(N_{j,i,t}P_{j,t} + N_{j,i,t-1}P_{j,t-1})}, \quad (3)$$

where $P_{j,t}$ and $N_{j,i,t}$ represent the price and the number of shares, respectively, of company $j$ held by institutional investor $i$ in quarter $t$. A higher value of $CR$ indicates a shorter investment horizon. Then, we calculate the institutional investor horizon for firm *k* by taking the weighted average of churn rates of the institutional owners of firm *k* for each year *T*:

$$InstTO = \sum w_{k,i,t} \left(\frac{1}{4} \sum CR_i\right), \tag{4}$$

where $w_{k,i,t}$ is the weight of institutional investor $i$ in the total percentage held by institutional investors in firm *k* in quarter *t*. The weighted average of the churn rates is averaged over 4 quarters. Transient institutional investors have higher *InstTO* values, which represent higher turnover rates.

We split the entire sample into two subsamples based on *InstTO* and re-run the baseline regression for the two subsamples, separately, and report the results in Table 14. We note that the estimated coefficients on *TMT_REP* are positive and significant at the 1% level in high *InstTO* subsample. In the low *InstTO* subsample, the coefficients of *TMT_REP* under different model specifications are all insignificant. Moreover, on average, the magnitudes of estimation results for *TMT_REP* based on the former are nearly tripled compared to those of the latter sample, confirming that the presence of short-term institutional investors exacerbates managerial myopia, prompting firms to engage in more corporate process innovation.

### 5.4 TMT Tenure and Compensation

Top managers' tenure is an important factor shaping their ideologies into financial decisions (Core and Larcker, 2002; Jin, 2002; Coles et al., 2006). According to the previous literature on CEO tenure, the effects of CEO characteristics on organizational outcomes are likely to be positively moderated by CEOs' tenure (Hambrick & Cannella, 2004). Some studies find that a CEO's personality is more clearly manifested in the strategic profiles of his or her company when that CEO's tenure is longer than three years (Miller, Kets de Vries, & Toulouse, 1982). Thus, we expect that TMT tenure will positively moderate the effects of TMT republicanism on firms' innovation strategies. Furthermore, executive compensation may also play an important role in the influence of top manager political preferences, since TMTs will especially act on their values when they stand to gain financially from their actions (Guay, 1999; Core and Guay, 2002; Dutta, 2008; Gupta et al., 2018).

We split the entire sample into two subsamples based on TMT average tenure and TMT average compensation and re-run the baseline regression for the two subsamples, separately. TMT average tenure is the average of number of years since becoming TMT members. TMT compensation includes salary, bonus, the value of stock awards, the value of option awards, non-equity incentive, change in pension value and non-qualified deferred compensation earnings, and all other compensation. Data of tenure and compensation are obtained from the Boardex and Execucomp database.

The results are reported in Table 15. We find that the estimated coefficients on *TMT_REP* are positive and significant at the 1% level in longer tenure and higher compensation subsample, while in the shorter tenure or lower compensation subsample, the coefficients of *TMT_REP* under different model specifications are significant at the 10% level or insignificant. We thus conclude that the longer the

TMT average tenure is, the stronger the positive association between TMT conservatism and firms' process innovation. On the one hand, executives with longer terms are more likely to inject their political leanings into decision-making because they have less fear of losing their jobs. This is consistent with the interpretation under the framework of managerial discretion that executives with lower work pressure are more able to do things according to their own wishes (Hambrick & Mason, 1984; Chin et al., 2013). On the other hand, managerial tenure is also recognized as an important source of power within the firm (Chin & Semadeni, 2017; Gupta et al., 2021). TMT tenure can also be a proxy of the power relative to the board, and the longer tenure, the greater the relative power. Thus, the political ideologies of long tenure executives can be more manifested in firm decision making, because they can make investment decisions without having to negotiate extensively with their boards.

In addition, conservative TMT with higher compensation is more prone to inject their political ideologies into firm strategies, strengthening the relationship between TMT conservatism and firms' process innovation. This is because compensation is a form of incentive and recognition of executive's current job. Following from the logic of "motivated cognition," which is the psychological process by which individuals see instrumental merits in options that align with their preferences, TMTs will especially act on their values when they get more financially compensation from their actions (Kunda, 1990; Chin & Semadeni, 2017). Higher compensation means recognition from the board of directors towards executives. Hence, executives who get more compensation will tend to be more socialized into the ideological leanings of the firm's body politic, and easier to inject their ideologies into firm strategic making (Finkelstein & Boyd, 1998; Gupta et al., 2019). Thus, the relationship between TMT conservatism and process innovation is more pronounced of TMTs with longer tenures and higher compensations.

## 6. Conclusions

In this paper, we extend prior literature by investigating the role of political preferences of top managers in shaping firms' innovation horizons. Based on the investment risk and time required to generate earnings, innovation is classified as less risky process innovation focusing on short-term payback and more risky non-process innovation focusing on long-term payback. We find that the short-termism of Republican managers leads them to engage in more process innovation.

We further provide empirical evidence supporting the two potential mechanisms through which TMT republicanism influences firm process innovations. We show that firms led by conservative managers tend to invest less in tangible assets and employ less debt financing, and thus are more prone to engage in process innovations to raise the marginal productivity of existing physical capital and cope with the stringent financial constraints. Managerial discretions, such as ideology homogeneity between managers and boards as well as industry environment uncertainty, better enable Republican managers to act on their own preferences, and thus strengthen the relation between TMT political ideology and firm process innovation. Furthermore, our results are stronger for firms in industries with higher labor costs, as well as for firms with higher analyst coverage, more transient institutional investors, longer TMT tenure and higher TMT compensation. This paper highlights the unique driver of managerial conservatism, political preference, within the managerial personal characteristics framework, which plays an important role in shaping corporate innovation strategies. Our findings suggest that future research should fully consider the role of the top managers' personal traits, especially their political preferences, when investigating firm innovation horizons.

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245-271.

## Table 1. Summary statistics of variables

| Variable | 25th | Mean | Median | 75th | STD | OBS |
|---|---|---|---|---|---|---|
| *Process_C* | 0.000 | 1.417 | 0.000 | 4.003 | 1.909 | 54,764 |
| *Process_P* | 0.000 | 0.532 | 0.000 | 2.418 | 1.362 | 54,764 |
| *Product_C* | 0.000 | 1.794 | 0.000 | 4.614 | 2.137 | 54,764 |
| *Product_P* | 0.000 | 1.106 | 0.000 | 3.512 | 1.013 | 54,764 |
| *Ratio_C* | 0.000 | 0.268 | 0.174 | 0.629 | 0.215 | 54,764 |
| *Ratio_P* | 0.000 | 0.207 | 0.000 | 0.845 | 0.296 | 54,764 |
| *TMT_REP* | -0.032 | 0.499 | 0.286 | 0.711 | 0.243 | 54,764 |
| *Log(Age)* | 2.172 | 3.429 | 3.482 | 4.500 | 0.906 | 54,764 |
| *Log(AT)* | 7.093 | 8.695 | 8.562 | 9.816 | 1.045 | 54,764 |
| *RoA* | 0.048 | 0.071 | 0.084 | 0.143 | 0.067 | 54,764 |
| *R&D* | 0.000 | 0.029 | 0.006 | 0.042 | 0.051 | 54,764 |
| *MTB* | 1.096 | 1.613 | 1.384 | 2.157 | 1.832 | 54,764 |
| *Capex* | 0.033 | 0.069 | 0.045 | 0.081 | 0.041 | 54,764 |
| *HHI* | 0.125 | 0.306 | 0.298 | 0.405 | 0.189 | 54,764 |
| $HHI^2$ | 0.016 | 0.122 | 0.043 | 0.147 | 0.176 | 54,764 |
| *PAC* | 0.000 | 0.154 | 0.000 | 0.000 | 0.056 | 54,764 |
| *TMT_own* | 0.014 | 0.039 | 0.024 | 0.198 | 0.019 | 54,764 |
| *TMT_size* | 4.853 | 7.295 | 7.936 | 9.995 | 2.317 | 54,764 |
| *Dir_own* | 0.017 | 0.161 | 0.152 | 0.320 | 0.024 | 54,764 |
| *Board_size* | 5.205 | 10.075 | 10.116 | 14.028 | 2.541 | 54,764 |

This table presents the summary statistics of variables. The sample covers a period from 1992 to 2021. The definitions of all variables are listed in the Appendix. All continuous variables are winsorized at the 1st and 99th percentiles.

## Table 2. Correlation matrix of variables

| | *Ratio_C* | *Ratio_P* | *TMT_REP* | *Log(Age)* | *Log(AT)* | *RoA* | *R&D* | *MTB* | *Capex* | *HHI* |
|---|---|---|---|---|---|---|---|---|---|---|
| *Ratio_C* | 1 | | | | | | | | | |
| *Ratio_P* | 0.261$^{***}$ | 1 | | | | | | | | |
| *TMT_REP* | 0.544$^{***}$ | 0.627$^{***}$ | 1 | | | | | | | |
| *Log(Age)* | 0.326 | 0.757$^{***}$ | 0.163$^{***}$ | 1 | | | | | | |
| *Log(AT)* | 0.155$^{***}$ | -0.456$^{***}$ | 0.471$^{***}$ | 0.320$^{***}$ | 1 | | | | | |
| *RoA* | 0.359$^{***}$ | -0.184$^{*}$ | -0.147$^{***}$ | 0.244$^{**}$ | 0.012 | 1 | | | | |
| *R&D* | 0.487 | 0.664 | 0.138 | 0.310 | 0.107$^{***}$ | -0.484 | 1 | | | |
| *MTB* | -0.147$^{***}$ | 0.523$^{***}$ | -0.023$^{***}$ | 0.127$^{***}$ | 0.222 | 0.132$^{***}$ | -0.596 | 1 | | |
| *Capex* | -0.749$^{**}$ | -0.433 | 0.089$^{***}$ | 0.347$^{**}$ | 0.156 | -0.124$^{***}$ | 0.238$^{***}$ | 0.128 | 1 | |
| *HHI* | 0.071 | -0.388$^{**}$ | -0.131 | -0.479 | 0.189$^{*}$ | 0.075$^{***}$ | -0.073$^{*}$ | 0.817$^{***}$ | -0.235 | -0.034 |
| *$HHI^2$* | 0.602$^{*}$ | -0.124 | -0.388$^{***}$ | -0.764$^{*}$ | -0.748 | -0.534 | 0.126$^{***}$ | 0.139 | 0.833$^{***}$ | 0.088$^{**}$ |
| *PAC* | -0.167 | 0.470$^{***}$ | 0.347 | 0.733 | 0.182$^{*}$ | 0.182$^{*}$ | -0.405 | -0.293 | -0.237 | -0.017$^{***}$ |
| *TMT_own* | -0.096$^{***}$ | -0.033 | 0.443$^{***}$ | -0.157$^{***}$ | 0.684$^{***}$ | -0.693$^{***}$ | 0.346$^{***}$ | -0.189$^{**}$ | -0.730$^{***}$ | -0.208 |
| *TMT_size* | 0.385$^{**}$ | -0.084 | -0.300 | -0.380 | -0.059 | 0.186$^{*}$ | -0.443$^{***}$ | -0.218 | 0.363 | -0.512 |
| *Dir_own* | 0.476 | 0.014$^{***}$ | 0.257$^{***}$ | 0.576$^{***}$ | 0.389$^{***}$ | 0.760 | 0.324$^{***}$ | 0.199$^{*}$ | -0.687$^{**}$ | -0.524$^{***}$ |
| *Board_size* | 0.763$^{***}$ | 0.837 | -0.185$^{***}$ | 0.673$^{**}$ | 0.402 | -0.158 | -0.338 | 0.436$^{***}$ | 0.287$^{***}$ | 0.209$^{**}$ |

This table reports the Pearson correlation coefficients of TMT political preference measure, firm innovation measures, and other control variables. All variables are winsorized at the1st and 99th percentiles. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

**Table 3. Results of effects of TMT political preference on firm process innovation**

| | (1) | (2) | (3) | (4) | (2) | (3) |
|---|---|---|---|---|---|---|
| | *Process_C* | *Process_P* | *Product_C* | *Product_P* | *Ratio_C* | *Ratio_P* |
| *TMT_REP* | 0.046*** | 0.039*** | -0.035 | -0.021 | 0.105*** | 0.299*** |
| | (4.863) | (4.509) | (-1.217) | (-1.113) | (4.207) | (4.623) |
| *Log(Age)* | -0.074 | -0.071 | -0.656 | -0.350 | -0.076 | 0.416* |
| | (-0.891) | (-0.388) | (-0.890) | (-1.584) | (-0.906) | (1.935) |
| *Log(AT)* | 0.014* | 0.034* | 0.009*** | 0.020*** | 0.072 | 0.023 |
| | (1.751) | (1.941) | (2.748) | (2.651) | (0.419) | (0.177) |
| *RoA* | 0.018* | 0.044** | 0.333 | 0.541 | -0.023 | -0.302*** |
| | (1.882) | (2.005) | (0.719) | (0.522) | (-0.988) | (-3.244) |
| *R&D* | 0.155** | 0.114 | -0.009 | -0.029 | 0.534* | 0.321* |
| | (3.126) | (0.438) | (-0.527) | (-0.745) | (1.938) | (1.741) |
| *MTB* | 0.128** | -0.050** | 0.177*** | 0.341* | 0.444*** | 0.161 |
| | (2.099) | (-2.037) | (3.504) | (1.749) | (4.157) | (1.244) |
| *Capex* | -0.023* | -0.056* | -0.013 | -0.028 | 0.310*** | 0.180*** |
| | (-1.796) | (-1.931) | (-0.734) | (-0.686) | (3.516) | (3.162) |
| *HHI* | 0.004*** | 0.008*** | -0.044 | -0.014 | 0.667 | 0.477 |
| | (3.417) | (4.899) | (-0.357) | (-0.235) | (0.215) | (1.001) |
| $HHI^2$ | 0.065 | 0.202 | 0.003*** | 0.121*** | -0.008 | 0.463** |
| | (0.435) | (0.604) | (3.886) | (3.911) | (-0.413) | (2.157) |
| *PAC* | 0.021** | 0.042* | 0.148*** | 0.202 | -0.090** | 0.763 |
| | (2.052) | (1.813) | (3.941) | (0.851) | (-2.457) | (0.048) |
| *TMT_ own* | 0.075 | 0.169 | -0.023 | -0.011 | 0.396 | 0.629* |
| | (0.643) | (0.648) | (-0.240) | (-0.052) | (0.208) | (1.708) |
| *TMT_size* | 0.107*** | 0.093*** | 0.060* | 0.024 | 0.004*** | 0.541*** |
| | (3.276) | (3.118) | (1.906) | (0.465) | (3.852) | (3.514) |
| *Dir_own* | 0.119 | 0.208 | 0.023 | -0.015*** | 0.348 | -0.370 |
| | (1.199) | (0.946) | (0.031) | (-2.796) | (1.491) | (-0.246) |
| *Board_size* | 0.026*** | -0.777 | -0.041** | -0.016*** | 0.650 | 0.206*** |
| | (3.123) | (-1.439) | (-2.017) | (-2.775) | (1.027) | (3.401) |
| *Intercept* | 0.355*** | 0.688** | 0.016 | -0.016 | 0.497 | 0.044 |
| | (2.779) | (2.411) | (1.090) | (-1.485) | (1.237) | (0.248) |
| Firm dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| adj. $R^2$ | 0.436 | 0.448 | 0.417 | 0.415 | 0.205 | 0.281 |
| N | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 |

This table presents the estimation results of panel regressions that investigate the effects of *TMT_REP* on firm process and non-process innovations. The dependent variables in Columns (1)-(6) are *Process_C. Process_P, Product_C, Product_P, Ratio_C* and *Ratio_P*, respectively. All independent variables are lagged by one year. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all regressions are based on clustered standard errors at firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

**Table 4. Regression results of the effects of TMT political preference based on alternative firm process innovation measures**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | *Cit_per* | *Claim$^{time}$* | *Citation$^{time}$* | *citation$^{tech}$* | *citation$^{tech\text{-}time}$* |
| *TMT_REP* | 0.240*** | 0.029*** | 0.196*** | 0.082*** | 0.134*** |
| | (3.246) | (4.465) | (3.099) | (4.215) | (3.962) |
| *Log(Age)* | -0.464 | -0.044 | -0.015*** | 0.288 | 0.170* |
| | (-0.389) | (-0.357) | (-2.796) | (1.046) | (1.711) |
| *Log(AT)* | 0.331 | 0.003*** | -0.020 | 0.255 | 0.260** |
| | (0.886) | (3.886) | (-0.153) | (0.409) | (2.362) |
| *RoA* | 0.499 | 0.148*** | 0.301* | -0.380*** | 0.128 |
| | (0.768) | (3.941) | (1.876) | (-3.729) | (1.278) |
| *R&D* | 0.341** | 0.023*** | -0.016 | 0.527*** | -0.016*** |
| | (2.475) | (3.240) | (-1.485) | (5.793) | (-2.775) |
| *MTB* | 0.182*** | 0.051*** | 0.192** | -0.015 | -0.172** |
| | (4.064) | (3.054) | (2.314) | (-0.054) | (-2.279) |
| *Capex* | 0.180 | 0.073 | -0.090 | -0.015*** | 0.233* |
| | (1.563) | (1.226) | (-0.285) | (-3.262) | (1.785) |
| *HHI* | 0.635 | -0.719*** | 0.554*** | -0.135 | -0.588*** |
| | (0.701) | (-3.066) | (3.188) | (-0.153) | (-3.690) |
| *HHI$^2$* | -0.002 | -0.011* | 0.136 | 0.726** | 0.163 |
| | (-0.261) | (-1.754) | (0.349) | (2.108) | (1.139) |
| *PAC* | -0.273** | 0.498*** | 0.029 | -0.998 | 0.162 |
| | (-2.562) | (3.624) | (0.117) | (-1.556) | (0.974) |
| *TMT_own* | 0.484 | -0.337 | 0.192*** | -0.145 | 0.0782 |
| | (0.714) | (-1.466) | (2.943) | (-0.377) | (0.721) |
| *TMT_size* | 0.009*** | 0.015 | 0.464*** | 0.263 | 0.301 |
| | (3.850) | (1.009) | (3.240) | (0.304) | (1.526) |
| *Dir_own* | 0.085 | 0.605 | 0.967*** | 0.019 | 0.400** |
| | (1.391) | (0.207) | (3.637) | (0.036) | (2.482) |
| *Board_size* | 0.016 | 0.418 | 0.219* | 0.462* | 0.048 |
| | (0.204) | (1.276) | (1.864) | (1.779) | (0.319) |
| *Intercept* | 0.499*** | 0.042 | 0.140 | 0.273 | -0.326* |
| | (3.000) | (0.103) | (1.038) | (0.905) | (-1.754) |
| Firm dummies | Yes | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes | Yes |
| adj. $R^2$ | 0.212 | 0.323 | 0.377 | 0.387 | 0.209 |
| N | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 |

This table presents the estimation results of panel regressions using alternative firm process innovation measures. The dependent variables are *Cit_per*, calculated as log (1+citations per process patent), *Claim$^{time}$*, calculated as log (1+process claim$^{time}$), *Citation$^{time}$*, calculated as log (1+process patent citation$^{time}$), *Citation$^{tech}$*, calculated as log (1+process patent citation$^{tech}$), and *Citation$^{tech\text{-}time}$*, calculated as log (1+process patent citation$^{tech\text{-}time}$), respectively. For the sake of brevity, we only report the results with firm and year fixed effect in all models, and the results with industry fixed effect are available upon request. The t-statistics are shown in parentheses. All variables are defined in the Appendix. The t-statistics for all regressions are based on clustered standard errors at the firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

**Table 5. Results of the second-stage 2SLS Regressions based on the instrumental variable method**

| | *Ratio_C* | | | *Ratio_P* | | |
|---|---|---|---|---|---|---|
| | Model (1): $IV_1$= industry peer conservatism | Model (2): $IV_2$= TMT average age | Model (3): $IV_3$= predecessor TMT ideology | Model (4): $IV_1$= industry peer conservatism | Model (5): $IV_2$= TMT average age | Model (6): $IV_3$= predecessor TMT ideology |
| *Pre_TMT_REP* | $0.304^{***}$ | $0.380^{***}$ | $0.040^{***}$ | $0.093^{***}$ | $0.022^{***}$ | $0.032^{***}$ |
| | (4.764) | (4.828) | (4.283) | (3.310) | (3.647) | (3.097) |
| *Log(Age)* | 0.313 | 0.545 | $0.783^{***}$ | -0.052 | $0.027^{***}$ | 0.023 |
| | (1.018) | (0.834) | (3.761) | (-0.853) | (4.888) | (0.073) |
| *Log(AT)* | 0.141 | 0.201 | -0.094 | $-0.197^{***}$ | 0.115 | 0.397 |
| | (1.093) | (0.730) | (-1.167) | (-5.355) | (1.149) | (0.018) |
| *RoA* | $0.215^{*}$ | $0.319^{***}$ | $0.498^{**}$ | $-0.031^{***}$ | $-0.120^{***}$ | $-0.616^{***}$ |
| | (1.738) | (3.110) | (2.181) | (-3.254) | (-3.124) | (-3.569) |
| *R&D* | $0.115^{***}$ | 0.186 | -0.534 | $-0.167^{***}$ | 0.137 | 0.248 |
| | (3.013) | (0.743) | (-1.359) | (-4.319) | (1.261) | (1.482) |
| *MTB* | 0.208 | 0.391 | $-0.378^{***}$ | -0.114 | $0.139^{***}$ | $0.360^{*}$ |
| | (1.437) | (1.234) | (-2.963) | (-0.031) | (3.350) | (1.766) |
| *Capex* | 0.179 | 0.186 | $0.084^{**}$ | 0.418 | $0.396^{**}$ | 0.106 |
| | (0.957) | (0.455) | (2.316) | (1.473) | (2.141) | (0.606) |
| *HHI* | 0.012 | $0.093^{***}$ | 0.619 | $0.677^{**}$ | $0.455^{*}$ | 0.991 |
| | (0.026) | (3.105) | (0.089) | (2.251) | (1.872) | (0.755) |
| *HHI2* | $0.222^{***}$ | -0.208 | $-0.111^{***}$ | $-0.235^{***}$ | $-0.105^{***}$ | 0.102 |
| | (3.931) | (-0.937) | (-3.060) | (-3.740) | (-3.431) | (0.631) |
| *PAC* | 0.363 | $-0.241^{***}$ | -0.016 | 0.194 | 0.300 | $0.387^{***}$ |
| | (1.559) | (-3.913) | (-0.060) | (0.198) | (1.235) | (2.617) |
| *TMT_own* | 0.202 | 0.055 | -0.456 | 0.333 | $0.495^{***}$ | 0.188 |
| | (0.599) | (0.019) | (-0.075) | (0.707) | (3.267) | (1.393) |
| *TMT_size* | 0.075 | $0.045^{**}$ | $-0.286^{***}$ | 0.181 | -0.352 | $0.202^{***}$ |
| | (0.636) | (2.304) | (-3.638) | (0.654) | (-0.884) | (3.644) |
| *Dir_own* | 0.688 | $0.385^{***}$ | $0.003^{**}$ | 0.415 | $0.185^{***}$ | 0.140 |
| | (0.412) | (3.727) | (2.427) | (0.600) | (3.280) | (0.483) |
| *Board_size* | $-0.417^{***}$ | 0.009 | -0.461 | $-0.023^{***}$ | $0.441^{**}$ | 0.340 |
| | (-3.465) | (0.184) | (-0.573) | (-3.847) | (2.225) | (1.574) |
| *Intercept* | $-0.681^{***}$ | -0.109 | $-0.868^{**}$ | $-0.213^{***}$ | $-0.406^{**}$ | $0.404^{***}$ |
| | (-5.914) | (-0.319) | (-2.550) | (-3.483) | (-2.488) | (3.560) |
| Firm dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| N of obs | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 |
| Cragg-Donald Wald F statistic | 15.345 | 16.093 | 13.317 | 14.489 | 13.705 | 15.322 |
| Kleibergen-Paap Wald F statistic | 14.182 | 15.260 | 14.711 | 13.421 | 13.059 | 14.768 |
| Sargan test p value | 0.494 | 0.682 | 0.535 | 0.506 | 0.619 | 0.550 |
| $Adi\_R^2$ | 0.414 | 0.407 | 0.462 | 0.283 | 0.230 | 0.235 |

This table reports the estimation results of the second-stage 2SLS regressions, using the instrumental variable (IV) approach. The fitted values of *TMT_REP* are computed from first-stage regressions, in which *TMT_REP* is regressed on the instruments along with all other exogenous variables. Columns (1) and (4) present the results of the regression where the instrument is industry peer conservatism. Columns (2) and (5) present the results where the instrument is TMT average age. Columns (3) and (6) present the results where the instrument is firm predecessor TMT ideology. The dependent variables in columns (1)-(3) and columns (4)-(6) are *Ratio_C* and *Ratio_P*, respectively. All regressions include firm and year dummies. All variables are defined in the Appendix. The t-statistics are based on heteroskedastic-consistent standard errors, corrected for correlation across observations of a given firm. The lower part of the table shows the F-statistics from the first-stage regression for the weak instrument test and the Sargan test represents over-identifying restrictions test. ***, **, and * indicate significance at the 1%, 5%, 10% levels, respectively.

**Table 6. Results of impacts of managerial political preference using difference-in-differences**

| | (1) | (2) |
|---|---|---|
| | *Ratio_C* | *Ratio_P* |
| *Treat×time* | 0.034*** | 0.152*** |
| | (3.314) | (4.895) |
| *Log(Age)* | -0.051 | -0.087 |
| | (-0.909) | (-0.532) |
| *Log(AT)* | 0.134*** | -0.011*** |
| | (3.936) | (-3.828) |
| *RoA* | 0.017 | -0.072 |
| | (1.298) | (-1.261) |
| *R&D* | 0.104*** | 0.071*** |
| | (3.929) | (3.369) |
| *MTB* | -0.086 | 0.034 |
| | (-0.125) | (0.936) |
| *Capex* | -0.049 | 0.044 |
| | (-0.887) | (1.004) |
| *HHI* | 0.187 | -0.056* |
| | (1.291) | (-1.933) |
| *HHI2* | 0.541 | 0.021 |
| | (0.516) | (0.046) |
| *PAC* | 0.028*** | 0.009*** |
| | (3.485) | (2.936) |
| *TMT_own* | -0.083*** | -0.023* |
| | (-3.233) | (-1.789) |
| *TMT_size* | 0.202 | -0.011*** |
| | (0.435) | (-3.051) |
| *Dir_own* | -0.213 | 0.414 |
| | (-0.742) | (0.469) |
| *Board_size* | -0.128*** | -0.025 |
| | (-4.170) | (-0.523) |
| Firm dummies | Yes | Yes |
| Year dummies | Yes | Yes |
| Obs. | 54,764 | 54,764 |
| Adi_$R^2$ | 0.357 | 0.411 |

This table reports average estimated coefficients, corresponding t-statistics of panel regressions of difference-in-differences (DID) model with both industry and year fixed effects. The treat dummy *Treat* equals to 1 if firm *i* experiences TMT turnover during the sample period, and 0 otherwise. *Time* equals to 1 after TMT turnover activities, and 0 otherwise. All variables are defined in the Appendix. The t-statistics are in parentheses below parameter estimates. The standard errors are clustered by industry. ***, **, and * indicate significance at the 1%, 5%, 10% levels, respectively.

**Table 7. Cross-sectional regression of the change in process innovation on change of TMT political preference during TMT turnover periods**

| | (1) | (2) |
|---|---|---|
| | *△Ratio_C* | *△Ratio_P* |
| *△TMT_REP* | 0.391*** | 0.013*** |
| | (3.598) | (3.066) |
| *△Log(Age)* | 0.029 | 0.665 |
| | (0.485) | (0.474) |
| *△Log(AT)* | -0.053*** | -0.449*** |
| | (-3.722) | (-2.815) |
| *△RoA* | 0.006 | -0.126 |
| | (0.345) | (-0.046) |
| *△R&D* | 0.211 | 0.182 |
| | (0.363) | (0.285) |
| *△MTB* | -0.049 | -0.131 |
| | (-0.036) | (-0.147) |
| *△Capex* | 0.014 | 0.410 |
| | (0.870) | (1.474) |
| *△HHI* | 0.622*** | 0.084* |
| | (3.479) | (1.862) |
| *△HHI2* | -0.345 | -0.466 |
| | (-1.401) | (-0.939) |
| *△PAC* | 0.054 | -0.205** |
| | (0.239) | (-2.005) |
| *△TMT_own* | 0.024*** | -0.068 |
| | (3.868) | (-0.115) |
| *△TMT_size* | 0.722 | 0.084*** |
| | (1.495) | (2.684) |
| *△Dir_own* | 0.927 | 0.031 |
| | (0.382) | (0.943) |
| *△Board_size* | 0.014** | -0.499 |
| | (2.178) | (-0.270) |
| Adj. $R^2$ | 0.176 | 0.186 |
| N | 3,681 | 3,681 |

This table presents the cross-sectional regression results of the changes in firm process innovation, *△Ratio_C* and *△Ratio_P*, on the changes of *TMT_REP*, *△TMT_REP,* with other firm and TMT characteristics controlled. All the control variables are changes in the values of corresponding variables. All control variables are defined in the Appendix. The t-statistics are shown in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## Table 8. Results of the effects of tangible assets on firm process innovation

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | *Tan* | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* |
| *TMT_REP* | -0.164*** | | | | |
| | (-4.534) | | | | |
| *Predicted_Tan* | | -0.030*** | -0.128*** | -0.335*** | -0.171*** |
| | | (-4.131) | (-4.245) | (-3.843) | (-4.097) |
| *Log(Age)* | | 0.640 | 0.064** | 0.191*** | -0.887*** |
| | | (1.611) | (2.334) | (2.859) | (-3.071) |
| *Log(AT)* | | -0.519*** | 0.017 | -0.157 | 0.326 |
| | | (-3.086) | (0.139) | (-0.121) | (0.513) |
| *RoA* | | -0.082 | 0.316 | 0.089 | 0.112 |
| | | (-0.567) | (0.518) | (0.481) | (0.429) |
| *R&D* | | 0.189 | 0.153*** | -0.802*** | -0.345*** |
| | | (1.536) | (-5.279) | (-5.254) | (-2.700) |
| *MTB* | | 0.019 | -0.042*** | 0.074 | 0.523*** |
| | | (0.173) | (-7.568) | (0.402) | (5.750) |
| *Capex* | | -0.070* | -0.076* | -0.068* | 0.004*** |
| | | (-1.833) | (-1.836) | (-1.832) | (3.075) |
| *HHI* | | 0.323 | 0.718 | 0.069 | 0.551*** |
| | | (1.613) | (1.638) | (0.407) | (3.208) |
| *HHI2* | | 0.534* | 0.211* | -0.122*** | 0.216 |
| | | (1.844) | (1.884) | (-3.684) | (0.491) |
| *PAC* | | -0.420*** | -0.419*** | 0.134 | -0.046*** |
| | | (-3.751) | (-2.743) | (0.939) | (-3.028) |
| *TMT_own* | | -0.816*** | 0.439 | -0.730*** | 0.360 |
| | | (-3.268) | (1.602) | (-3.518) | (1.127) |
| *TMT_size* | | -0.106*** | -0.502*** | -0.009 | 0.146** |
| | | (-3.670) | (-3.023) | (-0.248) | (2.132) |
| *Dir_own* | | 0.163 | -0.186 | -0.497*** | 0.376 |
| | | (0.415) | (-0.574) | (-2.672) | (1.123) |
| *Board_size* | | 0.060* | -0.826*** | -0.121*** | -0.001 |
| | | (1.741) | (-3.591) | (-9.754) | (-0.007) |
| *Intercept* | 0.157 | 0.331 | 0.460 | 0.676 | -0.251 |
| | (1.364) | (1.283) | (1.167) | (0.732) | (-0.574) |
| Firm-FE | Yes | Yes | no | Yes | no |
| Year-FE | Yes | Yes | Yes | Yes | Yes |
| Industry FE | no | no | Yes | no | Yes |
| Adj. R2 | 0.281 | 0.402 | 0.241 | 0.382 | 0.290 |
| N | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 |

This table reports the estimation results of 2SLS panel regressions where the firm process innovation, *Ratio_C* and *Ratio_P*, is regressed on the TMT conservatism predicted value, *Predicted_Tan*. To obtain the predicted values, we first regress the asset tangibility variable (*Tan*) on lagged *TMT_REP* and then use the predicted value in the second-stage regression along with all control variables in the baseline regression. Columns (2) and (4) include both firm and year fixed effects, and columns (3) and (5) include both industry and year fixed effects. The first stage regression in column (1) includes firm and year effects. Stock return volatility is the standard deviation of daily stock returns over the fiscal year, in percentage. All independent variables are lagged by 1 year. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all regressions are based on clustered standard errors at the firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## Table 9. Results of the effects of firm leverage on firm process innovation

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | *Lev* | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* |
| *TMT_REP* | -0.012*** | | | | |
| | (-4.109) | | | | |
| *Predicted_Lev* | | -0.458*** | -0.359*** | -0.116*** | -0.151*** |
| | | (-3.685) | (-4.616) | (-4.127) | (-4.024) |
| *Log(Age)* | | -0.786 | 0.151 | 0.014*** | 0.071 |
| | | (-0.551) | (1.454) | (3.755) | (0.181) |
| *Log(AT)* | | 0.029 | 0.298 | 0.006*** | 0.060* |
| | | (0.487) | (1.175) | (3.045) | (1.906) |
| *RoA* | | -0.624*** | 0.633*** | 0.296 | -0.038*** |
| | | (-3.493) | (3.151) | (0.461) | (-3.028) |
| *R&D* | | -0.704*** | -0.609 | 0.367 | -0.049 |
| | | (-3.539) | (-0.311) | (1.435) | (-0.274) |
| *MTB* | | -0.034*** | -0.069*** | 0.581** | 0.202 |
| | | (-3.776) | (-3.658) | (2.021) | (1.039) |
| *Capex* | | -0.342*** | 0.611 | 0.039*** | -0.085*** |
| | | (-3.183) | (0.921) | (3.950) | (-3.573) |
| *HHI* | | 0.250*** | -0.214*** | -0.442 | 0.246** |
| | | (3.399) | (-3.366) | (-1.001) | (2.312) |
| *HHI2* | | 0.155 | 0.626** | 0.061 | 0.093 |
| | | (1.334) | (2.371) | (0.192) | (0.605) |
| *PAC* | | 0.395*** | -0.102*** | 0.054 | 0.259*** |
| | | (3.466) | (-4.225) | (0.117) | (3.169) |
| *TMT_own* | | 0.886** | 0.259 | 0.556 | 0.098*** |
| | | (2.473) | (1.315) | (1.276) | (3.107) |
| *TMT_size* | | 0.010 | 0.302** | 0.635** | 0.294 |
| | | (0.033) | (2.127) | (2.015) | (1.338) |
| *Dir_own* | | 0.291 | 0.096* | 0.275* | 0.499 |
| | | (1.573) | (1.769) | (1.751) | (1.392) |
| *Board_size* | | -1.066** | 0.258** | 0.575** | -0.124 |
| | | (-2.412) | (2.227) | (2.078) | (-0.327) |
| *Intercept* | -0.017 | -0.012 | 0.059 | -0.121 | 0.023 |
| | (-0.401) | (-0.063) | (0.128) | (-0.276) | (0.031) |
| Firm-FE | Yes | Yes | no | Yes | no |
| Year-FE | Yes | Yes | Yes | Yes | Yes |
| Industry FE | no | no | Yes | no | Yes |
| Adj. R2 | 0.231 | 0.482 | 0.111 | 0.202 | 0.194 |
| N | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 |

This table reports the estimation results of 2SLS panel regressions where the firm process innovation, *Ratio_C* or *Ratio_P*, is regressed on the TMT conservatism predicted value, *Predicted_lev*. To obtain the predicted values, we first regress the leverage measure (*Lev*) on lagged *TMT_REP* and then use the predicted value in the second-stage regression along with all control variables in the baseline regression. Columns (2) and (4) include both firm and year fixed effects, and columns (3) and (5) include both industry and year fixed effects. The first stage regression in column (1) includes firm and year effects. All independent variables are lagged by 1 year. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all regressions are based on clustered standard errors at firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## Table 10. Results of the moderating effects of board conservatism

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* |
| *TMT_REP* | $0.199^{***}$ | $0.135^{**}$ | $0.051^{**}$ | $0.034^{***}$ |
| | (3.544) | (2.496) | (2.437) | (3.368) |
| *Board_REP* | $0.357^{**}$ | $0.776^{**}$ | 0.061 | 0.696 |
| | (2.229) | (2.241) | (0.380) | (0.344) |
| *TMT_REP×Board_REP* | $0.266^{***}$ | $0.224^{***}$ | $0.309^{***}$ | $0.189^{***}$ |
| | (4.027) | (3.655) | (3.728) | (3.811) |
| *Log(Age)* | $0.339^{*}$ | 0.626 | $0.252^{*}$ | 0.055 |
| | (1.721) | (1.442) | (1.724) | (0.115) |
| *Log(AT)* | $0.073^{***}$ | $0.165^{***}$ | 0.231 | -0.247 |
| | (3.542) | (3.520) | (1.127) | (-0.258) |
| *RoA* | -0.058 | -0.052 | 0.046 | $-0.044^{*}$ |
| | (-0.145) | (-0.046) | (0.245) | (-1.836) |
| *R&D* | 0.053 | 0.038 | -0.437 | $0.095^{***}$ |
| | (0.142) | (0.044) | (-1.521) | (3.059) |
| *MTB* | $0.005^{***}$ | $0.017^{***}$ | $0.475^{***}$ | $0.008^{***}$ |
| | (2.889) | (3.184) | (3.618) | (4.295) |
| *Capex* | -0.301 | 0.096 | -0.344 | -0.644 |
| | (-0.163) | (0.119) | (-0.481) | (-0.218) |
| *HHI* | $0.686^{***}$ | -0.015 | $0.705^{***}$ | $0.045^{*}$ |
| | (3.007) | (-0.017) | (3.473) | (1.758) |
| *HHI2* | $-0.021^{*}$ | 0.424 | -0.006 | -0.086 |
| | (-1.757) | (0.716) | (-0.119) | (-0.748) |
| *PAC* | 0.010 | -0.021 | 0.008 | $0.374^{*}$ |
| | (0.559) | (-0.427) | (0.582) | (1.734) |
| *TMT_own* | $-0.004^{*}$ | -0.006 | $-0.004^{*}$ | -0.060 |
| | (-1.887) | (-1.243) | (-1.832) | (-0.580) |
| *TMT_size* | $-0.072^{**}$ | $-0.150^{***}$ | $-0.068^{***}$ | $0.476^{**}$ |
| | (-2.297) | (-3.760) | (-2.872) | (2.181) |
| *Dir_own* | 0.242 | -0.428 | 0.102 | $0.199^{***}$ |
| | (0.400) | (-0.512) | (0.334) | (3.191) |
| *Board_size* | $0.020^{***}$ | $-0.021^{***}$ | $-0.016^{***}$ | -0.034 |
| | (3.501) | (-3.209) | (-3.445) | (-0.367) |
| *Intercept* | 0.065 | 0.273 | 0.083 | $0.195^{***}$ |
| | (0.667) | (0.779) | (1.341) | (3.131) |
| Firm -FE | Yes | no | Yes | no |
| Year-FE | Yes | Yes | Yes | Yes |
| Industry FE | no | yes | no | yes |
| adj. $R^2$ | 0.447 | 0.407 | 0.315 | 0.292 |
| N | 29,147 | 29,147 | 29,147 | 29,147 |

This table presents the estimation results of panel regression of with the interaction term *TMT_REP×Board_REP* in the baseline regression. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all regressions are based on clustered standard errors at firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## Table 11. Results of the moderating effects of environmental discretion

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | *Ratio_C* | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* | *Ratio_P* |
| *TMT_REP* | 0.040*** | 0.202** | 0.015*** | 0.011** | 0.033*** | 0.059*** |
| | (3.513) | (2.062) | (2.744) | (2.330) | (3.101) | (3.309) |
| *Industry_growth* | 0.569** | | | 0.437 | | |
| | (2.312) | | | (0.452) | | |
| *Industry_instability* | | 0.093 | | | 0.954 | |
| | | (0.413) | | | (1.463) | |
| *R&D_intensity* | | | 0.194 | | | 0.185** |
| | | | (1.557) | | | (2.409) |
| *TMT_REP×Industry_growth* | 0.304*** | | | 0.528*** | | |
| | (3.946) | | | (4.750) | | |
| *TMT_REP×Industry_instability* | | 0.209*** | | | 0.087*** | |
| | | (3.872) | | | (4.090) | |
| *TMT_REP×R&D_intensity* | | | 0.426*** | | | 0.171*** |
| | | | (5.220) | | | (3.623) |
| *Log(Age)* | 0.366 | 0.136 | -0.064*** | 0.014*** | -0.017*** | 0.487*** |
| | (1.443) | (0.932) | (-5.870) | (5.682) | (-5.040) | (3.551) |
| *Log(AT)* | 0.271 | -0.046*** | -0.074 | -0.003 | -0.997 | -0.813*** |
| | (1.036) | (-3.231) | (-0.489) | (-0.015) | (-0.747) | (-2.846) |
| *RoA* | 0.481 | -0.0745 | -0.077*** | -0.235*** | -0.940*** | -0.230 |
| | (1.560) | (-0.338) | (-7.929) | (-4.241) | (-3.221) | (-0.036) |
| *R&D* | 0.024*** | -0.261 | -0.022*** | 0.016 | 0.420*** | 0.970 |
| | (3.160) | (-1.392) | (-3.932) | (0.203) | (3.679) | (1.095) |
| *MTB* | 0.376*** | 0.107*** | -0.172 | -0.005 | 0.067 | 0.499*** |
| | (3.118) | (3.793) | (-0.872) | (-0.137) | (0.919) | (3.394) |
| *Capex* | 0.536 | 0.059 | -0.617** | 0.072** | 0.008 | 0.780 |
| | (1.219) | (0.277) | (-2.485) | (2.402) | (1.003) | (0.880) |
| *HHI* | 0.055*** | 0.901*** | 0.459 | 0.405 | 0.051** | -0.186*** |
| | (3.369) | (3.163) | (0.981) | (0.851) | (2.177) | (-3.451) |
| *HHI2* | 0.052*** | 0.619*** | 0.102 | -0.317 | -0.037* | 0.326 |
| | (3.219) | (3.038) | (1.026) | (-0.665) | (-1.983) | (0.506) |
| *PAC* | 0.201*** | 0.075 | -0.049 | -0.269*** | 0.365 | 0.112** |
| | (3.325) | (0.016) | (-1.106) | (-3.838) | (0.179) | (2.342) |
| *TMT_own* | 0.165 | -0.043 | 0.059 | -0.420*** | -0.004 | 0.175 |
| | (0.528) | (-0.739) | (0.078) | (-3.007) | (-0.045) | (0.547) |
| *TMT_size* | -0.411 | -0.070 | -0.206 | -0.863 | -0.012 | 0.718 |
| | (-0.755) | (-0.102) | (-1.267) | (-0.394) | (-1.351) | (1.625) |
| *Dir_own* | 0.291*** | 0.017*** | -0.013*** | 0.201 | 0.009** | 0.211* |
| | (3.996) | (3.680) | (-3.741) | (0.699) | (2.235) | (1.877) |
| *Board_size* | 0.029*** | 0.011*** | -0.019*** | 0.418 | -0.053 | -0.186*** |
| | (3.753) | (3.532) | (-3.169) | (1.467) | (-0.731) | (-3.566) |
| *Intercept* | 0.424 | 0.341 | 0.402*** | 0.545*** | 0.360*** | 0.216 |
| | (0.716) | (0.129) | (3.195) | (3.844) | (4.122) | (0.491) |
| Firm -FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year-FE | Yes | Yes | Yes | Yes | Yes | Yes |
| adj. $R^2$ | 0.329 | 0.303 | 0.219 | 0.374 | 0.401 | 0.330 |
| N | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 |

This table presents the estimation results of regressions with the interaction terms *TMT_REP* × *Industry_growth*, *TMT_REP*×*Industry_instability*, or *TMT_REP*×*R&D_intensity* in the baseline regression. All regressions include both firm and year fixed effects. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all regressions are based on clustered standard errors at firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## Table 12. Cross-sectional analysis of labor costs and the effects of TMT political preference on firm process innovation

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | *Ratio_C* | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* | *Ratio_P* |
| *TMT_REP* | 0.011*** | 0.018*** | 0.096*** | 0.029*** | 0.014*** | 0.043** |
| | (4.897) | (3.583) | (3.119) | (3.126) | (3.393) | (2.186) |
| *TMT_REP × ELS* | 0.037*** | | | 0.103*** | | |
| | (4.551) | | | (4.932) | | |
| *ELS* | 0.105* | | | 0.170 | | |
| | (1.742) | | | (0.893) | | |
| *TMT_REP × Labor-CostShr* | | 0.027*** | | | 0.039*** | |
| | | (3.590) | | | (4.113) | |
| *Labor-CostShr* | | 0.054 | | | 0.048** | |
| | | (0.033) | | | (2.198) | |
| *TMT_REP × Labor-to-Capital* | | | 0.148*** | | | 0.202*** |
| | | | (3.056) | | | (3.884) |
| *Labor-to-Capital* | | | 0.686 | | | 0.269* |
| | | | (1.008) | | | (1.809) |
| *Log(Age)* | 0.205 | 0.197 | -0.023 | -0.249 | -0.247 | -0.257 |
| | (0.641) | (1.428) | (-0.757) | (-0.876) | (-0.870) | (-0.903) |
| *Log(AT)* | 0.051 | -0.015*** | 0.107 | -0.238*** | -0.236 | -0.246 |
| | (0.194) | (-3.004) | (0.129) | (-2.815) | (-0.809) | (-0.840) |
| *RoA* | 0.108*** | -0.196 | -0.038 | -0.281 | -0.271 | -0.282*** |
| | (3.304) | (-0.504) | (-0.028) | (-0.915) | (-0.909) | (-2.916) |
| *R&D* | 0.761 | 0.260* | 0.004*** | -0.091 | -0.084 | -0.099 |
| | (0.863) | (1.678) | (3.848) | (-0.275) | (-0.266) | (-0.300) |
| *MTB* | 0.370*** | -0.299 | 0.583 | 0.807*** | 0.809*** | 0.800*** |
| | (3.153) | (-1.035) | (1.450) | (2.722) | (2.728) | (2.694) |
| *Capex* | 0.425 | -0.112*** | 0.142*** | 0.017 | 0.184*** | 0.632 |
| | (0.978) | (-3.649) | (2.678) | (1.029) | (3.902) | (1.122) |
| *HHI* | 0.352 | -0.006 | -0.053*** | -0.042*** | -1.214** | -0.590 |
| | (0.484) | (-0.304) | (-3.022) | (-4.045) | (-2.366) | (-0.094) |
| *HHI2* | -0.202 | 0.147 | -0.008*** | -0.729** | 0.775 | 0.483 |
| | (-0.958) | (0.114) | (-3.345) | (-2.489) | (0.325) | (1.205) |
| *PAC* | -0.156*** | -0.001*** | 0.335*** | -0.073 | 0.009 | -0.121 |
| | (-3.205) | (-3.017) | (4.468) | (-0.609) | (1.007) | (-1.222) |
| *TMT_own* | -0.548*** | -0.424*** | 0.609 | 0.028 | 0.796 | 0.360 |
| | (-3.519) | (-3.716) | (0.690) | (1.299) | (1.514) | (0.861) |
| *TMT_size* | -0.014*** | -0.160*** | -0.024 | -0.302*** | -0.634*** | -0.837*** |
| | (-3.821) | (-2.925) | (-0.255) | (-3.208) | (-4.114) | (-2.974) |
| *Dir_ own* | 0.506 | 0.611 | -0.674** | -0.130*** | -0.111*** | 0.270 |
| | (0.770) | (0.921) | (-2.560) | (-3.152) | (-3.068) | (0.364) |
| *Board_size* | 0.061*** | 0.495*** | 0.610 | -0.245*** | -0.037*** | -0.096*** |
| | (3.843) | (2.987) | (0.199) | (-3.844) | (-3.040) | (-3.204) |
| *Intercept* | 0.013 | 0.519*** | -0.089** | 0.012*** | 0.645 | 0.432*** |
| | (0.174) | (3.915) | (-2.450) | (3.848) | (1.026) | (4.100) |
| Firm-FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year-FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Adj. R2 | 0.413 | 0.404 | 0.482 | 0.223 | 0.277 | 0.286 |
| Obs. | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 | 54,764 |

This table reports the estimation results of panel regressions where the firm process innovation, *Ratio_C* or *Ratio_P*, is regressed on both *TMT_REP* and the interaction term between *TMT_REP* and labor cost measures (*ELS, Labor-CostShr* or *Labor-to-Capital*) along with the labor cost measure itself and other control variables. All regressions include both firm and year fixed effects. All independent variables are lagged by 1 year. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all Models are based on clustered standard errors at firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

**Table 13. Subsample results of the effects of TMT political preference on firm process innovation based on analyst coverage**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | High Ana_cov | Low Ana_cov | High Ana_cov | Low Ana_cov |
| | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* |
| *TMT_REP* | 0.241*** | 0.119* | 0.270*** | 0.132* |
| | (4.019) | (1.814) | (5.213) | (1.770) |
| *Log(Age)* | 0.201* | 0.016 | 0.276 | 0.500 |
| | (1.723) | (1.361) | (1.517) | (1.218) |
| *Log(AT)* | 0.034*** | 0.053*** | 0.191 | 0.284 |
| | (3.873) | (3.422) | (1.412) | (0.925) |
| *RoA* | 0.027*** | 0.122*** | -0.138 | -0.487 |
| | (3.284) | (3.154) | (-0.315) | (-0.525) |
| *R&D* | -0.009 | -0.120 | 0.410** | 0.813* |
| | (-0.215) | (-1.269) | (2.027) | (1.815) |
| *MTB* | 0.689*** | 0.783*** | -0.047 | -0.023 |
| | (3.194) | (3.921) | (-0.116) | (-0.041) |
| *Capex* | 0.081 | 0.175 | 0.376 | -0.788 |
| | (0.572) | (0.515) | (0.563) | (-0.625) |
| *HHI* | -0.008 | -0.218 | -0.036 | -0.118* |
| | (-0.909) | (-1.207) | (-0.196) | (-1.797) |
| *HHI2* | 0.177 | -0.225*** | 0.071*** | 0.354*** |
| | (0.226) | (-2.689) | (3.062) | (6.570) |
| *PAC* | -0.009 | 0.998 | -0.064** | -0.021 |
| | (-1.165) | (0.703) | (-2.335) | (-0.007) |
| *TMT_ own* | -0.381*** | -0.399*** | 0.098 | 0.670*** |
| | (-5.019) | (-5.046) | (0.627) | (6.582) |
| *TMT_size* | -0.324 | -0.331 | -0.022*** | 0.036*** |
| | (-0.836) | (-0.893) | (-3.311) | (2.897) |
| *Dir_ own* | -0.317*** | -0.362*** | -0.201*** | 0.897*** |
| | (-8.777) | (-4.991) | (-6.611) | (4.417) |
| *Board_size* | -0.200*** | -0.227*** | 0.928*** | 0.465 |
| | (-3.612) | (-3.424) | (4.534) | (1.578) |
| *Intercept* | -0.043* | -0.037 | 0.458 | 0.054*** |
| | (-1.754) | (-1.466) | (0.685) | (4.534) |
| Firm-FE | Yes | Yes | Yes | Yes |
| Year-FE | Yes | Yes | Yes | Yes |
| Adj. R2 | 0.304 | 0.219 | 0.393 | 0.205 |
| N | 27,382 | 27,382 | 27,382 | 27,382 |

This table presents estimation results of panel regressions of firm process innovation, *Ratio_C* and *Ratio_P*, on 1-year lagged TMT political preference, *TMT_REP*, with 1-year lagged firm, TMT, board, and industry level control variables, for the subsamples classified based on analyst coverage. Columns (1) and (2) report the results based on *Ratio_C*, and columns (3) and (4) report the estimation results of *Ratio_P*. All regressions include firm and year fixed effects. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all regressions are based on clustered standard errors at firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## Table 14. Subsample results of the effects of TMT political preference on firm process innovation based on institutional investor horizon

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | High InstTO | Low InstTO | High InstTO | Low InstTO |
| | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* |
| *TMT_REP* | 0.156*** | 0.054 | 0.110*** | 0.042 |
| | (3.052) | (1.318) | (3.973) | (1.531) |
| *Log(Age)* | 0.769*** | 0.704** | 0.847*** | 0.074 |
| | (3.087) | (2.463) | (3.154) | (0.438) |
| *Log(AT)* | -0.135 | 0.425 | -0.466 | -0.215*** |
| | (-0.152) | (1.457) | (-0.996) | (-3.780) |
| *RoA* | 0.726** | 0.286 | -0.205*** | -0.115*** |
| | (2.097) | (0.826) | (-3.975) | (-3.014) |
| *R&D* | -0.998*** | 0.366 | 0.928 | 0.150 |
| | (-3.550) | (1.428) | (0.157) | (0.736) |
| *MTB* | -0.145 | 0.271*** | 0.068 | -0.064 |
| | (-0.373) | (3.064) | (0.616) | (-0.463) |
| *Capex* | 0.263 | 0.481*** | -0.198*** | -0.047 |
| | (0.297) | (3.501) | (-4.615) | (-0.163) |
| *HHI* | 0.639*** | 0.536 | -0.604 | 0.177 |
| | (3.179) | (1.215) | (-0.806) | (1.036) |
| *HHI2* | 0.273 | 0.886** | -0.011*** | 0.185 |
| | (0.898) | (2.468) | (-3.748) | (1.630) |
| *PAC* | 0.164*** | 0.103 | 0.047 | -0.146 |
| | (3.530) | (0.030) | (0.401) | (-1.207) |
| *TMT_ own* | 0.340 | 0.240 | 0.023*** | -0.118 |
| | (1.535) | (0.693) | (3.278) | (-1.083) |
| *TMT_size* | 0.037*** | -0.093*** | 0.147 | 0.022*** |
| | (3.419) | (-4.433) | (0.183) | (3.713) |
| *Dir_own* | -0.236 | -0.155 | -0.258 | -0.028*** |
| | (-0.892) | (-1.171) | (-0.265) | (-3.168) |
| *Board_size* | 0.035 | 0.141** | 0.242* | -0.087 |
| | (0.109) | (2.074) | (1.793) | (-0.674) |
| *Intercept* | 0.212 | -0.260** | 0.018*** | -0.051 |
| | (1.044) | (-2.029) | (3.011) | (-0.238) |
| Firm-FE | Yes | Yes | Yes | Yes |
| Year-FE | Yes | Yes | Yes | Yes |
| Adj. R2 | 0.342 | 0.335 | 0.276 | 0.229 |
| Obs. | 27,382 | 27,382 | 27,382 | 27,382 |

This table presents estimation results of panel regressions of firm process innovation, *Ratio_C* and *Ratio_P*, on 1-year lagged TMT political preference, *TMT_REP*, with 1-year lagged firm, TMT, board, and industry level control variables, for the subsamples classified based on institutional turnover rate (*InstTO*). Columns (1) and (2) report the results based on *Ratio_C*, and coumns (3) and (4) report the estimation results of *Ratio_P*. All regressions include firm and year fixed effects. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all regressions are based on clustered standard errors at firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

**Table 15. Subsample results of the effects of TMT political preference on firm process innovation based on TMT tenure and compensation**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Long tenure | Short tenure | Long tenure | Short tenure | High compensation | Low compensation | High compensation | Low compensation |
| | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* | *Ratio_C* | *Ratio_C* | *Ratio_P* | *Ratio_P* |
| *TMT_REP* | 0.211*** | 0.023* | 0.194*** | 0.105* | 0.153*** | 0.024 | 0.246*** | 0.081 |
| | (3.175) | (1.886) | (3.209) | (1.740) | (3.089) | (1.315) | (3.071) | (1.185) |
| *Log(Age)* | 0.056 | 0.124*** | -0.210 | -0.253 | 0.038*** | 0.120*** | -0.178* | -0.451 |
| | (0.789) | (3.505) | (-1.301) | (-0.842) | (3.426) | (4.017) | (-1.794) | (-0.173) |
| *Log(AT)* | -0.013*** | -0.045*** | -0.026*** | 0.435 | -0.205 | -0.219 | -0.013 | 0.040*** |
| | (-3.941) | (-2.909) | (-2.911) | (1.489) | (-0.283) | (-0.370) | (-0.584) | (4.283) |
| *RoA* | 0.029 | 0.012 | 0.061 | 0.176** | 0.014*** | 0.042 | 0.473*** | 0.783* |
| | (0.485) | (0.853) | (0.295) | (2.240) | (3.094) | (0.132) | (3.078) | (1.761) |
| *R&D* | 0.170 | -0.050 | 0.016*** | -0.009*** | -0.271* | -0.082*** | 0.023** | -0.094 |
| | (0.455) | (-1.638) | (4.162) | (-4.647) | (-1.730) | (-3.076) | (2.274) | (-1.167) |
| *MTB* | -0.993* | 0.084* | -0.791* | -0.425 | 0.058 | 0.084* | -0.099*** | 0.498** |
| | (-1.823) | (1.784) | (-1.803) | (-1.152) | (0.021) | (1.738) | (-3.238) | (2.181) |
| *Capex* | 0.942*** | -0.375 | 0.199 | 0.648 | -0.071 | -0.005** | -0.235*** | -0.534 |
| | (3.085) | (-0.169) | (0.224) | (0.529) | (-1.042) | (-2.083) | (-3.371) | (-1.359) |
| *HHI* | 0.139 | -0.301*** | 0.241 | 0.369*** | -0.043*** | -0.469** | -0.044 | -1.378*** |
| | (0.119) | (-3.148) | (1.497) | (2.744) | (-3.178) | (-2.436) | (-0.206) | (-2.963) |
| *HHI2* | 0.619 | 0.209 | -0.726 | 0.453 | 0.090** | 0.020* | -0.083 | 0.084** |
| | (1.392) | (0.188) | (-0.492) | (1.628) | (2.332) | (1.710) | (-1.009) | (2.316) |
| *PAC* | -0.226*** | -0.361 | 0.626 | -0.036** | -0.017 | -0.048*** | 0.065 | -0.005 |
| | (-3.193) | (-0.051) | (0.802) | (-2.268) | (-1.319) | (-3.532) | (0.135) | (-1.070) |
| *TMT_own* | 0.475 | -0.068*** | 0.772*** | -0.985 | -0.024*** | -0.097 | 0.131*** | 0.204*** |
| | (0.844) | (-2.639) | (3.849) | (-1.211) | (-3.196) | (-1.164) | (3.083) | (3.009) |
| *TMT_size* | 0.688** | 0.206 | 0.319 | 0.761 | -0.185*** | 0.056 | 0.643 | 0.746 |
| | (2.412) | (0.664) | (0.011) | (0.859) | (-3.863) | (0.491) | (0.580) | (0.394) |
| *Dir_ own* | 0.417** | 0.510*** | 0.101*** | 0.370*** | -0.084 | -0.649* | -0.290 | -0.234 |
| | (2.465) | (2.944) | (3.283) | (3.151) | (-0.373) | (-1.892) | (-1.076) | (-0.012) |
| *Board_size* | 0.381 | -0.397 | 0.174 | 0.425 | -0.179** | -0.183** | -0.350*** | -0.046*** |
| | (1.100) | (-0.902) | (0.613) | (0.967) | (-2.289) | (-2.365) | (-2.790) | (-3.037) |
| *Intercept* | 0.854* | 0.418 | 0.209 | -0.511** | -0.046*** | -1.814*** | 0.215 | -0.190 |
| | (1.780) | (1.273) | (1.482) | (-2.344) | (-2.882) | (-3.205) | (0.741) | (-1.028) |
| Firm-FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year-FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adj. R2 | 0.379 | 0.321 | 0.376 | 0.385 | 0.274 | 0.209 | 0.218 | 0.224 |
| N | 27,382 | 27,382 | 27,382 | 27,382 | 27,382 | 27,382 | 27,382 | 27,382 |

This table presents the subsample estimation results of panel regressions of firm process innovation, *Ratio_C* and *Ratio_P*, on 1-year lagged TMT political preference, *TMT_REP*, with 1-year lagged firm, TMT, board, and industry level control variables. Columns (1)-(4) are the results based on subsamples classified by tenure and Columns (5)-(8) are the results based on subsamples classified by compensation. All regressions include firm and year fixed effects. All variables are defined in the Appendix. The t-statistics are shown in parentheses. The t-statistics for all regressions are based on clustered standard errors at firm level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## Appendix

| Variables | Definitions |
|---|---|
| *Process_C* | Calculated as the log of one plus the process claims number contained in all patents filed (and ultimately awarded) by the firm in each year. |
| *Product_C* | Calculated as the log of one plus the non-process claims number contained in all patents filed (and ultimately awarded) by the firm in each year. |
| *Process_P* | Calculated as the log of one plus the citation-weighted number of process patents filed (and ultimately awarded) by the firm in each year. Citations received are counted, for each patent, over the period that ends three years after the patent award year. Process patents are patents that contain only process claims. |
| *Product_P* | Calculated as the log of one plus the citation-weighted number of non-process patents filed (and ultimately awarded) by the firm in each year. Citations received are counted, for each patent, over the period that ends three years after the patent award year. Non-process patents are patents that contain only non-process claims. |
| *Ratio_C* | Calculated as the ratio of the process claim number to the total claim number of a firm in each year. |
| *Ratio_P* | Calculated as the ratio of the citation-weighted number of process patents to the total patents of a firm in each year. |
| *TMT_REP* | Calculated as pay-rank weighted cycle-average donation-based indexs of top five managers. First, the cycle-specific political orientation measure is calculated as the difference between his or her contributions to the Republican Party and the Democratic Party divided by the total contributions to both parties during a 2-year election cycle. Then, we used the mean of all election cycles. Finally, we assign weights that vary inversely with the ExecuComp salary rank around TMT members to calculate *TMT_REP*. |
| *PPE* | Gross property, plant and equipment. |
| *Tan* | Asset tangibility is measured as [0.715 × receivables + 0.547 × inventories + 0.535 × PPE + (cash and short-term investments)]/total assets. |
| *Lev* | Calculated as total debt (long-term debt and debt in current liabilities) divided by book value of total assets. |
| *Log(Age)* | The natural logarithm of the number of years since the firm first appeared in the CRSP database. |
| *LogAT* | The natural logarithm of the total assets. |
| *RoA* | Annual return on assets, defined as the ratio of income before extraordinary items (IB) to total assets. |
| *R&D* | The R&D expenses scaled by total assets. |
| *MTB* | Market value of assets scaled by the book value of total assets. |
| *Capex* | Capital expenditures scaled by total assets. |
| *HHI* | Herfindahl-Hirschman Index, calculated as the sum of sales revenue scaled by sales for four-digit standard industrial classification (SIC) code. |
| $HHI^2$ | The square of the variable *HHI*. |
| *PAC* | A binary variable with a value of 1 when a firm contributes more money to Republican than Democratic, and 0 otherwise. |
| *TMT_own* | TMT stock ownership, calculated as percentage of shares held by TMT members. |
| *TMT_size* | Number of TMT members. |
| *Dir_own* | Director stock ownership, calculated as percentage of shares held by independent directors. |
| *Board_size* | Measured as the total number of directors. |