UNIVERSITA' COMMERCIALE "LUIGI BOCCONI"

PhD SCHOOL

PhD program in Business Administration and Management

Cycle: 32

Disciplinary Field (code): SECS-P/10

Essays on Strategic Information Disclosure, Innovation, and Human Capital

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Year 2022

INTRODUCTION

I am interested in studying innovation management strategies by firms. Specifically, in the context of public firms, I investigate: (1) How do firms strategically use vague language in documents such as patents to protect their innovation efforts? and (2) How do agency conflicts shape these strategies? In my research, I use a combination of Python algorithms and empirical approaches such as instrumental variables and difference-in-differences. My research is necessary because the financial and strategic implications of language are becoming increasingly prominent in business settings such as (patent) lawsuits; however, until recently, this has been relatively under-theorized in management studies. In particular, firms scrutinize rivals' documents for understanding rivals innovation and competitive efforts. By strategically manipulating language, firms can maintain competitive advantage over their rivals.

In the first chapter, we investigate how firms capture value from CEOs' human capital. We argue that mobility constraints of CEOs (e.g. founder status and proximity to retirement) shape this dynamic in firms. We test our predictions on public firms in the US. Our paper contributes to strategic human capital literature and to the discussion on how labor market imperfections can be a source of competitive advantage for firms.

In the second chapter, we examine how conflicts between shareholders and CEOs determine vagueness in innovation-related documents (patents). On the one hand, institutional investors want patents to be less vague because they promote transparency and want to avoid future litigation risk; on the other hand, CEOs want patents to be vaguer because of competitive pressures. We focus on patents owned by US public firms and find that institutional ownership promotes transparency in patents. This relationship is stronger when misalignment between the long-termism of institutional investors and CEOs increases. Our results show that institutional investors are not only involved in innovation activities but also in how firms craft and

disseminate information about these activities. Our assessment is central to understanding the drafting of patents from a strategic perspective.

In the third chapter, we explore the role of firm status in negative interactions and their financial impact on firms. Status literature has typically explored the benefits of high-status. We argue that high-status also induces competitive pressure among firms and that firms strategically use their status to harm their high-status rivals. Our context is patent litigations in the US. Our findings contribute to status literature in particular on strategic use and negative implications of high-status.

When do firms capture value from CEOs?

ABSTRACT

We examine the relationship between CEOs' contributions to value creation and firm's value capture. Findings demonstrate that firms vary in their ability to capture value generated from CEOs' human capital. We explain this through supply-side and demand-side mechanisms. On the supply-side, we find that firms that capture value generated from CEOs opt to reward CEOs through shares for non-monetary pay and have CEOs who are founders. On the demand-side, we find that firms are unable to capture value generated from CEOs when their CEOs are close to retirement. This study is among the first to measure firms' value capture from CEO's human capital and link it with mobility constraints.

Keywords: Firm Value Capture, CEO Human Capital, Mobility Constraints

INTRODUCTION

CEOs have unique styles and abilities that shape how a firm's resources are deployed (Bertrand and Schoar, 2003). In spite of a substantial variation in estimates of the CEO effect on firm performance, even the smallest estimates would lead us to conclude that CEO human capital affects their firms' ability to create value beyond organizational routines, capabilities or industry membership (Fitza, 2014, 2017; Mackey, 2008; Quigley and Graffin, 2017). While the differential contribution of CEOs' to value creation has been explored, the extent to which CEOs and firms capture value remains unclear (Wright, Coff, and Moliterno, 2014). CEOs do not necessarily capture value in direct proportion to the value they create. For example, Angelo Mozilo, CEO of Countrywide Financial, was paid $470 million immediately before the firm collapsed when the US housing bubble burst. He not only destroyed shareholder value, but also disproportionately captured value. In this study, we investigate various factors (mobility constraints) that determine the extent to which CEOs capture the value they create.

An existing literature explores the relationship between firm performance and CEO pay (Tosi *et al.*, 2000). However, most of the studies in this literature use firm performance as a proxy for CEO value creation rather than the effect of CEOs on performance. A more recent stream of research has examined the effect of CEOs on firm performance and suggest that the CEO effect may explain from 5% to over 35% of the firm's performance (Hambrick and Quigley, 2014; Quigley and Graffin, 2017). While this is quite significant, one would not expect that CEO pay would be closely aligned with overall firm performance. Rather, it should back out other factors such as the economy, industry profitability, and path dependent firm capabilities that are beyond the CEOs control. This presents a tougher CEO compensation problem for firms that may exacerbate misalignment of value creation and value capture by CEOs. This may be addressed by linking the effect of CEOs on firm performance, i.e. CEO value creation, with CEO pay, i.e. CEO value capture. This approach has been used to link

value creation and value capture by store-level managers (De Stefano, Bidwell and Camuffo, 2017).

It is theoretically important to assess the degree to which firms over- or under-capture value that CEOs create. First, it is often implicit in the strategy literature that market mechanisms recognize the distinct value generated by CEOs' human capital (Castanias and Helfat, 2001). Second, if there is mismatch between value creation and value capture, this could represent either a source of competitive advantage (with firms able to extract human capital rents) or an extra cost (as CEOs gain more than what they contribute) (Chadwick, 2017). What determines these labor market frictions? Mechanisms, such as demand- and supply-side mobility constraints, generate these frictions and allow firms or CEOs to over- or under-extract rents from general human capital of CEOs (Call and Ployhart, 2020; Campbell, Coff, and Kryscynski, 2012). Constraints at the demand-side force CEOs to stay as they do not have outside options, whereas at the supply-side, CEOs choose to stay with their firms.

We use mixed-model specifications (Lazear, Shaw, and Stanton, 2016) to estimate differences in the contribution of CEOs to firm value creation and then link these estimates with demand- and supply-side mobility constraints. We analyze a sample of public US firms between 1992 and 2019 and find that while value capture by firms increases with supply-side constraints such as CEO share ownership in the firm and CEO's founder status, it decreases with demand-side constraints such as CEO's proximity to retirement age. Collectively our results contribute to the research investigating firm value capture from managerial human capital (Call and Ployhart, 2020; Wright *et al.*, 2014), linking managerial effect on value creation with managerial pay (De Stefano, Bidwell and Camuffo, 2017), labor market frictions (Campbell *et al.*, 2012).

THEORY

Value creation in firms and variation in CEO human capital

CEOs have unique management styles and abilities that explain different financial outcomes and organizational practices of a firm (Bertrand and Schoar, 2003). Financial markets recognize this and react positively (negatively) when a firm replaces a low-ability (high-ability) CEO with a high-ability (low-ability) CEO (Demerjian, Lev, and McVay, 2012). Interestingly, even strategic human resource management literature has indirectly supported this line of research showing that, among all the high performing human resource management practices, those that are ability enhancing have a stronger effect on performance (Jiang *et al.*, 2012). In the past, special emphasis was given to the firm-specific nature of managerial human capital, with a specific focus on the interaction between managerial skills and firm processes to create value (Carpenter and Fredrickson, 2001; Finkelstein and Hambrick, 1996). More recently, this emphasis was dampened with studies offering a more nuanced view of the degree of portability of CEOs' human capital (Groysberg, McLean, and Nohria, 2006) and underlying how institutional factors affect CEOs' human capital evaluation by board of directors (Peng, Sun, and Markóczy, 2015).

Studies of managerial human capital converge on the conclusion that managers such as CEOs matter and differ in their ability to create value (Bertrand and Schoar, 2003; Holcomb, Holmes Jr, and Connelly, 2009; Mollick, 2012). Findings about the extent of CEOs' impact varies, in part, due to different empirical approaches adopted (Bertrand and Schoar, 2003; Hambrick and Quigley, 2014). Some studies conceptualize CEO's ability as the human capital accumulated by managers over their career histories, and operationalize it using proxies like experience (job and company tenure, diversity of functional background), education (year, number and type of degrees, filed/discipline diversity), and past performance (Carpenter and

Fredrickson, 2001; Holcomb *et al.*, 2009). They seek to identify managerial skills and processes that are more relevant to value creation (Holcomb *et al.*, 2009) and empirically test which ones are positively related to firm performance (Finkelstein and Hambrick, 1996; Miller and Shamsie, 2001). Their findings show that CEOs differ in their contribution to value creation because of the differences in abilities such as using and recombining firm resources (Holcomb *et al.*, 2009), and managing relationships with subordinates, and customers (Hitt *et al.*, 2001).

Other studies aim at estimating the marginal contribution of CEOs to value creation (Bertrand and Schoar, 2003), beyond contextual factors such as the firm processes (Mollick, 2012), and the subordinates' characteristics (Lazear *et al.*, 2016) and the performance effect of randomness (Fitza, 2014, 2017; Quigley and Graffin, 2017). These studies identify CEOs' marginal contribution to performance by observing the effect of CEOs' moves across firms (Bertrand and Schoar, 2003). In line with these studies, this paper exploits CEOs' mobility across firms to estimate the differences in the marginal effects of CEOs on firm performance, i.e. value creation, (Hambrick and Quigley, 2014; Quigley and Graffin, 2017) and link it with CEO pay, i.e. value capture, (De Stefano, Bidwell and Camuffo, 2017).

Firm-CEO bargaining leverage

As previously mentioned, scholars generally agree that CEOs vary in their contribution to create value for firms. However, how these differences in managerial contribution to value creation map onto differences in managerial value capture through pay remains unclear.

A stream of strategy research on human capital assumes that differences in CEOs' ability to create value for their employers are well-reflected in pay differences (Becker, 1980; Belliveau, O'Reilly III, and Wade, 1996; Castanias and Helfat, 2001; Kaplan, 2008a, 2008b; McGuire, Chiu, and Elbing, 1962). This happens through labor markets where differences in

CEO's human capital translate in differences in contribution to value creation, i.e. marginal CEO productivity across firms, and get reflected in pay (Becker, 1980). The next-best wage that a CEO can get from other firms is equal to the CEO's productivity outside the focal firm (Mahoney and Kor, 2015). Thus, assuming a CEO is well-matched to a firm, pay should (at least) equal the next-best wage of the CEO. CEOs negotiate their wage with their firms; these wages reflect variation in CEO's contribution to value creation for the firm. If CEO pay is below the next-best offer, it is assumed that the CEO will quit unless the firm increases CEO pay. If CEO pay is above the next-best offer, the firm would decrease it. In theory, this adjustment process allows firms to capture value from the human capital of CEOs and motivate them to stay at the firm (Chadwick, 2017). CEOs who differ in their ability to contribute would have different next-best offers and eventually, pay would adjust to reflect this (Bertrand and Schoar, 2003; Harris and Helfat, 1997).

Mobility constraints

A recent stream of strategic human capital research has theoretically challenged the idea that labor markets correctly value human capital and that firm specificity is the sole determinant of labor market frictions (Campbell *et al.*, 2012). In particular, supply-side mobility constraints result from a CEOs' reluctance to leave a firm while demand-side mobility constraints imply that demand for CEOs decreases because of the firm-specificity of their ability to create value for firms (Becker, 1980). Demand-side and supply-side factors may generate frictions in the labor markets that allow firms to pay managers below their marginal productivity. Conversely, demand-side and supply-side factors might prevent firms from correctly assessing the value of CEOs' human capital and possibly pay CEOs more than their marginal productivity.

This new approach not only suggests that labor market frictions do not necessarily derive from the firm-specificity of skills (Coff and Raffiee, 2015; Morris *et al.*, 2017; Raffiee and Coff, 2016), but also that firms and CEOs can strategically create or manage them, e.g. through compensating differentials (Gambardella, Panico, and Valentini, 2015). Overall, this stream of research posits that CEOs and firms might asymmetrically share the value that CEOs create and proposes that firms may extract more or less of the extra value that CEOs create through their general human capital contingent upon the characteristics the human capital and the degree of competitiveness of the labor market (Molloy and Barney, 2015).

As their ownership in their firms increases, CEOs create more value for their firms (Adams and Santos, 2006; Kale, Reis, and Venkateswaran, 2009). Share ownership can change the incentives of the CEOs by aligning them with the firm's (Kroll *et al.*, 1997; Von Lilienfeld-Toal and Ruenzi, 2014). Furthermore, as their ownership in the firm increases, CEOs have a long-term orientation and are invested in the firm's long-term future (Aggarwal and Samwick, 2006). Because of their increased investment in the firm, CEOs are unlikely to look for outside options. Over time, they may become increasingly less aware of their outside options. Taken together, as their share ownership increases CEOs may become increasingly likely to accept a wage below their marginal productivity and not look for alternatives outside.

Moreover, as their ownership increases, CEOs incur greater costs to move to other firms. This may result from a combination of things. First, they may incur substantial cost to exit (part of) their position from the firm. When they divest from their firm a substantial amount of shares need to be sold; this may drive the share price down and result in financial loss for the CEOs if they decided to move. Moreover, CEOs with high levels of ownership are more sensitive to leave the firm as most of their wealth is concentrated in their respective firms (Walters, Kroll, and Wright, 2008). Second, these CEOs might have to reset their outlook by

emotionally withdrawing from their association with the firm and commit to another firm, resulting in higher psychological costs for CEOs who move.

Thus, increasing share-ownership increases mobility costs for CEOs. In this situation, CEOs are less willing to look for alternatives and move even if they receive wage below their next-best wage. As previously mentioned, since CEOs voluntarily stay with their firms, retaining them is not costly for firms. Additionally, since they have compensation differentials these CEOs are likely to create value for their firms despite not receive a wage that is equal or greater than their marginal revenue product. Therefore,

Hypothesis 1*: Increase in share ownership of CEOs increases firm value capture*

CEOs who have (co-) founded their firms identify with their firms, have strong attachment and commitment to their firms, and closely link their personal success with their firms' (Carroll, 1984; Dobrev and Barnett, 2005; Donaldson and Davis, 1991). Relatedly, they have a strong intrinsic motivation to pursue strategies that maximize shareholder value rather than concentrating on short-term or "quiet life" actions (Fahlenbrach, 2009). Taken together, this suggests that founder CEOs are less willing to even consider leaving their firms. Therefore, they have higher information asymmetry due to which they are unaware of outside options and also have greater mobility costs. This may be due to several reasons: because of their high identification with their firms, moving to another firm will incur considerably high costs as the new firm may be unable to imitate a similar level of identification.

Next, since founder CEOs have a long-term orientation, e.g. increased innovation efforts (Lee, Kim, and Bae, 2020) and commitment to the firm (Adams, Almeida, and Ferreira, 2009), with their firms; to change that orientation and move to another firm may not be worth the monetary rewards that they may receive from a move. Finally, since they link their personal

success with their firms, other firms may not be able to offer them a comparable compensation package (Campbell *et al.*, 2012). Therefore, even if they receive lower monetary compensation for their efforts, founder CEOs are unlikely to consider moving to another firm.

Founder CEOs also have a better fit with their firms as their firm culture and routines are heavily by them. CEOs who identify themselves with their organization perceive their success with their organization's (Mael and Ashforth, 1992). Therefore, founder-led firms offer compensation differentials to their CEOs. Since the firm reflects them and they are embedded in the firm, founder CEOs would consider staying with the firms (Mitchell *et al.*, 2001). Moreover, in their perception leaving their firms would involve making big psychological sacrifices (Kiazad *et al.*, 2015). Furthermore, because of their fit with their firms, founders are unwilling to move from their firms (Morley *et al.*, 2007).

All these mechanisms are likely to align the interests of the firm with those of founder CEOs. Founder CEOs continue to make efforts to create value for their firms while not seek to appropriate value for their efforts. Founder CEOs have a lower willingness to move to other firms even if they can get better financial compensation. Instead they continue at their firms and their firms capture the value that they generated through their human capital. Therefore:

Hypothesis 2*: Presence of founder CEOs increases firm value capture*

Literature on labor economics and finance argues that employees' preferences to continue working versus taking retirement seem to change rapidly at age 65 (Jenter and Lewellen, 2015). Finance literature also reports a spike in CEO turnovers when they are at 65 and departure rates continue to stay high after age 65 (Weisbach, 1995). If the preference of CEOs to work over leisure declines as they approach retirement age, then their propensity to extract value from their firms should gradually increase as these CEOs increasingly focus on

short-term gains (Dechow and Sloan, 1991). As CEOs approach retirement they prioritize their gains over their firms' (Gibbons and Murphy, 1992). Since committing efforts to create value for their firms typically involve extra costs, which may continue in the future, to the CEO, CEOs who are near the end of the careers would care less about making such investments and in the firm's long-term future (Simsek, 2007).

Moreover, as CEOs go closer to retirement, they have fewer outside options. Therefore, this may be their last chance to appropriate value. Thus, they would likely try to capture value from the firm. Since the preference of CEOS changes from work to leisure as they grow closer to retirement, firms may have to offer them substantial compensation to convince them to work for the firm. Furthermore, since firms perceive these CEOs to have unique skills specific to the firm, firms may pay these CEOs substantial more than their marginal productivity. This may exacerbate the problem as CEOs decrease their effort to value creation as they grow closer to retirement age. As firms are unable to accurately evaluate alternatives, they continue to overpay their CEOs despite not necessarily creating value for the firm. Therefore, as they grow closer to retirement age not only do CEOs contribute less to creating value for their firms but firms also pay these CEOs for their unique expertise. Thus:

Hypothesis 3*: CEOs proximity to retirement age decreases firm value capture*

DATA AND METHODS

We build a sample by combining data from various sources. First, we start with the universe of listed US companies as reported in COMPUSTAT. COMPUSTAT contains comprehensive financial and accounting information of public firms. Second, we obtain data on CEO attributes from Execucomp. Third, we complement data on CEO attributes with data from BoardEx.

Following the sampling approach from studies on CEOs (Quigley and Graffin, 2017): First, we excluded firms that belong to SIC codes beginning with 6 and 9. Second, we removed firms that had assets less than $20 million. Third, we removed firms that had return on assets as well as net income in the 1st and 99th percentiles. Fourth, we excluded firms operating in financial sector. Finally, we removed firms that had only one CEO during the period of our study, CEOs that spent less than two years in office, and CEOs whose age was in the 99th percentile. Therefore, our final sample covers the years 1992 to 2019 and includes almost 26,000 observations.

Analytical approach

The main goal of our study is to investigate whether firms are able to appropriate value from CEOs and the factors that strengthen or weaken it. More specifically, we consider Net Income as the measure of value creation in firms. Since Net Income is the value left with the firm after paying various resource providers such as suppliers, partners, government, and its employees (including the CEO and top management) we can measure the value CEOs create for their firms on top of what they receive as their pay in exchange for their efforts. Next, we measure the variation in Net Income that is attributable to the CEO.

Recent studies have identified issues analysis such as bias from number of observations and inability to distinguish CEO effect from randomness when using ANOVA in variance decomposition analyses (Fitza, 2014, 2017; Quigley and Graffin, 2017). Quigley and Graffin (2017) recommend using mixed methods when using variance decomposition analyses to estimate the effect of CEOs in value creation i.e. firm performance. Consistent with studies in this field (Hough, 2006; Misangyi *et al.*, 2006), we calculate variation in firm value creation that is attributed to the CEO effects by using Multi-Level Modeling (MLM). First we use an unconditional model, which is a three-level model with yearly CEOs nested in firms, and firms

nested in industries. We use the variance estimates from this model to calculate the relative effect sizes for industry, firm, and CEO by dividing the respective variance component by the total variance.

Second, we use a growth model since we want to measure the effect of CEOs on value creation in firms. We do so by including time effects at the lowest level i.e. CEO level. More specifically, we use Net Income as the dependent variable and CEO tenure as the time variable. We estimate variance among CEOs in their ability to contribute to firm value creation by using mixed effects regressions of firm value creation, Net Income, and also include CEO pay and year fixed effects. Our unit of analysis is CEO i in firm j in industry j at year t (Lazear *et al.*, 2016).

The mixed effect regression for value creation and value capture is modeled as:

$$Y_{ijkt} = \alpha + \beta_1 \text{Tenure}_{ijkt} + \beta_2 \text{CEO Pay}_{ijk} + \theta_t + \theta_{1k} + \theta_{2j} + \theta_{3i} + \theta_{4i}\text{Tenure} + \epsilon_{ijkt} \quad (1)$$

Y is value creation in firm j in industry k with CEO i at time t. θ_{1k} denotes industry-level random effects, which take different values for each industry (random intercept for each four-digit SIC code). θ_{2j} represents firm-level random effects (i.e. random intercept for each firm). θ_{3i} denotes CEO-level random effect that takes different values for different CEOs (random intercept for each CEO), θ_{4i} shows a random effect that measures the effect of CEO on performance over time (random slope for each CEO), and ϵ_{ijkt} is the error term whose value varies with a combination of industry, firm, CEO, and time. For a CEO i in firm j in industry k at time t: Tenure is the number of years in office and CEO pay is total compensation measured by the variable TDC1 from Execucomp.

In mixed effect models, individual values of random effects are assumed to have a normal distribution in which the mean is zero and the standard deviation is estimated by the mixed effect models (Baayen, Davidson, and Bates, 2008; Rabe-Hesketh and Skrondal, 2008).

This approach can estimate the component of variation in performance and pay that is determined by the CEO after controlling for sources of variation at the industry and firm levels (Abowd, Kramarz, and Roux, 2006). CEO effects θ_{3i} (random intercept) and θ_{4i} (random slope) measure differences in firm value creation, i.e. net income, among CEOs after considering the effects of industry, firm, and random variation. If CEOs increasingly differ in their contribution to value creation in firms, then the variation at the level of CEOs estimated in the mixed effect regressions increases. On the other hand, if CEOs do not differ in their contribution to firm value creation, then the variation at the level of CEOs would not significantly differ from zero.

In the above models, we measure firm income and CEO pay in millions of dollars. Therefore, the random effects at the CEO level variation for Net Income are also in millions of dollars. We measure the value that a frim captures from its CEO as a combination of the random intercept and random slope that we obtain from the mixed models estimations.

We compute firm value capture from CEO using the following equation

$$\text{Firm value capture}_{it} = \theta_3 + \theta_4 \text{Tenure}_{it} \quad (2)$$

Now that we have a measure of firm value capture from its CEO, we investigate mobility constraints at the supply- and demand-sides at the CEO-level that change value capture by firms. We use test our predictions by using the following model:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 A_{it} + \pi_i + \epsilon_{it} \quad (3)$$

In the above equation, Y is the firm value capture, X is our independent variable, i.e. mobility constraint. The vector A contains firm level controls. We add fixed effects at the CEO level (π) to reduce concerns of omitted factor bias. We test our main predictions by using an OLS regression with clustered standard errors at the CEO and year level, which account for serial correlation and heteroscedasticity in the structure of residuals.

Dependent variable

We measure firm value capture from CEO as the random effects at the level of the CEO from the mixed effects regressions. For a firm, this variable measures the deviation of its net income from the sample mean. A large value suggests that it is doing a much better job relative to an average firm at capturing the value that its CEO creates. Conversely, a small value implies that the firm is doing worse relative to an average firm at capturing value from its CEOs.

Explanatory variables

Our explanatory variables measure supply-side and demand-side mobility constraints. At the supply-side, we measure CEO's reluctance to move through two variables: shares owned in the firm and the founder status. We measure share ownership in terms of percentage while for the founder we create a dummy variable set equal to one if the CEO is a (co-) founder of the firm. Data on the CEO (co-) founder status comes from BoardEx.

At the demand-side, we measure mobility constraints by CEOs' proximity to retirement age (Jenter and Lewellen, 2015). We measure it through four dummy variables: First, age greater than 66 set to one if the CEO is older than 66 years in a given year. Second, retirement age set to one when CEO's age is between 64 and 66. Third, age between 59 and 63 set to zero if the CEO is not in that age group. Fourth, age less than 54 if the CEO is younger than 54 years of age.

Control variables

We include firm-level controls such as firm size (natural logarithm of a firm's assets), market valuation (market to book ratio), investment (measured as ratio of capital expenditure to total assets), and profitability (i.e. return on assets). As previously mentioned, we control for time invariant attributes of a CEO by including CEO fixed effects. These would include important

measures of CEO human capital such as industry as well as professional experience before becoming the CEO, education background, elite education, and career path.

RESULTS

We report the descriptive statistics for our variables of interest in Table 1. The data is at the CEO-year level. On average, a firm is unable to capture $4 million of the value generated by its CEO. An average firm reports $296 million in net income and pays its CEO $5.25 million. At the CEO-level, an average CEO is about 56 years old and owns about 2.2% of a firm's shares. Around 6% of the CEOs are founders.

INSERT TABLE 1 HERE

In Figure 1, we present the yearly averages of the variables of interest: firm value capture from the CEO, CEO pay, and Net Income of a firm. An average firm is unable to capture value created by its CEO while CEO value capture through pay tends to stay stable. In some cases firms on average pay their CEOs more than they are worth; however, they also pay their CEOs less than they are worth.

INSERT FIGURE 1 HERE

In Table 2, we report the results of the mixed models specification in which we investigate variance decomposition of Net Income at different levels: industry, firm, and CEO. In Column (1), which reports the unconditional mean model, the variance estimates are significant at all the three levels. In Column (2), we add the CEO tenure to Column (1), i.e. a growth model, and the likelihood ratio test reports that the growth model, random slope and random intercept, is a better fit than the random intercept model reported in Column (1). In Column (3), we report the linear growth model. In Column (4), we report the model with CEO tenure, CEO pay, and year fixed effects. We use the random effects at the CEO level from this model as our variable of interest: firm value capture. We report the percentage of variance at different levels in Table 3: consistent with research that focuses on variance decomposition at the CEO level (Mackey, 2008; Quigley and Graffin, 2017) we find that CEO's account for about 20 – 25% of the variance in firm performance.

INSERT TABLE 2 HERE

INSERT TABLE 3 HERE

In Table 4, we report the results of OLS regressions that investigate the relationship between mobility constraints and firm value capture after including firm-level controls and CEO fixed effects. In Column (1), which tests CEO share ownership (i.e. a supply-side mobility constraint), reports a positive association between CEO share ownership ($\beta = 2.20$, $p < 0.01$). We interpret this as a percentage point increase in share ownership of CEOs increases firm value capture by $2.2 million, i.e. a 47.6% of the sample mean.

In Column (2), we test another supply-side mobility constraint, i.e. founder status of the CEO, and find a positive relationship between the founder status of CEOs and value capture by their firms ($\beta = 20.71$, $p < 0.10$). Firms led by founder CEOs capture $20.7 million more (4.48 times the sample mean) than those led by non-founder CEOs. Even though we include CEO-fixed effects, the result that founder CEO has a statistically different effect from zero suggests that founder CEOs may leave their firm and found another firm.

In Column (3), which tests CEO retirement age, a demand-side mobility constraint, reports a negative relationship between CEOs' retirement age ($\beta = - 23.46$, $p < 0.05$) and firm value capture. Moreover, we find a positive relationship ($\beta = 22.74$, $p < 0.01$) between younger CEOs and value capture in firms. When CEOs are around retirement age, firm value capture decreases by $23.46 million, i.e. 5.1 times the sample mean); however, when CEOs are younger, firm value capture increases by $22.74 million, i.e. 4.92 times the sample mean).

INSERT TABLE 4 HERE

Robustness checks and additional analyses

In Column (4) of Table 3, we check for a linear relationship between CEO age and firm value capture: CEO age has a negative association ($\beta = - 3.98$, $p < 0.01$) with firm value capture. Firms each lose about $4 million of the value created by their CEOs as they age by a year. In Column (5) of Table 3, we test an alternative explanation that age has a quadratic relationship with firm value capture rather than the retirement age explaining decrease in firm value capture. In this model, we do not find support for a quadratic relationship between CEO age and firm value capture.

In Table 5, we investigate an alternate computation of standard errors. We cluster standard errors at the CEO, firm, and fiscal year levels. Doing so, would allow correlations among observation at the year, firm, and CEO levels. After doing so while the standard errors generally increase, the results stay statistically significant and support those of Table 3.

INSERT TABLE 5 HERE

INSERT TABLE 6 HERE

DISCUSSION

Our findings further question the boundary conditions of the relationship between value creation deriving from CEOs' individual human capital and value capture by CEOs through pay assuming that their individual human capital is general enough to be highly portable across employers. As described above, mainstream literature on strategic human capital would argue that CEOs should capture the full value of their general human capital. However, a more recent stream of literature would instead argue that supply-side and demand-side labor market factors might prevent firms from capturing the full value from their CEO's general human capital (Campbell *et al.*, 2012). The estimations presented in Table 2 and 3 allowed us to show the existence of significant variation in value creation for firms at the level of the CEO. However, these estimations are not informative about the actual distribution of these random effects. In order to understand to what extent firms and/or CEOs might over- or under-capture the value

CEOs generated through their general human capital, we predicted random effects for the CEO in order to get an estimate of their actual degree of value creation.

We then proposed and tested mobility constraints that determine the amount of value that firms capture from their CEOs. Supply-side mobility constraints explain the phenomenon that CEOs who contribute more stay in firms and accept a wage below their next-best offer. Firms capture the value generated from CEO human capital and do not compensate CEOs based on their human capital. CEOs may not want to move despite lower pay because of compensation differentials such as satisfaction from working for the firm, better fit with their firms, higher search and mobility costs, and commitment to their firms. Increasing share ownership makes CEOs more committed with their firms. Moreover, they may associate their long-term future with their firms' so they increase their efforts to value creation but at the same time do not push for higher pay in return. Another supply-side mobility constraint consists of founder CEOs who may find moving and working to another firm difficult after having such a good fit with the firms that they founded. Taken together, supply-side mobility constraints increase CEO's commitment to firms and increase opportunities for the firm to capture value from CEO's human capital.

Alternatively, demand-side mobility constraints may explain firms overvaluing the human capital of CEOs for reasons related to management compensation practices. Firms fail to penalize low contributing CEOs for poor contribution to value creation and sometimes they may not only escape penalties but also capture some value from the firm. We test CEOs' proximity to retirement age. As their CEOs grow closer to retirement, firms are unable to capture value from that CEOs create through their human capital. We explain this by lack of outside options for older CEOs but moreover, older CEOs tend to prefer leisure to working. Moreover, given their experience, older CEOs may be perceived to have greater expertise that makes replacing them difficult. Therefore, firms overpay these CEOs more than they are worth.

On the other hand, firms extract more value from younger CEOs. We explain this finding by younger CEOs have a longer career ahead of them and may need to demonstrate strong results to negotiate a better compensation package or to move to a better firm.

Limitations and future research

One of the main limitations of our study could be the generalizability of our results. Our research setting has data for CEOs from different firms, but our data has only one level of executives. Multi-firm database of executives at different levels with information on their value creation and pay would be an important contribution to future research. Focusing on lower-level or middle-managers may provide cleaner measures of value capture in firms. Doing so may offer a more precise measure of managerial effect on firm value creation. While the CEOs have effect on firm performance but its magnitude has been debated in recent literature (Fitza, 2014, 2017; Hambrick and Quigley, 2014; Quigley and Graffin, 2017). Studies focusing on lower-level managers may be better able to overcome this issue.

Another limitation is that we examine the shares that a CEO owns in a firm, which is endogenous to firm performance. An alternative measure of CEO's reluctance to move could be their geographical preferences. For example, if a CEO grew up and lived for a long time in locations geographically close to the headquarters of the focal firm, the CEO may be more reluctant to move or relocate to another firm.

An extension to our study can investigate the differences in these CEOs that are not captured by traditional measures of human capital. For example, by using text analysis techniques on CEOs communication, studies can investigate the supply side constraints that make high contributing CEOs stay in their current firms despite having lower compensation. Another promising avenue would be to investigate the dynamics of value capture in family

firms by comparing family firms led by family CEOs with those led by professional CEOs. Finally, another perspective that can improve this study can be to examine the role of compensation consultants as well as head-hunters. These may increase CEO's awareness to outside options as well as search costs to move to another firm.

CONCLUSION

In this study, we examine the relationship between the contribution of CEOs to value creation and mobility constraints that may influence CEOs contribute to value creation for their firms. Our findings demonstrate that CEOs contribute to value creation in their firms; however, the extent to which firms capture this value varies with attributes of CEOs that serve as mobility constraints. Our findings contrast with the predictions of the traditional human capital theory. Our study has four main contributions. First, our findings have implications for the recent debate about how firms can capture value from managerial human capital (Campbell *et al.*, 2012; Chadwick, 2017). Through our analysis, we can calculate how much value CEOs capture from their general human capital (Campbell *et al.*, 2012).

Second, we contribute to the literature that analyzes the effect of CEOs on value creation (Bertrand and Schoar, 2003). Third, we contribute to the literature on strategic human resource management that focuses on designing effective pay and performance systems (Gerhart, Rynes, and Fulmer, 2009). Fourth, we contribute to the resource-based view of the firm, in which we highlight cases in which managerial human capital is a source of competitive advantage for a firm and those cases in which it is not.

Our findings suggest that there is a misalignment between contribution to value creation and value capture at the top level. This finding is consistent with the argument that at certain positions managers disproportionately appropriate the value created from human capital

(Blyler and Coff, 2003). In our findings, we identify CEOs and firms that have misalignment between CEO contribution to performance and CEO pay (determined by their CEO human capital).

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TABLES AND FIGURES

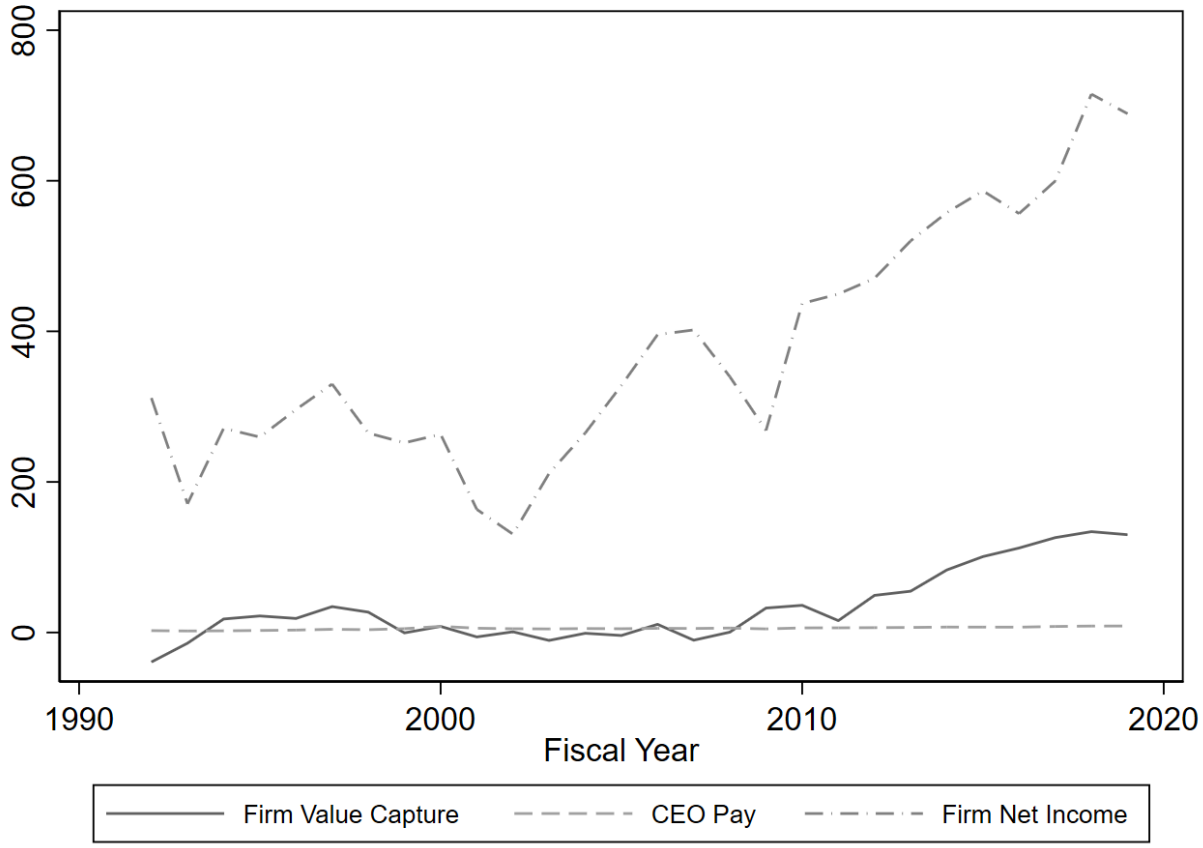

Figure 1. Yearly Distribution of Variables

Table 1. Descriptive statistics

	N	Mean	SD	P25	P50	P75	P95	Min	Max
Firm Value Capture	25672	-4.62	326.55	-140.2	-58.12	38.22	532.86	-1593	3108.11
Net Income	25672	296	681	16.1	76.59	278.02	1550.39	-1102	5248.2
Firm Controls									
Firm Size	25672	6337	14680	647	1865.9	5800.8	27655	21.57	479922
Market to Book	25672	1.46	2.03	0.58	1.01	1.75	4.02	0	105.03
Capex/Assets	25672	0.05	0.05	0.02	0.04	0.07	0.15	0	0.82
ROA	25672	4.27	8.69	1.89	4.83	8.53	15.71	-56.7	26.39
CEO Attributes									
Total Pay	25672	5.25	9.19	1.5	3.27	6.54	15.27	0	655.45
Age	25672	55.82	6.93	51	56	60	67	29	85
Age squared	25672	3164	783.9	2601	3136	3600	4489	841	7225
Age >= 67	25672	0.05	0.22	0	0	0	1	0	1
Ret Age (64-66)	25672	0.06	0.24	0	0	0	1	0	1
Age 59-63	25672	0.23	0.42	0	0	0	1	0	1
Age <= 53	25672	0.36	0.48	0	0	1	1	0	1
Tenure	25672	6.30	6.47	2	4	8	19	0	54
Shares owned (%)	17475	2.19	5.48	0.15	0.43	1.36	12.20	0	79.47
CEO Founder	9532	0.06	0.29	0	0	0	1	0	1

We obtain firm value capture as a residual measure from mixed models estimations

Table 2. Mixed model specification to examine variation in firm value creation

Dependent variable: Net Income				
	(1)	(2)	(3)	(4)
CEO tenure			16.34***	3.92***
			(13.44)	(1.08)
CEO pay				3.22***
				(1.22)
Variance Decomposition				
Industry	40029.93	36844.50	37439.74	39010.11
	(9120.84)	(8632.77)	(17402.20)	(16904.90)
Firm	206147.00	158257.80	159484.80	174803.40
	(10175.49)	(9310.82)	(29805.52)	(30878.18)
CEO				
CEO	127787.90	171358.80	172127.20	140258.50
	(4169.70)	(6134.01)	(24172.37)	(20804.82)
CEO –Tenure		3181.81	2880.47	2553.18
		(148.42)	(527.69)	(527.76)
Residual	122416.40	90998.12	91085.43	89882.24
	(1158.24)	(867.40)	(12033.71)	(11713.03)
Year Dummies	No	No	No	Yes
Observations	26548	26548	26548	26425
Wald chi2			180.66	407.29

Clustered Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3. Variance decomposition of firm value creation

Dependent variable: Net Income	
Level	% Variance
Industry	8.07 %
Firm	41.53 %
CEO	25.74 %
Unexplained	24.66 %

These estimates are obtained from Column (1) of Table 2.

Table 4. Firm value capture based on CEO attributes

Dependent variable: Firm Value Capture					
	(1)	(2)	(3)	(4)	(5)
CEO % shares (no options)	2.204***				
	(0.664)				
CEO Founder		20.71*			
		(10.90)			
Age >= 67			-38.90*		
			(21.15)		
Ret Age (64-66)			-23.46**		
			(10.71)		
Age (59-63)			-8.313		
			(6.389)		
Age <= 53			22.74***		
			(7.237)		
CEO age				-3.980***	-3.600
				(1.070)	(8.703)
CEO age squared					-0.00338
					(0.0773)
CEO Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes
Observations	16976	9532	25211	25211	25211
Adjusted R2	0.914	0.885	0.872	0.872	0.872

Clustered Standard Errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Clusters: CEO and Firm

Table 5. Firm value capture based on CEO attributes. Alternate computation of SE

Dependent variable: Firm Value Capture					
	(1)	(2)	(3)	(4)	(5)
CEO: % shares (no options)	2.204***				
	(0.687)				
CEO age		-3.980***	-3.600		
		(1.108)	(8.866)		
CEO age squared			-0.00338		
			(0.0786)		
Age >= 67				-38.90*	
				(20.69)	
Ret Age (64-66)				-23.46**	
				(11.20)	
Age 59-63				-8.313	
				(6.536)	
Age <= 53				22.74***	
				(7.099)	
CEO Founder					20.71*
					(11.87)
CEO Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes
Observations	16976	25211	25211	25211	9532
Adjusted R2	0.914	0.872	0.872	0.872	0.885

Clustered Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Clusters: CEO, Firm, and Year

Table 6. Moves for individual CEOs

	Founder		Total
Moves as CEO	0	1	
0	1122	37	1159
1	76	56	132
2	2	1	3
Total	1200	94	1294

An Agency Perspective on the Strategic Drafting of Patents

ABSTRACT

We examine how agency relationships between the CEO and the shareholders affect the textual transparency of a firm's patents. Developing arguments on the (dis)advantages of disclosure over time, we hypothesize that institutional ownership promotes transparency in a firm's patents. We expect this effect to be particularly salient in the presence of incentive misalignments between (long-term) institutional owners and the firm's management, due to CEOs' short-term career concerns and awareness of the strategic advantages of withholding innovation-related information. Analyzing the textual properties of around 200,000 US patents, we find empirical support for our theoretical contentions. Collectively, our results suggest that agency relationships influence not only the extent of innovation activities but also the way in which companies craft and disseminate information about such activities.

Keywords: Institutional investors; CEOs; Vagueness; Patents; Disclosure

INTRODUCTION

A long tradition of scholarship has suggested that the quality of agency relationships within the firm matters for corporate strategies. In particular, several works in this field have studied how CEO and owners' incentives can affect investment strategies (e.g., Amihud and Lev 1999; Zajac and Westphal 1994). A class of owners that has lately received significant attention is that of institutional investors, which have amassed growing portions of equity in public firms around the world (Bebchuk *et al.*, 2017). The presence of institutional investors in a firm's equity has been shown to promote several processes that ameliorate agency problems within the firm and thus improve firm performance (McCahery *et al.*, 2016; Field and Lowry, 2009). Importantly, the governance role of institutional ownership is not confined to active investors but can also arise from passive funds, which often exert an influence through large voting blocs (Appel *et al.*, 2015; Hshieh *et al.*, 2021).

Existing evidence indicates that the positive impact of institutional ownership on value-enhancing activities is particularly strong for innovation variables like R&D (Bushee, 1998; Wahal and McConnell, 2000), product development (Kochhar and David, 1996), patenting (Aghion *et al.*, 2013) as well as exploration strategies (Connelly *et al.*, 2018). A key mechanism behind these results is that institutional owners spur innovation through their commonly held long-term incentives, which curb problems of managerial short-termism typically associated with underinvestment in innovation (Zhang and Gimeno, 2016; Cremers *et al.*, 2020).

In this paper, we argue that institutional owners not only affect the *level* of innovation (in its variants, from R&D to patents) but also the way in which a firm crafts and disseminates information about its innovation activities. Specifically, we set to examine for the first time

how ownership by institutional investors affects the textual content of a firm's patents, i.e. how vague is the language used in drafting the patent documents.[1]

Firms rely extensively on the patent system to capture value from their innovative efforts (Teece, 1986; Cockburn *et al.*, 2016). The patent system is set to both provide innovation incentives by granting intellectual property rights and disseminate knowledge through the publication of patent documents (Hall et al., 2014). Thus, patents provide significant information to a broad set of parties including competing firms, which often monitor available patent datasets to scrutinize the technological moves of rivals (Aristodemou and Tietze, 2018). Consistently, Kim and Valentine (2021) show that greater mandatory patent disclosure increases the pace of innovation by the rivals of the disclosing firm. By crafting a patent document in a *vague* manner, a firm can make its competitors less able to decipher the technological nature of its innovation activities and thus engage in imitation or predatory actions. However, due to a more blurred definition of the underlying technology and its legal boundaries, a vague patent (in terms of its textual properties) may provide a more fragile legal protection, which may in turn lead to: (1) a greater risk of patent invalidation (Boothe, 2015), and (2) a lower predictability of the outcome of a lawsuit. Importantly, a firm faces these risks far away in time: the average patent lawsuit is filed about 10 years after patent application. The costs of vagueness for society might loom large. Blurred patent claims have indeed been associated with the upsurge of patent lawsuits in recent decades (Bessen and Meurer, 2008) and legal scholars have suggested that vagueness may not only hamper the development and teaching functions of patent documents but can also distort infringement systems (Chakroun, 2020). In our data, we find an economically significant association between patent vagueness and the risk of patent invalidation.

[1] We refer to vagueness as "the use of linguistic means to make communication less precise in meaning and impossible to paraphrase precisely" (Channell, 1994; Guo et al., 2017).

Drawing on these notions we argue that, in drafting their patent documents, firms would face an intertemporal tension between using a vague language in order to manage current competitive pressures vis-à-vis using a transparent language in order to obtain a higher legal protection and thus minimize invalidation risk in the long run. Institutional investors play a key role in shaping this tradeoff as they typically influence a firm's information environment (Ajinkya *et al.*, 2005; Bushee and Noe, 2000), change the nature of the agency relationships with executives (McCahery *et al.*, 2016), and ultimately impact on a firm's innovation processes. In particular, we posit that institutional ownership affects patent vagueness as a result of a discrepancy between the time-horizon of institutional investors and that of CEOs (Zhang and Gimeno, 2016). While patent lawsuits are, on average, filed about ten years after a patent application, CEOs spend around 6 years at a given firm (Jenter and Lewellen, 2015). An opportunistic CEO may thus be able to reap the short-term strategic benefits of patent vagueness (not necessarily via direct actions but also through their broad influence on the organization) while avoiding the private costs of patent invalidation lawsuits (direct litigation costs, negative stock market reaction, reputational damage), that typically manifest in the long run. In contrast, institutional investors often embrace a long-term perspective, and have enough power and incentives to discipline an opportunistic management (Boone and White, 2015; Ajinkya *et al.*, 2005; Pukthuanthong *et al.*, 2017). These arguments suggest that, by constraining CEOs' opportunism and excessive focus on short-term goals, institutional ownership would promote transparency (i.e. decrease vagueness) in a firm's patents. To validate this mechanism, we explore how CEO characteristics shape the relationship between institutional ownership and patent vagueness.

Several works have argued that founder CEOs exhibit a strong attachment and commitment to their firms, and closely link their personal success with their firms' long-term prospects (Carroll, 1984; Dobrev and Barnett, 2005; Donaldson and Davis, 1991). This

intrinsic motivation lengthens the time-horizon of their decision-making (Fahlenbrach, 2009), which, in turn, implies that the effect of institutional ownership on patent vagueness is muted for founder CEOs. Next, we look into CEO's educational background. In particular, we focus on CEOs who have obtained a degree from law schools and argue that such a background makes CEOs overly confident about their ability to successfully deal with legal issues (Goodman-Delahunty *et al.,* 2010) and better able to grasp the legal advantages of strategic drafting of patents. This suggests that a CEO's legal background will be positively associated with patent vagueness. Institutional owners, in turn, will have stronger incentives to ameliorate the divergence between CEOs and long-term investors' incentives toward patent transparency.

We test our hypotheses on a rich dataset covering around 200,000 patents filed by US listed firms from 1980 to 2006. For each of these patent documents, we use linguistic analysis to construct a text-based measure of vagueness. We find support for our baseline hypothesis that institutional ownership is negatively associated with patent vagueness. This result holds controlling for several characteristics at the patent level, such as citations, scope, originality, claims and the number of figures, which proxy for a patent's quality and its underlying technological complexity, as well as for firm characteristics such as size, profitability, capital expenditures, the presence of a law firm, market valuation, and industry. To facilitate a causal interpretation, we use the instrumental variable approach based on the Russell and 1000 and 2000 reconstitutions (e.g., Boone and White 2015; Appel et al. 2016) which largely confirms that institutional ownership decreases patent vagueness. Then, testing our moderation hypotheses, we find evidence that institutional ownership reduces patent vagueness mostly when the CEO is non-founder and when he/she holds a law degree. Finally, to validate our argument on the different time-horizon between CEOs and institutional owners, we show that institutional ownership decreases patent vagueness only when the investors have a long-term orientation (i.e. low portfolio turnover).

In a set of additional analyses, we further find that the effect of institutional ownership on patent vagueness is stronger when the firm is subject to high product market competition (computed using the measure in Hoberg & Phillips, 2016). Moreover, we focus on the role of CEO tenure to examine the notion that CEOs early in their tenure (who arguably expect to spend a longer time in the firm) would have a longer time-horizon, and this in turn should weaken the influence of institutional investors on patent vagueness. Our data provide support for this argument.

Collectively, our work expands literature on the importance of agency relationships for firms' decision-making (including strategic disclosure) as well as literature on the organizational and strategic implications of institutional ownership. Our key message is that agency relationships between CEOs and owners matter not only for the extent of technological activities but also for how companies craft and disseminate information about such activities. Our assessment is thus central to understanding the drafting of patent documents from a strategic perspective. In the discussion section, we will elaborate on our findings from a regulatory and managerial perspective.

THEORY AND HYPOTHESES

Before theorizing about the mechanisms linking institutional owners and CEOs' incentives to patent vagueness, we offer an overview on the governance role of institutional investors and their impact on corporate outcomes.

Institutional investors and corporate actions

Institutional investors own a big chunk of outstanding equity of US corporations (Parrino *et al.*, 2003). Often, they have access to information that is typically unavailable to other investors (Gillan and Starks, 2007), which, in parallel with their significant equity holdings (and hence

voting power) and long-term time horizon, makes them well positioned to orient the firm's top management toward shareholders' long-term wealth (Holderness and Sheehan, 1988; Hoskisson *et al.*, 1994). Research has shown that institutional owners often undertake significant "behind the scene" governance interventions (McCahery *et al.*, 2016) and use the threat of liquidating their equity position (McCahery *et al.*, 2016) to discipline the firm's management (Parrino *et al.*, 2003). For instance, Chung *et al.* (2002) demonstrate their role in controlling earnings manipulation.

While there are differences in their time horizon, recent works argue that even those institutional investors classified as passive investors (like index funds) do play a relevant role in disciplining short-term opportunistic management. Along this line, Appel et al. (2015) show that passive owners influence firms' governance by increasing board independence, lowering takeover defenses, and equalizing voting rights. Other works have shown that passive owners' voting behavior on governance issues is similar to the one of active owners (Hshieh et al. 2021) and that passive owners facilitate the activism of other investors (Appel et al. 2019).

Institutional owners have also been shown to affect the type of strategies and activities that the companies undertake (Gilson and Kraakman, 1991; Smith, 1996) and shareholders' decision-making processes (Sundaramurthy, 1996). In particular, the evidence indicates that institutional owners influence CEO compensation (David *et al.*, 1998), strategic turnaround (Filatotchev and Toms, 2006), but also more specific strategic decisions such as corporate R&D spending (David *et al.*, 2001), exploration (Connelly *et al.*, 2018), CSR activities (Dyck *et al.*, 2019) and patents (Aghion *et al.*, 2013). With regard to patent and R&D, which are especially pertinent to our study, the existing literature has shown that there are positive effects of institutional ownership.

Institutional investors and patent vagueness

The extent to which a firm can reap the benefits of its innovation depends on appropriability mechanisms (Teece, 1986), among which patents are perhaps the most notorious one (Cockburn, *et al.*, 2016; Galasso and Schankerman, 2015; Somaya, 2012). Patents provide the right to exclude others from using an invention for a limited duration in exchange of disclosing the knowledge behind the invention (Hall *et al.*, 2014). Disclosure is thus a crucial component of the patent system because it sets the foundation for follow-on inventions (Scotchmer, 1991) and informs other innovators so as to minimize the risk of infringement (Chakroun, 2020). At the same time, disclosing information in a patent document may help the rivals of the patenting firm to develop competing innovation projects which may undermine a company's positioning and competitive advantage. There is indeed evidence that mandatory patent disclosure reduces the innovator's advantage (Kim and Valentine, 2021). This tension explains why in many circumstances innovating firms prefer to protect their innovation through secrecy rather than patents (Kultti *et al.*, 2007; Png, 2017).

As patent-based market intelligence proliferates (Aristodemou and Tietze, 2018), companies are developing strategies to reduce the downsides of patent disclosure. One such approach is the use of vague language in patent documents in order to minimize the disclosure of information that can be used by rivals.[2] Linguistic vagueness can make rivals less capable of deciphering the technological nature of a firm's innovation activities and thus limit their ability to imitate the patented innovation. In addition, vagueness could help broaden the scope of the legal protection conferred by patents (Arinas, 2012), which is another channel through which vague language might keep rivals at bay. Vague language plagues patent documents

[2] Inventors are not those who draft a firm's patents. In large corporations, this is often done by internal patent attorneys in collaboration with patent engineers (who understand both the technology and the patent system, but do not hold a law degree). Patent attorneys often report to the Business Development unit rather than the R&D unit. Some firms outsource patent filing to law firms. In our dataset, around 43% of the patents report the name of a law firm.

(Arinas, 2012). According to a patent attorney at a major European company interviewed by one of the authors, "the burden imposed by the legal language is in sharp contrast with the precision of the technical language used by inventors to such an extent that inventors often have a hard time to recognize their own inventions."[3] The use of vague language for strategic purposes is not confined to patents and is often found in other corporate documents like survey responses about environmental sustainability (Fabrizio and Kim, 2019), annual reports (Guo *et al.*, 2017) and legal texts (Li, 2017). In this realm, Guo *et al.* (2017) document how airline companies intentionally manipulate various dimensions of their annual reports in order to deter new entrants and decrease information spillovers.

These advantages notwithstanding, vagueness in patent documents comes at a cost. A more blurred definition of a firm's technologies and their legal boundaries in patent documents may increase the risk of patent invalidation and raise uncertainty about the outcome of potential lawsuits. Indeed, the patent document should inform those skilled in the art of the invention with *reasonable certainty* (Boothe, 2015). Nautilus Inc. v. Biosig Instruments Inc. provides an illustrative example of these potential risks. Biosig had sued Nautilus, its competitor, for allegedly infringing a heart-rate monitor patent granted in 2005. While the District Court and the Court of Appeals for the Federal Circuit found that the patent was valid in favor of Biosig, the Supreme Court on June 2, 2014, ruled unanimously that Biosig's patent was too vague to meet patentability standards. More in general, research has shown that firms are concerned about the risk of lawsuits as a consequence of vague language in contracts (Choi and Triantis, 2010) and that they seek to minimize the risk of litigation by raising the accuracy the information disclosed to the public (Humphery-Jenner *et al.*, 2019). As we will show later, we find an economically significant association between patent vagueness and the risk of patent invalidation.

[3] Phone interview held on May 15th, 2020. Name kept anonymous for confidentiality.

Choosing the optimal degree of linguistic vagueness in a patent, therefore, entails a tradeoff between the benefits of lower imitation risk vis-à-vis the costs of higher invalidation risk. Importantly, these two risks manifest over a different time horizon.[4] Usually, imitation concerns are a function of an industry's current competitive dynamics. Typically, imitation efforts start to kick in as soon as a patent document is published, which occurs 18 months after filing if the patent is not granted before. Imitation likely generates additional competitive pressures that result in lower margins and/or reduced market share, whose effects are amplified by financial markets, which are typically short-termed. Evidence shows that early mandatory patent disclosure benefits rivals and penalizes the patenting firm (Kim and Valentine, 2021). To the contrary, invalidation concerns arise much later in time and are less likely to be anticipated by analysts and financial markets. For instance, in our data, the average patent lawsuit is filed about 10 years after a firm has applied for a patent (see Figure 1). Despite their late occurrence in time, patent lawsuits represent an important burden for firms. The direct costs have been estimated to be between $1 million and $6 million.[5] Arguably, the total costs are much higher. Event studies have shown that a firm's share price decreases by around 2-3% after a lawsuit is announced (Bhagat *et al.*, 1994) and, on average, there is a drop in firm value by $28.7 million during a lawsuit (Bessen and Meurer, 2012). More in general, allegations of wrongdoing make firms face significant financial losses and reputational damage (Pontikes *et al.*, 2010), difficulties in procuring resources (Weber *et al.*, 2009), and weakening of relationships with suppliers (Jensen, 2006), customers (Jonsson *et al.*, 2009) and employees

[4] If vagueness is pushed to the limit, the patent granting process might fail altogether or be seriously delayed. In unreported analyses, we found some evidence of a positive correlation between patent vagueness and grant delays. This is another risk of patent vagueness that we do not analyze here because it does not affect the intertemporal tradeoff central to our theoretical mechanism.

[5] American Intellectual Property Law Association (Report of the Economic Survey, 2011). This is an estimate of the legal costs and it is independent of the outcome of the litigation. The estimated costs are an increasing function of the total value at stake.

(Sullivan *et al.*, 2007). Even if the court decision may eventually be favorable, a firm defending its patent in court has to incur these losses before the verdict is given.

A natural implication of these arguments is that a decision-maker with a short-term horizon that heavily discounts the future will care more about the risk of imitation and less about the risk of invalidation. This, in turn, will tilt his/her preference towards patent vagueness. By contrast, a decision-maker with a long-term horizon will tend to more carefully assess the risk of patent invalidation and thereby choose a lower level of patent vagueness. As anticipated, there is significant evidence that executives often engage in short-term actions that are detrimental to long-term value (Graham *et al.*, 2005). For instance, Cremers et al. (2020) show that a short-term orientation leads to cuts in long-term investment and increased short-term earnings. In turn, this generates boosts in equity valuations that are, however, reversed over time. The general discussion on short-termism goes in parallel with recent evidence that the average CEO serves the company for 5-6 years. Such a short job horizon tends to magnify career-concerns making a CEO more likely to engage in actions that increase short-term performance, rather than actions aimed at reducing risks, such as those of patent invalidation, which threaten the firm's value in the long-term.[6] By contrast, as argued above, institutional owners tend to have a longer time-horizon. They do, as the CEO, like to keep competitors at bay and thus understand the benefits of greater vagueness. However, compared to the CEO, institutional owners weigh much more the long-term costs and thus prefer a lower level of patent vagueness. In short, a greater share of institutional ownership in a firm's equity will curb

[6] Importantly, CEOs do not have to be actively involved in patent drafting for this argument to hold true: The effect may come, more generally, from the influence of CEOs on the direction of the firm, which orients the behavior of actors who carry out specific tasks within the firm. We envision CEOs putting pressure on the Business Development unit to meet revenue targets and expand the firm's market share. Patent attorneys work closely with the Business Development unit to define the scope of patent claims. Thus, the chain of transmission goes from the CEO to the Head of the Business Development unit to the patent attorneys. Institutional owners may influence this process by influencing the CEO (via direct actions or voting pressure) or, indirectly, by engaging with board members and other executives.

executives' tendency to pursue short-term benefits, and will thus be positively associated with transparency in patent documents.

***Hypothesis 1*:** Institutional ownership is negatively associated with patent vagueness.

The role of CEO characteristics

A rich literature has investigated the effect of CEO traits on firm-level outcomes, such as leverage and investment (Bertrand and Schoar, 2003; Malmendier and Tate, 2005), innovation (Galasso and Simcoe, 2011) and ultimately firm performance (Bennedsen *et al.* 2020; Mackey, 2008). We draw from this literature to investigate how two key CEOs' characteristics, namely their founder status and educational background, interact with institutional investors to shape the intertemporal tradeoff between the risk of imitation and the risk of patent invalidation.

Founder CEOs

In Hypothesis 1, we have argued that because, on average, CEOs tend to prioritize short-term results (Graham *et al.*, 2005) while institutional investors display stronger preferences for long-term outcomes (Bushee, 1998), the latter tend to influence top executives to decrease vagueness in their firms' patents. Of course, not all CEOs (and institutional investors) are equally short- (or long-) term oriented, i.e. the time (in) consistency between CEOs' and institutional owners' time horizon may vary significantly. Here, we posit that CEOs who have (co-) founded their firms would feature a longer time orientation as compared to non-founder CEOs.

Our arguments rely on the notion that founder CEOs tend to identify with their firms, have strong attachment and commitment to the company, and closely link their personal success with that of the firms they lead (Carroll, 1984; Dobrev and Barnett, 2005; Donaldson and Davis, 1991). As a result, they have a strong intrinsic motivation to pursue strategies that maximize shareholder value rather than concentrating on short-term or "quiet life" actions that

generate personal benefits (Fahlenbrach, 2009). Since they are in office for much longer than non-founder CEOs (in our data, the tenure of founder CEOs is more than three times longer than that of non-founders, i.e. 17 years on average) and also own more equity than they do (Nelson, 2003), founder CEOs tend to be more sensitive to long-term threats to their firms' value. All these mechanisms are likely to align the interests of institutional investors with those of founder CEOs and, in turn, attenuate the direct effect of institutional investors on patent vagueness.

By contrast, non-founder CEOs are expected to behave more consistently with the arguments theorized in Hypothesis 1. They will be more likely to shape their organization so as to meet short-term performance targets by cutting long-term investments, demonstrate their success to analysts and other stakeholders, negotiate better contracts within their firms, and even get better job offers from other firms. As non-founder CEOs typically spend a relatively short time-spell in a firm (e.g., Jenter and Lewellen, 2015), they are keen to make their firms pursue the short-term benefit of innovation by disclosing less information, i.e. increasing vagueness, in their patents and thus keeping imitators and rivals at bay (Guo *et al.*, 2017). However, by doing so they expose their firms to the risk of future lawsuits for patent invalidation, which, as argued, increases with the level of vagueness in firms' patents. In such firms, institutional investors will need to exert a stronger monitoring and governance effort to pressure the CEO to pursue strategies that increase transparency and, thus, increase shareholder value over the long term.

> ***Hypothesis 2:*** A CEO's non-founder status will positively moderate the negative association between institutional ownership and patent vagueness.

Lawyer CEOs

The literature on top management teams shows that the educational background of executives may significantly influence their firms' outcomes and behaviors (Finkelstein *et al.*, 2009). For instance, CEOs with advanced business degrees induce their firms to implement more energy efficient policies (Amore *et al.*, 2019) and improve firm performance by adopting riskier business models (King *et al.*, 2016) while CEOs with legal degrees tend to decrease voluntary disclosure of information (Lewis *et al.*, 2014). Because both the drafting of patent documents and patent lawsuits are activities that demand a strong legal understanding, we focus on CEOs with legal background.

We shall argue that institutional owners will need to exert more aggressively their monitoring and governance role when the CEO has a legal background. First, compared to other CEOs, CEOs with legal background are expected to be more aware of the opportunities provided by the strategic drafting of corporate documents to obfuscate key information to rivals. Given their legal expertise, they are also more likely to be heard by patent attorneys, who are materially in charge to draft patent documents, or influence the top management to whom the patent attorneys respond. In other words, if they like to do so, CEOs with a law degree are more likely to play an active role in shaping the information content of their firms' patents. Second, in addition to the above-mentioned argument that patent litigation occurs, on average, about 10 years after a firm has filed the patent application, which is considerably longer than the average CEO's tenure in a firm, there is empirical evidence suggesting that individuals with a legal background tend to be highly confident in their ability to reach certain goals in legal disputes (Goodman-Delahunty *et al.*, 2010). A higher confidence in the ability to deal with legal issues makes CEOs with a law degree likely to prioritize the strategic advantage of withholding information over the expected cost of vagueness.[7] As argued, institutional

[7] Our data confirm that a CEO's law background is positively associated with the likelihood of litigation.

investors would instead value transparency and firms' long-term prospects. Accordingly, we expect institutional ownership to have a larger transparency effect in firms led by CEOs with law background, who may use their expertise to strategically influence the drafting of patents to derive benefits at the expense of a higher exposure to long-term hazards.

> ***Hypothesis 3:*** A CEO's legal background will positively moderate the negative association between institutional ownership and patent vagueness.

DATA AND METHODS

To test our theory, we build a sample by merging data from different sources. First, we start with the universe of US listed companies as reported in Compustat, which contains comprehensive accounting and financial information. Second, we get information on institutional ownership from Thomson Reuters and complement it with data from 13-F forms (from the SEC's EDGAR database), which public firms are required to submit to the SEC. Third, for each of these firms we extract patent documents from the USPTO website. We supplement this data with information from the NBER patent dataset (Hall *et al.*, 2001), which contains rich data including a patent's application and grant date, number of claims, technological classes, and citations.

We combine data on patents, institutional ownership, and financial measures by using the matching file provided by the NBER patent dataset (Bessen, 2009). After removing observations with missing values in our main variables (described below), the final dataset contains 262,025 patents and 3,177 unique US listed firms for the period 1980-2006.[8]

[8] While the NBER patent dataset covers the period 1976-2006, data on institutional investors start in 1980 and this explains the time-span of our sample. In some regressions, we further restricted the analysis to the period 1992-2006 because data on CEOs' individual characteristics start in 1992.

Dependent variable

Our main variable of interest captures the level of linguistic vagueness in a patent document. To operationalize this variable, we use the list of vague expressions developed by Arinas (2012). This study randomly selected 350 US patents and made a list of the vague expressions that occur most frequently in such sample (see Appendix A for details). This approach has been used in other works such as Kim (2019) and Amore (2020). Using a Python algorithm, we rely on the above list to identify and count the number of vague expressions in all patents filed by our sample firms. For each of these patents, we divide the number of vague expressions by the total number of words and thus create our dependent variable (*Percentage of Vague Expressions*). Our interpretation is that the number of vague expressions proxies for the effort of the patent drafting agent to limit the disclosure of the relevant information and broaden the boundaries of the claims with the goal of keeping an edge over rivals. For the baseline results, we compute the percentage of vague expressions using the entire patent document. While information might be disclosed throughout the entire patent document, the claims define the scope of the legal protection. We will later show that the vagueness in claims is highly correlated with vagueness in other portions of the patent document.

Explanatory variables

Our main explanatory variable is the percentage of shares owned by institutional investors. We aggregate the quarterly data on institutional ownership into yearly data by taking the average of the quarterly data.

To test our second and third hypotheses, we need information at the CEO level. First, we identify if CEOs have (co-)founded the firms where they currently serve as the CEO. Since we are interested in Non-Founder or Professional CEOs, we create a dummy variable set equal to 1 if the CEO is *not* a (co-) founder and zero otherwise. Second, we measure a CEO's legal

background through a dummy variable, which we set to 1 if the CEO has a law degree, and zero otherwise. Data on both CEO education and (co-) founder status come from BoardEx.

Control variables

We include controls at both firm and patent level. At the firm level, we control for profitability (i.e. return on assets, computed as the ratio of earnings before interest and taxes scaled by the book value of total assets), size (natural logarithm of a firm's assets)[9], investment (ratio of capital expenditures to total assets), capital-to-labor ratio (natural logarithm of property, plants and equipment scaled by employees), and market valuation (market value of equity to the book value of equity). These controls are apt to capture the fact that firms with varying degrees of performance and investment opportunities may have different incentives to file vaguer patents.

At the patent level, we control for a patent's originality and scope, truncation-adjusted forward citations, number of claims, and number of figures. Originality and scope account for a patent's technological breadth, citations account for differences in patent quality, the number of claims accounts for the stringency of legal boundaries, and the number of figures aims at capturing the underlying technological complexity. Generally, these controls are useful to alleviate the omitted-factor concern that institutional ownership influences vagueness by affecting other key aspects of patents. For a patent *i*, we measure originality as:

$$\text{Originality}_i = 1 - \sum_{j}^{n} s_{ij}^2$$

where s_{ij} is the percentage of the citations that a patent *i* makes from a technological class *j*; hence, new patents that cite more patents from a broader range of technological classes will have a higher originality score (Hall *et al.*, 2001). We measure the scope of a patent as the natural logarithm of the number of words in its first claim (Kuhn & Thompson, 2019): patents

[9] Results are unchanged if we measure firm size by the natural logarithm of sales rather than total assets.

that have longer claims have a narrow scope. Additionally, we also include a dummy variable set to 1 if a law firm is listed on the patent of a focal firm.

Empirical analysis

Our baseline hypothesis maintains that institutional ownership will be negatively associated with the use of vague expressions in a firm's patents. We test this prediction by estimating the following model:

$$Y_{i,p,t} = \beta_0 + \beta_1 X_{i,p,t} + \gamma_2 A_{i,t} + \gamma_3 B_{p,t} + \delta_i + \theta_t * \pi_j + \in_{i,p,t} \quad (1)$$

where Y is the percentage of vague expressions in the patent document *p* of the firm *i* at time *t*, and X is our main independent variable, i.e. the percentage of institutional ownership in a firm's equity. The vector A contains firm-level controls (described in the previous section), while the vector B contains patent-level controls. We also add a set of fixed effects to further reduce concerns of omitted factor bias: δ_i are firm fixed effects, θ_t are year dummies, and π_j industry fixed effects (at the 3-digit SIC level). Including firm fixed effects removes constant heterogeneity across firms, while the interaction between year and industry dummies controls for industry-time trends. We test our main prediction by using OLS regressions with clustered standard errors at the firm level, which account for serial correlation and heteroskedasticity in the structure of residuals.

RESULTS

We report the descriptive statistics for our variables of interest in Table 1. Notice that our dataset is at the patent level. As shown, the share of institutional ownership on average amounts to about 55% with a standard deviation of 19%.[10] An average patent makes 18 claims, includes

[10] Notice that these figures are computed from our regression sample at the patent level (while institutional ownership varies at the firm level). At the firm-level, the average of institutional ownership is 40% and the standard deviation is 25%. To account for this feature, our standard errors are always clustered at the firm level.

6 figures, and about 1.7% of its text is made up of vague expressions. At the CEO-level, 89% of CEOs are non-founders, and about 7% of them have a law degree.

We report the correlation among patent characteristics in Appendix B. As shown, there is a positive and fairly high correlation (0.67) between vagueness in claims and vagueness in the entire patent document. We also find a small but positive correlation between vagueness and scope. Like Kuhn & Thompson (2019), longer first claim suggests a narrower scope. So higher values of the measure of patent scope suggest a narrow scope.

INSERT TABLE 1 HERE

In Figure 1, we present filing years and lawsuit years (for patents involved in invalidation attempts), whereas in Figure 2 we compare the distribution of the number of years between patents' filing and lawsuit with the distribution of CEO tenure (in years). Because of data availability, the years in which patent lawsuits are filed range from 2003 to 2016. The figure reports a substantial lag between the filing year of patents and the year in which they are sued for invalidation, i.e. invalidation risk is more of a long-term hazard for firms. Taken together, these figures provide support to the notion that patent lawsuits for invalidation often do not occur during the tenure of CEOs who were in office when firms applied for those patents. Later we will provide evidence on the other main assumption behind our theoretical mechanism, namely, that patent vagueness is positively associated with the risk of patent invalidation.

INSERT FIGURE 1 HERE

INSERT FIGURE 2 HERE

Institutional ownership and patent vagueness

In Table 2, we present the results of OLS regressions that estimate the relationship between patent vagueness and institutional ownership. In Column (1), which includes institutional ownership and no time-varying controls at the firm and patent levels, we find that institutional ownership has a negative (β = - 0.0008) and significant ($p < 0.05$) relationship with patent vagueness. In Column (2), we add the firm-level controls. Here, we find no statistically significant relationship between ROA, capital expenditure, capital-to-labor ratio and market to book ratio, and patent vagueness; however, the negative relationship between institutional ownership and patent vagueness becomes larger and statistically more precise (β = - 0.0011, $p < 0.01$). In Column (3), we further add the patent-level controls, which show that that larger firms use vaguer expressions in their patents ($\beta = 0.0241$ and $p < 0.05$). At the patent-level, patents that make more claims ($\beta = 0.0024$ and $p < 0.01$), that receive more citations ($\beta = 0.0004$ and $p < 0.01$), and report a law firm ($\beta = 0.0362$ and $p < 0.05$) use vaguer expressions, whereas patents that have a higher number of figures (β = - 0.0019 and $p < 0.10$) and a narrower scope (β = - 0.0399 and $p < 0.01$) use fewer vague expressions. Overall, the models in Tables 2 provide support for H1 that as the share of institutional ownership in a firm increases, the level of vagueness in its patents decreases.

INSERT TABLE 2 HERE

Endogeneity of Institutional Ownership

While the above results hold controlling for an extensive set of variables, endogeneity concerns remain. In particular, it is plausible that institutional ownership correlates with omitted factors which, in turn, are also associated with patent vagueness. Or it may be that causality runs in the opposite direction, i.e. that institutional owners invest more in companies with more transparent patent portfolios. These concerns may threaten the magnitude of our previous estimates.

To overcome these problems, we use an instrumental variable approach. We acknowledge that addressing endogeneity concerns in institutional ownership is cumbersome and there is no consensus in extant literature. Following recent works like Boone and White (2015), we exploit the annual reconfiguration of the Russell 1000/2000 indices. Every year at end of May, Russell 1000 and 2000 indices rank firms by market capitalization. The Russell 1000 index includes the first 1000 firms by market capitalization while the Russell 2000 index includes the next 2000 firms ranked by market capitalization. The Russell indices are value-weighted indices. Institutional investors notoriously monitor these indices and prioritize firms that have greater value per each index. As a result, they tend to invest more in firms that are at the top of Russell 2000 index rather than in firms at the bottom of the Russell 1000 index. Since differences in market cap often result from small variations in share prices, firms above and below the cutoff point are comparable in their fundamentals but attract different levels of interest from institutional investors. To operationalize this method, we estimate the following two-stage least squares model:

$$IO_{i,p,t} = \alpha + \tau D_{i,t} + f(R_{i,t}) + \beta_1 A_{i,t} + \beta_2 B_{p,t} + \delta_i + \theta_t * \pi_j + \in_{i,p,t} \quad (3)$$

$$Y_{i,p,t} = \beta_0 + \beta_1 \widehat{IO}_{i,t} + g(R_{i,t}) + \beta_2 A_{p,t} + \beta_3 B_{p,t} + \delta_i + \theta_t * \pi_j + \in_{i,p,t} \quad (4)$$

where $D_{i,t}$ is an indicator variable equal to 1 if the firm *i* is in the Russell 2000 index at time *t* and 0 otherwise. $R_{i,t}$ is the distance between the threshold 1000 and the size rank of firm *i* at time *t*. Functions f and g are second order polynomials that allow the relationship between size rank R and IO to vary around the Russell 1000 threshold (Boone and White, 2015; Chen *et al.*, 2020). Function f takes the following form:

$$f(R_{i,t}) = \delta_1 R_{i,t} + \delta_2 R_{i,t}^2. \quad (5)$$

The F-statistic of the first-stage regressions is 21.16, which alleviates weak-instrument concerns. We report the results of the two stage models in Table 3. In Column (2), i.e. the second stage, the main coefficient confirms that an increase in institutional ownership decreases patent vagueness and its magnitude ($\beta = -0.0024$, $p < 0.10$) is twice as large than the OLS one (reported in Column 3 for comparison purposes). Despite a limited statistical precision, this finding yields further support to Hypothesis 1.

INSERT TABLE 3 HERE

Using the estimated coefficients from Table 3 one can compute the magnitude of the effect of institutional ownership on patent vagueness. Specifically, at the sample mean, a standard deviation increase in institutional ownership (equal to 25 at the firm level) decreases patent vagueness by 4% if one considers the instrumented regression or 2% if one considers the OLS regression. The magnitude of the effect is admittedly small because the average firm in our sample is unlikely to be subject to a severe agency conflict, due to the presence of multiple governance mechanisms that characterize listed firms. However, as we shall see

below, and consistent with our theory, the effect of institutional owners will become larger when the agency conflict is more salient.

CEO attributes, institutional ownership, and patent vagueness

In Table 4, we report the OLS models that test the moderating effect of CEOs' attributes on the relationship between patent vagueness and institutional ownership. In Column (1), we test our first moderator about founder and non-founder CEOs. The interaction term indicates that when CEOs are not founders, an increase in institutional ownership would decrease patent vagueness (β = - 0.0023, $p < 0.05$), an effect that roughly doubles the one we estimated in Table 2. Moreover, the insignificant direct effect of institutional ownership suggests that when CEOs are founders, an increase in institutional ownership does not influence patent vagueness.

In Column (2), we test our second moderator about a CEO's law background. The direct effect of the law dummy shows that when institutional ownership is (close to) zero, patent vagueness is greater when the CEO has a law background ($\beta = 0.3682$, $p < 0.01$). Also, the direct effect of institutional ownership indicates that an increase in institutional ownership would decrease patent vagueness when the CEO does not have a law background (β = - 0.0016, $p < 0.05$). Finally, the interaction term indicates that patent vagueness decreases even further with institutional ownership when the CEO has a law background (β = - 0.0059, $p < 0.01$). To quantify the magnitude of the effect, firms led by CEOs who have a law background and have (nearly) zero institutional ownership file patents that are almost 30% vaguer than the average patent; however, this differential effect tends to vanish as institutional ownership increases. Put it differently, in firms led by a CEO with a law background, a standard deviation increase in institutional ownership (equal to 25 at the firm level) decreases patent vagueness by 11.4%.

Collectively, these findings provide empirical support to our hypotheses 2 and 3.

INSERT TABLE 4 HERE

Post-hoc analyses

In this section, we conduct a number of additional tests, which validate some of the assumptions behind our theory and provide additional evidence on the mechanisms at play.

Institutional Owners' Time Horizon

We have painted institutional owners with a broad brush as a homogenous group of investors. However, extant works have shown that there is a wide heterogeneity in institutional owners' objectives and time horizons (Dharwadkar *et al.*, 2008, Connelly *et al.*, 2010; Hoskisson *et al.*, 2002). Institutional owners can be classified as transient, quasi-indexers, and dedicated depending on their portfolio turnover and diversification (Bushee, 1998). Transient institutional owners are considered short-term oriented, while quasi-indexers and dedicated institutional investors are considered long-term oriented. Transient institutional investors typically trade at a high turnover rate, hold diversified portfolios, and thus prioritize current results rather than long-term results (Bushee, 2001). Most importantly, they may exit the firm before threats to long-term firm value, such as patent lawsuits, affect their investment. Thus, in the case of transient institutional investors, the time horizon misalignment with an opportunistic CEO is likely small, as they both prefer the short term (Dharwadkar *et al.*, 2008). By contrast, dedicated investors and quasi-indexers have long holding periods, and hold concentrated and diversified portfolios. As stated in Hypothesis 1, these funds are expected to counteract the CEO's tendency to meet short-term goals (Bushee, 2001). We explore this

heterogeneity to validate the proposed mechanism on the differences in time-frame between institutional owners and CEOs' decision-making.

To this end, we measure short-term institutional ownership as the ratio of shares owned by transient institutional investors to the total outstanding shares of a firm; similarly, we measure long-term institutional ownership as the ratio of shares owned by dedicated investors and quasi-indexers to the total outstanding shares of a firm (Cremers *et al.*, 2020). Alternatively, we measure the relative presence of long-term oriented vs. short-term oriented investors by creating a dummy variable, *Long-Term IO Majority*, set equal to one if long-term oriented investors own more shares than short-term oriented investors do. In our sample, 13.52% and 31.22% of the shares of the average company are held by short-term and long-term institutional investors, respectively. Consistent with our theory, 91.52% of the observations in our sample are associated with a dominance of long-term institutional owners vs. short-term owners.

In Table 5, we present the results of our investigation of the relationship between the time-horizon of institutional owners and the use of vague expressions in patents. In Column (1) we estimate separately the effects of short-term and long-term orientation of institutional owners on patent vagueness. As shown, patent vagueness decreases when the ownership of institutional owners with a long-term orientation increases ($\beta = -0.0007$, $p < 0.05$); however, an ownership change of short-term oriented institutional owners is not significantly related with patent vagueness. In Column (2), we test whether the relationship between institutional ownership and patent vagueness is moderated by the dominance of long-term oriented institutional owners over short-term oriented ones. The coefficient of the interaction between this variable and the share of institutional ownership suggests that when long-term oriented institutional owners own more shares than short-term oriented ones, an increase in institutional ownership decreases patent vagueness ($\beta = -0.0012$, $p < 0.01$). The conditional effect of

institutional ownership when short-term oriented institutional owners own more shares than long-term oriented ones is not statistically different from zero.

INSERT TABLE 5 HERE

Invalidation Risk from Patent Vagueness

In this section, we wish to validate our assumption on the relationship between patent vagueness and invalidation risk. We use the patent litigation dataset from the USPTO to identify the patents that were involved in patent litigation for invalidation from the period 2003-2016. First, we identify patents for which the firm that owns the patent is a defendant in the patent litigation (i.e. a defendant about the validity of its patent). Second, we consider only the first instance of litigation (so that we do not include countersuits for invalidation); therefore, our dataset of sued patents consists of unique observations at the patent-level. Third, we match this litigation dataset with our main dataset. We set the variable *Sued* to 1 if the patent is in the litigation dataset and to 0 otherwise.

While increasing in recent years (Bessen and Meurer, 2005), patent litigation is still a rare event affecting 1-2% of all patents. This implies that not all patents are at risk of facing lawsuits. To address this problem, we use propensity score matching to build a more plausible control sample of patents that are at risk of facing litigation for invalidation. We use the application year and the average probability of lawsuit in a patent class as variables to build the matched sample by using 10, 15, and 25 neighbors. Then, we use observations from the resulting sample (containing sued patents and non-sued matched patents) to investigate the relationship between risk of invalidation and patent vagueness. We run logit models to estimate this relationship and include the patent scope, citations, and originality as controls. We report the results in Table 6. All models (which employ a different number of matched non-sued

neighbors and thus a different sample size) report a positive correlation ($p < 0.05$) between patent vagueness and invalidation risk. Focusing on the model with 25 neighbors and using descriptive statistics of the full sample (Table 1), we find that as a one standard deviation increase in vagueness of a patent increases its invalidation risk by 36.5%. Since, the direct costs of patent litigation were between US$1 and US$6 million in the middle of our sample period (AIPLA, Report of the Economic Survey, 2011), vagueness can result in a significantly higher expected monetary cost of patent litigation.

INSERT TABLE 6 HERE

Market Reaction to Patent Litigation

In this section, we measure the impact of patent litigation on the market value of the defendant firm. We consider only those firms that are defendants in the patent lawsuit and consider the first instance of lawsuit involving a particular patent for a firm (these are thus lawsuits for patent invalidation). Then, we run an event-study and consider a 7-day window around the filing of a patent lawsuit. We compute the CAR for firms by using different market-models: Market-Adjusted, Fama-French 3 factor, and Cahart 4 factor. We report the results of the event study in Table 7. Across all models, defendant firms experience a significant value loss during the period around the announcement of a patent lawsuit. In particular, defendant firms lose around 0.3% to 0.43% of market value. In our sample, the market capitalization of an average firm is US$ 4.4 billion. These figures indicate that the average firm loses between US$ 13.1 million and US$ 18.9 million around the announcement of a patent lawsuit against it. A 36.5% increase in the probability to face such costs (as suggested by the previous section) is therefore an economically relevant event for our sample firms.

INSERT TABLE 7 HERE

Patent Invalidation Risk for CEOs with Law Background

We have argued that CEOs with a law background would incur in higher litigation hazard because of their overconfidence about their ability to resolve legal dispute in their favor and their awareness of the strategic opportunities of patent vagueness to generate short-term benefits. Here, we confirm this notion by estimating a model in which the dependent variable measures invalidation risk at the patent class level. For each patent class, we calculate citation-weighted number of sued patents, i.e. focal firm is defendant, and then divide it by the total number of lawsuits in a patent class. We take the natural logarithm of this variable. We use OLS regressions to estimate the relationship between patent invalidation risk and the educational background of the CEO. We report the results in Table 8. In all models, we include controls at the firm and patent levels and control for fixed effects at industry-year and firm. We cluster standard errors by firm in all models.

In Column (1), we include a dummy variable, Law Background, and set it to 1 if the CEO has a law degree and 0 otherwise. The coefficient of "Law Background" ($\beta = 0.1223$, $p < 0.05$) suggests that litigation risk increases by 12% for firms led by CEOs with a legal background. In Column (2), we include a dummy variable set to 1 if the CEO has a technical background and zero otherwise. Similarly, in Column (3) we include a dummy variable set to 1 if the CEO has an MBA degree and 0 if not.

As shown, the legal background is positively associated with patent litigation for invalidation. By contrast, other types of education (such as technology-related degrees or MBA) do not have a significant effect on the risk of patent invalidation.

INSERT TABLE 8 HERE

Product Market Competition

We investigate if our baseline hypothesis changes in industries that have high product market competition. High product market competition would increase managerial focus on short-term firm performance and prioritize it over long-term consequences such as litigation. On the other hand, high product market competition may also increase the risk of future patent litigation and invalidation. Thus, we expect that when product market competition is high, the corrective effect of institutional investors on patent vagueness will be greater as their interests become relatively more dis-aligned with those of the CEO. We measure product market competition by using the TNIC HHI measure from Hoberg and Phillips (2016).

We split the sample to distinguish between high and low levels of product market competition. When TNIC HHI is above median, we consider Product Market Competition to be high and low when TNIC HHI is below median. We report the results in Table 9 and include firm and patent controls in all models. In Column (1), i.e. low competition, we find no relationship between institutional ownership and patent vagueness. In Column (2), i.e. high competition, we find that when institutional ownership increases patent vagueness decreases ($\beta = -0.0017$, $p < 0.01$).

INSERT TABLE 9 HERE

CEO Tenure

We argued that the discrepancy in time orientation between institutional investors and CEOs determines the misalignment between their incentives to use vague language in their patents. We further investigate this argument by distinguishing among CEOs based on their tenures. CEOs who are early in their tenure may envision a longer association with their firms. This can increase CEOs' concern about invalidation risks and align their incentives with the institutional investors. On the other hand, CEOs who are later in their tenure may be closer to ending their association with their firms. These CEOs would likely care more about imitation risks rather than litigation risks, increasing misalignment between their incentives and institutional investors'. Therefore, as CEOs stay longer in their firms their short-termism increases resulting in greater preference for using vague language in their patents. This elicits a greater influence from institutional investors to decrease vagueness in their firms' patents.

We split the sample to differentiate between CEOs who are early in their tenure and those who are later in their tenure. We classify CEOs in late tenure when their tenure is above the median (i.e. 4 years) and in early tenure otherwise. We report the results in Table 10 and include firm and patent controls in all models. In Column (1) we find that institutional investors have a stronger corrective effect ($\beta = -0.0025$, $p < 0.10$) on patent vagueness when CEOs are later in their tenure while in Column (2) we find that when CEOs are earlier in their tenure institutional investors do not have a corrective effect.

INSERT TABLE 10 HERE

CONCLUSION

In this study, we investigated the influence of agency relationships between CEOs and owners on the strategic drafting of patent documents. By probing into the textual content of patents, we demonstrated that institutional owners can affect not only the level of firms' innovation activities, as previously analyzed (e.g. Aghion *et al.*, 2013), but also the way in which firms communicate information about such innovation.

Conceptually, we theorized about the presence of an intertemporal tradeoff between the strategic advantages of withdrawing innovation-related information versus the legal advantages of transparency in terms of reduced invalidation risk. Then, we discussed how such tradeoff is affected by the congruence or discrepancy in the time horizon of CEOs and institutional investors. The literature on institutional investors and innovation has extensively investigated the effect of innovation inputs such as R&D (Bushee, 1998) as well as innovation outputs such as patents (Aghion *et al.*, 2013) and product development (Kochhar and David, 1996). To the best of our knowledge, our study is the first to investigate the role of institutional investors in shaping the information content of firms' patents. In this way, we expand existing research on the nexus between institutional ownership and a firm's information environment (Ajinkya *et al.*, 2005) as well as research on strategic disclosure more generally (Fabrizio & Kim, 2019).

Our results indicated a causal relationship between institutional ownership and patent vagueness: an increase in institutional ownership decreases patent vagueness. Moreover, we identified a number of boundary conditions for this relationship. First, certain characteristics of the CEO influence the relationship between institutional investors of a firm and the vagueness of its patents. We demonstrated that institutional investors influence information disclosure in patenting when CEOs are non-founders or hold a law background. As such, we contribute to research on managerial styles (Bertrand and Schoar, 2003) and on the role of

(long-term) institutional investors in improving governance in firms (McCahery *et al.*, 2016). These findings complement existing works on the two-sided role of institutional owners depending on their portfolio turnover (Bushee, 2001; Dharwadkar *et al.*, 2008).

In unpacking the mechanisms at play, we found that high competition exacerbates the CEO-institutional ownership misalignment thus strengthening the baseline effect: short-term oriented CEOs push for vagueness in patents to maintain competitive advantage when product market competition is high while long-term oriented institutional investors exert more influence to decrease vagueness as high competition likely increases litigation risks. Relatedly, we found that CEOs who are early in their tenure align with the institutional investors in their longer-term orientation whereas those who are late in their tenure have a greater misalignment with institutional investors. As CEOs come closer to leaving their firms, they show short-term behavior and institutional investors exhibit a corrective effect on CEOs' tendency to increase patent vagueness. While this finding supports our argument, we recommend caution on interpreting it. First, CEOs who have stayed longer in office have a greater commitment to their firms and thus are concerned with their firms' long-term value and reputation (Mael & Ashforth, 1992; Ng & Feldman, 2010). Second, when CEOs leave their position they may continue in the firm as, e.g., board chairman. Third, long-serving CEOs may be more sensitive to their legacy in the firm. Taken together, these arguments portray an unclear relationship between CEO tenure and short-term actions.

We have also demonstrated a positive correlation between a patent's vagueness and its litigation risk and found a negative reaction from the market around the filing of a litigation (for patent invalidation) against a firm. In other words, firms incur significant long-term costs for using vagueness in their patents. These findings complement the literature on corporate misconduct and legitimacy that reports non-financial costs, such as reputational damage, poorer relationships with suppliers, customers, and critical resource providers, greater regulatory

scrutiny, and unfavorable evaluations relative to peers, to a firm following allegations of wrong-doing.

Taken together, our findings are relevant for institutional investors seeking to spur their portfolio firms' innovation and align executive incentives toward long term value creation, for rival firms who actively search for information to compete more effectively in the marketplace, and for regulators and policy makers who wrestle around the pros and cons of patents as a mean to protect firms' intellectual property.

Limitations and future research

In our inquiry, we have faced a number of limitations, which we wish to mention before concluding. First, establishing the direction of causality is a tall order. Our instrumental variable approach, which produced marginally significant results, is useful to this end. But it is important to keep in mind that the whole institutional ownership literature is still struggling to find an ideal identification strategy to ascertain causal effects. Second, we exclusively focus on the textual content of patent documents. While patents are certainly important for many actors from analysts to technology experts, institutional investors and firms can strategically manage communication across multiple other documents such as 10-Ks, letters to shareholders, and conference calls. For example, they may simultaneously increase use of vague language in one or more documents and decrease vague language in other documents. Accounting for these potential substitution (or additive) effects across different level of vagueness is a fruitful research avenue. This is especially important because the influence of CEOs on patent vagueness may come not from a direct role in the patent drafting but from their broad impact on the organization's stance in the area of transparency and disclosure. This in turn would help qualify the role of CEOs for our findings. Another useful extension of our work could be to examine the consequences and outcomes of patent vagueness, in terms of e.g. CEO

compensation or firm value. Relatedly, an interesting channel of inquiry could be to investigate information spillovers among rivals after a focal firm uses vaguer expressions in its patents. Finally, we have specifically focused on the long-term costs of patent vagueness, that is, the risk of future litigation. However, another negative consequence of using a vague language in patents is that, on average, patent examiners might spend more time in examining vague patents. This may become more critical in a patent race: firms that file vague patents may risk losing out to firms that file clearer patents.

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Figure 1. Filing years and lawsuit years of sued patents

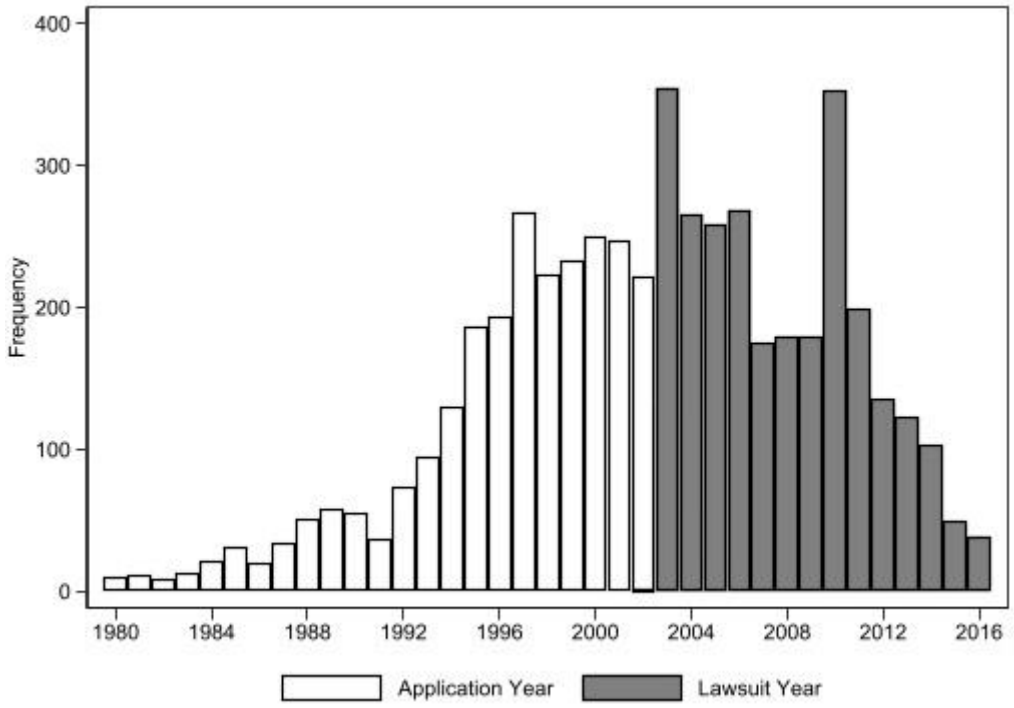

Figure 2. Time to lawsuit and CEO tenure

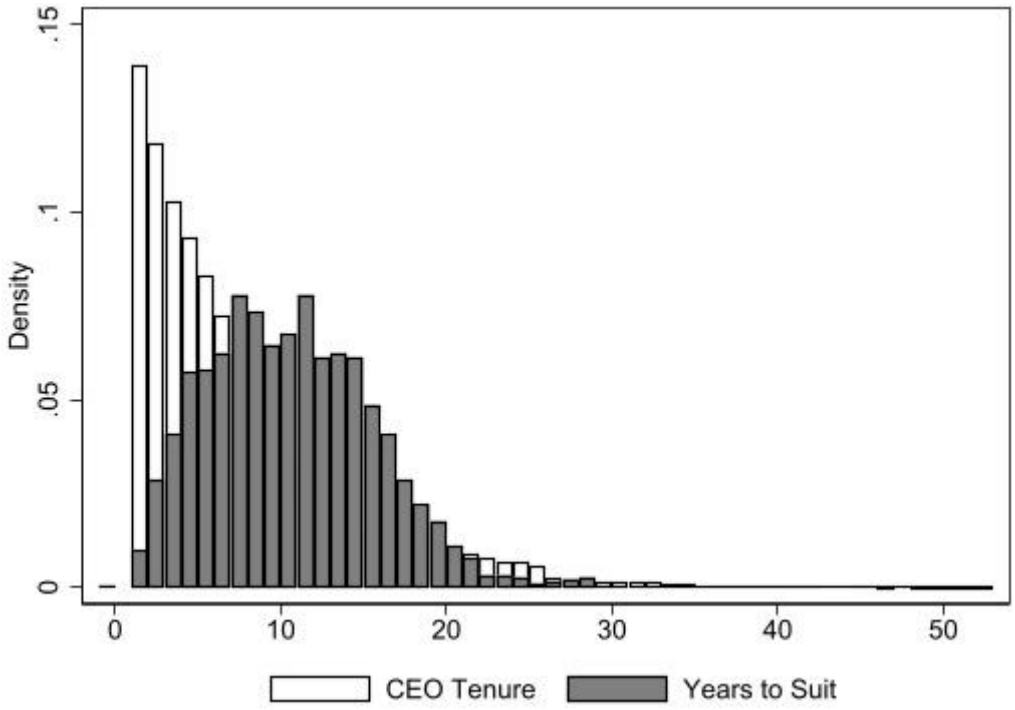

Table 1. Descriptive Statistics

	N	Mean	SD	P25	Median	P75	P95	Min	Max
Firm Characteristics									
Institutional Ownership	262,025	54.73	19.24	42.05	56.99	68.96	82.04	0	99.98
ROA	262,025	0.14	0.14	0.1	0.15	0.2	0.29	-1.37	0.39
Firm Size	262,025	8.00	1.90	6.90	8.33	9.38	10.52	-3.35	11.82
Capital/Labor	262,025	3.98	0.9	3.32	3.87	4.64	5.56	-2.91	8.53
Capital Expenditure	262,025	0.07	0.05	0.04	0.06	0.1	0.16	0	0.9
Market to Book Ratio	262,025	4.39	3.58	1.28	3.05	7.85	10	0	10
Patent Characteristics									
Patent Vagueness	262,025	1.65	0.69	1.19	1.55	1.98	2.86	0	13.63
Number of Citations	262,025	16.61	26.48	1.92	8.6	20.38	60.72	0	712.01
Patent Scope	262,025	4.89	0.59	4.55	4.92	5.27	5.79	0.69	9.36
Originality of Patent	262,025	0.53	0.33	0.29	0.61	0.8	1	0	1
Number of Figures	262,025	6.92	6.21	3	6	9	20	0	29
Law Firm	262,025	0.44	0.50	0	0	1	1	0	1
Number of Claims	262,025	18.52	14.89	9	16	23	45	1	868
CEO Characteristics									
Non-Founder	159,265	0.89	0.31	1	1	1	1	0	1
Law Background	123,103	0.07	0.25	0	0	0	1	0	1
Tenure	187,338	6.43	6.60	2	4	9	20	0	53

Table 2. Institutional Owners and Patent Vagueness

Dependent variable: Patent Vagueness			
	(1)	(2)	(3)
Institutional Ownership	-0.0008**	-0.0011***	-0.0012***
	(0.0004)	(0.0004)	(0.0004)
ROA		0.0110	0.0128
		(0.0319)	(0.0311)
Firm Size		0.0241**	0.0241**
		(0.0115)	(0.0108)
Capital/Labor		-0.0015	0.0013
		(0.0175)	(0.0172)
Capital Expenditure		-0.0324	-0.0443
		(0.0900)	(0.0875)
Market to Book Ratio		0.0023	0.0022
		(0.0018)	(0.0018)
Number of Citations			0.0004***
			(0.0001)
Patent Scope			-0.0399***
			(0.0058)
Originality of Patent			0.0120
			(0.0086)
Number of Figures			-0.0019*
			(0.0010)
Law Firm			0.0362**
			(0.0158)
Number of Claims			0.0024***
			(0.0003)
Firm Fixed Effects	Yes	Yes	Yes
Industry×Year Fixed Effects	Yes	Yes	Yes
Observations	261,010	261,010	261,010
Adjusted R^2	0.121	0.121	0.125

Standard errors in parentheses. SE clustered at the firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3. 2SLS results

Dependent variable:	Institutional Ownership	Patent Vagueness	Patent Vagueness
	First Stage	*Second Stage*	*OLS*
	(1)	(2)	(3)
Institutional Ownership		-0.0024*	-0.0012***
		(0.0013)	(0.0004)
Russell 2000 Membership	2.0338**		
	(0.9115)		
1000 – Rank	-25.6564***		
	(9.3989)		
$(1000 - Rank)^2$	55.9931***		
	(8.7746)		
Firm Controls	Yes	Yes	Yes
Patent Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Industry×Year Fixed Effects	Yes	Yes	Yes
Observations	261,010	261,010	261,010

Standard errors in parentheses. SE clustered at the firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4. The Moderating Effect of CEO characteristics

Dependent variable: Patent vagueness		
	(1)	(2)
Institutional Ownership	-0.0003	-0.0016**
	(0.009)	(0.0008)
Non-Founder CEO	0.0831	
	(0.0600)	
Non-Founder CEO X Institutional Ownership	-0.0023**	
	(0.0011)	
Law Background		0.3682***
		(0.1368)
Law Background X Institutional Ownership		-0.0059***
		(0.0020)
Firm Controls	Yes	Yes
Patent Controls	Yes	Yes
Firm Fixed Effects	Yes	Yes
Industry×Year Fixed Effects	Yes	Yes
Observations	159,042	122,950
Adjusted R^2	0.10	0.080

Standard errors in parentheses SE clustered at the firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5. The Role of Institutional Owners' Time horizon

Dependent variable: Patent vagueness		
	(1)	(2)
Institutional Ownership		-0.0001
		(0.0005)
Ownership of Long-Term IO	-0.0007**	
	(0.0003)	
Ownership of Short-Term IO	-0.0005	
	(0.0005)	
Long-Term Ownership Majority		0.0347
		(0.0212)
Long-Term Ownership Majority X Institutional Ownership		-0.0012***
		(0.0004)
Firm Controls	Yes	Yes
Patent Controls	Yes	Yes
Firm Fixed Effects	Yes	Yes
Industry×Year Fixed Effects	Yes	Yes
Observations	251,923	251,923
Adjusted R^2	0.124	0.125

Standard errors in parentheses. SE clustered at the firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6. Patent vagueness and patent invalidation lawsuits

Dependent variable: Patent is sued			
	Number of neighbors		
	(10)	(15)	(25)
Patent Vagueness	0.0674**	0.0642**	0.0631**
	(0.0340)	(0.0327)	(0.0312)
Patent Controls	Yes	Yes	Yes
Observations	13,744	19,318	30,002
Chi^2	350.05	358.68	369.70

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

Table 7. Market reaction to patent invalidation lawsuits

Dependent variable: CAR [-3, 3]			
	Market Model		
	Market-Adjusted	Fama French 3	Cahart 4
Average CAR	- 0.298%	- 0.394%	- 0.429%
Average Market Cap (in Millions USD)	4400	4400	4400
Average Loss (in Millions USD)	13.11	17.34	18.88

Table 8. CEO background and risk of patent invalidation

Dependent variable: Invalidation risk			
	(1)	(2)	(3)
Law CEO	0.1223**		
	(0.0590)		
Tech CEO		0.0117	
		(0.0437)	
MBA CEO			-0.0344
			(0.0296)
Firm Controls	Yes	Yes	Yes
Patent Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Industry×Year Fixed Effects	Yes	Yes	Yes
Observations	120,231	120,231	120,231
Adjusted R^2	0.289	0.289	0.289

Standard errors in parentheses. SE clustered by firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9. Product market competition and patent vagueness

Dependent variable: Patent vagueness		
	Low Competition	High Competition
	(1)	(2)
Institutional Ownership	-0.0000	-0.0017***
	(0.0006)	(0.0005)
Firm Controls	Yes	Yes
Patent Controls	Yes	Yes
Firm Fixed Effects	Yes	Yes
Industry×Year Fixed Effects	Yes	Yes
Observations	106,644	106,417
Adjusted R^2	0.129	0.100

Standard errors in parentheses. SE clustered by firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10. CEO tenure and patent vagueness

Dependent variable: Patent vagueness		
	Late Tenure	Early Tenure
	(1)	(2)
Institutional Ownership	-0.0025*	-0.0004
	(0.0014)	(0.0007)
Firm Controls	Yes	Yes
Patent Controls	Yes	Yes
Firm Fixed Effects	Yes	Yes
Industry×Year Fixed Effects	Yes	Yes
Observations	88,016	94,838
Adjusted R^2	0.103	0.111

Standard errors in parentheses. SE clustered by firm. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix A. List of vague expressions

Vague category identifiers		
According to +	an/the alternate +	embodiment of the present invention
In accordance with +	an/the alternative +	
In +	an/the +	aspect of the present invention
It is +	another +	
	one +	
	the above described +	
	a (still) further exemplary +	
	a further +	
	an illustrative +	
	a predetermined +	
	a preferred +	
	an +	
	still/yet another +	
	a broad +	
This +	invention is not limited +	by
The present +		in this respect
The +		thereto
The present disclosure relates +	To	
The present invention relates +	generally to	
This invention is related +	in general to	

Vague quantities
between, at least ranging from, preferably, preferred, a plurality of, a ratio of , a set of, a subset of, a member of, a section of, a mixture of, a segment of, portions of, components of, embodiments of

Lack of interpretation standard
may be, may also be, can be, can also be, if, substantially, selectively

Source: Arinas (2012).

Appendix B. Correlations among patent characteristics

		1.	2.	3.	4.	5.	6.	7.	8.	9.
1.	Patent vagueness (full document)	1								
2.	Patent vagueness (no claims)	0.952	1							
3.	Patent vagueness (only claims)	0.665	0.468	1						
4.	Number of Citations	0.011	0.002	0.035	1					
5.	Originality of Patent	0.016	0.025	-0.014	-0.024	1				
6.	Number of Figures	0.019	-0.006	0.103	0.134	-0.038	1			
7.	Number of Claims	0.123	0.132	0.058	0.104	0.022	0.174	1		
8.	Patent Scope	-0.070	-0.095	0.041	0.049	-0.081	0.134	-0.050	1	
9.	Law Firm	0.069	0.061	0.070	0.031	-0.002	0.158	0.157	0.002	1

N = 262,025

Negative Strategic Interactions among High-Status Firms

ABSTRACT

We examine how firm status determines negative interactions in firms and consequences for firms. Literature on status has demonstrated numerous benefits associated with a high-status position. One such benefit is that high-status firms generally transact with each other and not with low-status firms. We argue that in negative interactions high-status will target other high-status firms and that this tendency increase as uncertainty between the two firms decreases. We also investigate the financial damage cause by the negative interaction on target firms and argue that this damage increases with status of the target firm. We find support for our hypotheses. Collectively, our findings have implications to status and status homophily literature and to the more recent literature focusing on costs of high-status.

Keywords: Status, Status Homophily, Allegations, Wrongdoing

INTRODUCTION

Status of a firm is a measure of the quality of the firm and its offerings e.g. products. A firm's status is determined by past demonstrations of quality by the firm and by the status of its affiliations (Piazza & Castellucci, 2014; Podolny & Phillips, 1996; Rindova, Williamson, Petkova, & Sever, 2005). High-status firms receive greater recognition for a given level of quality (Merton, 1968) and have cost advantages relative to low-status firms (Podolny, 1993). High-status firms have advantages in innovation as they grow faster (Podolny, Stuart, & Hannan, 1996), have easier access to capital (Stuart, Hoang, & Hybels, 1999), can easily enter related markets (Jensen, 2003), face less retaliation from incumbents (Podolny & Scott Morton, 1999), and exchange their products for higher prices (Ertug & Castellucci, 2013). Therefore, high-status firms try to maintain their status and benefit from a high-status position.

Since the market infers the status of a firm also through the status of its affiliations (Podolny & Phillips, 1996), high-status firms affiliate with other high-status firms (Chung, Singh, & Lee, 2000). Affiliating with a low-status firm results in a transfer of status from a high-status firm to a low-status firm: positive transfer for a low-status firm and negative transfer for a high-status firm (Piazza & Castellucci, 2014). Therefore, high-status firms are more exclusive when forming relationships with firms in the market (Podolny, 1994). Indeed, research on status has largely argued beneficial motivations to form exchange results between firms of the same status bracket (Jensen & Roy, 2008; McPherson & Smith-Lovin, 1987; Rosenkopf & Padula, 2008).

Given the unique benefits that high-status firms enjoy, they are likely to compete with each other for market position and superior resource providers, which determine sustained competitive advantage (Barney, 1991). Research has shown that peers incur losses because of high-status firms. For example, peers lose recognition for their work. Peers of high-status

resource providers experience greater drain in resources and fewer spillovers while working with high-status resource providers. Firms also engage in various strategies such as gaming to specifically try and improve their status (Espeland & Sauder, 2007). This can make high-status firms more likely to be targeted by their peers.

Firms can cause financial and reputational damage to their rivals through negative interactions such as lawsuits (Bessen & Meurer, 2012; Bhagat, Brickley, & Coles, 1994). Since status transfers via affiliations, firms are sensitive with whom they choose to interact (Podolny & Phillips, 1996). Moreover, since firms compete with their rivals for resources such as talent (Aime, Johnson, Ridge, & Hill, 2010), market position (Bothner, 2003), and technology (Miao, Salomon, & Song, 2021), they are likely to engage in negative interactions with each other. In particular, high-status firms have a particularly higher sense of entitlement that likely makes them engage in disputes with each other. Therefore, we predict a positive association between the status of firms in a negative interaction.

Next, we examine the effect of uncertainty between firms in a negative interaction. The role of status becomes more relevant when uncertainty increases (Podolny, 1994). Firms that have a greater overlap in products and markets are more likely to be familiar with each others' resources and capabilities, reducing the uncertainty they have about each other. Therefore, we argue that product similarity between the firms positively moderates the positive association between the status of firms in a negative interaction.

Finally, we investigate the financial implications of negative interactions on targeted firms. Firms targeted in negative interactions typically incur financial and reputational damage and this is considerably larger for high-status firms as they have betrayed the high expectations of market participants (King & Carberry, 2018; Rhee & Haunschild, 2006). Hence, we hypothesize that lawsuits from high-status firms result in financial damage for defendants.

We test our hypothesis on US public firms. In particular we consider patent litigation as negative interactions. We find a positive association between the status of the defendant and plaintiff and that this positive association increases as uncertainty firms have about each other decreases. We also find that following the announcement of the lawsuit, market penalties on the defendant increase with status. Our findings have implications for research on status and status homophily. In particular by examining how high-status firms compete with each other and how they strategically use negative interactions to harm high-status rivals, we contribute to the more recent research that examines the inverse Matthew effect and the costs of status (Graffin, Bundy, Porac, Wade, & Quinn, 2013; Kovács & Sharkey, 2014; Sharkey, 2018).

THEORY

Status and its benefits

Status is a measure of quality. Status of a firm is determined by a combination of past demonstrations of quality and by the pattern of its affiliations (Podolny, 1994; Podolny & Phillips, 1996). High-status positions are characterized by benefits such as lower costs and greater recognition for a given level of quality (Podolny, 1993). When making important decisions about the firm, relevant stakeholders such as investors, partners, and analysts rely on the status of a firm; the role of status in this decision-making process becomes more pronounced as the uncertainty among the stakeholders increases (Podolny, 1993, 1994).

Firms connect with similar firms for various strategic purposes such as alliances, knowledge transfer, and exchange relationships (Benjamin & Podolny, 1999; Castellucci & Ertug, 2010; Greve, Mitsuhashi, & Baum, 2013; McPherson, Smith-Lovin, & Cook, 2001). A rich stream of literature on status has argued that high-status firms transact with each other more frequently and continue to do so for a substantial period of time (Benjamin & Podolny,

1999). Since the status of a firm is determined by the status of its affiliations (Podolny & Phillips, 1996), interacting with firms of a similar status becomes particularly relevant for a high-status firm. This is because high-status firms may be perceived as lower status if they affiliated with a low-status firm. Similarly, low-status firms may be considered high-status if they are interacting with a high-status firms. Compared to low-status firms, high-status firms receive variety of benefits such as access to superior resources and an elite network (Piazza & Castellucci, 2014), greater freedom to deviate from norms (Phillips & Zuckerman, 2001), and protection from poor performance (Washington & Zajac, 2005).

While high-status firms are a part of an elite club that other firms cannot easily access (Merton, 1968), high-status firms can compete with each other to move up in the social hierarchy of elite firms. Given the benefits that they get, high-status firms may build up a base of resources and capabilities on which they can compete with each other in multiple markets. Since high-status firms transact with each other, a higher status relative to its partner will give it a better bargaining position and costs advantages (Podolny, 1993). Indeed, a relative difference in status enables high-status firms to extract greater efforts from their lower-status exchange partners (Castellucci & Ertug, 2010). Moreover, as firms of similar status interact with each other they will likely also compete with each other for supremacy in market position and technological leadership. Firms can maintain sustained competitive advantage over their rivals through their innovations (Barney, 1991).

Costs of status

While the status literature has examined the benefits of status, a more recent and growing stream of status research has investigated the costs of high status (Graffin et al., 2013; Sharkey, 2018). High-status firms attract greater attention from audiences. This puts these firms under a

lot of scrutiny (King & Carberry, 2018), resulting in decreased evaluations for the firms (Kovács & Sharkey, 2014). On a related note, relevant resource providers have higher expectations from high-status firms (Rhee & Haunschild, 2006), making these firms particularly under pressure. High-status firms also actively engage in activities such as gaming (Espeland & Sauder, 2007) to maintain their status (Sauder & Espeland, 2009); this makes them more susceptible to engage in illegal activities such as false-reporting (Ody-Brasier & Sharkey, 2019) and impression management tactics (McDonnell & King, 2013). High-status brings a sense of entitlement (Graffin et al., 2013; Malmendier & Tate, 2009), which may make firms particularly competitive with other firms that are also high-status.

High-status firms compete with each other in many ways. As they operate in similar leadership brackets in market position and technology, high-status firms are more likely to compete with each other in technological as well as product markets. On the other hand, low-status firms do not possess valuable resources and are thus unlikely to operate in product markets and technologies where high-status firms operate. Moreover, low-status firms are unlikely to compete with high-status firms for market leadership and may not be able to suitably compensate high-status firms (Podolny, 1993). Thus, high-status firms will have substantially greater incentives to pursue other high-status firms.

On the other hand, low-status firms do not have enough resources to engage in negative interactions with high-status firms (Piazza & Castellucci, 2014). Whereas, high-status firms avoid pursuing low-status firms as it creates a negative reaction among audiences. This may because they may be surprised that a low-status firm is capable of generating something comparable and relevant enough that a high-status firm decides to pursue a low-status firm. A consequence of this could be that audiences put low-status and high-status firms in a similar bracket, resulting in negative status transfer for the high-status firm (Podolny & Phillips, 1996).

Low-status firms compete with each other and have incentives to pursue negative interactions with low-status firms over competitive pressures. Low-status are unlikely to target high-status firms because of the substantial costs of attaining high status (Bendersky & Shah, 2012). Low-status firms may sue each other to protect their positions and possibly outperform similar low-status firms. Thus, high-status firms are more likely to pursue negative interactions against other high-status firms whereas low-status firms pursue negative interactions against other low-status firms. Therefore:

> ***Hypothesis 1****: The status of firms in a negative interaction are positively associated with each other*

Moderating effect of uncertainty

Uncertainty increase the importance of status (Benjamin & Podolny, 1999; Chung et al., 2000; Podolny, 1994). Audiences increasingly rely on status when uncertainty they have about a firm and outcomes increases. Status literature has demonstrated that conditions such as newness of the market (Podolny, 1994), firm age (Stuart et al., 1999), technical complexity (Podolny & Stuart, 1995) and restricted market activity (Shrum & Wuthnow, 1988) increase uncertainty about firms and therefore audiences rely more on status. At the level of firms, when uncertainty increases, they increasingly rely on status of other firms when entering in exchange relationships.

A firm's uncertainty about another firm increases when the firms are less familiar with each other's resources and capabilities (Beckman, Haunschild, & Phillips, 2004). However, certain factors such as social comparison make firms more familiar with each other and they even benchmark their strategies on their peers (Peteraf & Shanley, 1997). For example, peers firms determine investment in product market (Bustamante & Frésard, 2021), financial policies

(Leary & Roberts, 2014), inter-organizational imitation (Gupta & Misangyi, 2018), and corporate philanthropy (Marquis & Tilcsik, 2016). Firms compete with their peers for strategic reasons such as market position (Bothner, 2003), technological development (Miao et al., 2021), attracting and retaining talent (Aime et al., 2010), and protecting their innovations (Kim & Pennings, 2009). Firms initiate negative interactions such as lawsuits to protect their innovations and for strategic reasons such as causing financial and reputation damage to their peers and rivals.

A growing stream of literature has used product market similarity to determine peers of firms (Dessaint, Foucault, Frésard, & Matray, 2019; Foucault & Fresard, 2014; Grennan, 2019; Klasa, Ortiz-Molina, Serfling, & Srinivasan, 2018). Product market similarity between two firms determines the degree of overlap in the business segments, resources and capabilities of the two firms. Firms that have greater product market similarity are more similar and are increasingly aware of each other's activities and strategies. This decreases uncertainty that firms have about each other. As uncertainty decreases, firms' reliance on status also increases.

As similarity between two firms increases, the uncertainty they have about each other also decreases (Peteraf & Shanley, 1997). Therefore, their reliance on status decreases, decreasing their reluctance to sue high-status firms. However, since this uncertainty pertains to peers or similarity between firms, firms from different groups, e.g. status, are unlikely to benefit from this uncertainty. High-status firms are more likely to engage in negative interactions with each other; this tendency will be stronger as uncertainty between them decreases. Therefore:

> ***Hypothesis 2****: Similarity between the firms positively moderates the positive association between their status in negative interactions.*

Strategic use of status

Status literature has investigated the role of status as a resource for firms. Firms strategically use status for acquisitions (Shen, Tang, & Chen, 2014), obtaining greater effort from resource providers (Castellucci & Ertug, 2010), and recruiting talent (Rider & Tan, 2015). Firms strategically initiate negative interactions such as allegations of wrong-doing, filing a litigation against a firm. By doing so they can signal their efforts to protect their market position and resources. For example, in corporate lawsuits, defendant firms incur penalties in the stock market (Bhagat et al., 1994). Another example is that firms that can initiate or protect themselves from litigation are better able to pursue technological diversification (Ganco, Miller, & Toh, 2020).

Literature on misconduct and wrongdoing has demonstrated that stakeholders penalize firms that are accused of misbehavior (Baker, Derfler-Rozin, Pitesa, & Johnson, 2019). The mere accusation or allegation of wrong-doing is enough for the market players to immediately penalize the firm (Bowen, Call, & Rajgopal, 2010). For example, a firm accused of misreporting numbers immediately loses market value after the allegation is made (DuCharme, Malatesta, & Sefcik, 2004).

Audiences, who typically control important resources, of the firm do not wait to see if the allegation is proven in a court of law (Durand & Vergne, 2015). Furthermore, audiences increase their scrutiny over the firm, which has to take concrete actions to allay their concerns. For example, some firms were forced to divest their resources from an industry segment to address allegations of wrong-doing (Piazza & Perretti, 2015). Similarly, after lawsuits are announced the defendant loses market value, i.e. 2-3% decrease in stock price (Bhagat et al., 1994), and have to wait for a longer period of time for the outcome of the lawsuit. Thus, firms

can also use a negative interaction, e.g. filing lawsuits, as a strategy to cause financial damage to their rivals and peers (Tan, 2016).

High-status firms receive extraordinary recognition compared to lower-status firms (Waguespack & Sorenson, 2011). This recognition also comes with a cost – high scrutiny and increased risk of engaging in deviant behavior (Rhee & Haunschild, 2006). Moreover, high-status firms are also more likely to receive blame and punishment for engaging in deviant behavior (McDonnell & King, 2018). Audiences have high-expectations from high-status firms and feel betrayed when a high-status firm violates these expectations (Barlow, Verhaal, & Hoskins, 2018; Janney & Gove, 2011). Therefore, compared to a low-status firm, a high-status firm incurs greater penalties following allegations of wrongdoing.

When a focal firm is accused of wrong-doing, e.g. defendant in a patent litigation, by another firm, the focal firm experiences substantial financial penalties (Bessen & Meurer, 2012). The firm at the receiving end in a negative interaction incurs substantial financial and reputational damage. This loss is amplified by the status of this firm. Thus,

> ***Hypothesis 3****: In a negative interaction, financial damage to recipient firms increases with their status.*

DATA AND METHODS

We focus on US public firms. In particular on the inter-firm patent litigations. We build our sample by merging data from different sources to test our hypotheses. First, we start with the litigation dataset from the USPTO. This dataset includes patent litigation data on court cases filed between 1963 and 2016. Second, we complement it with financial information from COMPUSTAT, which contains comprehensive accounting and financial information. Third, we obtain data an analyst coverage from Thomson Reuters. Fourth, we collect data on share

prices of plaintiff and defendant firms from CRSP. Finally, we supplement this data with the NBER patent dataset, which includes important patent-level data such as weighted citations, generality, and originality.

We combine data on patents and financial measures by using the matching file from the NBER patent dataset and from Kogan et al. (Bessen, 2009; Kogan, Papanikolaou, Seru, & Stoffman, 2017). Next, we implement an algorithm in Python to perform text-based matching to identify defendants listed in the patent lawsuit: in particular, we match the names of the defendants with the names of firms covered in the COMPUSTAT universe. We repeat this procedure for plaintiff firms. Next, we combine all the data mentioned above and our final data is at the patent or patent lawsuit level. After removing missing data for our main variables, the final dataset consists of 1026 patent lawsuits filed between 1983 and 2016.

Firm status

We measure firm status as a residual of analyst coverage (Shen et al., 2014). We did so for each year, by using the number of analysts in the earnings forecast consensus for a firm. For each year, we run cross-sectional regressions with analyst coverage as the dependent variable and firm size, stock return, return on assets, and volatility of stock return as covariates. We calculate residual analyst coverage using the following model

$$lnCoverage = \alpha + \beta_1 * lnAssets + \beta_2 * lnRet + \beta_3 * ROA + \beta_4 * STDRET + \varepsilon$$

In the above model, for each firm-year observation lnCoverage is the natural logarithm of analyst coverage plus one, lnAssets is the natural logarithm of assets plus one, ROA is EBITDA divided by total assets, and STDRET is the standard deviation of monthly returns of the firm over the calendar year. For each year, we estimated this model and then standardized the residuals. This measure has been validated in recent empirical works.

Dependent variables

Our main dependent variable is the status of a defendant firm for a given patent. We operationalize this measure per the procedure describe above and then create our dependent variable *Defendant Status*. The measure captures the status of the defendant in the year in which the patent lawsuit was filed in the court.

Our second dependent variable is the cumulative abnormal returns (Paruchuri, Han, & Prakash, 2020). We compute if for a 7-day event window i.e. 3 days before and 3 days after the date on which the patent lawsuit was filed. We operationalize it in percentage as create our second dependent variable: *CAR for Defendant*.

Explanatory variables

Our independent variable is the status of a plaintiff firm. We measure it according to the procedure mentioned above and create our independent variable *Plaintiff Status*.

We operationalize the uncertainty that a plaintiff faces around the lawsuit by examining the product similarity (Hoberg & Phillips, 2010, 2016) between the plaintiff and defendant. This measure is computed by textual analysis of product descriptions from form 10-Ks of firms. For each firm pair, cosine similarity is computed for vectors of product descriptions of the two firms (Hoberg & Phillips, 2010, 2016). Greater value of this variable denotes greater similarity between two firms. This variable ranges between 0 and 1; value of 1 means firms are identical while value of 0 means firms are completely different.

Control variables

We include controls at the firm and the patent portfolio levels. Since the observations are firm pairs i.e. defendant and plaintiff we control for the relative differences between firms for characteristics at the firm- and patent portfolio- levels. All control variables are computed as:

$$Delta\ variable = Variable_{Defendant} - Variable_{Plaintiff}$$

At the firm level attributes, we control for relative differences between: firm size (measured as natural logarithm of sales), market to book ratio, growth focus (capital expenditure divided by total assets), cash holdings, and if they are in operating in the same industry (3-digit SIC) and are headquartered in the same state. At the patent portfolio, we measure the relative differences between: average number of citations, originality, and generality of patents in the firm's portfolio.

Empirical analysis

Our baseline hypothesis argues that status of the plaintiff firm will be positively associated with the status of the defendant firm. We test this hypothesis by estimating the following model:

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t} + \beta_2 A_{i,t} + \beta_3 B_{i,t} + \theta_t + \epsilon_{i,t}$$

where Y is the status of the defendant firm, and X is our main independent variable, i.e. status of the plaintiff firm. The vector A contains firm-attribute controls while vector B contains patent-portfolio controls. We also add a set of fixed effects to decrease concerns of omitted factor bias: θ_t are year dummies. We test our main hypothesis using an OLS regression with robust standard errors.

RESULTS

We report the descriptive statistics for variables of interest in Table 1. The dataset is at the patent lawsuit level. On average, the status of the defendant and plaintiff firms are not substantially different. At the firm-level attributes, on average the defendant has larger market valuation, is bigger, and lower growth focus than the plaintiff firm. At the patent-portfolio level, on average the patents of plaintiff firms have greater citations, more generality, and greater numbers than the defendant firms. On average, the defendant firm loses market value following a patent lawsuit.

INSERT TABLE 1 HERE

Plaintiff status and defendant status

In Table 2, we report the results of OLS regressions that estimate the association between status of the plaintiff and status of the defendant after including controls for relative differences for firm characteristics and for patent portfolio.

In Column (1), which includes plaintiff status and no controls at differences between firm and patent portfolio levels, we find that plaintiff status has a positive ($\beta = 0.234$) and significant ($p < 0.01$) relationship with defendant status.

In Column (2), we add controls for relative differences in firm characteristics. We find that defendant status has a positive and statistically significant relationship with relative-growth focus ($\beta = 1.5723$, $p < 0.05$), market valuation ($\beta = 0.0789$, $p < 0.01$), and same state ($\beta = 0.2358$, $p < 0.01$). The relationship between plaintiff status and defendant status is still positive ($\beta = 0.2788$, $p < 0.01$).

In Column (3), we add controls for relative differences in patent portfolios. We find that defendant status has a positive and statistically significant relationship with plaintiff status ($\beta = 0.2785$, $p < 0.01$) relative differences in growth focus ($\beta = 1.5622$, $p < 0.05$), market valuation ($\beta = 0.0792$, $p < 0.01$), same state ($\beta = 0.2137$, $p < 0.01$), generality of patent portfolio ($\beta = 0.2721$, $p < 0.01$), and repeat lawsuits ($\beta = 0.0618$, $p < 0.10$).

Overall, the results in Table 2 provide support to our baseline hypothesis that the status of the plaintiff has a positive association with that of the defendant. A standard deviation increase in plaintiff status results in a 0.28 standard deviation increase in defendant status.

INSERT TABLE 2 HERE

Moderating effect of uncertainty

In Table 3, we report the results for Hypothesis 2 that investigates the moderating effect of uncertainty, i.e. product similarity between the plaintiff and defendant firms, on the positive association between plaintiff status and defendant status. In Column (1), we report the results for the baseline model controlling for differences between defendant and plaintiff at firm and patent portfolio attributes. The coefficient of the plaintiff status is positive ($\beta = 0.2937$, $p < 0.01$) and significant. We split the sample based on the median value of product similarity between the defendant and plaintiff. In Column (2) we report the results for high values of product similarity i.e. above median. The coefficient of the plaintiff status is positive ($\beta = 0.3535$, $p < 0.01$) and significant. In Column (3) we report the results for high values of product similarity i.e. above median. The coefficient of the plaintiff status is positive ($\beta = 0.2071$, $p < 0.05$) and significant. Together, these results suggest a positive moderating effect of product

similarity uncertainty on positive relationships between status of defendant and plaintiff firms. Thus, the models Table 3 provide support to Hypothesis 2 that product similarity will positively moderate the positive association between plaintiff status and defendant status.

INSERT TABLE 3 HERE

Market reaction to patent lawsuits

In Table 4, we report the results for Hypothesis 3 that predicts a negative association between the status of the defendant and the cumulative abnormal return of the defendant during a 7-day window around the filing of the patent lawsuit, i.e. 3 days before the filing date of the lawsuit, the date on which the lawsuit was filed, and 3 days after the lawsuit was filed.

In Column (1), Defendant Status has a negative ($\beta = -0.0044$, $p < 0.1$) relationship with CAR of the defendant. In Column (2), which adds controls for differences in firm attributes, we find a negative ($\beta = -0.0046$, $p < 0.10$) relationship between Defendant Status and CAR of the defendant. In Column (3), which adds controls for repeat interactions between the firms, we find a negative ($\beta = -0.0047$, $p < 0.10$) relationship between Defendant Status and CAR of the defendant. Thus, the CAR of the defendant decreases by around 0.46% as the status of the defendant changes by a unit i.e. standard deviation.

INSERT TABLE 4 HERE

The models in Table 4 together provide support for our third hypothesis that predicts a negative association between CAR of the defendant and the defendant status.

Additional analyses

In Table 5, we include controls for the plaintiff firm instead of the relative difference between defendant and plaintiff. Additionally, at the level of the plaintiff we also examine alternative variables that may be picked up by firm status. Specifically, we control for CEO power, i.e. CEO is the chair of the board, firm reputation, i.e. performance in the top 10 percentile in an industry (3-digit SIC) in a given year, and firm performance, i.e. Return on Equity.

In Column (3), which adds alternative explanations of firms status mentioned above, reports a positive ($\beta = 0.2941$, $p < 0.01$) and significant relationship between the status of the plaintiff and that of the defendant. In Column (3), which includes controls for firm attributes and patent portfolio for the plaintiff, the coefficient of Plaintiff Status is positive ($\beta = 0.2607$) and significant ($p < 0.01$).

INSERT TABLE 5 HERE

In Table 6, we investigate if the relationship between the Status of the Plaintiff and the defendant holds if we control for attributes of the defendant. In particular, at the firm level: size, growth focus, market valuation, value of patent portfolio, and patent count. In Column (1), which includes plaintiff status and no controls at differences between firm and patent portfolio levels, we find that plaintiff status has a positive ($\beta = 0.2269$) and significant ($p < 0.01$) relationship with defendant status. In Column (2), we add controls for firm characteristics

of the defendant. We find that the relationship between plaintiff status and defendant status is still positive ($\beta = 0.1484$, $p < 0.01$). In Column (3), we add controls for relative differences in patent portfolios. We find that defendant status has a positive and statistically significant relationship with plaintiff status ($\beta = 0.1487$, $p < 0.01$).

INSERT TABLE 6 HERE

As a final check in Table 7, we investigate if the relationship between the Status of the Plaintiff and the defendant holds if we control for attributes of the plaintiff. In particular, at the firm level: size, growth focus, market valuation, value of patent portfolio, and patent count. In Column (1), which includes plaintiff status and no controls at differences between firm and patent portfolio levels, we find that plaintiff status has a positive ($\beta = 0.230$) and significant ($p < 0.01$) relationship with defendant status. In Column (2), we add controls for firm characteristics of the plaintiff. We find that the relationship between plaintiff status and defendant status is still positive ($\beta = 0.2359$, $p < 0.01$). In Column (3), we add controls for relative differences in patent portfolios. We find that defendant status has a positive and statistically significant relationship with plaintiff status ($\beta = 0.2213$, $p < 0.01$).

INSERT TABLE 7 HERE

DISCUSSION

In this study, we investigated status dynamics in negative interactions among firms. Our results demonstrate a positive association between the status of the firms in a negative interaction. We also show that this relationship strengthens as uncertainty between the firms decreases. Finally, we also show that firms strategically use status to cause financial damage to their peers/rivals. Collectively, our results show the costs of high-status. Traditionally, the status literature has focused on the benefits of status and status homophily (i.e. similarity in status), we investigate the negative implications of associations among high-status firms. By doing so, we contribute to the recent but growing research that investigates the costs and penalties of high-status (McDonnell & King, 2018; Sharkey, 2018).

Status literature has investigated and demonstrated the protective role of status for high-status firms (Phillips & Zuckerman, 2001; Sauder, Lynn, & Podolny, 2012); however, we find a boundary condition to this relationship. The protective role of status diminishes when the negative interaction or exchange is among high-status firms. Once high-status firms interact with each other in disputes such as litigation, status switches from an insulating role to a competitive role. By alleging high-status peers of wrong-doing, a high-status firm can not only improve its social standing, by inflicting reputational damage on peers, but also cause financial damage to its rivals.

Next, we investigate the role of uncertainty in status homophily. As demonstrated by literature on status, importance of status increases with uncertainty. We test and find support for this effect of status. A high-status firm is more likely to engage in a negative interaction with another high-status firm as uncertainty between the two firms decreases. This is because the high-status of the target firm does not deter the initiating firm as it is familiar with the resources and capabilities of the target firm. Thus, our findings reinforce the argument that

status is more relevant under uncertainty (Podolny, 1994). Another interpretation is the interesting dynamic of status under high uncertainty: in a negative interaction such as patent litigation, high-status protects some firms, i.e. defendants, while it deters some firms, i.e. plaintiffs from litigation.

Finally, we show that when accused of misconduct, high-status firms incur greater penalties from the market. This is because audiences have high expectations from high-status firms; audiences feel betrayed when these firms face allegations of wrongdoing (Rhee & Haunschild, 2006). They respond by imposing greater penalties on these firms; these penalties increase with the status of the accused firm (McDonnell & King, 2018). We also show that high-status is unable to protect accused firms from financial damage. Taken together, the market punishes high-status firms accused of wrongdoing. Market participants penalize firms within days after announcement of the lawsuit implying that they do not wait before the outcome of the litigation. Thus, we contribute to the literature on media attacks and allegations of wrong doing by demonstrating how status factors into allegations of wrongdoing.

Limitations and future research

Our study has several limitations. First, as we examine negative interactions between public firms i.e. defendant and plaintiff, we lose substantial number of observations that involve negative interactions involving private firms. This is partly because our measure of status uses financial data that is publicly available. An alternative could be to consider private firms as well with an alternative measure of status e.g. media coverage. However, by focusing on IP disputes between public firms, we exclude disputes initiated by NPEs, whose main business is filing IP disputes against firms.

Second, we consider only lawsuits that happened and do not investigate strong counterfactuals of lawsuits that could have occurred between firms. An extension could be to attempt to use a more complex matching approach in which we estimate a counterfactual of patents that could be used but were not sued in addition to building firm pairs that are more likely to sue each other. By doing so, we could better investigate status homophily in patent lawsuits. The design would help us see how likely high-status firms are to sue each other over patent infringements rather than investigating correlations between status of plaintiff and defendant. Our analysis suffers from endogeneity or omitted variable bias as status may measure some other important variable.

Third, we have not considered past relationships among firms. A promising extension would be to check whether firms that engage in patent litigation collaborated with each other through alliances or joint ventures to develop technologies. Litigation dynamics among firms that had fruitful collaborations would be an interesting context to examine. We leave these questions for further studies and believe that our findings have implications to multiple streams of literature: status, status homophily in negative interactions, and misconduct.

CONCLUSION

Our study make an important contribution to status literature that has largely focused on the benefits of status. Collectively our results show that high-status firms can strategically use their status to cause financial damage to their high-status rivals. High-status of a firm, makes it particularly susceptible to allegations of wrong-doing as well as a target for negative interactions such as patent litigations from high-status rivals. Additionally, while status literature documents positive consequences of interactions among high-status firms, we argue and demonstrate that these interactions can also have negative consequences.

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TABLES

Table 1. Descriptive statistics

	N	Mean	SD	Min	P25	Median	P75	P95	Max
Status									
Defendant	854	0.39	0.97	-2.45	-0.25	0.39	1.08	1.96	3.45
Plaintiff	854	0.33	1.01	-3.15	-0.31	0.37	1.03	1.89	2.8
Delta Variables (Defendant – Plaintiff)									
Firm Size	854	0.12	2.55	-8.8	-1.64	0.07	1.62	4.72	8.8
Growth Focus	854	-0.003	0.05	-0.35	-0.02	0	0.02	0.07	0.27
Market Valuation	854	0.20	4.43	-10	-2.38	0	2.9	8.29	10
Same SIC3	854	0.44	0.5	0	0	0	1	1	1
Same State	854	0.24	0.43	0	0	0	0	1	1
Patent Portfolio									
Generality	854	-0.003	5.86	-2.24	0	2.31	6.85	-17.9	12.74
Citations	854	-0.440	0.18	-0.09	0	0.16	0.28	-0.27	0.44
Patent Count	854	-205.02	0.18	-0.19	0	0.14	0.27	-0.37	0.37
Repeat Interactions	854	1.69	1.1	1	1	1	2	4	6
Plaintiff Variables									
Firm Size	904	7.07	2.07	1.16	5.68	7.08	8.36	10.62	12.24
Growth Focus	904	0.05	0.05	0	0.02	0.04	0.07	0.13	0.42
Market Valuation	904	5.49	3.57	0	2.02	5.38	10	10	10
Patent Portfolio									
Generality	904	0.54	0.16	0	0.46	0.55	0.63	0.81	1
Citations	904	8.94	7.33	0.13	4.73	7.38	10.96	18.68	60.14
Patent Count	904	1228.46	2781.26	1	35	160.5	966	5831	17409
Repeat Interactions	904	1.67	1.08	1	1	1	2	4	6
Alternatives to Status									
CEO Duality	673	0.42	0.49	0	0	0	1	1	1
Reputation	673	0.21	0.41	0	0	0	0	1	1
ROE	673	0.33	1.01	-2.14	0.18	0.31	0.43	0.81	23.20
Defendant Variables									
Firm Size	910	7.27	2.11	1.16	5.68	7.24	8.59	10.99	12.68
Growth Focus	910	0.05	0.04	0	0.02	0.04	0.07	0.12	0.51
Market Valuation	910	5.72	3.58	0	2.35	5.46	10	10	10
Patent Portfolio									
Generality	910	0.53	0.17	0	0.44	0.54	0.64	0.83	1
Citations	910	8.56	7.88	0.32	4	7.13	10.75	18.2	98
Patent Count	910	1075.83	2353.13	1	31	148	966	4910	15449
Repeat Interactions	910	1.8	1.48	1	1	1	2	4	11
CAR	978	-0.004	0.08	-0.51	-0.03	-0.004	0.03	0.11	0.59

Table 2. Positive relationship between status in patent lawsuits

Dependent Variable: Defendant Status			
	(1)	(2)	(3)
Plaintiff Status	0.2340***	0.2788***	0.2785***
	(0.0333)	(0.0332)	(0.0340)
Delta Variables (Defendant – Plaintiff)			
Firm Attributes			
Size		0.0041	0.0167
		(0.0115)	(0.0131)
Growth Focus		1.5723**	1.5622**
		(0.6265)	(0.6263)
Market Valuation		0.0789***	0.0792***
		(0.0070)	(0.0070)
Same Industry		0.0997	0.0778
		(0.0612)	(0.0616)
Same State		0.2358***	0.2137***
		(0.0711)	(0.0720)
Patent Portfolio			
Generality			0.2721*
			(0.1507)
Citations			0.0018
			(0.0031)
Patent Count			-0.0000
			(0.0000)
Repeat Interactions			0.0618**
			(0.0291)
Year Fixed Effects	Yes	Yes	Yes
Adjusted R2	0.089	0.237	0.242
Observations	852	852	852

Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
We compute Firm and Patent Portfolio Controls as Defendant – Plaintiff

Table 3. Moderating effect of product similarity on positive association between status

Dependent Variable: Defendant Status			
		Product Similarity	
		High	Low
	(1)	(2)	(3)
Plaintiff Status	0.2937***	0.3535***	0.2071**
	(0.0588)	(0.0974)	(0.0827)
Firm Controls	Yes	Yes	Yes
Patent Portfolio Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R2	0.187	0.182	0.113
Observations	285	136	147

Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
We compute Firm and Patent Portfolio Controls as Defendant – Plaintiff

Table 4. Cumulative abnormal returns (CAR) for defendant. Event window [-3, 3]

Dependent Variable: CAR for Defendant			
	(1)	(2)	(3)
Defendant Status	-0.0044*	-0.0047*	-0.0046*
	(0.0026)	(0.0028)	(0.0028)
Differences in firm attributes			
Market Valuation		0.0002	0.0002
		(0.0007)	(0.0007)
Size		0.0012	0.0013
		(0.0012)	(0.0013)
Repeat Interactions		0.0003	0.0002
		(0.0014)	(0.0002)
Patent portfolio			
Citations			-0.0030
			(0.0043)
Year Fixed Effects	Yes	Yes	Yes
R2	0.035	0.036	0.037
Observations	978	978	978

Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
We consider 7-day event window: 3 days before filing, date of filing lawsuit, 3 days after filing

Table 5. Controlling for alternatives to plaintiff status

Dependent Variable: Defendant Status				
	(1)	(2)	(3)	(4)
Plaintiff Status	0.3137***	0.2705***	0.3094***	0.2607***
	(0.0366)	(0.0455)	(0.0379)	(0.0460)
CEO Duality			0.0533	0.0298
			(0.0761)	(0.0767)
Reputation			0.0680	0.0205
			(0.1038)	(0.1101)
Return on Equity			-0.0877***	-0.0874**
			(0.0347)	(0.0359)
Firm Controls	No	Yes	No	Yes
Patent Portfolio Controls	No	Yes	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R2	0.139	0.155	0.143	0.159
Observations	673	673	673	673

Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Firm and Patent Portfolio Controls are for Plaintiff Firm

Table 6. Positive relationship between status in patent lawsuits

Dependent Variable: Defendant Status			
	(1)	(2)	(3)
Plaintiff Status	0.2260***	0.1484***	0.1487***
	(0.0312)	(0.0288)	(0.0294)
Defendant Firm Attributes	No	Yes	Yes
Defendant Patent Portfolio	No	No	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R2	0.086	0.297	0.298
Observations	908	908	908

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

Table 7. Positive relationship between status in patent lawsuits

Dependent Variable: Defendant Status			
	(1)	(2)	(3)
Plaintiff Status	0.2299***	0.2359***	0.2231***
	(0.0322)	(0.0370)	(0.0373)
Plaintiff Firm Attributes	No	Yes	Yes
Plaintiff Patent Portfolio	No	No	Yes
Year Fixed Effects	Yes	Yes	Yes
Adjusted R2	0.086	0.083	0.094
Observations	902	902	902

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