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## Behavioural Agency and Firm Productivity: Revisiting the Incentive Alignment Qualities of Stock Options

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**ABSTRACT** Drawing on behavioural agency theory, we revisit the incentive alignment qualities of stock options. Using behavioural agency's logic, we theorize that chief executive officers (CEOs) are likely to perceive efforts directed at firm productivity as a means of protecting their option wealth (the value of previously awarded stock options). Our reasoning suggests that CEO option wealth positively influences firm productivity and that productivity mediates the relationship between CEO option wealth and firm value. Our theory also points to boundary conditions at the CEO level and the firm level. Our study advances research on the utility of stock options by focusing on effort and productivity as the mechanism through which option incentives affect CEO behaviours. We demonstrate that option risk bearing can align CEO–shareholder interests.

**Keywords:** behavioural agency, CEO stock options, executive compensation, productivity

### INTRODUCTION

Do chief executive officer (CEO) stock options enhance or destroy shareholder value? Classical agency scholars suggest that stock options enhance shareholder value by mitigating two dimensions of the agency problem: agent risk aversion, leading to lower risk-taking than would be preferred by shareholders (Jensen and Meckling, 1976), and declining firm productivity due to agent effort aversion (Alchian and Demsetz, 1972; Hart, 1983). To date, management scholars have focused on the utility of stock options in mitigating the first dimension of the agency problem, CEO risk aversion, by exploring the implications of CEO stock options for strategic risk-taking (e.g., Nyberg et al., 2010; Sanders and Hambrick, 2007; Wiseman and Gomez-Mejia, 1998; Wowak et al., 2015).

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Notwithstanding extensive research on the relationship between CEO stock options and strategic risk-taking, the core promise of stock options as an incentive alignment mechanism – namely, to foster shareholder value – remains largely unproven (Wowak and Hambrick, 2010; Zolotoy et al., 2021). Moreover, the management literature has yet to explore the implications of CEO stock options for the second dimension of the agency problem: ensuring that the agent (CEO) directs effort towards firm productivity.

A lack of attention to the implications of CEO stock options for firm productivity is surprising given (1) classical agency predictions on the role of stock options in incentivizing agents to direct effort towards productivity (Alchian and Demsetz, 1972; Fama and Jensen, 1983); (2) recognition of heterogeneity in the level of effort that CEOs exert on behalf of the firm and the centrality of CEO effort to maintaining and enhancing firm productivity (Chadwick et al., 2015; Koester et al., 2017; Lieberman et al., 1990; Mannor et al., 2016); and (3) the centrality of firm productivity to shareholder value (Alchian and Demsetz, 1972; Delgado et al., 2002; Huselid, 1995; Palia and Lichtenberg, 1999). We address this gap in the incentives and productivity literature by drawing on behavioural agency reasoning to examine the effect of option wealth on CEO effort.

The behavioural agency model (BAM; Wiseman and Gomez-Mejia, 1998) replaced the assumption of agent risk aversion with the concept of loss aversion to propose that CEO option wealth is negatively related to strategic risk-taking, thereby destroying shareholder value. Casting the CEO as loss averse, behavioural agency scholars have focused on how option wealth influences CEO risk preferences, as reflected in strategic investments, earnings manipulations, and tax policies (e.g., Devers et al., 2008; Larraza-Kintana et al., 2007; Zhang et al., 2008; Zolotoy et al., 2021). This literature argues that CEOs are likely to view strategic risk-taking as an avoidable threat to the value of their option wealth (Wiseman and Gomez-Mejia, 1998). Extending behavioural agency logic, we reason that CEOs are likely to perceive effort directed at firm productivity as a means of protecting their option wealth.

Our theoretical arguments point to the mediating role of productivity in the relationship between CEO option wealth and firm value. We also explore boundary conditions for both (1) the relationship between CEO option wealth and productivity and (2) the mediating role of productivity in the CEO option wealth–firm value relationship. We reason that, as entrenched CEOs are less influenced by the magnitude of their option wealth, entrenchment is likely to mitigate the relationship between CEO option wealth and productivity. We also reason that, as productivity is more central to firm value when competitors in the product market have similar offerings (Sirmon et al., 2008), product market competition is likely to amplify the mediating role of firm productivity in the relationship between CEO option wealth and firm value. Our exploration of these boundary conditions allows us to develop a richer theoretical understanding of CEO effort as the underlying mechanism for the relationship between CEO option wealth and firm productivity. We find empirical support for our theorizing in a longitudinal sample of US firms.

Our findings offer important theoretical contributions. First, we advance agency research on the utility of stock options as an incentive alignment mechanism (Bebchuk and Fried, 2003; Devers et al., 2007; Martin et al., 2013; Tosi et al., 2000). In particular, the lack of empirical evidence regarding the implications of CEO stock options

for shareholder wealth has been an ongoing concern (e.g., Bebchuk and Fried, 2003; Sanders and Hambrick, 2007). This concern is perhaps unsurprising given a near singular research focus on the implications of stock options for strategic risk. Our behavioural theory draws on evidence that loss aversion incentivizes greater CEO effort. This allows us to elucidate an alternate and less complex mechanism – firm productivity due to CEO effort – through which CEO options affect shareholder wealth. As productivity aligns with shareholder interests, our study challenges classical agency theory's proposition that agents' firm-specific wealth-at-risk (risk bearing) incentivizes behaviours that destroy shareholder value (Amihud and Lev, 1981; Devers et al., 2008; Eisenhardt, 1989). Thus, we qualify classical agency theory's proposition that incentives should offer prospective gains with minimal risk bearing to alleviate shareholder agency costs.

Second, we advance behavioural agency literature on the consequences of CEO option wealth. While fruitful in shedding light on the implications of option incentives for CEO risk behaviour, behavioural agency theory has been applied in a limited range of empirical settings (e.g., Devers et al., 2008; Martin et al., 2013; Zhang et al., 2008). Moreover, the risk and governance literature has yet to achieve consensus on the performance (and shareholder wealth) consequences of risk-taking incentivized by stock options (Martin et al., 2016). Hence, this literature remains subject to the criticism that it fails to offer clear guidance as to whether stock options (or other forms of executive compensation) create incentives compatible with shareholder or societal interests (Hambrick et al., 2008). More broadly, our study expands behavioural agency research to a new domain of inquiry – decision-making with effort implications – by drawing on (1) the concepts of effort and productivity from classical agency theory (e.g., Alchian and Demsetz, 1972; Delgado et al., 2002; Huselid, 1995) and (2) insights from neuroscience and behavioural economics on decision-making with effort implications (e.g., Chen et al., 2020; Imas et al., 2017). Finally, we advance literature exploring the relationship between CEO compensation and firm performance. Empirical research has suggested that total CEO compensation is not related to firm performance, emphasizing the need for further research (e.g., Aguinis et al., 2018; Wowak et al., 2018). We offer an alternate explanation regarding how CEO compensation (in the form of stock options) can affect firm performance by offering a novel mechanism (effort) and construct (productivity).

## **BACKGROUND AND HYPOTHESES**

### **The CEO and Firm Productivity**

Firm productivity is defined as the ratio of real output to real input (i.e., returns on the firm's resources) (Palia and Lichtenberg, 1999). Heterogeneous returns from firms' resources provide the foundation of a resource-based view of the firm (Barney, 1991; Peteraf, 1993), which emphasizes senior management's role in productive resource utilization (Mahoney, 1995). In orchestrating the productive utilization of firm resources, the CEO is responsible for firm productivity (Chadwick et al., 2015; Koester et al., 2017; Mannor et al., 2016). As

the executive with ultimate responsibility for firm productivity, the CEO is tasked with synchronizing employee capabilities, intellectual property, and organizational reputation along with more tangible resources such as plant and equipment (Mannor et al., 2016). The CEO is also expected to devise and coordinate firm-level initiatives in an uncertain information environment while facing dynamic internal and external constraints (Carpenter et al., 2004).

In arranging the productive utilization of firm resources, the CEO is expected to communicate a compelling vision for the firm and ensure that employees are aligned with these objectives (Helfat et al., 2007). In this regard, the CEO is the central actor in developing and sustaining an organizational culture that supports productive work – ensuring that productive workers are rewarded and that productive relationships are enhanced (Avolio, 1999; Podsakoff et al., 1996; Shamir et al., 1993). Given the centrality of their role, CEOs' attention to motivating and monitoring subordinates and coordinating firm resources has a profound impact on firm productivity (Chadwick et al., 2015; Lieberman et al., 1990). Underlining the link between the CEO and firm productivity, De Luque et al. (2008) show that the CEO's leadership is positively related to employees' effort, which enhances firm performance.

Discharging their responsibility for the productive utilization of firm resources requires a high level of cognitive and psychological effort on the part of CEOs (Biggerstaff et al., 2017; Mannor et al., 2015; Mintzberg, 1973; Ocasio, 1997; Simons et al., 1999). The CEO is expected to attend to a wide range of activities, temporal dimensions, and levels of detail (Cyert and March, 1963; Mintzberg, 1973). Attending to and switching between a wide range of responsibilities is cognitively arduous and physically tiring (Eggers and Kaplan, 2009; Garg and Eisenhardt, 2017). Moreover, the complexity of the CEO's task environment demands high levels of self-discipline and perseverance in ensuring that standards are maintained (Elenkov et al., 2005; Herrmann and Nadkarni, 2014). While CEOs play a dominant role in building and maintaining firm productivity, they also have discretion in the extent to which they attend to this responsibility (Eisenhardt, 1989).

## **CEO Incentives and Firm Productivity**

Classical agency theory has provided the core lens for scholars contemplating the problems associated with a separation of ownership and control. The agency problem has been defined as being created by the combination of (1) agent–principal goal divergence and (2) the difficulty of observing agent behaviours (Eisenhardt, 1989). This insight has been the catalyst for agency research exploring the limitations of board monitoring and the need for incentive alignment to compensate for the imperfections of board monitoring as a governance mechanism (Beatty and Zajac, 1994; Martin et al., 2019; Rediker and Seth, 1995; Zajac and Westphal, 1994). In the specific context of the CEO, the unobservable nature of effort ('hidden actions') weakens the role of monitoring, thereby amplifying the importance of incentives in ensuring that the CEO maximizes the productive utilization of firm resources (Alchian and Demsetz, 1972; Grinstein and Hribar, 2004; Stiglitz, 1974).

The tendency of executives to exert suboptimal effort is argued to have negative consequences for shareholders (Manso, 2011). This is due to lower levels of effort negatively impacting firm productivity, creating an erosion in firm value. The prospect of a CEO exerting suboptimal effort has been described using a range of terms, including

the pursuit of the quiet life (Bertrand and Mullainathan, 2003; Hart, 1983), shirking (Eisenhardt, 1989), managerial slack, and the lazy manager hypothesis (Aguilera et al., 2008). A common theme in these studies is that executives will be reluctant to engage in many of the burdensome and cognitively difficult aspects of their role in the absence of monitoring or incentives, with negative consequences for firm performance. Consistent with this reasoning, Biggerstaff et al. (2017) find a significant negative relationship between their proxy for CEO reduced effort (golfing) and both operating performance and firm value. Similar evidence has been provided in the finance literature (e.g., Yermack 2006, 2014).

Management scholars have shown less proclivity to embrace the simplifying assumptions – favoured by agency theorists in financial economics – that CEOs (managerial agents) have unbounded self-interest and are singularly motivated by pecuniary rewards (e.g., Davis et al., 1997; Fong and Tosi, 2007). Instead, management scholars reason that individuals who attain the CEO role are likely to have developed the routines and work habits to engage in high levels of effortful endeavor necessary to succeed in the promotion tournaments they are part of as their careers progress.<sup>[1]</sup> Moreover, executives are argued to be unlikely to automatically shirk in the absence of incentives and monitoring (for example, due to their conscientiousness and/or a sense of fairness) (Fong and Tosi, 2007).

Nonetheless, while executives may have developed a strong work ethic and engage in their role conscientiously, they are also thought to exert effort in accordance with their self-interest (Bosse and Phillips, 2016; Fong and Tosi, 2007; Wowak and Hambrick, 2010). That is, despite more generous assumptions about CEO tendency to shirk by management scholars, there is evidence of an overlap across the financial economics and management agency streams of literature in the premise that there is heterogeneity in the level of effort exerted by CEOs. The management literature has argued that CEOs are likely to exert greater effort in discharging their responsibilities when they have stronger compensation incentives (e.g., Carpenter and Sanders, 2004; Wang et al., 2017; Wowak and Hambrick, 2010) and/or where they are subject to closer monitoring by the board and other stakeholders (Shen, 2003). Said differently, while CEOs may be conscientious and diligent, such characteristics are thought to operate in tandem with self-interest in shaping CEO effort.<sup>[2]</sup>

In sum, the expectation that managerial agents can be incentivized through compensation design to exert greater effort on behalf of their firm is pervasive in the management literature (Bosse and Phillips, 2016; Fong and Tosi, 2007; Wowak and Hambrick, 2010). A common contention in these studies is that as effort becomes more difficult to observe, the utility of incentives increases. In what follows, we examine how effort incentivized by CEO option wealth is likely to affect firm productivity and therefore firm value.

### **CEO Stock Options and Firm Productivity**

Stock options have been offered as an incentive alignment mechanism for addressing agency concerns arising from the separation of ownership and control by aligning CEO wealth and shareholder wealth (Jensen and Meckling, 1976). The logic for using

stock options as an incentive for CEOs is embedded in the modelling of optimal principal–agent contracts, intending to balance agent CEO utility maximization with shareholder wealth creation. That is, principal–agent contracts attempt to provide incentives for the CEO to productively utilize firm resources by linking the CEO's financial outcomes to firm performance (e.g., Gao, 2010; Jensen and Meckling, 1976; Levinthal, 1988).

Literature examining the effects of CEO stock options on firm performance has suggested that stock options may incentivize CEOs to further exert themselves in their jobs (Sanders and Hambrick, 2007). In line with this reasoning, scholars have anticipated that boards may award stock options to CEOs with the specific aim of inducing greater effort (Conyon, 2006; Wang et al., 2017; Wowak et al., 2011). Similarly, boards of firms with higher firm-specific assets are thought to use restricted stock to motivate CEOs to exert the effort necessary to develop firm-specific knowledge (Wang et al., 2017). Consistent with this expectation, Wang et al. (2017) find a positive relationship between firm-specific assets and use of restricted stock in CEO compensation packages.

Casting the managerial agent as loss averse, behavioural agency scholars argue that executives are likely to include the accumulated value of previously awarded stock options in estimations of their personal wealth (Wiseman and Gómez-Mejía, 1998). Behavioural agency theory proposes that as wealth-at-risk (risk bearing) increases, executives shun risk-taking in order to protect their wealth (Wiseman and Gómez-Mejía, 1998); that is, option wealth is argued to be negatively related to agent (CEO) risk-taking (Devers et al., 2008; Larraza-Kintana et al., 2007). The negative relationship between option wealth and risk-taking advanced by behavioural agency theory has been used predominantly to predict strategic risk-taking by CEOs on behalf of their firm, operationalized as investments and capital structure choices with uncertain payoffs, such as research and development (R&D), capital expenditure (CAPEX), and debt financing (e.g., Devers et al., 2008; Gómez-Mejía et al., 2019; Kish-Gephart and Campbell, 2015; Larraza-Kintana et al., 2007). The negative relationship between option wealth and risk-taking has also been used to predict other types of CEO risk behaviour, such as earnings management (Zhang et al., 2008), product safety (Wowak et al., 2015), and pension underfunding (Martin et al., 2020).

While the behavioural agency literature has yet to be extended to firm productivity, insights from the theory provide a platform for exploring how CEO option wealth may shape firm productivity. As we have previously noted, behavioural agency theory posits that the CEO will avoid threats to the accumulated value of previously awarded stock options and that the motivation to preserve her/his option wealth is proportionate to the value of that wealth (Wiseman and Gomez-Mejia, 1998). These expectations are consistent with the logic of loss aversion and prospect theory's value function depicting how individuals place greater emotional weight on losses relative to gains (Tversky and Kahneman, 1992). This reasoning underpins behavioural agency's prediction that executives are likely to reduce risk-taking (e.g., curb investments in R&D and other assets) as option wealth increases, viewing higher risk as an avoidable threat to their option wealth (Devers et al., 2008).

The logic of loss aversion has also been applied to decision-making with implications for effort (e.g., Chen et al., 2020; Imas et al., 2017). In a series of experimental studies, Chen et al. (2020) show that loss aversion influences effort-based decision-making, such that individuals exert greater effort to avoid punishment than to realize a gain of the same magnitude. Similarly, Imas et al. (2017) show that people exert greater effort when working under a loss contract than when working under a payoff-equivalent gain contract. Specifically, people worked harder when provided upfront payments that could be lost dependent on performance. This is consistent with BAM logic that executives endow future payments considered assured and will take action to avoid loss of that wealth.

More recently, Gutierrez et al. (2021) provide evidence that former leaders exert greater effort than otherwise identical executives. Gutierrez et al. (2021) take this finding as support for the expectation that former leaders are likely to view their current situation as a loss that must be recouped and thus exert more effort compared with executives who have never held a leadership position. Scholars have also found support for the expectation that the effort induced by rewards at risk of loss has positive implications for workplace productivity. In a study of incentives and teacher productivity, Fryer et al. (2012) show that teachers become more productive when paid in advance and asked to give back the money if their students do not improve sufficiently, but that significant improvements in productivity were not observed when the equivalent reward was framed as a gain. Employing a natural experiment, Hossain and List (2012) showed that team productivity in a Chinese high-tech manufacturing facility was more sensitive to rewards posed as losses avoided than comparable rewards posed as gains.

Extending behavioural agency reasoning to firm productivity, we posit that effort directed at firm productivity is likely to be perceived by CEOs as an important means of protecting their option wealth.<sup>[3]</sup> The agency literature has described the role of compensation design in incentivizing effort (Conyon, 2006; Wowak et al., 2011). This literature also suggests that there is likely to be heterogeneity in CEO effort and that incentives such as stock options are likely to play an important role in incentivizing CEOs to exert higher levels of effort. Further developing that logic, we argue that option wealth provides CEOs with an important cue regarding the levels of effort they should direct towards firm productivity. This expectation is based on the logic that CEOs are likely to estimate prospective losses in option wealth (financial wealth-at-risk if firm productivity declines) when making choices that affect how much effort they direct towards enhancing firm productivity. Recall that orchestrating firm productivity demands the cognitive and physiological effort of the CEO (Avolio, 1999; Chadwick et al., 2015; Mannor et al., 2015). Where the CEO has more to lose, the incentive to exert greater effort becomes stronger.

In sum, we argue that as their option wealth increases, CEOs will summon additional effort to preserve that wealth. This is based on behavioural agency reasoning that CEOs will increasingly attempt to preserve their wealth as it increases (Wiseman and Gomez-Mejia, 1998). Hence, as CEO option wealth accumulates, the need to preserve that wealth is likely to dominate the disutility of effort required to avoid losses. Said formally:

*Hypothesis 1:* A positive relationship exists between the CEO's option wealth and her/his firm's productivity.

## **CEO Option Wealth, Firm Productivity, and Firm Value**

From a shareholder perspective, the ultimate test of the efficacy of CEO incentives is whether they enhance shareholder value (e.g., Jensen, 2002). However, there is limited evidence that CEO compensation incentives enhance firm value (Devers et al., 2007; Tosi et al., 2000; Wowak and Hambrick, 2010). Moreover, in the context of stock options, there has been some evidence that option grants lead to more extreme negative outcomes for shareholders (Sanders and Hambrick, 2007). Consequently, the merit of awarding such incentives remains highly contentious (Bebchuk and Fried, 2003; O'Connell and O'Sullivan, 2014). Yet, the literature exploring the implications of option wealth for firm performance (or firm value) remains underdeveloped. This reflects a lack of empirical research examining the mediating role of CEO (or executive) behaviours in the relationship between stock options and firm value (Martin et al., 2016). Hence, while we understand the implications of CEO option wealth for a range of CEO behaviours, we know little about whether option wealth – and the behaviours incentivized by option wealth – influence firm value. This absence of evidence limits the utility of agency theory for advancing our understanding of the incentive alignment qualities of stock options (Gomez-Mejia et al., 2019). Therefore, we extend our theoretical reasoning by describing the interplay between CEO stock option wealth, firm productivity, and firm value.

Recall that in developing Hypothesis 1, we advanced the argument that CEOs are likely to view firm productivity as a mechanism for protecting their option wealth. The logic underpinning this prediction is that productivity is positively related to firm value, given that the definition of productivity – the ratio of real output to real input – implies that higher firm returns are yielded due to higher productivity (e.g., Palia and Lichtenberg, 1999). Thus, we theorize in Hypothesis 1 that effort directed at firm productivity provides CEOs with a mechanism to protect their option wealth. If option wealth motivates the CEO to attend to firm productivity as a means of enhancing his/her personal wealth, the CEO is likely to be mindful of the implications of these efforts for firm value. That is, to the extent that option wealth incentivizes the CEO to exert greater effort at enhancing productivity, productivity should mediate the relationship between CEO option wealth and firm performance. Therefore, we posit that firm productivity mediates the relationship between CEO option wealth and firm value:

*Hypothesis 2:* Firm productivity mediates the positive relationship between the CEO's option wealth and her/his firm's value.

### **Contextual Boundary Conditions**

Having argued the main effect of CEO option wealth on firm productivity and the mediating role of productivity in the CEO option wealth–firm value relationship, we now turn to boundary conditions for both relationships. Exploring boundary conditions allows us to provide greater theoretical specificity and corroborate the role of CEO effort as the causal mechanism in hypothesized baseline relationships. Consistent with prior

governance research (e.g., Devers et al., 2007; Martin et al., 2016; Zhang et al., 2008), we offer boundary conditions at the CEO level and at the firm level in order to provide greater guidance as to when the hypothesized relationships are likely to be attenuated or accentuated.

*CEO entrenchment.* At the CEO level, the boundary condition we consider is the extent to which the CEO is entrenched in her/his role, circumventing the market for corporate control. The market for corporate control provides an external governance mechanism that mitigates agency concerns associated with the separation of ownership and control (Manne, 1965). As executives do not wish to lose their jobs and the benefits they enjoy from control, the market for corporate control imposes a disciplining external force (Jensen, 1993; Morck et al., 1989). Thus, when CEOs are entrenched, the potential for losses become less salient.

Behavioural logic suggests that effort in response to potential losses will increase when the potential for losses increases. For example, in a novel study, Schneemann and Deutscher (2017) show that professional soccer players exert the greatest effort when their team is leading by a single goal – i.e., when the negative consequences of conceding a goal are greatest. In a similar vein, studies in management suggest that the losses associated with dismissal shape the level of effort that executives are likely to exert (Pitcher et al., 2000; Shen, 2003). Shen (2003), for example, reasons that scrutiny by the board provides a strong motivation for CEOs to work hard to prove themselves and thus retain their position and associated entitlements (including compensation incentives). Conversely, it has been argued that when executives are protected from this disciplining force (i.e., when they are ‘entrenched’), they have greater discretion to exert less effort and opportunistically transfer wealth from outsiders to themselves (Bebchuk and Fried, 2003; Larcker and Tayan, 2015). Consistent with this reasoning, prior studies in management have described how managerial entrenchment, and more broadly, factors that insulate executives from the downsides of failure, weaken the relationship between executive compensation and firm performance (e.g., Finkelstein et al., 2009).

A deterioration in firm productivity jeopardizes firm value and thus threatens the CEO’s tenure at his/her firm. CEOs who are dismissed experience substantial losses, including losing unvested stock options and retirement benefits (Cruz et al., 2010; Martin et al., 2013). We reason that these potential losses become less salient in decision-making when CEOs are entrenched in their role. That is, when CEOs perceive external governance mechanisms are less likely to affect them, the potential losses incurred in the event of dismissal are less likely to weigh on their decisions regarding the level of effort directed at managing firm productivity. Therefore:

*Hypothesis 3:* Entrenchment attenuates the positive relationship between the CEO’s option wealth and her/his firm’s productivity.

*Product market competition.* At the firm level, we explore how product market competition affects the interplay between CEO option wealth, firm productivity, and firm value.

Hypothesis 1 predicts that CEO option wealth positively influences firm productivity, given that the CEO is likely to view firm productivity as a means of protecting her/his option wealth. Agency scholars suggest that the CEO will consider whether the financial payoff justifies the effort associated with her/his actions (e.g., Gao, 2010; Hölmstrom, 1979). In the context of stock options wealth and firm productivity, we reason that the CEO is likely to be mindful of the extent to which bolstering productivity preserves firm value – and thus the utility of productivity as a means of protecting the CEO's option wealth. In particular, we reason that the CEO is likely to be mindful that the centrality of productivity to firm performance varies with the nature of competition in the product market (Karuna, 2007). Firms with highly differentiated offerings face fewer direct competitors and are thus less reliant on maintaining industry-leading cost and productivity for their competitive success (e.g., Hotelling, 1929; Salop, 1979).

Conversely, in product markets in which firms have similar (less differentiated) offerings, margins tend to be tighter, and productivity becomes more critical for firm performance and competitive success (Sirmon et al., 2008). Thus, we reason that when competitors in the product market have similar offerings to the focal firm – a context in which productivity is more central to firm value – CEOs are likely to place greater weight on directing effort at managing productivity as a means of protecting their option wealth. Accordingly, we expect that the role of productivity in mediating the positive relationship between CEO option wealth and firm value will be stronger for firms with product offerings that are more similar to those of competitors.

*Hypothesis 4:* Product similarity accentuates the mediating role of firm productivity in the positive relationship between the CEO's option wealth and her/his firm's value.

## METHODS

### Sample

Our initial sample consisted of all firms covered by Peter Demerjian's database (<http://faculty.washington.edu/pdemerj/data.html>), from which we obtained estimates of firm productivity (discussed in detail in the following section). We merged this sample with the Standard and Poor's ExecuComp database, which contains data on compensation items for executives in companies included in the S&P 1500 Index. The S&P 1500 includes the S&P 500, the S&P MidCap 400, and the S&P SmallCap 600 indices, representing the large-cap, midsize, and small-cap segments of the US equity market, respectively.

We obtained data on CEO entrenchment from RiskMetrics and data on firms' product similarity from Gerard Hoberg and Gordon Phillips's database (<http://hobergphilips.usc.edu/industryconcen.htm>). We obtained firm financial information and analyst coverage data from the Compustat and Institutional Brokers Estimates System (IBES) summary files, respectively. We obtained data on CEO characteristics (i.e., age, tenure,

and gender) from ExecuComp. A final sample of 19,598 observations for the period 1993–2015 was available to test our baseline hypothesized relationships (i.e., Hypothesis 1 and Hypothesis 2). The sample size used to test the hypothesized boundary conditions (i.e., Hypothesis 3 and Hypothesis 4) was smaller due to excluding observations with missing data on CEO entrenchment and product similarity.

## Measures

*Firm productivity.* We capture firm productivity using the measure developed by Demerjian et al. (2012). This measure is derived from frontier analysis and captures how productive the firm is in converting its resources such as capital, labour, and intangible assets into revenues compared with its industry peers. Frontier analysis has been widely applied in assessing the productivity of decision-making units (for reviews, see Fried et al., 2008; Liu et al., 2013; Murillo-Zamorano, 2004). Recently, this method has gained momentum in management research (e.g., Chen et al., 2015; Koester et al., 2017; Surroca et al., 2016). The estimation procedure of the *Productivity* variable involves two steps, which we outline in what follows; for a detailed discussion, see Demerjian et al. (2012) and Koester et al. (2017).

In the first step, data envelopment analysis, an optimization procedure used to evaluate the relative efficiency of decision-making units, is employed to build an efficient frontier from the level of firm output (i.e., revenues) and the combination of inputs used to generate firm output. These inputs include the cost of goods sold, net property, plant and equipment, sales, general and administrative expenses, net R&D, net operating leases, goodwill, and other intangibles. Data envelopment analysis optimization is conducted by comparing the sales revenue of each firm conditional on a vector of these input variables among firms in the same year and in the same industry. As a result, data envelopment analysis yields a firm-specific vector of optimal weights on input variables, which are then used to compute a firm-year productivity score that takes a value between zero (for the least productive firms) and one (for the most productive firms). The second step of the estimation procedure involves regressing firm-year productivity scores on a set of firm-level attributes expected to facilitate or hinder the productive management of firm resources. These attributes include size of the firm, market share, firm age, positive free cash flow, multi-segment, and international operations.<sup>[4]</sup> Accordingly, the *Productivity* variable is the residual from the regression, capturing the portion of firm productivity that is not explained by the aforementioned firm-level characteristics.

*CEO option wealth.* CEO option wealth represents the CEO's estimate of the wealth he/she has accumulated due to past option grants that subsequently increased in value. Accumulated option wealth is at risk of loss given that it is positively correlated with the firm's share price (Wiseman and Gómez-Mejía, 1998). Following prior studies (e.g., Kish-Gephart and Campbell, 2015; Larraza-Kintana et al., 2007), we calculate *CEO option wealth* as the number of in-the-money options from each option grant, multiplied by their corresponding spread (the difference between the market price of a firm's stock and the strike price) on the final day of the fiscal year. As *CEO option wealth* is highly

skewed, we log-transform the variable. *CEO option wealth* is a heuristic for the CEO's estimate of his/her potential personal wealth losses (losses to endowed wealth) if firm productivity declines, given that adverse firm outcomes negatively affect the share price and, therefore, the value of the CEO's stock options.

*Firm value.* The strongest test of the efficacy of CEO compensation is whether it improves shareholder value (Jensen, 2002). Yet, the shareholder value criterion highlighted by Jensen (2002) has been overlooked in many studies examining pay–performance sensitivity. Instead, scholars have considered ‘intermediate’ results such as firm profitability (e.g., Finkelstein and Hambrick, 1996). Shareholder value provides a more complete and theoretically grounded assessment of pay–performance sensitivity (e.g., Carpenter and Sanders, 2002; O’Connell and O’Sullivan, 2014). Consistent with these studies, we use Tobin’s *Q* as our measure of firm value. We calculate *Tobin’s Q* as the ratio of market value of assets to the book value of assets. We calculate the market value of assets as the market value of equity plus the book value of assets minus the book value of equity and minus deferred taxes. We winsorize *Tobin’s Q* at both the top and bottom percentile to mitigate the potential effects of outliers.

*CEO entrenchment.* We measure the extent to which a CEO is entrenched within the firm using an Entrenchment Index introduced by Bebchuk et al. (2009). This measure has been widely used in the management literature (e.g., Christensen et al., 2015; Gartenberg and Pierce, 2017). Bebchuk et al. (2009) identify six corporate governance provisions that enhance executives’ entrenchment within a firm. These include four constitutional provisions that limit shareholders’ power (limits to shareholder bylaw amendments, staggered boards, supermajority requirements for mergers, and supermajority requirements for charter amendments) and two anti-takeover provisions (poison pills and golden parachutes). The *CEO entrenchment* variable is constructed by counting provisions from the aforementioned list that are enacted in the firm. A higher value of *CEO entrenchment* indicates a greater level of a CEO’s entrenchment in his/her firm.

*Product similarity.* We use a product similarity measure developed by Hoberg and Phillips (2016), which has been widely used in recent management literature (e.g., Hoberg and Phillips, 2018; Shi et al., 2017; Wang et al., 2017). This measure relies on a text-based network industry classification (TNIC) system, in which each firm has its own set of distinct competitors.<sup>[5]</sup> Hoberg and Phillips (2016) construct firm-by-firm pairwise similarity scores by parsing the product descriptions from firms’ 10-K filings and forming word vectors for each firm to calculate measures of product similarity for every pair of firms each year. The accuracy of these product descriptions is a legal requirement, and they must also be representative of the current fiscal year of the 10-K (Hoberg and Phillips, 2016; Shi et al., 2017). As a result of this text-based analysis, any two firms *i* and *j* are assigned a product similarity score, a real number bounded between zero and one. Hoberg and Phillips (2016) use a minimum similarity threshold of 21.32 per cent to produce text-based industries that have the same level of coarseness (namely, the same fraction of membership pairs) as

three-digit Standard Industry Classification (SIC) industries. For each firm within a given text-based industry, a total product similarity score (*Product similarity*) is calculated as the sum of the pairwise similarities between the focal firm and all other firms in a given text-based industry in a given year. A higher value of *Product similarity* indicates greater similarity between the product offerings of the focal firm and those of its competitors.

*Control variables.* We control for other aspects of CEO equity-based compensation suggested by prior literature (e.g., Bulan et al., 2010; Devers et al., 2008; Martin et al., 2016). Specifically, we include CEO equity wealth sensitivity to stock price (*CEO delta*), the sensitivity of CEO stock options to stock return volatility (*CEO vega*), and CEO stock ownership in the firm. We calculate *CEO delta* as the dollar change in the value of the CEO's stock and option portfolio in response to a 1 per cent increase in the firm's stock price. As equity wealth typically comprises both stocks and stock options, *CEO delta* is the sum of deltas for these two components. For the option component of CEO equity wealth, *Delta* is constructed based on the Black and Scholes (1973) dividend-adjusted option-pricing model following Core and Guay (2002). We calculate *CEO vega* as the dollar change in the CEO's option portfolio for a 0.01 change in the annualized standard deviation of the firm's stock return based on the Black and Scholes (1973) dividend-adjusted option-pricing model (Core and Guay, 2002). As both *CEO delta* and *CEO vega* are significantly skewed in our sample, we follow prior literature by log-transforming the variables. We calculate *CEO stock ownership* as the number of stocks owned by the CEO divided by the total number of shares outstanding.

In addition, we control for firm strategic risk-taking, which could also be influenced by CEO option wealth (e.g., Martin et al., 2013). To that end, we include *CAPEX*, *R&D*, and *Leverage* – variables that are suggested by prior research to be positively associated with strategic risk-taking (Devers et al., 2008; Larraza-Kintana et al., 2007). We calculate *CAPEX* as the ratio of capital expenditure over the book value of assets; we calculate *R&D* as the ratio of R&D expenses over the book value of assets; we calculate *Leverage* as the ratio of long-term debt over the book value of assets.

We include *Firm size* to control for potential economies of scale in managing firm resources and verify that our findings are not spuriously driven by the correlation between the firm's size and the CEO's option compensation. We calculate *Firm size* as the natural logarithm of firm assets. We further include firm age to control for a firm's life cycle; we calculate *Firm age* as the (log-transformed) number of years a firm's financial data was available in Compustat prior to fiscal year-end. We also include *Advertising intensity* and *Analyst coverage* to control for firm visibility to customers and investors, respectively (Mehran and Peristiani, 2009; Servaes and Tamayo, 2013). We calculate *Advertising intensity* as the ratio of advertising expenses over the book value of assets; we calculate *Analyst coverage* as the (log-transformed) number of analysts covering the stock over the fiscal year. We also include *Foreign income* as a dummy variable which takes a value of one if the firm reported foreign income and zero otherwise to control for the geographic span of a firm's operations.

Further, we include *Bankruptcy risk* to control for a firm's probability of default and *Financial constraints* to control for a firm's access to capital. We calculate *Bankruptcy risk* as the arithmetic inverse of Altman Z-score (Altman, 1968); we calculate *Financial constraints* using the Hadlock and Pierce financial constraints index (Hadlock and Pierce, 2010). We also include *CEO age*, *CEO gender*, and *CEO tenure* as prior research shows that these CEO

characteristics influence corporate policies (Devers et al., 2008). We calculate *CEO gender* as an indicator variable, which takes a value of one for male CEOs and zero otherwise; we calculate *CEO tenure* as the number of years the CEO has held her/his position in the firm.

As we discuss in the following section, we estimate our models using fixed-effects panel regressions. This approach controls for all enduring characteristics (both observed and unobserved) of the firm and the headquarters' location, including all stable aspects of the geographic, cultural, social, and political landscape of communities as well as firms' industry affiliations (Tilcsik and Marquis, 2013). We also include year dummies to control for potential time trends in firms' productivity and/or CEO option wealth.

### **Estimation Method**

Both fixed- and random-effects models are common when working with panel data (Certo and Semadeni, 2006; Halaby, 2004; Sanders, 2001). Our theoretical arguments imply within-firm effects – i.e., we hypothesize that the extent to which the CEO productively manages firm resources varies with CEO option incentives at the firm level. Fixed-effects models are recommended over random-effects models in research hypothesizing within-firm effects (Certo et al., 2017; Woolridge, 2010). Further, the (untabulated) Hausman (1978) test statistics are statistically significant ( $p$ -value  $< 0.01$ ), suggesting that, in our setting, fixed-effects models (which estimate within-firm effects) are more appropriate than random effects models (which rest on the assumption that within- and between-firm effects are the same) (Certo et al., 2017). Based on the foregoing discussion and consistent with prior behavioural agency studies (e.g., Desjardine and Shi, 2021; Gomez-Mejia et al., 2019), we conduct our analyses using fixed-effects models.

## **RESULTS**

Table I reports the descriptive statistics. In our sample, average *Productivity* is equal to 0.012, and average *CEO option wealth* is equal to 7.189. As (untabulated) results indicate, the highest variance inflation factor is below the threshold of 5, indicating that multicollinearity does not pose a concern in our setting (O'Brien, 2007).

### **Baseline Analysis**

To test Hypothesis 1, we regressed *Productivity* on *CEO option wealth* and control variables discussed in the previous section. Following prior literature (e.g., Devers et al., 2008; Martin et al., 2013), throughout our analyses, we used one-year lagged values of *CEO option wealth* and other CEO compensation-related control variables.

We report the results of this analysis in Table II. Model 1 includes *CEO option wealth* and year dummies (the latter are untabulated for brevity). Model 2 includes *CEO option wealth*, CEO compensation-related control variables, and year dummies. Model 3 is our fully specified baseline model, which includes *CEO option wealth*, all control variables, and year dummies. All models were estimated using a fixed-effects

Table I. Descriptive statistics and correlations

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1 Productivity	0.012	0.148	1																					
2 GEO option wealth	7.189	3.147	0.180	1																				
3 Tobin's Q	1.977	1.383	0.292	0.271	1																			
4 GEO entrenchment	2.256	1.242	-0.120	-0.021	-0.107	1																		
5 Product similarity	3.288	3.934	0.222	0.043	0.223	-0.045	1																	
6 GEO vega	4.003	1.582	0.182	0.452	0.104	-0.006	0.027	1																
7 GEO delta	5.346	1.465	0.209	0.600	0.250	-0.116	0.050	0.620	1															
8 GEO stock ownership	0.017	0.041	-0.026	-0.029	0.042	-0.132	-0.009	-0.124	0.379	1														
9 Firm size	7.451	1.588	0.179	0.307	-0.113	-0.053	-0.090	0.568	0.491	-0.185	1													
10 Leverage	0.194	0.189	-0.142	-0.044	-0.108	0.072	0.043	0.049	0.000	-0.047	0.217	1												
11 Firm age (log)	3.142	0.649	0.007	0.029	-0.163	0.073	-0.207	0.205	0.043	-0.168	0.438	0.080	1											
12 Foreign income	0.636	0.481	0.025	0.074	-0.012	0.069	-0.134	0.183	0.066	-0.124	0.205	-0.083	0.203	1										
13 R&D intensity	0.037	0.069	0.196	-0.018	0.290	-0.072	0.426	-0.017	-0.049	-0.030	-0.264	-0.165	-0.168	0.109	1									
14 CAPLX	0.056	0.055	0.005	0.038	0.030	-0.027	0.145	-0.066	0.049	0.038	0.001	0.067	-0.075	-0.185	-0.114	1								
15 Advertising intensity	0.014	0.038	0.119	0.018	0.103	-0.071	-0.066	0.046	0.038	0.036	-0.036	-0.027	-0.029	-0.043	-0.061	0.013	1							
16 Financial constraints	-3.125	0.191	0.044	-0.229	0.137	-0.138	0.138	-0.370	-0.325	0.142	-0.621	-0.229	-0.378	-0.184	0.368	-0.010	0.043	1						
17 Bankruptcy risk	-1.815	2.054	-0.106	-0.173	-0.020	0.002	0.265	-0.072	-0.150	-0.059	-0.098	0.197	-0.105	0.014	0.432	0.002	-0.104	0.279	1					
18 Analyst coverage (log)	1.972	1.112	0.153	0.192	0.126	-0.069	0.052	0.245	0.265	-0.056	0.285	-0.047	0.026	0.074	0.025	0.052	0.019	-0.214	-0.106	1				
19 GEO gender	0.977	0.149	0.007	0.025	0.006	0.056	-0.004	0.002	0.038	0.021	0.011	0.028	0.011	0.026	0.023	0.012	-0.044	-0.039	0.026	0.020	1			
20 GEO age	55.548	7.015	-0.028	0.039	-0.078	0.015	-0.049	0.060	0.126	0.090	0.125	0.041	0.194	0.030	-0.092	-0.009	-0.039	-0.043	0.015	0.032	0.032	1		
21 GEO tenure	6.859	6.834	0.003	0.110	0.023	-0.083	0.050	0.044	0.296	0.337	-0.066	-0.019	-0.043	-0.076	0.007	0.036	-0.023	0.030	-0.029	0.036	0.047	0.380	1	

Table II. The influence of CEO option wealth on productivity

	<i>Model 1</i>		<i>Model 2</i>		<i>Model 3</i>	
CEO option wealth	<b>0.078***</b>	<b>(0.009)</b>	<b>0.074***</b>	<b>(0.010)</b>	<b>0.055***</b>	<b>(0.010)</b>
CEO Vega			-0.039**	(0.018)	-0.044**	(0.019)
CEO delta			0.032	(0.019)	-0.006	(0.020)
CEO stock ownership			-0.005	(0.0182)	0.012	(0.013)
Firm size					0.182***	(0.049)
Leverage					-0.037**	(0.017)
Firm age					0.116**	(0.048)
Foreign income					0.006	(0.032)
R&D intensity					0.165***	(0.034)
CAPEX					0.047***	(0.015)
Advertising intensity					0.083***	(0.022)
Financial constraints					0.102***	(0.036)
Bankruptcy risk					-0.239***	(0.033)
Analyst coverage					0.037	(0.019)
CEO gender					0.179***	(0.069)
CEO age					0.019	(0.013)
CEO tenure					-0.017	(0.014)
Obs.	19,598		19,598		19,598	
R <sup>2</sup> (within)	0.014		0.015		0.056	
R <sup>2</sup> (between)	0.042		0.034		0.133	
R <sup>2</sup> (overall)	0.035		0.029		0.129	

*Note:* The models were estimated using a fixed effects (FE) panel estimator. Year dummies are included in all models but not tabulated for brevity. Standard errors (in parentheses) are adjusted for heteroskedasticity and clustering at the firm level. All p-values are for two-tailed tests. Coefficients of interest are highlighted in bold.

\*\*Denotes two-tail significance at the 5% level.

\*\*\*Denotes two-tail significance at the 1% level.

panel regression estimator. Robust standard errors adjusted for clustering by firm are reported in parentheses. To facilitate interpretation, the dependent variable (i.e., *Productivity*) and all non-binary explanatory variables were standardized with a mean of zero and a standard deviation of one. The coefficient of *CEO option wealth* is positive and significant (p-value < 0.01), lending support for Hypothesis 1. The reported effect of CEO option wealth on firm productivity is non-trivial: the coefficient estimate of *CEO option wealth* is 0.055 (Model 3 in Table II), and the interquartile range of *Productivity* is 0.926, implying that, in our sample, a one standard deviation increase in CEO option wealth is associated, on average, with an increase of 5.94 per cent in firm productivity relative to its interquartile range.<sup>[6]</sup>

Next, we tested Hypothesis 2, which predicts that firm productivity mediates the relationship between CEO option wealth and firm value. In testing Hypothesis 2, we first estimated the total effects of CEO option wealth on firm value. We report the

Table III. The mediating role of firm productivity in the CEO option wealth–firm value relationship

	<i>Model 1</i>		<i>Model 2</i>	
Productivity			<b>0.138***</b>	<b>(0.022)</b>
CEO option wealth	<b>0.135***</b>	<b>(0.013)</b>	0.127***	(0.013)
CEO vega	−0.186***	(0.029)	−0.180***	(0.028)
CEO delta	0.373***	(0.031)	0.374***	(0.031)
CEO stock ownership	−0.117***	(0.026)	−0.118***	(0.026)
Firm size	−0.949***	(0.079)	−0.974***	(0.079)
Leverage	−0.012	(0.047)	−0.007	(0.046)
Firm age	−0.208**	(0.085)	−0.224***	(0.083)
Foreign income	−0.054	(0.057)	−0.055	(0.057)
R&D intensity	0.145***	(0.051)	0.122**	(0.048)
CAPEX	0.042**	(0.017)	0.035**	(0.016)
Advertising intensity	−0.002	(0.032)	−0.012	(0.031)
Financial constraints	−0.018	(0.059)	−0.032	(0.058)
Bankruptcy risk	−0.202***	(0.070)	−0.169**	(0.069)
Analyst coverage	0.069***	(0.020)	0.064***	(0.020)
CEO gender	0.004	(0.098)	−0.021	(0.092)
CEO age	−0.006	(0.018)	−0.009	(0.018)
CEO tenure	−0.039**	(0.017)	−0.037**	(0.017)
Obs.		19,598		19,598
R <sup>2</sup> (within)		0.196		0.204
R <sup>2</sup> (between)		0.118		0.139
R <sup>2</sup> (overall)		0.101		0.119

*Note:* The models were estimated using a fixed effects (FE) panel estimator. Year dummies are included in all models but not tabulated for brevity. Standard errors (in parentheses) are adjusted for heteroskedasticity and clustering at the firm level. All p-values are for two-tailed tests. Coefficients of interest are highlighted in bold.

\*\*Denotes two-tail significance at the 5% level.

\*\*\*Denotes two-tail significance at the 1% level.

results of this estimation as ‘Model 1’ in Table III, showing that the coefficient of *CEO option wealth* is significantly positive (p-value < 0.01). We then modified Model 1 to include *Productivity* as the explanatory variable of interest. We report the results of this estimation as ‘Model 2’ in Table III, showing that the coefficient of *Productivity* is significantly positive (p-value < 0.01). The coefficient estimate of *Productivity* is 0.138 (Model 2 in Table III) and the sample mean of *Tobin’s Q* is 1.977, implying that, in our sample, a one standard deviation increase in firm productivity is associated, on average, with an increase of 6.98 per cent in firm value. Combining the estimates of Model 2 in Table III with those from Model 3 in Table II, we tested the mediation effect using the product of coefficients approach (Sobel, 1982). Specifically, we computed the indirect effects – i.e., the effects of CEO option wealth on firm value

through productivity – as the product of the coefficients of the corresponding paths and tested for significance using Sobel's (1982) standard error formula. This approach has been shown to perform well in large samples and has been widely used in the management literature (Seo et al., 2015; Stone and Sobel, 1990). The product of the coefficients test statistic is positive and statistically significant (p-value < 0.01), providing support for Hypothesis 2.

Next, we tested Hypothesis 3, which predicts that the intensity of the positive relationship between CEO option wealth and firm productivity is attenuated at higher levels of CEO entrenchment, suggesting a strength moderation effect (Boyd et al., 2011). As Boyd et al. (2011, p. 1914) point out: 'Strength moderation occurs when the intensity of the  $xy$  relationship differs at various levels of  $z$  and is analyzed by subgroups'. To test Hypothesis 3, we followed Boyd et al. (2011) and partitioned the sample into two subsamples based on the sample median of the *CEO entrenchment* variable. We then re-estimated Model 3 in Table II (i.e., our fully specified baseline model of firm productivity) twice, once using the low CEO entrenchment subsample and once using the high CEO entrenchment subsample (i.e., observations with *CEO entrenchment* below and above the sample median, respectively). We report the results of this estimation in Table IV. For the low CEO entrenchment subsample, the coefficient of *CEO option wealth* is positive and highly significant ( $b = 0.073$ , p-value < 0.01); for the high CEO entrenchment subsample, the coefficient of *CEO option wealth* is positive and significant ( $b = 0.030$ , p-value = 0.049). The difference between the two coefficient estimates is positive and significant (p-value of the difference test = 0.070, two-tail), providing support for Hypothesis 3.

Last, we tested Hypothesis 4, which predicts that product similarity accentuates (i.e., positively moderates) the mediating role of firm productivity in the relationship between CEO option wealth and firm value. Hence, analogous to Hypothesis 3, Hypothesis 4 implies a strength moderation effect (Boyd et al., 2011). To test Hypothesis 4, we first partitioned the sample into two subsamples based on the sample median of the *Product similarity* variable. We then re-estimated models used to test for mediation effects (i.e., Model 3 in Table II and Model 2 in Table III) twice, once using the high product similarity subsample and once using the low product similarity subsample (i.e., observations with *Product similarity* above and below the sample median, respectively). The results of this analysis are reported in Table V. Using the results from Table V, we estimated the indirect effect of CEO option wealth on firm value – i.e., the mediating effect of firm productivity in the CEO option wealth–firm value relationship – using Sobel's (1982) approach separately for the high- and low-product similarity subsamples and tested for the differences. The mediating effect of firm productivity is significant in the high product similarity subsample (p-value < 0.01) and is significantly larger than the one in the low product similarity subsample (p-value of the difference test = 0.014, two-tail), lending support for Hypothesis 4.

### Supplemental Analysis

We sought to provide further evidence for CEO effort as the mechanism behind our findings. Here, we were challenged by the largely unobservable nature of CEO effort ('hidden actions'). Reflecting on this challenge, we sought out settings where CEO

Table IV. The moderating effect of CEO entrenchment on the CEO option wealth–productivity relationship

	<i>Low entrenchment</i>		<i>High entrenchment</i>	
CEO option wealth	<b>0.073***</b>	<b>(0.018)</b>	<b>0.030**</b>	<b>(0.015)</b>
CEO vega	−0.111***	(0.027)	0.003	(0.029)
CEO delta	0.031	(0.033)	−0.045	(0.032)
CEO stock ownership	−0.011	(0.020)	0.026	(0.025)
Firm size	0.313***	(0.087)	0.172**	(0.083)
Leverage	0.022	(0.026)	−0.069**	(0.028)
Firm age	0.193**	(0.099)	0.200**	(0.092)
Foreign income	−0.008	(0.049)	0.048	(0.055)
R&D intensity	0.272***	(0.063)	0.265***	(0.084)
CAPEX	0.087**	(0.021)	0.025	(0.023)
Advertising intensity	0.066	(0.037)	0.055**	(0.027)
Financial constraints	0.133**	(0.061)	−0.049	(0.076)
Bankruptcy risk	−0.241***	(0.052)	−0.333***	(0.066)
Analyst coverage	0.063	(0.038)	0.107***	(0.033)
CEO gender	0.185	(0.124)	0.243**	(0.098)
CEO age	0.033	(0.019)	0.017	(0.016)
CEO tenure	−0.004	(0.025)	−0.042**	(0.017)
Obs.		7,385		5,881
R <sup>2</sup> (within)		0.072		0.077
R <sup>2</sup> (between)		0.140		0.138
R <sup>2</sup> (overall)		0.159		0.124

*Note:* The models were estimated using a fixed effects (FE) panel estimator. Year dummies are included in all models but not tabulated for brevity. Standard errors (in parentheses) are adjusted for heteroskedasticity and clustering at the firm level. All p-values are for two-tailed tests. Coefficients of interest are highlighted in bold.

\*\*Denotes two-tail significance at the 5% level.

\*\*\*Denotes two-tail significance at the 1% level.

effort is clearly on display and thus is subject to measurement. CEO participation in firms' earnings conference calls represents one such setting. Our intuition is that the effort CEOs exert towards the firm would be reflected in the intensity of their contribution to conference calls and that, during conference calls, CEOs who were exerting greater effort towards the firm would feel more comfortable addressing comments concerning firm performance. Therefore, building on our core prediction – that option wealth incentivizes the CEO to direct greater effort towards firm productivity – we anticipated a positive association between option wealth and the intensity of the CEO's communications.

To test this conjecture, we employed a textual analysis of transcripts from conference calls. Specifically, we examined the linkage between CEO option wealth and the

Table V. The moderating effect of product similarity on the CEO option wealth–productivity–firm value relationship

Dependent variable	Panel A: High product similarity		Panel B: Low product similarity	
	Productivity	Tobin's Q	Productivity	Tobin's Q
Productivity		<b>(0.033)</b>		<b>(0.029)</b>
CEO option wealth	<b>0.089***</b>	<b>(0.016)</b>	<b>0.020*</b>	<b>(0.011)</b>
CEO vega	-0.079***	(0.025)	-0.017	(0.023)
CEO delta	-0.043	(0.029)	0.017	(0.027)
CEO stock ownership	0.038	(0.020)	-0.003	(0.015)
Firm size	0.205***	(0.077)	0.096	(0.075)
Leverage	-0.065***	(0.025)	-0.002	(0.018)
Firm age	0.041	(0.087)	0.125**	(0.063)
Foreign income	-0.036	(0.059)	0.039	(0.036)
R&D intensity	0.201***	(0.047)	0.116**	(0.045)
CAPEX	0.059***	(0.020)	0.045**	(0.019)
Advertising intensity	0.077	(0.040)	0.118***	(0.025)
Financial constraints	-0.009	(0.054)	0.146***	(0.054)
Bankruptcy risk	-0.227***	(0.040)	-0.179***	(0.041)
Analyst coverage	0.049	(0.031)	-0.026	(0.023)
CEO gender	0.174	(0.097)	0.134	(0.087)
CEO age	0.036	(0.020)	-0.005	(0.016)
CEO tenure	-0.029	(0.022)	0.004	(0.019)
Obs.	8,741	8,741		
R <sup>2</sup> (within)	0.072	0.242		8,742
R <sup>2</sup> (between)	0.130	0.118		0.051
R <sup>2</sup> (overall)	0.117	0.103		0.109
				0.127

Note: The models were estimated using a fixed effects (FE) panel estimator. Year dummies are included in all models but not tabulated for brevity. Standard errors (in parentheses) are adjusted for heteroskedasticity and clustering at the firm level. All p-values are for two-tailed tests. Coefficients of interest are highlighted in bold.

\*Denotes two-tail significance at the 10% level.

\*\*Denotes two-tail significance at the 5% level.

\*\*\*Denotes two-tail significance at the 1% level.

intensity of CEO communications to analysts during conference calls, captured using the following two variables: (1) % *CEO text*, calculated as the total number of characters (i.e., letters) spoken by the CEO divided by the total number of characters spoken by company employees during the conference call and (2) % *CEO comments*, calculated as the total number of times that the CEO spoke divided by the total number of times that company employees spoke during the conference call (Li et al., 2014). The data used to construct these variables were obtained from Feng Li's website (<https://webuser.bus.umich.edu/feng/>) and covered the period 2003–2007. We regressed each of the two CEO communication measures just described on *CEO option wealth* and a set of controls from our baseline model. As the time variation in this sample is small, we followed prior literature (e.g., Li et al., 2014; O'Sullivan et al., 2021) and used a pooled regression design with industry-fixed effects included as additional control variables. Notwithstanding a dramatic reduction in sample size in these tests, we find that *CEO option wealth* is significantly positively associated with both % *CEO text* (p-value = 0.028) and % *CEO comments* (p-value = 0.073). The results of this analysis lend further support to CEO effort as the mechanism underpinning our findings.

We also considered the possibility that our findings are confounded by endogeneity arising from one or more potential omitted correlated variables. To examine this issue, we carried out four tests. In the first test, we modified our baseline model to include CEO fixed effects. Inclusion of CEO fixed effects controls for all observable and unobservable enduring CEO attributes. Of particular relevance, the inclusion of CEO fixed effects controls for CEO ability, which could also drive firm productivity. In the second test, we considered the possibility that our estimation results are confounded by unobservable time-varying firm-level characteristics not captured by the fixed-effects model specification – e.g., accumulation of labour and human capital in the firm – which could generate 'momentum' in firm productivity. To examine this issue, we estimated a dynamic specification of our baseline model by controlling for the lagged values of firm productivity. In the third test, we augmented our baseline model to include additional controls capturing corporate governance in the focal firm, which could influence firm productivity and CEO option compensation structure. In this test, we included the following controls: (1) CEO–Chairman of the board duality, (2) proportion of independent directors on the board, (3) proportion of directors with financial expertise on the board, and (4) CEO–compensation committee interlock.<sup>[7]</sup> In the fourth test, we estimated our baseline model using a latent instrumental variable (IV) estimation method (Lewbel, 2012).<sup>[8]</sup> The Cragg-Donald Wald *F*-statistic exceeds the critical values derived by Stock and Yogo (2005), and the Hansen (1982) *J*-statistic is not significant (p-value = 0.47), suggesting that neither weak instrument issue nor model overidentification pose concerns in the latent IV analysis (Semadeni et al., 2014). For each of these tests, the tested coefficients retained their predicted signs and statistical significance, reinforcing a causal interpretation of our results.

Last, we considered the possibility that our findings are driven by outliers in the key explanatory variables of interest (i.e., *CEO option wealth* in Hypothesis 1 and *Productivity* in Hypothesis 2). To examine this issue, we conducted two tests. In the first test, we examined the maximum values of *dfbeta* for *CEO option wealth* (Model 3 in Table II) and *Productivity* (Model 2 in Table III). For *CEO option wealth*, the maximum value of *dfbeta* is

0.1487, and for *Productivity*, the maximum value of *dfbeta* is 0.535. For both variables, the maximum value of *dfbeta* lies considerably below the threshold of 1, suggesting that outliers do not pose a concern in our analysis (Bollen and Jackman, 1990). In the second test, we re-estimated our baseline models after winsorizing *CEO option wealth* and *Productivity* at both the top and bottom percentile. The coefficients of winsorized *CEO option wealth* and *Productivity* variables retain their predicted signs and statistical significance, and their magnitude remains almost identical to the one reported in the article, reaffirming that our findings are not affected by outliers.

## DISCUSSION

This study explores the incentive alignment consequences of CEO stock options by examining CEO option wealth's influence on effort, firm productivity, and firm value. We theorize that option wealth provides incentives for CEOs to exert effort towards firm productivity as a means of protecting that wealth. Consistent with our theoretical arguments, we find that CEO option wealth is positively related to firm productivity and that firm productivity mediates the positive effect of CEO option wealth on firm value. Consistent with our theoretical arguments, we find that the relationship between CEO option wealth and firm productivity is attenuated by CEO entrenchment and that product similarity accentuates the mediating effect of firm productivity in the CEO option wealth–firm value relationship. Our findings have significant implications for the executive compensation literature, agency theory, behavioural agency, and management practice, which we elaborate on in what follows.

First, our findings offer fresh insights on how CEO compensation may affect firm performance by elucidating how the stimuli associated with one ubiquitous form of compensation (stock options) influence productivity. The impact of CEO compensation arrangements on firm performance is one of the most controversial topics in the management literature on executive compensation (Aguinis et al., 2018; Hambrick, 2018; O'Connell and O'Sullivan, 2014). Prior studies have offered limited support for the expectation that CEO compensation is related to firm performance (Aguinis et al., 2018; Devers et al., 2007; Hambrick and Finkelstein, 1995; Tosi et al., 2000; Wowak and Hambrick, 2010). The lack of progress in research exploring the performance effects of CEO compensation suggests that a consensus has been reached that the link between pay and performance is almost non-existent (Hambrick, 2018). As Gupta and Wowak (2017) note, this puzzle, along with significant increases in CEO pay over the last 30 years, has given added impetus to a broader debate regarding the efficacy of corporate governance practices, including compensation design (e.g., Bebchuk and Fried, 2004; Daily et al., 2003). Our findings move this debate forward by offering an alternative mechanism – incentives to direct effort towards enhancing productivity – that underpins the relationship between CEO option incentives and firm performance. Specifically, we offer an alternative theoretical mechanism – loss aversion incentivizing effort – through which compensation and associated wealth-at-risk affects performance. We do so by focusing on productivity as a firm outcome that is more directly linked to option incentives and directly impacts firm value.

Second, our study advances behavioural agency research by shifting the focus from strategic investments to firm productivity. While behavioural agency scholarship has

advanced understanding of the incentive alignment consequences of CEO compensation, it has done so primarily through research on the influence of CEO equity incentives on CEO risk preferences and thus firm risk-taking in the form of strategic investments (e.g., Carpenter et al., 2003; Martin et al., 2013; Wright et al., 2007). Hence, BAM research has failed to advance understanding of the relationship between CEO stock options and firm performance and, therefore, the agent–principal incentive alignment consequences of CEO stock options. This failure largely arises from the BAM literature’s near-singular focus on agent risk aversion and strategic risk-taking as the mechanism through which CEO stock options and risk bearing affect firm performance and, therefore, shareholder wealth. The complex and empirically challenging relationship between risk and performance (e.g., Bromiley et al., 2001; Ruefli et al., 1999) has limited the potential for this BAM research to help agency scholars understand mediating behaviours or variables that explain the compensation–performance relationship. As a result, this research has left unanswered the question as to whether CEO risk behaviours and the associated risk bearing from stock option grants are ultimately value-enhancing or value-destroying. Consequently, boards of directors, regulators, and other stakeholders are left with limited guidance on the efficacy of option incentives and the wealth they accumulate (risk bearing) in mitigating agency costs. Our study addresses this gap by describing the role of firm productivity and effort in explaining how incentives affect firm value. Here our findings add to evidence from prior experimental studies pointing to the implications of rewards at risk of loss in inducing effort (e.g., Chen et al., 2020; Imas et al., 2017). More broadly, our study expands behavioural agency research to a new domain – the frame-dependent nature of decision-making with effort implications – integrating insights from neuroscience and behavioural economics.

Third, our findings extend agency research by providing novel evidence regarding the implications of the agent risk bearing created by option wealth: the wealth endowed by a managerial agent as their options accumulate value. Agency theory has described risk bearing as a necessary evil, aligning the interests of agent and principal yet concentrating agent wealth in the firm, leading to value-destroying risk aversion (Eisenhardt, 1989). For instance, normative agency scholars have argued that risk bearing aggravates agency problems with negative consequences for shareholders due to agent risk aversion (Amihud and Lev, 1981; Hölmstrom, 1979; Hölmstrom and Milgrom, 1987; Shavell, 1979). While evidence has been offered that risk bearing reduces risk-taking, the possibility that risk bearing could have positive implications for firm productivity – and consequently, firm performance – has rarely been considered. Our study highlights that agent (CEO) risk bearing’s positive implications for firm productivity could potentially counterweight the negative performance implications of risk aversion emphasized in prior agency literature. Therefore, understanding risk bearing’s dual effects of reduced firm risk and enhanced firm productivity is important for boards as they contemplate executive compensation design. Our findings also add to a broader literature pointing to the utility of rewards at risk of loss in inducing greater workplace productivity (e.g., Brooks et al., 2012; Fryer et al., 2012; Hossain and List, 2012). When considered alongside these earlier works, our findings show that the productivity implications of rewards at risk of loss extend from the factory floor (Hossain and List, 2012) to the apex of organizations.

Our findings with respect to boundary conditions also offer theoretical insights, given that they provide corroborating evidence for effort as the underlying mechanism for the core relationship. Prior studies in management suggest that even when subjects are highly conscientious, monitoring continues to play a role in shaping the effort exerted by these individuals (Fong and Tosi, 2007). Consistent with this expectation, our findings suggest that option incentives have a stronger impact on firm productivity in settings where CEOs are less entrenched (protected from the disciplining force of the market for corporate control). Thus, our findings add a further interesting insight on the negative shareholder consequences of weak external monitoring. While prior work underlines the need for incentives when external monitoring is weak, we show that the incentive power of stock options is more muted in this setting – at least, in the context of effort (we return to this topic in our discussion of areas for future research). We also show that the role of option incentives in achieving CEO–shareholder alignment is greater in settings where productivity plays a stronger role in driving firm value. Thus, our findings point to the importance of productivity and CEO effort in driving firm value, contingent on the level of product market competition.

Finally, our study extends research on the impact of senior management on the productive utilization of firm resources (e.g., Holcomb et al., 2009; Koester et al., 2017; Mannor et al., 2016). To date, interest in the relationship between senior executives and firm productivity has focused on the role of executive ability (e.g., Demerjian et al., 2012; Holcomb et al., 2009). Our study draws on agency reasoning to develop and test theory on the role of incentives and effort in explaining the impact of senior executives on firm productivity. Specifically, we describe how the incentives associated with option wealth shape firm productivity. While research from the economics domain has explored the relationship between stock options (delta and vega) and productivity (Bulan et al., 2010), that literature has not offered a behavioural-based explanation for this relationship. We draw on behavioural literature suggesting that CEOs use heuristics (such as estimates of option wealth) when responding to their options (Devers et al., 2008; Larraza-Kintana et al., 2007; Martin et al., 2013), rather than metrics such as delta and vega which they are less likely to estimate when making decisions. Empirically, we control for delta and vega in our analysis, reaffirming that the effect of CEO option wealth is distinct from the effects of delta and vega examined by Bulan et al. (2010).

In terms of practical implications, our study offers important insight for boards and compensation consultants regarding the benefits of including stock options in their CEO's compensation contract. The efficacy of stock options has been questioned based on their impact on risk behaviour – either because they accentuate executive risk aversion when they accumulate value (Wiseman and Gomez-Mejia, 1998) or because they incentivize excessive risk-taking (Sanders and Hambrick, 2007). We provide evidence that these negatives can be (at least partially) offset by the benefits that accumulated option wealth and risk bearing offer due to the incentives it creates for additional effort and productivity. Our findings suggest that boards can anticipate productivity benefits from creating risk bearing – for example, through granting stock with clawback provisions – when designing CEO compensation contracts.

## LIMITATIONS AND FUTURE DIRECTIONS

As with all studies, ours has its limitations which offer potential directions for future research. Our core theoretical argument is that stock option wealth incentivizes CEO effort towards enhancing firm productivity. As CEO effort is largely unobservable, we interpret our empirical findings as inferential evidence that the protection of option wealth (predicted by BAM) motivates CEOs to exert effort towards enhancing firm productivity. Our theory and empirical approach align with applications of behavioural agency to explore the implications of stock options for CEO risk preferences in large-scale studies. Within that literature, CEO risk preferences are captured via indicators of strategic risk-taking (such as R&D and CAPEX) – analogous to this literature, in our setting, we take firm productivity as an indicator of CEO effort. Our approach also aligns with applications of tournament theory in the management literature (see Connelly et al., 2014, for a review), where firm performance is taken as an indicator of the utility of tournaments in incentivizing executives to exert greater effort on behalf of the firm. As we do not directly examine the theorized underlying mechanism (CEO effort, as effort is a latent mediating variable), smaller-scale studies adopting an interview-based approach or laboratory setting could usefully capture the CEO's willingness to exert effort towards firm productivity as a means of protecting their equity wealth. Relatedly, while it is beyond the scope of our study, an exploration of the specific focus of CEO efforts to bolster firm productivity in response to option incentives would be valuable.

It would be informative to explore how other option characteristics, such as CEO prospective wealth (potential wealth gains if risk-taking is successful), influence productivity. Prospective wealth has previously been offered as a heuristic that should incentivize the CEO to direct effort at additional risk-taking to realize potential gains in option wealth (Martin et al., 2013); hence, its effects on effort in the context of productivity are warranted exploration. CEO psychological attributes would also be of interest in the study of firm productivity.

In the nearly 25 years since the introduction of behavioural agency theory, scholars have examined a wide range of contingencies shaping the relationship between CEO option wealth and strategic risk-taking (mediated by CEO risk preferences). These contingencies include levels of institutional ownership in the firm (Martin et al., 2019), stakeholder expectations (Zolotoy et al., 2021), and CEO temporal focus (DesJardine and Shi, 2021). In a similar vein, future studies could explore factors that moderate the extent to which the effort incentives associated with option wealth flow through to firm productivity. For example, given our findings with respect to the attenuating influence of the market for corporate control, it would also be interesting to consider the implications of internal monitoring – e.g., monitoring by the board – on the relationship between CEO stock options and firm productivity. More broadly, we hope that our reasoning and evidence provide an impetus for research on the implications of compensation design for executive effort and, in particular, a consideration of effort directed towards firm productivity as a promising avenue for research on the incentive alignment properties of compensation. While we restrict our analytical focus to equity-based incentives (specifically, stock options), the model that we present

may be usefully extended to encompass other features of executive compensation, such as short-term bonuses and inside debt.

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## NOTES

- [1] A core insight from applications of tournament theory in executive compensation is that the prospect of winning – with the associated pay increases and promotions in the next round – motivates executives to exert greater effort in their roles (Cappelli and Cascio, 1991; Chin and Semadini, 2017, Conyon et al., 2001; Fredrickson et al., 2010).
- [2] This intuition is reflected in Warren Buffett's (1996: An Owner's Manual) observation that "Most of our managers are independently wealthy, and it's therefore up to us to create a climate that encourages them to choose working with Berkshire over golfing or fishing."
- [3] Studies on CEO under- or overpayment suggest that CEOs are conscious of their compensation relative to labour market norms, meaning that the motivational impact of compensation is underpinned by factors beyond the raw quantum of financial rewards (e.g., Seo et al., 2015). Hence, in addition to their motivation to avoid financial losses, diligent and conscientious CEOs are also likely to be mindful of the value of their option wealth as a measure of their relative success and achievement.
- [4] Demerjian et al. (2012) take the resultant measure as a proxy for managerial ability, showing that it is correlated with CEO fixed effects. We control for CEO ability by including CEO fixed effects in robustness tests.
- [5] For the discussion of advantages of Hoberg and Phillips's (2016) industry classification method over standard (e.g., SIC and NAICS) industry classification methods, see Shi et al. (2017, p. 2086).
- [6] We follow prior literature (e.g., Demerjian et al., 2012; Koester et al., 2017) by orthogonalizing firm-year productivity scores with respect to a set of firm-level attributes expected to facilitate or hinder the productive management of firm resources. Accordingly, the *Productivity* variable is the residual from the regression, and thus can take both positive and negative values, which would offset each other when calculating the sample mean. Therefore, we do not measure the size of the effect relative to the sample mean of *Productivity*, as it would lead to overestimation of the effect size (O'Sullivan et al., 2021).
- [7] We constructed these variables using the data from Boardex, RiskMetrics, and Execucomp. As inclusion of these additional controls results in significant sample attrition due to limited availability of required data, we do not include these variables in our baseline models.
- [8] The latent IV approach has been applied across a wide range of disciplines and has recently gained momentum in management research (e.g., Anderson and Core, 2018).

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