Effects of an Advancing Tenure on CEO Cognitive Complexity

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Abstract

We study how the cognitive complexity of CEOs changes during their tenures. Drawing from prior theory and research, we argue that CEOs attain gradually greater role-specific knowledge, or expertise, as their tenures advance, which yields more complex thinking. Beyond examining the main effect of CEO tenure on cognitive complexity, we consider three moderators of this relationship, each of which is expected to influence the accumulation of expertise over a CEO's time in office: industry dynamism, industry jolts, and CEO positional power. We conduct our tests on a sample of 684 CEOs of public corporations. The analytic centerpiece of our study is a novel index of CEO cognitive complexity, based on CEOs' language patterns in the question-and-answer portions of quarterly conference calls. As part of our extensive theory of measurement, we provide evidence of the reliability and validity of our index. Our results indicate that CEOs, in general, experience substantial increases in cognitive complexity over their time in office. Examined moderators somewhat, but modestly, alter this general trajectory, and non-linearities are not observed. We discuss the implications of our findings.

Among upper echelons researchers, who seek to understand the effects of executives' attributes on organizational outcomes (Hambrick and Mason 1984), perhaps no executive characteristic has garnered more attention than CEO tenure (summarized in Finkelstein et al. 2009). Drawn to the premise that CEOs, and perhaps leaders of all types, exhibit somewhat predictable trajectories over their time in office, scholars have shown that CEOs' tenures are associated with an array of important organizational outcomes. For instance, as leaders' tenures advance, they tend to make fewer and smaller changes (Gabarro 1987, McClelland et al. 2010, Miller 1991), and organizational performance exhibits an inverted-U trend, getting better for a while (or simply remaining satisfactory) but then deteriorating because of maladaptation (Henderson et al. 2006, Miller and Shamsie 2001, Wu et al. 2005).

Even though these tenure-based outcomes are thought to be due to psychological changes in CEOs over their time in office, there is little understanding of what those changes actually are. Theorists have surmised various things. Hambrick and Fukutomi (1991) proposed an increasing "commitment to one's paradigm" as a CEO's tenure advances, but no empirical work has explored such a construct. Miller (1991) spoke of increased CEO confidence, to the point of overconfidence, as well as complacence, but here too verification has been lacking. Indeed, with limited exceptions, the psychological processes that mediate between CEO tenure and organizational outcomes remain the proverbial "black box" that is endemic to so much upper echelons research (Lawrence 1997, Hambrick 2007).

We study how CEOs' cognitions (Kaplan 2011, Gavetti et al. 2012) – specifically their cognitive complexity – change during their time in office. There are two main reasons we focus on cognitive complexity, which we define as *the degree to which one engages in differentiated (as opposed to unitary) and nuanced (as opposed to black-and-white) thinking.* First, we see a major need to bring new clarity and elaboration to the very concept of cognitive complexity. Definitions of this important concept vary widely; and it is the rare work, particularly in management, that offers more than a few lines of explanation of the concept or any reconciliation with related concepts. Second, prior literature on CEOs' tenures (Miller 1991, Hambrick and Fukutomi 1991) and on the cognitive effects of experience and expertise (Chi et al. 1981, Ericsson and Towne 2010, Simon and Chase 1973) allows us to construct a

promising core hypothesis: As CEOs' tenures advance, they tend to become cognitively more complex. As such, we adopt a within-person theoretical focus, rather than a between-person focus, examining how the cognitive complexity of individual CEOs changes over time.

In developing our main hypothesis, we argue that CEOs attain gradually greater levels of role-specific knowledge – or expertise in being CEOs – as their tenures advance. This increasing expertise allows more complex thinking, as longer-tenured CEOs are able to comprehend and assess more aspects of their role responsibilities and task environments, and with greater nuance, than when they were relatively new on the job (Ceci and Liker 1986, Chi et al. 1981, Ericsson and Towne 2010, Simon and Chase 1973). New CEOs, confronted with an abundance of unfamiliar and unstructured information, are essentially compelled to greatly simplify (Hambrick and Fukutomi 1991), but experience in the job confers greater role-specific expertise, which in turn allows greater complexity of thought (Simon and Chase 1973).

Beyond our interest in the main effect of CEO tenure on cognitive complexity, we examine moderators of this relationship, specifically focusing on three conditional factors that are expected to alter the accumulation of expertise over a CEO's time in office. First, we hypothesize that industry dynamism moderates the association between CEO tenure and cognitive complexity, such that cognitive complexity of CEOs in more dynamic industries increases more steeply than occurs for CEOs in more stable industries. Here, our argument is that the sheer volume of stimuli in dynamic industries provides greater opportunity, or capacity, for advances in expertise, which in turn yield greater advances in cognitive complexity (Ericsson and Towne 2010, Simon and Chase 1973). Second, we consider the moderating influence of industry jolts, or bursts of dynamism that greatly exceed the industry's prevailing degree of dynamism (Meyer 1982, Meyer et al. 1990). Here, we argue that industry jolts tend to arrest, or even reverse, a CEO's advancing expertise, and that this disruption will be greater for longer-tenured CEOs. Thus, our hypothesis is that industry jolts negatively affect CEO cognitive complexity in proportion to CEO tenure: the longer the tenure, the stronger the negative effect of jolts on CEO cognitive complexity. Third, invoking prior literature on "power as cognitive disinhibitor" (Keltner et al. 2003), we argue that a

CEO's degree of positional power tends to diminish the positive relationship between an executive's advancing tenure and cognitive complexity. An advancing tenure only yields increased expertise and cognitive complexity to the extent that new knowledge is deliberated and paired with feedback (Ericsson et al. 1993). Positional power causes cognitive laziness in the forms of reduced deliberation and feedback-seeking (Gruenfeld et al. 2003). Thus, CEOs with greater positional power will exhibit slighter increases in their expertise, and in turn in their cognitive complexity, over their time in office, compared to CEOs who have less positional power.

In the case of all three moderators – industry dynamism, industry jolts, and positional power – we are doubtful about their main effects on CEO cognitive complexity, as we envision that CEOs who are in the early stages of their tenures face circumstances that essentially compel cognitive simplification, and thus these contextual factors will have little early effect. It is only with the passage of time in office that these contextual factors will alter the trajectory of a CEO's cognitive complexity.

We conduct our tests on a sample of 684 CEOs of U.S.-based public corporations. The analytic centerpiece of our study is a novel index of CEO cognitive complexity, for which we provide an extensive theory of measurement. Applying the widely-accepted premise that individuals' thought processes are reflected in the language they use (Pennebaker et al. 2003), we conduct automated content analysis of CEOs' language in the question-and-answer portions of quarterly conference calls with investment analysts. Compared to the prepared portions of such calls, or especially to letters to shareholders, these comments have the advantage of being relatively unscripted and spontaneous, and they clearly emanate from the CEOs personally; thus, such passages are relatively suitable for gauging these executives' cognitive processes. To build our index, we use a combination of existing and new dictionaries of words that capture one's degree of cognitive complexity. Even at the level of the quarterly conference call, which typically contains only about two thousand words from the CEO, the elements of our index cohere, thus exhibiting reliability. Moreover, through multiple tests, we demonstrate that our cognitive complexity index has considerable validity.

Data for our other variables, including control variables, come from conventional archival sources. Among our controls is a correction for selection bias, to account for the reality that CEOs who remain in office tend to be different from those who leave. In keeping with our within-person focus, we use fixed-effects regression to explore how our time-varying independent and control variables influence changes in cognitive complexity of individual CEOs. We conduct various robustness tests to check for possible nonlinearities and threshold effects.

We find considerable support for our hypotheses, thus shedding new light on the psychological changes occurring as CEOs' tenures advance. Even though the consequences of CEO cognitive complexity lie beyond our theoretical scope, our findings raise the intriguing – and counterintuitive – possibility that mounting levels of CEO cognitive complexity may contribute to the well-documented tendency for CEOs to make fewer and smaller strategic adjustments as their tenures advance. Such a conclusion is supported by research showing that greater expertise and enhanced cognitive complexity tend to bring about cognitive entrenchment, limiting one's adaptiveness (Dane 2010, Finkelstein 2019). Far from being an ideal, high levels of cognitive complexity can induce paralysis or timidity, as decision-makers become conflicted, even stymied, by their differentiated and nuanced thinking.

BACKGROUND ON COGNITIVE COMPLEXITY

In the decades since Carnegie theorists introduced the concept of bounded rationality (Cyert and March 1963, Simon 1955), scholars have been keenly interested in the cognitions of top executives. Recognizing that executives typically operate under conditions of information overload, surrounded by far more stimuli than they can attend to or absorb, with many of the stimuli ambiguous or contradictory (e.g., Gavetti and Rivkin 2007, Ocasio 1997), researchers have pursued the insight that executives take actions (or refrain from actions) according to what is in their minds and how their minds work. This research agenda – featuring such phenomena as executive knowledge, beliefs, assumptions, and schemas – has proven to be an important complement to research that considers only, or primarily, the technical or economic determinants of executive decision-making (summarized in Finkelstein et al. 2009).

Most research on executives' cognitions has focused on "cognitive content," or *what* is in an executive's mind and the way it is structured. Key concepts in this stream include attention (Cho and Hambrick 2006, Ocasio 1997), selective perception (Sutcliffe and Huber 1998, Walsh 1988), cognitive maps and schema (Eden 1992, Reger and Huff 1993), and blind spots (Zajac and Bazerman 1991). Far less research has focused on "cognitive processes," or *how* an executive's mind works. Here, scholars have considered Jungian thinking styles (Hurst et al. 1989, Nutt 1993), inferential leaps (Busenitz and Barney 1997), paradoxical thinking (Hahn et al. 2014, Smith and Tushman 2005), and cognitive complexity (Calori et al. 1994, Hitt and Tyler 1991, McNamara et al. 2002, Wally and Baum 1994).

In the vast literature on cognitive complexity, definitions of the construct vary but collectively point to two core elements: differentiation and nuance in thinking. In an early discussion, Bieri (1955: 263) defined cognitive complexity as "the degree of differentiation of an individual's construct system." Under this conception, a cognitively more complex individual carries multiple conceptual categories in his or her mind and is able to differentiate, or draw distinctions, among these categories. Since Bieri, almost all definitions of cognitive complexity have stipulated differentiation as a central element (e.g., Calori et al. 1994, Schneier 1979, Scott 1962).

Some conceptualizations have extended beyond one's tendency to differentiate, to include the nature, particularly the degree of nuance, of such differentiation. Scott (1962) was among the first to argue that differentiating between objects/phenomena in a binary way is not as complex as differentiating in scalar ways. For instance, when asked to put major countries into categories, a person might identify only two groups, say economically more-developed versus less-developed countries; alternatively, a person might identify multiple groups based on conjoint continua, seeing gradations in countries' economies, political systems, population sizes, and regions as meaningful factors for distinguishing among nations. In a related vein, Hale (1980: 305) emphasized that cognitive complexity is reflected in "the number *and* nature" of concepts employed by individuals (emphasis added). Similarly, Crockett (1965: 49) noted two facets of cognitive complexity, "increased differentiation and articulation of elements," where "articulation" refers to the organization of differentiated elements into intricate patterns

of nuance and interrelationship. And Wong and colleagues (2011a: 1479) explicitly noted that cognitively complex individuals not only exhibit higher degrees of differentiation but also "tend to see gradations in constructs."

In line with these prior conceptualizations, we define cognitive complexity as *the degree to which one engages in differentiated (as opposed to unitary) and nuanced (as opposed to black-and-white) thinking*. As such, a cognitively complex individual thinks in terms of distinctions, contrasts, comparisons, and multiple attributes or concepts simultaneously – all hallmarks of differentiation. And he or she tends to think in terms of gradations, shades of gray, and intermediate conditions – all hallmarks of nuance. In the context of CEOs, for example, a cognitively simple CEO might think about customers as a homogeneous set; a moderately complex CEO might think about two distinct subsets of customers; and an even more cognitively complex CEO might think about a nuanced array of customer subsets. Differences in CEO cognitive complexity could similarly manifest in thinking about technologies, geopolitical trends, competitors, employees, and so on. Moreover, differences in cognitive complexity could manifest in CEOs' thoughts about available alternatives, with some CEOs seeing more varied possibilities than do others (Hambrick and Finkelstein 1987). Although it is intriguing to consider the possibility that a given CEO could be cognitively more complex when thinking about some domains than others, we are interested in a CEO's overall, or aggregate, degree of role-related cognitive complexity.

Some theorists view cognitive complexity as an umbrella construct that captures one's general "organization of thought" (Conway et al. 2014, Suedfeld and Tetlock 2014: 597). As such, researchers have considered several conceptual cousins of cognitive complexity. For example, Hahn et al. (2014) focused on paradoxical framing, in which individuals exhibit a complex awareness of multiple and conflicting aspects of different concepts and issues. Scholars have also studied integrative complexity, which encompasses not only differentiation in thought, but also integration of (differentiated) concepts (Suedfeld and Tetlock 2014); however, these researchers very rarely observe cognitive integration, or upper values of the integrative complexity scale, even in educated professionals (Suedfeld et al. 2011,

Young and Hermann 2014). As such, when researchers observe variance in integrative complexity, they are largely detecting degrees of differentiated thought, a core element of cognitive complexity.

The cognitive simplicity-complexity continuum is distinct from the cognitive rigidity-flexibility continuum, which refers to the degree to which one's mind is open to change when faced with new stimuli (Martin and Rubin 1995, Scott 1962). Granted, a high level of cognitive complexity might lead one to consider fresh alternatives, in ways that cognitive simplicity might not allow. But it is also the case that simple thinking could lead to change, or that complex thinking could cause one to stay with the status quo (Dane 2010). In our estimation, these two dimensions, simplicity versus complexity and rigidity versus flexibility, are centerpiece constructs for scholars interested in executives' cognitive processes. Ultimately, the two constructs could and should be jointly considered. Our own contribution, however, is to shed new light on the former of these two.

It is also important to emphasize that cognitive complexity is not inherently beneficial (Downey and Slocum 1982, Finkelstein et al. 2009, Moore and Tenbrunsel 2014). To academics, who themselves value careful thinking, high degrees of cognitive complexity may seem ideal, somehow signifying mental sophistication and intellect. Moreover, it might be argued that complex circumstances, as CEOs face, call for complex thinking (McNamara et al. 2002, Wally and Baum 1994). At the same time, though, high levels of cognitive complexity may indicate an inability to extract essentials or establish priorities, in a form of mental muddiness (Downey and Slocum 1982). It is perhaps not surprising, then, that cognitive complexity has been shown to be essentially uncorrelated with intelligence (Bieri 1955) or occupation (Schneier 1979). And, as noted earlier, research has shown that high levels of cognitive complexity tend to bring about cognitive entrenchment (Dane 2010).

Indeed, cognitive complexity is thought to have an array of implications, some favorable and some unfavorable (summarized by Suedfeld and Tetlock 2014: 597). Specific to the field of management and organizations, theorists have highlighted some positive implications for leadership, as when Streufert and colleagues (1968) found that more cognitively complex leaders scored higher on leadership characteristics related to tolerance for ambiguity and consideration of alternative views. Wong and

colleagues (2011b), as well as Maak and colleagues (2016), found further evidence of such patterns. Others have focused on managerial decision-making. For instance, McNamara et al. (2002) showed a positive association between the complexity of executives' understanding of the competitive landscape (a domain-specific form of cognitive complexity) and firm performance. Similarly, Nadkarni and Narayanan (2007) found that the complexity of CEOs' cognitive schemas enhanced strategic flexibility, allowing executives to notice and respond to more stimuli and avoid strategic inertia.

Conversely, some works have considered the drawbacks of cognitive complexity in managers. In a study of division managers, Downey and Slocum (1982) found that cognitively complex managers performed worse than cognitively simple managers under conditions of high uncertainty, concluding that complex managers may become bogged down by considering too many options, and for too long. In the realm of behavioral ethics, Moore and Tenbrunsel (2014) found that cognitively complex individuals made less moral decisions, resulting from their inclination to rationalize and justify actions in moral gray-zones. And Finkelstein et al. (2009: 69) raised the possibility that CEO cognitive complexity could lead to decision paralysis, organizational complexity, and ambiguous leadership messages. Although the consequences of CEO cognitive complexity lie outside our scope, it is clear that this executive attribute may hold a host of implications for leadership behaviors and decision-making.

Our interest is in the origins, or antecedents, of cognitive complexity – about which relatively little is known. Specifically, what causes a CEO to have a given level of cognitive complexity? When researchers take a stand on the matter, they often conceptualize cognitive complexity as a stable and pervasive tendency, as when Vannoy (1965: 385) described it as a "quite general trait pervading all realms of cognitive functioning." Our view, however, is less absolute. First, we envision cognitive complexity as partly trait and partly state, or partly ingrained and partly conditional. In line with a growing view among scholars of individual differences (Caspi et al. 2005, Roberts et al. 2005), we anticipate that individual CEOs exhibit their own baseline tendencies on the cognitive complexity continuum but also exhibit considerable intertemporal variation from their personal baselines. Far from being only random perturbations, these rises and falls in cognitive complexity can be theoretically traced

to specifiable contextual conditions. Although future research could consider a host of contextual drivers of CEO cognitive complexity, we examine the influence of tenure in office and selected moderators.

Second, while recognizing that individuals might have general tendencies toward given levels of cognitive complexity, which in turn become manifested in all their walks of life (e.g., work, family, hobbies), we take a more cautious, circumscribed view. Specifically, our theory (and our measure) deal strictly with cognitive complexity of CEOs *in their CEO roles*. As we now argue, experience in the CEO role confers increased knowledge and expertise in that role, which in turn engenders greater role-specific cognitive complexity.

THEORY AND HYPOTHESES

CEO Tenure and Cognitive Complexity

According to upper echelons theory, executives perceive issues and options through personalized lenses that are formed by their experiences, personalities, and values (Hambrick and Mason 1984, Hambrick 2007). For the most part, researchers have applied the theory to explain how differences among executives explain differences in strategic outcomes (e.g., Bertrand and Schoar 2003, Nadkarni and Herrmann 2010). But some scholars have been interested in changes that occur *within* CEOs over time, specifically during their tenures in office.

From the body of work on CEO tenures, three major findings stand out. First, CEOs tend to undertake fewer and smaller initiatives, both strategically and structurally, as their tenures advance (Gabarro 1987, McClelland et al. 2010, Miller 1991). Second, initiatives undertaken by longer-tenured CEOs tend to echo or elaborate on previously-established themes, thus further engendering strategic stasis (Boeker 1997, Miller 1993, Miller and Shamsie 1996). Third, CEOs deliver satisfactory and sometimes improving performance for a while, but eventually their inertia brings about performance deterioration (Henderson et al. 2006, Miller and Shamsie 2001, Wu et al. 2005). How early and steep this descent will be depends on the rate of change in the environment (Henderson et al. 2006). Of course, CEO tenure lengths vary greatly, so not all CEOs experience the full array of phases documented by researchers.

Even though these patterns have been long-documented, there is little understanding of what causes them. Scholars have surmised about CEOs' psychological changes over their time in office, but empirical verification has been lacking. Miller (1991: 41) asserted that longer-tenured CEOs become "tired, enshrined, and stale." Hambrick and Fukutomi (1991) proposed that, beyond an initial period of open-mindedness and searchfulness, CEOs become increasingly committed to their paradigms, or worldviews. Others have suggested that tenure induces boredom (Ng and Feldman 2013) and reduces the tendency to seek novel information and advice (McDonald and Westphal 2003), ultimately leaving the executive with less motivation and fewer options when making decisions. As yet, these portrayals have not been rigorously examined.

Based upon the noted empirical patterns, one might be tempted to propose that CEOs become cognitively less complex over their time in office. After all, if CEOs' business strategies become more stylized as their tenures advance, it stands to reason that this is because CEOs' own mental processes become more stylized, or simple, as well. Under this view, CEOs become less able or willing to engage in differentiated and nuanced thinking as their tenures advance.

Such an argument, however, ignores a large body of research showing that the development of expertise, or domain-specific knowledge acquired through experience, brings about enhanced cognitive complexity. For example, in their seminal study, Simon and Chase (1973) showed that expert chess players were better able to recognize complex patterns of possible moves and countermoves, as compared to novice players who saw only simpler patterns. This finding has been verified in numerous task contexts, including music, gambling, physics, accounting, and medicine (see Chi et al. 1981, Dane 2010, Ericsson 2005, Gobet 2005).

The resulting view from this research is that novices, when confronted with inherent complexity, are not able to grasp – or even see – all the attendant intricacies. Moreover, in order to cope with the complexity and perform at just a basic level, novices must develop simple mental models of their situations and simple rules for their behaviors, essentially "tuning out" major parts of the inherent complexity they face. As they gain expertise, individuals gradually absorb more and more of the

complexity of their situations, developing correspondingly more complex mental models. The conversion of experience into expertise is not automatic or guaranteed, as individuals must deliberate and weigh feedback from their accumulated experience in order to become more proficient (Ericsson et al. 1993). In general, though, Ericsson and Towne's (2010: 407) conclusion in their review is apt: "Taken together, the results of these investigations suggest that experts maintain a highly complex and sophisticated representation of domain-specific situations relative to novices."

Even though Ericsson and Towne referred to a dichotomy (experts versus novices), research has shown that expertise is a continuum and that individuals tend to attain gradually more expertise – and gradually more cognitive complexity – as they accumulate more experience. That is, when faced with an inherently complex task or role, every increment of experience tends to confer an increment of expertise; if plateauing occurs at all, it tends to be at exceptionally high levels of accumulated experience (Ericsson 2005, Simon and Chase 1973), or when individuals stop deliberating and seeking feedback on their experiences (see Ericcson 2005, Ericcson et al. 1993).

New CEOs can be thought of as novices, at least in their new roles. Even though they may have distinguished records in prior positions, new CEOs face a panoply of largely unfamiliar issues, tasks, and constituencies (Andrews 1971, Gabarro 1987, Hambrick and Fukutomi 1991). Most notably, their responsibilities are more encompassing and wholistic than ever before. Having previously learned about their firms from specialized perspectives, say as functional heads or division presidents, they are now responsible for the integrated entirety of their firms. Similarly, having previously learned about their industries from specialized perspectives, say as marketing or operations executives, they are now confronted with many more facets of their external environments. And essentially all new CEOs, particularly of public corporations such as we study, are newly emmeshed in a largely unfamiliar array of constituents and critical observers, including investors, securities analysts, regulatory authorities, trade association officials, journalists, and yet others (Andrews 1971, Finkelstein et al. 2009, Mintzberg 1973, Porter and Nohria 2018).

As such, new CEOs are not able to absorb or perhaps even recognize the complexity they face, and thus they tune out great parts of it, instead adopting simple views and simple rules. As CEOs' tenures advance, even just from one year to the next, their degrees of expertise mount, and they have both the leeway and the task knowledge to become cognitively more complex – more differentiated and nuanced in their thinking.

To clarify, we follow prior studies that have considered the relationship between experience, expertise, and cognitive outcomes (including cognitive complexity). In this body of works, experience is typically measured by the observable amount of time (or number of times) an individual has spent practicing a task or performing a specific role. In our case, this is the number of quarters an individual has spent as CEO. Others have used similar tenure or time-based indicators of role experience (e.g., Brockmann and Simmonds 1997, Carpenter et al. 2001, Chi et al. 1981, Pennebaker and Stone 2003). Expertise, on the other hand, is only rarely captured, say via an official designation (e.g., chess "Grandmaster"; Simon and Chase 1973) or performance on some relevant task (e.g., horseracing handicap test; Ceci and Liker 1986). Because of the difficulty in directly capturing expertise, it is generally inferred as varying in direct proportion to experience. Accordingly, we use CEO tenure to proxy for the accumulation of expertise in the CEO role.

It is also important to emphasize that these envisioned causal linkages occur within the bounds of the CEO role: experience as a CEO confers expertise as a CEO, which in turn confers cognitive complexity as a CEO. As such, an advancing CEO tenure would not be expected to affect one's cognitive complexity in domains beyond the CEO role (say, in family or social matters or in avocations). Ours is not a study of *general* cognitive complexity; for ease, we often simply refer to expertise and/or cognitive complexity, but we mean role-specific expertise and role-specific cognitive complexity.

In sum, we envision that the mounting role-specific expertise that comes with experience as a CEO allows cognitive complexity to increase during an advancing tenure. As CEOs gain experience, they gain role-specific expertise and, in turn, their role-specific thinking becomes more and more differentiated and nuanced.

Our empirical analysis will explore possible non-linearities, including plateaus, but we anticipate that the positive relationship between CEO tenure and cognitive complexity is relatively linear. Thus:

Hypothesis 1: As a CEO's tenure advances, his or her cognitive complexity increases.

Conditional Moderators

Although our main expectation is that an advancing tenure brings about increases in a CEO's cognitive complexity, it is likely that contextual factors moderate the steepness of this rise over time in office. In keeping with our logic that mounting expertise is the driver of increased cognitive complexity, we consider three moderators that, each in their own way, affect the CEO's accumulation of expertise. First, we examine two attributes of the CEO's task environment. We argue that industry dynamism confers greater potential for advances in expertise, thus pushing upward the relationship between CEO tenure and cognitive complexity. Conversely, abrupt industry jolts (extraordinary dynamism beyond typical levels for the industry) cause expertise to be arrested; such jolts are more jarring for longer-tenured CEOs than for newer CEOs, thus pushing down the relationship between CEO tenure and cognitive complexity. Finally, we consider an internal attribute as a moderator, arguing that greater positional power induces CEO cognitive laxness, or disinhibition, dampening the accumulation of expertise and thus pushing down the relationship between CEO tenure and cognitive complexity.

While recognizing that each of these conditional factors could exert its own independent influence on CEO cognitive complexity (and we will be alert for such possibilities), we envision that their more pronounced effects will be manifested *in tandem with CEO tenure*. Because CEOs are essentially compelled to be cognitively simple at the outset of their tenures, these conditional factors will have little effect on this early tendency toward simplification; only as CEOs' tenures advance, and their mounting experience and expertise confer the *potential* for greater cognitive complexity, will the influence of these other factors become more pronounced and have a larger impact on the trajectory of this upward sweep.

Systemic industry dynamism. It is well known that industries vary widely in their inherent, or systemic, degrees of dynamism (Dess and Beard 1984, Henderson et al. 2006). Some industries are persistently dynamic, due to frequently changing customer behaviors, ongoing technological advances,

and varied competitive profiles; at the other extreme, some industries are persistently more stable, with relatively predictable customer behaviors, few and minor technological developments, and homogeneous competitive profiles (Ansoff 1979, Dess and Beard 1984, Miller 1993). Researchers have considered an array of strategic and performance implications of industry dynamism versus stability (e.g., Eisenhardt 1989, Henderson et al. 2006, Priem et al. 1995), but little attention has been paid to how this environmental dimension affects CEO cognition, particularly cognitive complexity.

While all CEOs will tend to simplify their thinking at the outset of their tenures, those who are in dynamic industries will exhibit greater increases in cognitive complexity as their tenures advance, compared to CEOs in more stable industries. We envision two reasons for this moderating effect of industry dynamism.

First, the more dynamic the industry, the more sophisticated and elaborate the CEO's task environment, and the greater the *potential* for advances in a CEO's expertise – and in turn cognitive complexity. Just as there is far more room for cognitive advances when learning chess as compared to checkers, so too is there more expertise to be attained in a dynamic industry as compared to a stable industry. As detailed above, expertise is a function of the acquired mental representations of a given context (Ericsson and Towne 2010). As individuals experience new and different contextual configurations, they tend to convert those experiences into expertise and gain complexity in their thinking. The more variations in the context, the greater potential for expertise. In this way, individuals are only able to advance their expertise to the degree that they face new and increasingly complex challenges; one does not become a chess grandmaster by playing the same people and the same games over and over (Simon and Chase 1973). Rather, as noted by Ericsson and Towne (2010: 410), expertise develops to the extent that individuals are increasing exposed to "appropriately challenging tasks, such as … difficult jumps in figure skating and difficult routines in rhythmic gymnastics." Because dynamic environments are characterized by change, and thus constantly challenge CEOs to expand their thinking, they allow for greater development of expertise. Paradoxically, CEOs in dynamic industries will never come close to fully comprehending their environments, but their advancing tenures will confer far more

elaborate knowledge structures, or expertise – and greater cognitive complexity – than will occur for CEOs in more stable settings.

Second, expertise is a function of deliberation and feedback (Ericsson et al. 1993). However, the usefulness of deliberation is a function of the time between action and feedback; more immediate feedback will result in greater expertise (Ericsson and Towne 2010). In other words, when new actions are taken, individuals only gain expertise to the extent that they quickly learn whether or not these actions are successful. Dynamic contexts are characterized by faster clock-speeds and velocities (Eisenhardt 1989), and thus feedback from (one's own and others') strategic moves is more immediate. In contrast, stable industries have relatively low velocities, and thus feedback from new initiatives may be slow in coming and relatively difficult to learn from. As noted by Ericssson and Towne (2010: 410), "the accuracy of many of the decisions made by managers…are never known or at least not known until weeks, months, or even years later." To the extent that feedback times are reduced, greater expertise and cognitive complexity will develop.[1]

Beyond research on expertise, theories of organizational knowledge and learning also recognize the importance of contextual dynamism for the development of complex understanding. For example, Grant (1996) highlighted the need for contextual "variability" in the generation of knowledge-based capabilities. Similarly, Nonaka (1994: 18) emphasized the role of external "fluctuation" in the development of organizational knowledge, arguing that "discontinuity can generate new patterns of interaction between individuals and their environment." And Fiol and Lyles (1985: 810) recognized that nonroutine and ambiguous contexts tend to engender "higher-level" learning processes, defined as "the development of complex rules and associations regarding new actions."

[1] By their nature, dynamic industries carry great uncertainty and ambiguity. As such, feedback in dynamic industries tends to be relatively ceaseless and quick, but it is not necessarily generalizable to future events and conditions. Thus, even though CEOs in dynamic industries gain relatively elaborate knowledge structures, or expertise, over time, as compared to their peers in more stable settings, we recognize that only portions of this abundant expertise are valid from one period to the next.

Given these arguments, we anticipate that systemic industry dynamism moderates the effect of CEO tenure on cognitive complexity. The general rise in a CEO's cognitive complexity over time in office (as developed in H1) is due to increased expertise in the role. New CEOs, all of whom are faced with unfamiliar stimuli and issues, cognitively simplify in order to cope with this overload; as they gain familiarity with the issues, along with other aspects of expertise, they become cognitively more complex. To the extent that CEOs face an ongoing stream of dynamic and varied external stimuli, we expect greater increases in cognitive complexity over their time in office, compared to CEOs who work in more stable contexts. In sum:

> *Hypothesis 2 (H2): The positive relationship between CEO tenure and cognitive complexity is moderated by the degree of systemic industry dynamism. Specifically, the greater the industry dynamism, the steeper the positive relationship between CEO tenure and cognitive complexity.*

Industry jolts. Although a given industry tends to have a prevailing degree of dynamism, which we have called systemic dynamism, the industry might also occasionally encounter extraordinary and abrupt increases in dynamism, or industry jolts. For instance, a generally stable industry might encounter an abrupt regulatory ruling that substantially alters the economics and competitive positions of incumbent firms. Even a systemically dynamic industry can encounter extraordinary bursts of upheaval above and beyond its typical level of dynamism, as when privacy and "fake news" issues became suddenly salient in the social media industry following the 2016 US presidential election.

When an industry jolt occurs, a CEO's expertise is somewhat negated, as uncertainty and dissonance arise (Meyer et al. 1990), in turn causing an interruption – and possibly even a reversal – of the CEO's advancing cognitive complexity. The CEO will not necessarily revert to the same level of simplification as at the beginning of his or her tenure, but there will be a pause, or even a drop, in the generally upward trajectory of cognitive complexity.

Research in crisis management supports this general premise (Bundy et al. 2017). Researchers studying the consequences of sudden crises often highlight the difficulty that managers face in integrating the lessons from such events (Lampel et al. 2009). Crises are rare and abrupt, inducing cognitive rigidity and reflexive decision-making (Billings et al. 1980, Starbuck 2009, Veil 2011). Faced with such episodes,

the deliberation required for advancement of expertise and cognitive complexity is stymied, as CEOs strive to get beyond these discrete events and back to "business as usual."

Such jolts are more jarring for longer-tenured CEOs than for newer CEOs. The longer a CEO has faced a given baseline degree of industry dynamism, the more accustomed the CEO is to that standard, and the more unsettling will be jolts that exceed that prevailing level. As such, industry jolts cause more cognitive disruption, particularly setbacks in cognitive complexity, for longer-tenured CEOs. In sum:

> *Hypothesis 3 (H3): The positive relationship between CEO tenure and cognitive complexity is moderated by the occurrence of an environmental jolt. Specifically, the occurrence of an environmental jolt weakens the positive relationship between CEO tenure and cognitive complexity.*

Positional power. CEOs vary substantially in how much positional power they possess (Finkelstein 1992, Ocasio 1994, Westphal and Zajac 1995). The term "positional power" designates the degree to which non-personal factors confer relative autonomy on the CEO (in contrast to personal sources of power, such as charisma or valued credentials; e.g., Finkelstein 1992, Flynn and Staw 2004). Common indicators of positional power are duality (being both board chair and CEO), CEO shareholdings, and the proportion of outside directors appointed during the CEO's tenure (Daily and Johnson 1997, Shen and Cannella 2002, Westphal and Zajac 1995).[2]

Research has shown that power causes individuals to be cognitively disinhibited, i.e., cognitively simple. Possessing a sense of social control, individuals who have power tend to abandon self-regulation in their thinking, which is arduous, in favor of more automatic thinking (Keltner et al. 2003). Such cognitive disinhibition is manifested as reduced deliberation and reduced cognitive carefulness. As evidence, one of the most-cited works in this stream studied U.S. Supreme Court justices and showed that the authors of majority opinions were cognitively less complex when the court was unanimous (high power) than when there was a sizeable and vocal minority (low power) (Gruenfeld and Kim 2002). And

[2] As such, positional power encompasses two of the facets of executive power identified by Finkelstein (1992), structural power and ownership power. It excludes expert power, which Finkelstein found to be only weakly valid, and prestige power, which captures the more personal origins of power (e.g., elite education). In recent years, researchers have come to rely heavily on the indicators we use here to measure CEO power (Briscoe et al., 2014; Pollock et al., 2002; Shi et al., 2019).

Tetlock and colleagues found that decision-makers who were told that they would not have to explain their decisions to others (high power) exhibited lower cognitive complexity than those who were told that they would have to justify their actions (low power) (reviewed in Lerner and Tetlock 1999).

We anticipate that a CEO's positional power moderates the influence of CEO tenure on cognitive complexity. The general rise in a CEO's cognitive complexity over time in office (as developed in H1) is due to increased expertise in the role. New CEOs, faced with an abundance of unfamiliar stimuli and issues, cognitively simplify in order to cope with this overload; as they gain familiarity with the issues, along with other aspects of expertise, they become cognitively more complex. However, because positional power exerts a disinhibiting effect on cognition (Keltner et al. 2003), high levels of positional power will tend to suppress, or push down, this rise in a CEO's cognitive complexity over time. Further, because the attainment of expertise is a function of deliberation and feedback seeking (Ericsson 2005, Ericsson et al. 1993), those CEOs with the most positional power, who are susceptible to reduced deliberation and feedback seeking, will manifest slighter increases in cognitive complexity over their time in office than will CEOs who have less positional power. In sum:

> *Hypothesis 4 (H4): The positive relationship between CEO tenure and cognitive complexity is moderated by the CEO's degree of positional power. Specifically, the greater the CEO's positional power, the less steep the positive relationship between CEO tenure and cognitive complexity.*

METHODS

We studied the cognitive complexity of CEOs of Standard & Poor's (S&P) 500 firms over the period 2004 to 2014. As we now describe, we developed a novel index of CEO cognitive complexity, based upon CEOs' language patterns in the question-and-answer portions of quarterly conference calls. We first tested the properties of our index on a pilot sample, and then used it for our hypotheses tests with a sample of 10,288 quarterly CEO cognitive complexity scores for 684 distinct CEOs. Data for independent and control variables came from archival sources which we describe below. To conduct our tests, we used a CEO fixed effects panel model, strictly assessing within-CEO changes.

Measurement of CEO Cognitive Complexity

Methods for measuring cognitive complexity have evolved considerably. An early instrument, developed by Bieri (1955), involved asking subjects to rate individuals they knew on a set of personality adjectives, with cognitive complexity gauged by the degree to which subjects scored the individuals differently. Despite mixed evidence of its reliability (Menasco and Curry 1978), this method was used extensively, including by management scholars, through the 1990s (e.g., Downey and Slocum 1982, Hitt and Tyler 1991, Wally and Baum 1994). A second approach, used in the same era as Bieri's, required subjects to generate specially-elicited writing samples, primarily via the "paragraph completion test," which were then assessed by trained raters who looked for evidence of cognitive differentiation in the subjects' writings. The paragraph completion test is still sometimes used by researchers studying integrative complexity, a variant of cognitive complexity (Suedfeld and Tetlock 2014). Like Bieri's technique, the paragraph completion test requires intensive subject involvement; moreover, the manual scoring system limits its practicality for large-sample studies.

As a partial solution to these limitations, some researchers manually score existing texts, rather than requiring elicited writing samples. For example, Nadkarni and Narayanan (2007) used a manually-scored mapping technique to capture the degree of complexity shown in companies' letters to shareholders. Similarly, Wong et al. (2011b) used trained coders to gauge the integrative complexity of CEOs and their executive teams on the basis of press clippings about these individuals. Although such methods overcome problems of intrusiveness and subject reactivity, they are vulnerable to unknown reliability (Conway et al. 2014, Tetlock et al. 2014) and are impractical for studying large samples.

Recently, researchers have leveraged advances in digital technology to conduct computer-aided text analysis (CATA) for gauging cognitive processes – in ways that are highly reliable and not at all intrusive. Relying on automated content analysis of subjects' pre-generated bodies of text (either written or spoken words), CATA researchers follow the well-supported premise that individuals' cognitions are reflected in their spoken and written language patterns (Pennebaker et al. 2003). In their review of the psychological meaning of words, Tausczik and Pennebaker (2010) highlighted the history of research

utilizing word usage and text analysis to tap into psychological constructs, including components of individual personality, attentional focus, and thinking styles. Highlighting roots back to Freud, the authors concluded that words are "the medium by which cognitive, personality, clinical, and social psychologists attempt to understand human beings" (Tausczik and Pennebaker 2010: 25).

To assess subjects' cognitions, CATA researchers score the prevalence of certain words or phrases that map onto constructs of interest. These cognitive constructs might pertain to cognitive *content* (*what* is in the subject's mind) or cognitive *processes* (*how* the subject's mind works), as is our interest. Researchers might develop their own dictionaries or use pre-developed, already validated dictionaries. Among the most widely used dictionaries are those found in the Linguistic Inquiry and Word Count (LIWC) software, which was developed and extensively validated by Pennebaker and colleagues (Duriau et al. 2007, Pennebaker et al. 2007, Pennebaker et al. 2015), and the dictionaries developed by Loughran and McDonald (2011), specifically for analyzing textual material in a business context. As we describe momentarily, we draw from both of these established sources and add our own new dictionary.

Of course, measuring psychological processes by tallying the appearance of certain words, without regard to context, has obvious drawbacks. But the disadvantages must be weighed relative to the chief alternative, human coding, which itself has major limitations. First, human coding is not feasible for large bodies of text. In our experience (described below), a human coder requires about 90 minutes to code for CEO cognitive complexity in 60 very brief paragraphs, roughly the amount of CEO text in a single quarterly conference call. Second, and relatedly, human coders are highly susceptible to fatigue and "coder drift" (Neuendorf 2017: 170); moreover, they are often distracted and biased by – rather than aided by – the context of the passages they are assessing (Tetlock et al. 2014). As a consequence, noted by Houck and colleagues (2014: 652), "human-scored measurements of complexity are not correlated with each other." And third, human coding suffers from limited transparency. By comparison, word-count algorithms "are perfectly transparent and reproducible" (Tetlock et al. 2014: 626).

In recent years, management scholars have fruitfully used dictionary-based word counts to gauge an array of psychological attributes of CEOs, including abstraction/concreteness (Pan et al. 2018), causal

reasoning (Savani and King 2015), regulatory focus (Gamache et al. 2015), and extraversion (Malhotra et al. 2018). Thus, it seems there is promise in using word counts to assess CEO psychology.

We measured CEO cognitive complexity by examining CEOs' language patterns in the question-and-answer (Q&A) portions of quarterly conference calls with investment analysts. Digital transcripts of calls were obtained from Factiva. In comparison to CEOs' prepared remarks during these calls, and certainly in comparison to letters to shareholders, which are known to be highly refined collaborative products (Cho and Hambrick 2006), these Q&A remarks are relatively unscripted and spontaneous. Investment analysts have an incentive to ask unexpected questions during these calls (Hong and Kubik 2003, Bushee et al. 2004, Chen and Matsumoto 2006), so the CEOs are unable to fully rehearse or polish their answers; thus, their answers should be relatively reflective of their cognitive processes. Still, we acknowledge that these Q&A remarks are susceptible to impression management tactics by CEOs, and their general themes may be somewhat anticipated. Moreover, CEOs' remarks may somewhat reflect the substance or style of analysts' questions (which we partially control for, as described below), as well as CEOs' emotions and stress levels (which we also partially control for).

We applied multiple criteria in developing our dictionaries. First, and most fundamentally, we sought dictionaries consisting of words that reflected either or both of the two facets of cognitive complexity: differentiation and nuance in thinking. Thus, our search for appropriate dictionaries was deductive, driven by the meaning of our construct. Second, we gave priority to established dictionaries, with records of prior use and validation, while also being open to the opportunity to develop new, supplemental dictionaries. Third, we strictly retained dictionaries that yielded evidence of coherence with each other. In order to claim that the several dictionaries all captured aspects of the same construct, cognitive complexity, we required CEOs' word-usage scores from the respective dictionaries to be suitably correlated with each other, thus allowing their combination into a meaningful reflective index.

Applying these criteria, our search led us to three non-overlapping dictionaries that comprise our index, summarized in Table 1.[3]

Insert Table 1 about here

The Language of Differentiation. To capture differentiation in thinking, we used the LIWC dictionary of "differentiation" words, which indicate that one is drawing distinctions or describing contrasts (Slatcher et al. 2007, Crilly et al. 2016). The differentiation dictionary includes such words as "but," "except," and "however," for a total of 81 words conveying a CEO's simultaneous consideration of multiple distinct phenomena, or differentiation in thinking. As evidence of the validity of this dictionary, Pennebaker and King (1999) showed convergent and discriminant factor loadings with related and unrelated constructs, respectively, as well as predictive validity with a range of psychometric and behavioral outcomes. Crilly et al. (2016) considered managers' use of these differentiation words (which they called "exclusion words") as evidence of openness and transparency in communication (which they argued is a more complex style of communication), while an absence of these words indicated more deception (which they argued is a simpler style of communication). Our measure of differentiation language was the number of such words used divided by all the CEO's Q&A words in a given call.

The Language of Nuance. The second facet of cognitive complexity is one's tendency to engage in nuanced versus absolutist, or black-and-white, thinking. To gauge this, we used a composite of dictionaries from Loughran and McDonald (2011) and LIWC 2015. Loughran and McDonald provided dictionaries of "weak" and "strong" modal words. Modal words are those that combine with verbs to convey envisioned likelihoods of outcomes or actions (Strunk and White 2000), which in turn indicate the speaker's relative degree of certitude. The use of weak modal words, indicating a low degree of certitude,

[3] Other researchers using narrower conceptions of cognitive complexity have relied on correspondingly narrower sets of words. For example, Crilly et al. (2016) used only one of the dictionaries we used, focused specifically on differentiation. Some have used proprietary dictionaries that are impossible to independently assess (Wong et al. 2011a, Conway et al. 2014). And others have used inductively-derived dictionaries (Pennebaker and King 1999, Slatcher et al. 2007), as opposed to the deductive approach we employ.

reflect nuanced thinking; the use of strong modal words, indicating a high degree of certitude, reflect absolutist or black-and-white thinking. Loughran and McDonald's dictionary of weak words includes "could," "might," and "possibly." Their dictionary of strong words includes "always," "will," and "must." Their dictionaries have been validated across a range of business and financial documents, including in predicting theoretically-expected outcomes. We supplemented the list of weak modal words with the LIWC 2015 dictionary of "tentative" words, such as "apparently" and "seems," which also indicate a lack of certitude (we removed a few overlaps with the differentiation dictionary), and we supplemented the list of strong modal words with LIWC's dictionary of "certainty" words, including words such as "completely" and "purely." Our measure of nuance leverages both valences: number of weak words divided by the total number of strong and weak words spoken by the CEO in the Q&A part of the call. We added .01 to the numerator and .02 to the denominator to allow for meaningful values when either term was zero.

The Language of Comparison. Our third measure spans the two facets of cognitive complexity – differentiation and nuance in thinking. Specifically, we expected that complexity would be revealed by the use of comparative language, including such words as "better," "earlier," "lower," "harder." As noted by Kennedy (2004: 2): "The ability to establish orderings among objects and make comparisons between them" is a reflection of complex cognition. In order to make a comparison, not only do concepts need to be differentiated (e.g., the focal firm versus its peers, or one technology versus another), but concepts also need to be assessed via "abstract representations of measurement" (Kennedy 2004: 3). As such, comparative words indicate complex thinking, both in terms of differentiation *and* nuance. Such words indicate that the person is simultaneously considering multiple distinct concepts, and they indicate an absence of absolutism (as would be indicated by superlatives, such as "best," "fastest," or "cheapest").[4]

[4] We experimented with the inclusion of superlatives in our cognitive complexity index, but such words did not cohere with other index items. This is probably because of the offsetting qualities of superlatives. On the one hand, they indicate differentiation in thinking; on the other hand, they indicate absolutist thinking, rather than nuanced thinking.

A dictionary of comparative words was not available in LIWC or in Loughran and McDonald's (2011) set, and we could not readily identify available others. As such, we developed a dictionary to identify comparatives in CEO speech. To create the dictionary, we first used linguistics software (Schmid 1994) to identify all words that were used as comparatives in our entire corpus of conference calls. To ensure that our dictionary would be useful in research contexts beyond our immediate project, we added all adjectives and adverbs identified as comparatives in the Brown University Standard Corpus of Present-Day American English (Francis and Kucera 1979) and the Open American National Corpus (American National Corpus Project n.d.). We then reviewed our resulting dictionary of comparatives and dropped several words that were misclassified (e.g., "upper").[5] Our final measure was the ratio of comparative words to all words spoken by the CEO in the Q&A portion of a given conference call.

Pilot Test. As a preliminary test of the coherence of our indicators, we examined a pilot sample of conference calls of public firms in the healthcare and information technology sectors (we excluded from this pilot sample any firms that were also in our primary sample as reported below). Retaining only calls with at least 250 words spoken by the CEO in the Q&A portions, our pilot sample consisted of 1,146 calls. Pairwise correlations among the three indicators were all significant at $p < .001$ and ranged from .09 to .11. Although these correlations are not high in an absolute sense, they indicate that our quarterly measures positively co-varied within each call. Moreover, factor analysis (oblique promax) of the three measures yielded a one-factor solution which accounted for 40 percent of variance; and all three measures had factor loadings above .59. Based on this pilot, we proceeded to use our three indicators to form a CEO cognitive complexity index.

Sample and Cognitive Complexity Index. Starting with a sampling frame of S&P 500 firms over the years 2004 to 2014, we excluded financial services firms (because of their distinctive performance metrics), leaving a feasible pool of about 18,000 conference calls. There was, however, considerable

[5] As the dictionary contains 269 entries, we do not include it in an appendix. It is available from the first author. To validate its accuracy, we correlated results from the dictionary with results from a rule-based software program to identify comparatives in language (Brill 1992). The correlation was .96 at $p < .001$.

attrition from this pool, for various reasons: some firms went bankrupt, were acquired, or were taken private; some firms, as a matter of policy, did not engage in calls every quarter; some scheduled calls did not occur; and some transcripts were not filed with Factiva. Moreover, we dropped any transcript in which the CEO's Q&A remarks were less than 250 words. In the end, we had a sample of 10,288 calls for which we were able to measure CEO cognitive complexity and obtain all other needed variables. There were 684 distinct CEOs in our sample, for an average of 15 calls per CEO, and each call contained an average of 2,246 Q&A words spoken by the CEO.

Using this sample, we measured our three component indicators of CEO cognitive complexity (differentiation, nuance, and comparison) for each call. As with our pilot sample, the three indicators cohered. Pairwise correlations ranged from .11 to .23, all significant at $p < .001$. Factor analysis yielded a one-factor solution, accounting for 44 percent of variance, with item factors loadings all above .52. To further test the appropriateness of our indicators, we also conducted a confirmatory factor analysis (CFA) using Stata's *sem* command. The one-factor solution provided a good fit to the data: $\chi^2 = 80.21$, $p < .001$; comparative fit index (CFI) = .94; root mean square error of approximation (RMSEA) = .03; standardized root mean square residual (SRMR) = .01 (Bagozzi and Yi 1988, Kline 2011). With this further evidence of coherence, we standardized and averaged the three items to compute a CEO's cognitive complexity score for each quarter *t*.

Validation. We sought to validate our new cognitive complexity index in three ways. First, as a demonstration of construct validity, we gave our definition to five individuals and asked them to rate the degree of cognitive complexity in a sample of 60 paragraph-length CEO passages drawn from conference call transcripts. We provided the panelists with no further guidance, least of all regarding our dictionaries. Thus, they subjectively assessed each paragraph in its entirety, rating its overall degree of cognitive complexity. The raters were doctoral students in management who were not involved or even familiar with our project. The 60 paragraphs were selected to equally represent all gradations of our cognitive complexity index scores for all paragraph-length passages in our entire corpus of transcripts. Thus, we randomly selected six paragraphs for each decile of our distribution of such scores. The raters were asked

to rate each passage on a 7-point scale, ranging from 1 = very low cognitive complexity to 7 = very high cognitive complexity. The raters exhibited moderate interrater agreement (ICC(A, K) = .67; r_{wg} = .51; AD_{Md} = .95; Graf-Vlachy 2017, LeBreton and Senter 2008), and their average scores were highly correlated with our index scores for the 60 passages (r = .40; $p < .001$). Thus, our index exhibits considerable construct validity.

As our second validation test, we examined the concurrent validity of our index. Specifically, we obtained the practice data sets used by Suedfeld et al. (1992) to train coders in scoring integrative complexity in texts. As noted above, integrative complexity is similar but not identical to our construct of interest, cognitive complexity. Integrative complexity is scored on a 7-point scale, with gradations of 1–3 representing increments of "conceptual complexity," which is roughly the same as the "differentiation" facet of cognitive complexity. Scores of 4–7 represent gradations of "integration," which are very rarely observed in real-world texts, and which our construct does not include. Thus, retaining only the 92 Suedfeld passages that had scores of 1–3 (a restricted range, which makes a high correlation difficult to achieve), we examined the correlation between these expert ratings of conceptual complexity and our own dictionary-based cognitive complexity scores. The correlation was .25 ($p < .05$). Given that the passages were relatively short (only 77 words on average) and that their conceptual complexity scores ranged narrowly, we take this correlation as evidence of concurrent validity.

Third, in another demonstration of concurrent validity, we compared our cognitive complexity scores to the human-coded integrative complexity scores for the ten most recent U.S. presidents (Dwight D. Eisenhower through George W. Bush) studied by Thoemmes and Conway (2007), based on each president's first four State of the Union addresses. Our cognitive complexity scores, generated from the same speech transcripts, were highly correlated with the scores obtained by Thoemmes and Conway (r = .77, $p < .001$), providing yet more evidence of the validity of our index.

Independent Variable and Moderators

Our primary independent variable, *CEO tenure*, was measured as the number of quarters the CEO had been in office (as of quarter *t*). These data came from ExecuComp and BoardEx.

Among our moderators, to measure *systemic industry dynamism* we took inspiration from the finance literature (Cain and McKeon 2016, Guenther et al. 2016) and constructed a measure based on the long-term, or inherent, degree of volatility of stock returns in each industry. Such a measure comprehensively captures various sub-forms of dynamism, including in customers' behaviors, technologies, and competitive dynamics.[6] To construct the measure, we first calculated the standard deviation of daily returns for each firm covered by the Center for Research in Security Prices (CRSP) database (which encompasses many more firms than in our sample) to obtain a measure of return volatility of each firm over the entire sampling time frame. We then aggregated these firm-specific values to the industry-level (2-digit-SIC-codes) and took the median size-weighted value of the firms' volatilities. Size-weighting, based on firms' average market capitalizations over the sampling time frame, appropriately gave greater importance to large firms in the construction of the industry measure. Finally, we standardized this measure.[7] Among the industries with the highest dynamism scores were consumer electronics and recreation services; among the lowest were food products and paper products.

To measure *industry jolts*, we coded a dummy variable to indicate whenever an industry's dynamism in the 45 days before a focal conference call was more than three times its level of systemic dynamism. With this coding threshold, which we deemed as indicating an extraordinary burst of dynamism relative to the industry's baseline tendency, there were 67 industry jolts in our sample.

Finally, we measured *CEO positional power* using an index consisting of three standardized indicators: (1) duality, coded to one when the CEO was also board chair, (2) percentage of company

[6] As such, this measure has advantages over the commonly-used Dess and Beard (1984) measure of industry dynamism, which is based, far more narrowly, on variability of industry sales levels over time.

[7] Our calculation of a single dynamism score for each industry was consistent with our interest in long-term, or inherent, degrees of dynamism. Scores based on narrower time-periods yielded very similar relative placements of industries.

shares owned by the CEO, and (3) percentage of directors who were appointed after the start of the CEO's tenure (Zajac and Westphal 1996, Cannella and Shen 2001). These data came from ExecuComp, ISS RiskMetrics, and BoardEx.

Controls

We controlled for potentially confounding factors at the industry, firm, CEO, and call level. Data were from Compustat, updated quarterly whenever possible, otherwise annually. To capture additional industry effects, we controlled for environmental *munificence*, regressing the log of the last five years' industry sales (at the 2-digit-SIC-level) on time and retaining the coefficients' antilogs (Keats and Hitt 1988). At the firm level, we controlled for *firm size*, measured by the log of firm assets. *Slack* was measured as working capital divided by sales, which is an indicator of "immediate" slack readily accessible for managerial initiatives (Bourgeois and Singh 1983, Finkelstein and Hambrick 1990). Because our data panel included multiple CEOs for most firms, we included *firm dummies* in all regressions. At the CEO level, we controlled for CEO *positional power* as described above. As a further control for stress, we controlled for the *CEO's recent performance,* the difference in a firm's industry-adjusted return on assets (ROA) between the current quarter (of the call) and the prior quarter. Industry-adjusted ROA was calculated as the firm's ROA minus the median ROA of all firms of the same primary 2-digit SIC code, and winsorized at the 1% level. Additionally, to control for the *CEO's cumulative performance record* we took the firm's industry-adjusted ROA, averaged over all quarters from the start of the CEO's tenure up until the quarter prior to the focal call (so as not to overlap with recent performance). For CEOs who were in the first quarter of their tenure, we assigned a cumulative performance record of zero, implying performance in line with the industry median. We included a dummy indicator, coded to one, for cases where a CEO was serving a *second tenure* within our sampling frame. For each quarterly call, we controlled for the *total number of Q&A words spoken by the CEO* and for the *cognitive complexity of analysts' questions* during the call (calculated across all questions, in the same way as for CEOs' answers). Finally, we included *year* and *quarter* dummies (Q1, Q2, Q3, Q4) to control for systematic differences over time.

We also controlled for potential selection bias, particularly the possibility that CEOs who remain in office differ systematically from those who depart. We followed Henderson and colleagues (2006), who employed the approach pioneered by Lee (1983). This approach, which is more robust than that of Heckman (1979), uses contemporaneous predictors to estimate the likelihood that a CEO's tenure concludes in quarter *t*. The predictor variables in this first stage were firm size, slack, CEO positional power, CEO cumulative performance record, and CEO tenure (all measured in $t - 1$), as well as CEO age at appointment. Since identification in Heckman-type models is improved when an exclusion restriction is added (Sartori 2003), we additionally included the firm's industry-adjusted performance in the prior quarter. This variable was a significant predictor in the first stage, which we expected, as firm performance is the one key predictor of CEO dismissal (Finkelstein et al. 2009). At the same time, the variable was not significantly correlated with cognitive complexity, our ultimate dependent variable of interest, satisfying the requirements imposed on exclusion restrictions (Bushway et al. 2007). We thus performed the first-stage estimation using an accelerated failure time model with an exponential distribution. We then computed

$$\lambda_{i,t} = \frac{\phi\left[\Phi^{-1}\left(F(i,t)\right)\right]}{1 - F(i,t)}$$

where i indexes CEO tenures, t indexes time in quarters, $\phi(x)$ denotes the standard normal density function, $\Phi^{-1}(x)$ signifies the inverse of the standard normal distribution, and $F(i,t)$ is the cumulative failure probability from the accelerated failure time model. We then controlled for $\lambda_{i,t}$ in our second stage regressions. An appropriate exclusion restriction aids identification in the second stage by solving possible collinearity problems there, which could lead to inflated standard errors and thus potentially render the significance of coefficients overly conservative. To see whether any such problems remained, we tested for multicollinearity by calculating variance inflation factors (VIF) for all variables (except the dummy variables for firms, quarters, and years, given that they represent categorical variables with more than two categories, representing cases in which even observed collinearity would not pose a threat). The

average VIF was 1.27, and the highest VIF was 2.42, far below the canonical cutoff of 10 (Wooldridge 2013). We concluded that multicollinearity was not a problem.

Econometric Analyses

Consistent with our within-person focus, we used CEO fixed effects models for our analyses. Such models control for persistent, difficult-to-observe characteristics of CEOs, such as personality, essentially setting aside any trait-like component of CEO cognitive complexity (Wooldridge 2013). Specifically, we employed a robust fixed effects panel estimator using the Huber-White standard error correction (Stata command *xtreg, fe robust*), as a Wald test indicated heteroskedasticity in our model.

RESULTS

Table 2 presents means, standard deviations, and correlations. As noted above, all VIF statistics were satisfactory, even for the high correlations among CEO tenure, CEO positional power, and lambda.

Insert Table 2 about here

Table 3 shows our regression models. Model 1 is a control model; Model 2 adds CEO tenure; Models 3–5 add individual interaction terms; and Model 6 includes all variables and interactions.

Insert Table 3 about here

Our results indicate that CEO tenure was positively related to CEO cognitive complexity, in support of H1. This relationship was significant in Models 2 through 6 (all at $p < .001$), indicating that cognitive complexity mounted over a CEO's time in office. Based on the coefficient in Model 6, for every additional quarter of tenure, a CEO's cognitive complexity increased (on average) by .047, or (because of our standardization) about five percent of a standard deviation. For a 31-quarter tenure (about eight years), which was the average duration of completed tenures in our sample, this implies an increase of one and a half standard deviations in CEO cognitive complexity, which is very substantial.

Turning to our hypothesized moderators, for H2, regarding systemic industry dynamism, Model 3 shows that its interaction with CEO tenure is significantly positively associated ($p < .024$) with cognitive

complexity, supporting H2; this interaction retains its significance in Model 6. Thus, H2 is supported: The more inherently dynamic the industry, the steeper the positive relationship between an advancing tenure and the CEO's cognitive complexity.

Regarding H3, both Model 4 and Model 6 show a marginally significant interaction ($p < .074$) of CEO tenure and industry jolts. Thus, our results provide marginal support for the idea that jolts cause greater disruptions to cognitive complexity for longer-tenured CEOs.

Finally, Model 5 indicates that the interaction of CEO tenure and positional power is marginally significant ($p < .055$) and negatively associated with cognitive complexity. This interaction retains its negative sign and becomes significant ($p < .049$) in the fully specified Model 6. These results provide support for H4: The greater a CEO's positional power, the less steep the positive relationship between an advancing tenure and the CEO's cognitive complexity.

Figures 1, 2, and 3 depict the interaction effects with the moderators set at +/- 2 SD of their mean values or at 1/0 in the case of industry jolts. The graphs extend for 15 years, which encompasses the completed tenure lengths for about 90 percent of our CEOs. As can be seen, the effects of the three moderators are proportional to CEOs' tenure lengths, manifesting most greatly for long-tenure CEOs.

Insert Figures 1, 2, and 3 about here

Although we hypothesized a linear association between CEO tenure and cognitive complexity, we explored the possibility of non-linear patterns. When we included tenure-squared in our models, this quadratic term had a negative coefficient which was marginally significantly associated ($p < .07$) with cognitive complexity, suggesting an inverted-U relationship. However, analysis of the coefficients indicated that the inverted-U peaked at a tenure length well beyond what we actually observed in our sample. Similarly, various spline analyses, which allowed examination of potential ups and downs of cognitive complexity over a CEO's term in office, further corroborated a largely monotonic rise in cognitive complexity, albeit with a slightly reduced rate of ascent for very long-tenured CEOs. In sum,

these sensitivity tests suggest that, except for exceedingly long-tenured CEOs, cognitive complexity rises steadily with each additional year of tenure.

DISCUSSION AND IMPLICATIONS

CEO cognitive complexity may have a host of implications for managerial decision-making and leadership behaviors, but we have examined a more fundamental question: *What are the origins, or determinants, of a CEO's degree of cognitive complexity?* We explored a partial answer to this question, arguing that a CEO's cognitive complexity depends on his or her degree of task-related expertise, which increases with the CEO's tenure. Using a novel measure of CEO cognitive complexity on a large sample of CEO communication episodes, we empirically tested the premise that a CEO's time in office – which allows the accumulation of expertise – influences his or her cognitive complexity. We found considerable support for our theory. This suggests that, in the initial phases of their tenures, CEOs tend to engage in relatively simple thinking, partly because they do not comprehend the complexity of their tasks and options, and partly because they must tune out much of that complexity in order to cope with their unfamiliar challenges. Over time, as they attain more experience and task knowledge, CEOs' mental representations of their task-worlds become more elaborate, that is they become more cognitively complex. Remarkably, this gradual rise in cognitive complexity occurs steadily throughout CEOs' tenures, without plateauing or turning down; and conditional factors, at least those we examined (discussed momentarily), only slightly alter the slope of this upward trajectory.

This core finding has major implications for theory and research on the seasons of CEOs' tenures (Hambrick and Fukutomi 1991). Numerous studies have found that organizations make fewer and smaller changes as their CEOs' tenures advance (summarized in Finkelstein et al. 2009). Two main explanations for this pattern have been set forth. One is that CEOs become cognitively simple, or "stale" (Miller 1991), as they continue in office, favoring stylized worldviews that are often crude caricatures of their earlier and more complex paradigms (Hambrick and Fukutomi 1991). The other explanation is that longer-tenured CEOs become risk-averse and otherwise prefer the status quo (Hambrick et al. 1993). Our own findings are clearly at odds with the former "cognitive impoverishment" explanation, and hence lend indirect

support for the latter explanation. As CEOs' tenures advance, they do *not* become cognitively simpler, but instead become cognitively more complex. So, any absence of strategic change is due to other factors, possibly including commitment to the status quo or cognitive entrenchment that comes with the accumulation of expertise (Dane 2010). Indeed, it is possible that increased cognitive complexity makes decision-making more difficult, as CEOs are then mentally confronted with a broader range of intertwined issues, options, and concepts. As Finkelstein et al. (2009: 69) noted, "It is tempting to think of cognitive complexity as a positive executive trait, but one could readily imagine that it leads to decision paralysis, organizational complexity, and ambiguous leadership messages." Thus, rather than becoming "stale," long-tenured CEOs may instead become bogged down, or overwhelmed by the complexity of their mental models, and thus less able to make and execute bold or novel decisions.

We examined the effects of three moderators, each of which was envisioned as affecting CEOs' accumulation of expertise over their time in office. Even though none of the three greatly altered the general rise in CEO cognitive complexity, they still had some effects and thus are of theoretical relevance for future research on CEO cognitive complexity. In line with the logic that industry dynamism will present the CEO with a stream of varied stimuli, we found a positive moderating effect of systemic industry dynamism on the relationship between tenure and cognitive complexity. Dynamic task environments are known to increase the development of expertise (Ericsson and Towne 2010), and so CEOs working in more dynamic industries attain greater cognitive complexity as their tenures advance, compared to CEOs in more stable settings. We also found that industry jolts are more jarring for longer-tenured CEOs, who have grown accustomed to a given degree of dynamism and who then are cognitively disrupted by major changes from that standard. Finally, we found support for an interactive effect of a CEO's positional power and CEO tenure. This effect, with its negative sign, indicates that greater positional power attenuates the positive effect of tenure on CEO cognitive complexity, supporting the premise that power dampens a CEO's capacity to garner the full potential for increasing expertise that an advancing tenure could afford him or her. This final result particularly highlights that the accumulation of experience, in and of itself, may not necessarily bring about proportional gains in expertise and cognitive

complexity; instead, experience needs to be thoughtfully deliberated in order for it to be converted into expertise (Ericsson et al. 1993).

Cognitive Complexity: Partly Trait, Partly State

Although our theory and findings emphasize the state-like nature of CEO cognitive complexity, particularly proposing that increases in expertise via tenure bring about increases in complexity, it is instructive to place this perspective within the broader question of whether cognitive complexity should be thought of as a trait or a state (Caspi et al. 2005, Roberts et al. 2005). In supplementary analyses, we address this question in multiple ways.

First, we sought to determine the degree to which CEO cognitive complexity is stable (trait-like) versus variable (state-like). We anticipated that each CEO exhibits a persistent, or ingrained, tendency toward a given degree of cognitive complexity, but also exhibits considerable variance from this personal baseline – which of course is what we partly explained through our hypotheses. To conduct this analysis, we performed an ordinary least squares (OLS) regression in which the dependent variable was the CEO's cognitive complexity score for a given quarter (N = 10,288), and the predictors were a set of dummy variables representing our 684 individual CEOs. From this analysis, we found that CEOs' fixed effects explained 46 percent of the total variance in cognitive complexity scores across all the quarterly calls in our sample. This statistic indicates that individual CEOs exhibited persistent personal tendencies in their cognitive complexity but also exhibited substantial variance from those baselines. Indeed, this statistic figuratively suggests that CEO cognitive complexity is roughly half trait and half state.

Second, in a further two-part demonstration of the partly-trait and partly-state nature of cognitive complexity, we explored the degree to which two-time CEOs (a) exhibit their personal baseline tendencies across their two tenures, which would support the premise that cognitive complexity has a trait-like component, *and* (b) exhibit greater cognitive complexity in their second tenures than in their first tenures, as a state-like reflection of accumulated expertise, further supporting our specific theory. These analyses could only be conducted on those few CEOs who we observed in two distinct CEO tenures in our data panel, of which there were fifteen.

In the first part of this demonstration, we performed an OLS regression in which the dependent variable was the CEO's cognitive complexity in a given quarter and the predictors were a set of dummy variables representing every CEO tenure observed, including two distinct dummies for each of the fifteen two-tenure CEOs. Extracting the fixed-effects coefficients for the two-tenure CEOs' respective terms, we found that the correlation between the first-tenure coefficients and the second-tenure coefficients was .78 ($p < .05$), indicating considerable across-tenure consistency for those fifteen CEOs.

The second part of this demonstration, or the expectation that two-tenure CEOs exhibit greater cognitive complexity in their second terms than in their first, is reported in Table 3. Specifically, the dummy variable for *second tenure* is positive and highly significant, indicating that CEOs indeed exhibit greater cognitive complexity if they have already previously been public company CEOs. In sum, these analyses suggest that individual CEOs carry their own baseline tendencies from one position to the next, but generally exhibit increased cognitive complexity in their second tenures, after accumulating experience and expertise in their first tenures, which is consistent with our theory.

Future Research

Our project opens up an array of promising avenues for future research. We start by highlighting research ideas that are most proximate, or highly related to our study, and then expand to discuss a wider set of ideas that are now facilitated by our new measure of CEO cognitive complexity.

Staying with the idea that expertise affects CEO cognitive complexity, researchers could consider additional ways in which CEOs might accumulate expertise. We focused on tenure and tested the moderating effects of industry dynamism, industry jolts, and power, but other sources of experience and knowledge, including shared knowledge from top management team members or directors might also substantially affect the expertise of CEOs, in turn affecting their cognitive complexity. Other forms of pressure or stress that might arise or recede for a given CEO – such as arrivals or departures of certain investors or directors, mergers and acquisitions, or the onset or settling of major lawsuits or labor disputes – could also precipitate changes in CEOs' cognitive processes.

Further, although we theorized that a CEO's increased expertise is the main driver of increased cognitive complexity across one's time in office, other sub-processes could contribute to this rise in cognitive complexity. Perhaps most prominently, new CEOs are under extraordinary pressure to demonstrate early efficacy; but as their tenures advance, they have firmer footholds (Hambrick and Fukutomi 1991). To the extent that high levels of stress cause cognitive constriction (Staw et al. 1981), a general alleviation of pressure over a CEO's time in office might allow greater cognitive complexity. Additionally, as CEOs' tenures advance, they may attach greater value to the perspectives of their top management teams (Hambrick 1994) or other trusted advisors, contributing to greater cognitive complexity, beyond gains in personal expertise.

Researchers could explore potential additional moderators of the main relationship we studied. For instance, how do CEO attributes (say, personality or prior experiences) affect the links between tenure and CEO cognitive complexity? In terms of CEOs' prior experiences, researchers could examine how insider versus outsider appointees, or those with prior industry experience versus those without, or yet other background attributes, might moderate the general pattern we have reported. Or researchers might consider the moderating role of various feedback conditions, as CEOs might be differentially shielded from useful feedback, depending on the structure and nature of their inner circles.

Our focus has been on the effects of tenure on CEOs' cognitive processes, specifically cognitive complexity, but effects on *cognitive content* are also worth considering. Does an advancing tenure bring about not only increased cognitive complexity but also a changed cognitive scope? Numerous researchers have studied CEOs' cognitive content, primarily via the attention-based view (Ocasio 1997, Cho and Hambrick 2006, Gavetti and Rivkin 2007, Eggers and Kaplan 2009), but the idea that CEO cognitive content might change as a function of tenure has not been explored. Researchers who simultaneously consider CEO cognitive complexity *and* CEO cognitive scope may be in an exceptional position to make predictions about CEO behaviors and performance, to which we now turn.

Now knowing that CEO cognitive complexity generally increases with tenure, there is abundant opportunity to study the behavioral and performance consequences of this pattern. When CEOs increase

the complexity of their thinking in response to an advancing tenure, what tends to then happen? As noted above, much of the empirical work on tenure describes a downward spiral of overly-simple decisions, which eventually cause performance declines. Is this pattern a direct outcome of enhanced complexity, or is it a function of something else? Ultimately, we believe the most relevant research question stemming from our findings is this: What determines whether a high degree of CEO cognitive complexity yields *favorable* outcomes (say, via innovation, experimentation, ambidexterity, and comprehensive reinforcement of strategies (Siggelkow 2001, O'Reilly and Tushman 2013)) versus *unfavorable* outcomes (say, due to too many initiatives, slow decision-making, entrenchment, and complicated leadership messages (Finkelstein et al. 2009))?

Although we have devoted our project to studying the state-like, conditional nature of cognitive complexity, particularly in response to an advancing tenure, our study also points to the promise of exploring the more trait-like, fixed aspect of cognitive complexity as well. Our novel measure suggests that individual CEOs exhibit their own personal tendencies toward given levels of cognitive complexity (with tenure causing intra-person variance from these baselines). As such, it would be interesting to explore the correlates or antecedents of high versus low levels of dispositional cognitive complexity in CEOs. Do CEOs' formative experiences (Kish-Gephart and Campbell 2015), educational levels and fields (Waller et al. 1995, Malmendier and Tate 2005), or career experiences (Crossland et al. 2014) co-vary with their dispositional levels of cognitive complexity? If so, or even if not, how does this inform our understanding of the very nature of cognitive complexity?

SUMMARY

We have attempted to contribute to the literature on CEO tenure and cognitions, particularly addressing the concept of CEO cognitive complexity. In contrast to most research on this topic, which has overwhelmingly focused on the consequences of CEO cognitive complexity, we have paused to consider its antecedents: *What determines a CEO's degree of cognitive complexity?* Based on research on expertise, we have shown that CEO tenure affects cognitive processes. As CEOs' tenures progress, their cognitive complexity increases; with every addition to their stock of expertise, CEOs become cognitively

more complex. This trend is mildly amplified by systemic industry dynamism and mildly attenuated by industry jolts and CEO positional power. Our findings have a host of implications for managerial decision-making and leadership behaviors. When these many implications are coupled with our novel, highly replicable index of CEO cognitive complexity, the opportunities for researchers appear abundant.

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TABLES AND FIGURES

Table 1. Summary of Three Dictionaries Used to Assess CEO Cognitive Complexity

Dictionary	**The Language of Differentiation**	**The Language of Nuance**	**The Language of Comparison**
Conceptual Definition	Language that draws distinctions or describes contrasts	Language that conveys degrees of (non-) certitude regarding likelihoods of outcomes or actions	Language that establishes ordering among objects or makes comparisons between them, but without absolutism
Source	LIWC 2015 – "differentiation" dictionary	Loughran and McDonald (2011) – "weak" and "strong" modal word dictionaries (2014 version), combined with LIWC 2015 – "tentative" and "certainty" dictionaries	Comparative words extracted from our corpus of text, supplemented by comparatives from Brown University Standard Corpus of Present-Day American English (1979) and the Open American National Corpus (n.d.)
Example Words	But, except, however (total 81 words)	Weak: Could, might, possibly, apparently, seems (total 180 words) Strong: Always, will, must, purely, totally (total 123 words)	Better, earlier, lower, harder (total 269 words)
Measure	Number of differentiation words divided by total number of words	Number of weak words divided by sum of weak and strong words	Number of comparison words divided by total number of words

Table 2. Correlations and Descriptive Statistics

Variable		Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8	9	10	11	12	13
1	CEO cognitive complexity †	0.00	1.00	-4.35	5.92													
2	Industry munificence	1.05	0.05	0.77	1.28	0.01												
						(0.38)												
3	Firm size	9.20	1.16	4.78	12.53	-0.09*	0.04*											
						(0.00)	(0.00)											
4	Immediate slack	0.79	1.17	-6.20	21.30	0.06*	0.00	-0.29*										
						(0.00)	(0.87)	(0.00)										
5	CEO second tenure	0.02	0.13	0.00	1.00	-0.01	0.02*	0.00	-0.04*									
						(0.20)	(0.02)	(0.74)	(0.00)									
6	CEO recent performance	-0.01	1.98	-16.63	16.63	0.01	-0.01	0.01	-0.01	0.01								
						(0.40)	(0.34)	(0.44)	(0.16)	(0.46)								
7	CEO cumulative performance record	1.41	1.71	-5.62	5.69	0.05*	0.10*	0.02	0.05*	-0.06*	-0.10*							
						(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)							
8	CEO words (thousands)	2.25	1.28	0.25	10.28	0.16*	0.01	-0.08*	0.07*	0.01	0.00	0.11*						
						(0.00)	(0.14)	(0.00)	(0.00)	(0.48)	(0.64)	(0.00)						
9	Analyst cognitive complexity †	0.00	1.00	-7.37	4.75	0.08*	-0.04*	-0.01	0.01	-0.01	-0.01	0.10*	0.04*					
						(0.00)	(0.00)	(0.28)	(0.37)	(0.33)	(0.45)	(0.00)	(0.00)					
10	Lambda	0.44	0.31	0.01	2.44	0.08*	-0.02*	0.12*	-0.07*	-0.02*	0.01	0.02*	-0.02*	0.03*				
						(0.00)	(0.02)	(0.00)	(0.00)	(0.04)	(0.43)	(0.06)	(0.04)	(0.00)				
11	Systemic industry dynamism †	0.00	1.00	-1.62	5.97	0.11*	0.12*	-0.01	0.05*	-0.02	0.00	-0.15*	0.05*	-0.03*	0.07*			
						(0.00)	(0.00)	(0.20)	(0.00)	(0.11)	(0.99)	(0.00)	(0.00)	(0.00)	(0.00)			
12	Industry jolt	0.01	0.08	0.00	1.00	0.00	0.06*	0.05*	-0.04*	0.00	-0.01	0.00	-0.02*	-0.02	0.02	0.02*		
						(0.92)	(0.00)	(0.00)	(0.00)	(0.85)	(0.28)	(0.69)	(0.02)	(0.10)	(0.05)	(0.04)		
13	CEO positional power †	0.00	1.00	-2.03	7.73	0.07*	0.03*	0.07*	-0.06*	-0.02*	0.00	0.12*	-0.03*	0.01	0.50*	0.05*	0.01	
						(0.00)	(0.00)	(0.00)	(0.00)	(0.04)	(0.93)	(0.00)	(0.01)	(0.48)	(0.00)	(0.00)	(0.40)	
14	CEO tenure (quarters)	24.26	20.51	1.00	154.00	0.13*	0.01	-0.02*	0.07*	-0.07*	0.00	0.13*	0.02	0.02	0.62*	0.06*	-0.01	0.67*
						(0.00)	(0.30)	(0.01)	(0.00)	(0.00)	(0.81)	(0.00)	(0.06)	(0.09)	(0.00)	(0.00)	(0.39)	(0.00)

Notes: N = 10,288. *p*-values in parentheses. * $p < .05$. † Standardized.
Firm, year, and quarter dummies not included in this table.

Table 3. Results of CEO Fixed Effects Estimation

	CEO cognitive complexity																	
	(1)			(2)			(3)			(4)			(5)			(6)		
Variable	**β**	**SE**	**p**	**β**	**SE**	**p**	**β**	**SE**	**p**	**β**	**SE**	**p**	**β**	**SE**	**p**	**β**	**SE**	**p**
Industry munificence	0.484	0.344	0.160	0.483	0.344	0.161	0.525	0.350	0.133	0.490	0.345	0.156	0.477	0.342	0.163	0.528	0.348	0.129
Firm size	-0.046	0.047	0.324	-0.046	0.047	0.327	-0.052	0.047	0.271	-0.045	0.047	0.339	-0.039	0.047	0.413	-0.043	0.047	0.360
Immediate slack	-0.007	0.017	0.676	-0.007	0.017	0.674	-0.004	0.016	0.804	-0.007	0.017	0.674	-0.004	0.016	0.808	-0.001	0.016	0.956
Firm dummies		Yes			Yes			Yes			Yes			Yes			Yes	
CEO second tenure	-0.321	0.250	0.199	1.425***	0.374	0.000	1.366***	0.373	0.000	1.424***	0.371	0.000	1.581***	0.373	0.000	1.524***	0.367	0.000
CEO recent performance	0.005	0.004	0.206	0.005	0.004	0.197	0.005	0.004	0.196	0.005	0.004	0.210	0.005	0.004	0.197	0.005	0.004	0.208
CEO cumulative performance record	0.020	0.015	0.202	0.021	0.016	0.179	0.019	0.015	0.209	0.021	0.016	0.187	0.021	0.016	0.167	0.019	0.015	0.205
CEO words (thousands)	0.068***	0.011	0.000	0.068***	0.011	0.000	0.068***	0.011	0.000	0.068***	0.011	0.000	0.068***	0.011	0.000	0.068***	0.011	0.000
Analyst cognitive complexity	0.076***	0.009	0.000	0.076***	0.009	0.000	0.076***	0.009	0.000	0.076***	0.009	0.000	0.076***	0.009	0.000	0.075***	0.009	0.000
Lambda	-0.189	0.144	0.189	-0.191	0.144	0.185	-0.226	0.145	0.119	-0.183	0.145	0.208	-0.141	0.145	0.331	-0.168	0.146	0.252
Industry jolt	-0.041	0.104	0.696	-0.041	0.104	0.695	-0.041	0.104	0.696	0.180	0.162	0.266	-0.041	0.104	0.692	0.182	0.161	0.259
CEO positional power ‡	-4.594†	2.442	0.060	-4.580†	2.442	0.061	-4.377†	2.462	0.076	-4.578†	2.444	0.061	-0.170	3.438	0.961	0.159	3.439	0.963
Year dummies		Yes			Yes			Yes			Yes			Yes			Yes	
Quarter dummies		Yes			Yes			Yes			Yes			Yes			Yes	
CEO tenure				0.045***	0.009	0.000	0.046***	0.009	0.000	0.045***	0.009	0.000	0.047***	0.008	0.000	0.047***	0.008	0.000
CEO tenure × Systemic industry dynamism ‡							0.226*	0.100	0.024							0.232*	0.098	0.018
CEO tenure × Industry jolt										-0.010†	0.006	0.074				-0.010†	0.006	0.070
CEO tenure × CEO positional power ‡													-0.119†	0.062	0.055	-0.122*	0.062	0.049
Constant	-0.439	0.570	0.441	-0.588	0.571	0.304	-0.586	0.570	0.304	-0.603	0.573	0.293	-0.626	0.567	0.270	-0.641	0.567	0.259
Observations		10288			10288			10288			10288			10288			10288	
Log-likelihood		-11331.639			-11331.192			-11327.714			-11329.599			-11327.461			-11322.170	
R^2		0.025			0.025			0.026			0.026			0.026			0.027	

Notes: Standard errors are Huber-White robust. ‡ Divided by one hundred to allow for more meaningful interpretation of coefficients.
Direct effect of systemic industry dynamism on CEO cognitive complexity not estimated as Stata omits the variable due to perfect multicollinearity with firm fixed effects.
Omission also required for estimation of margins for Figures 1 through 3 as H matrix is sensitive to collinear factor variables in the *xtreg*, *fe* estimator (StataCorp, 2015: 1412). Other parameter estimates are unaffected.
† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

Figure 1. Moderating Effect of Systemic Industry Dynamism

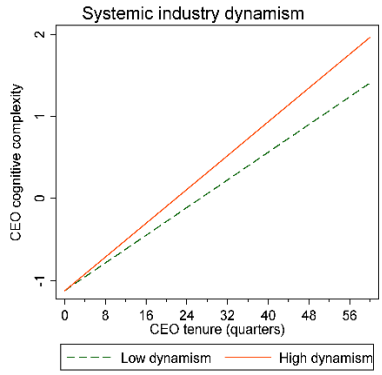

Figure 2. Moderating Effect of Industry Jolt

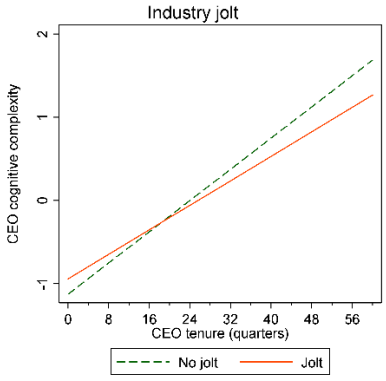

Figure 3. Moderating Effect of CEO Positional Power