Measuring Executive Personality using Machine-Learning Algorithms:

A New Approach and Validity Tests

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Abstract

We present a novel approach for measuring executive personality traits. Relying on recent developments in machine learning and artificial intelligence, we utilize the IBM Watson Personality Insights service to measure executive personalities based on CEOs' and CFOs' responses to questions raised by analysts during conference calls. We obtain the Big Five personality traits – openness, conscientiousness, extraversion, agreeableness, and neuroticism – based on which we estimate risk tolerance. To validate these traits, we first demonstrate that our risk tolerance measure varies with the existing inherent and behavioral-based measures (gender, age, sensitivity of executive compensation to stock return volatility, and executive unexercised-vested option) in predictable ways. Second, we show that variation of firm-year level personality trait measures, including risk tolerance, is largely explained by manager characteristics, as opposed to firm characteristics and firm performance. Finally, we find that the executive inherent risk tolerance helps explain the positive relation between client risk and audit fees documented in prior literature. Specifically, the effect of CEO risk tolerance as an innate personality trait on audit fees is incremental to the effect of increased risk appetite from equity risk-taking incentives (Vega). Measuring executive personality using machine-learning algorithms will thus allow researchers to pursue studies that were previously difficult to conduct.

JEL Codes: G41, G30, M12, M42

Keywords: Personality, Big Five, Machine learning, Risk tolerance

1. Introduction

Upper echelons theory predicts that organizational outcomes are “reflections of the values and cognitive biases of powerful actors” and that individual executives have a significant influence on corporate policies and activities (Hambrick & Mason, 1984, p. 193). And while accounting is subject to greater regulation than other corporate activities, research in accounting finds that top managers, particularly CEOs and CFOs, also exert significant influence on financial reporting decisions (Plöckinger, Aschauer, Hiebl, & Rohatschek, 2016). As research on upper echelons theory has grown, so too has the interest in developing proxies for the individual traits of executives. Over time, several broad approaches have emerged. The “black box” approach captures characteristics of individual executives using managerial fixed effects (Ge, Matsumoto, & Zhang, 2011; Dyreng, Hanlon, Maydew, 2010). While individual managers do appear to have unique financial reporting ‘styles’, this approach is unable to identify the specific personality traits or to articulate how they relate to accounting outcomes. Another approach is to infer personality from the actions that managers take, such as option-exercise behavior (Malmendier & Tate, 2005, 2008; Hribar and Yang 2016), or from demographic characteristics to predict personality traits (Bamber, Jiang, & Wang, 2010). However, managerial actions are often influenced by many other factors and demographic characteristics such as age, gender, and education; therefore, they have had limited ability to explain managerial fixed effects as they do not capture well the underlying personality characteristics (Ge et al., 2011). A third approach is to measure personality traits like the Big Five[1] through the administration of surveys known as personal inventory scales. While research shows these measurements to be reliable, administering these kinds of tests on a large scale is not feasible. As Ham, Lang, Seybert, and Wang (2017, p. 1090) note, "executives are understandably unwilling to complete surveys or questionnaires to directly measure personality traits such as narcissism." Plöckinger et al. (2016) call for additional research to continue the development and validation of meaningful measures to enable closer links between managerial idiosyncrasies and financial reporting choices, and our research is motivated by this call. The purpose of this paper is to propose a new approach to measure executive personality in a large sample setting.

In contrast to previous studies, we adopt a novel approach that relies on recent developments in machine learning and artificial intelligence to measure personality traits. Specifically, we use the IBM Watson Personality Insights service (Watson PI) to process transcripts of the Q&A sessions of conference calls made by CEOs and CFOs. This machine-learning software infers personality scores for the Big Five personality dimensions from textual information using an open-vocabulary approach. Researchers in psychology, psycholinguistics and marketing theorize that language can provide insight into a speaker's personality type, thinking style, and emotional states. The frequency with which speakers use certain categories of words,

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[1] The Big Five, also known as the five-factor model (FFM) developed by Norman (1963) and Costa and McCrae (1997), is one of the best studied and the most widely used personality models to describe how individuals generally engage with the world. The model's dimensions are captured by the mnemonic OCEAN, where 'O' stands for *Openness* (the extent to which a person is open to experiencing a variety of activities); 'C' for *Conscientiousness* (tendency to act in an organized or thoughtful way); 'E' for *Extraversion* (tendency to seek stimulation in the company of others); 'A' for *Agreeableness* (tendency to be compassionate and cooperative toward others); and 'N' for *Neuroticism* (emotional range, the extent to which a person's emotions are sensitive to the person's environment).

for instance, can provide clues to these, and word usage in written communications can predict aspects of personality (Fast & Funder, 2008; Hirsh & Peterson, 2009; and Yarkoni, 2010). Our study focuses on these Big Five (OCEAN) traits, as they portray basic underlying trait dimensions of personality (Goldberg, 1990) and are recognized as genetically based, relatively stable, and cross-culture generalizable (Costa & McCrae, 1997; Cobb-Clark & Schurer, 2012). Based on prior research that provides relatively consistent guidance on the relation between the Big Five personality traits and an individual's appetite for risk (Judge & Cable, 1997; Judge & Bono, 2000; Clarke & Robertson, 2005; Nicholson, Soane, Fenton-O'Creevy, & Willman, 2005; Borghans, Heckman, Golsteyn, & Meijers, 2009), we then combine the OCEAN personality traits to derive a measure for CEO and CFO risk tolerance (RT).

Given the novelty in using machine learning to measure executive personality traits, we validate the Watson Big Five personality traits, including risk tolerance, in several ways. First, consistent with prior literature (Byrnes, Miller, & Schafer, 1999; Barnea, Cronqvist, & Siegel, 2010; Chen, Gul, Veeraghavan, & Zolotoy, 2015; Lee, Hwang, & Chen, 2017), we show that our measure of CEO and CFO risk tolerance is related to two inherent and two behavioral-based measures used in prior literature in predictable ways. Specifically, we show that male executives are more risk tolerant than female executives and that risk tolerance decreases with age. We also find that our risk tolerance measure is positively correlated with the sensitivity of executive compensation to stock return volatility (Vega) and the ratio of a given executive's vested in-the-money option value to the executive's total compensation value (Option). Second, we demonstrate that the variation of firm-level CEO and CFO personality traits is explained by manager characteristics as opposed to firm characteristics and firm performance on which the CEOs and CFOs comment during the conference calls. Third, we find that adding executive fixed effects into regressions of the OCEAN and RT traits on firm characteristics significantly increases the explanatory power of the models (Adjusted R^2), with increases ranging between 18 and 40 per cent, while adding firm fixed effects only improves the R^2 by 4 percent at the most. This suggests that executives' personalities, rather than firm characteristics, explain the levels of the Big Five and RT traits. Fourth, we show that year-to-year changes in firm-level CEO and CFO Big Five and RT traits are significantly greater in years when a firm appoints a new executive, which is again consistent with the traits capturing personal rather than organizational characteristics. Therefore, while our firm-year personality measures are based on input from conference calls that contain firm-specific content, our validity tests confirm that these measures capture manager-specific traits.

As the final analysis of validity, we test the upper echelons theory in a setting where risk is predicted to affect reporting outcomes; specifically, we investigate the previously documented positive relationship between CEO risk tolerance and fees paid to the firm's auditor. Chen et al., (2015) argue that higher stock return volatility (Vega) induces managers to be more risk tolerant and that this higher risk tolerance is reflected in audit risks and audit fees. They find that a positive association between audit fees and the sensitivity of CEO compensation to vega. We consider the interplay between a CEO's inherent risk tolerance and risk appetite due to financial incentives provided by firms to align managers' risk tolerance with shareholders'. The objective of this analysis is threefold. First, as an additional validation test, we show that the CEO's inherent risk tolerance remains a significant determinant of audit fees over and above the previously documented effect of incentives (measured by the sensitivity of CEO compensation to stock return volatility, or vega). Second, we show that the effect of inherent risk tolerance and increased risk appetite due to financial incentives are complementary to each other. Specifically, we find a positive association between inherent risk tolerance and audit pricing with similar magnitude as the association between vega and audit pricing (Chen et al., 2015). However, when combined, the effect of financial incentives (high vega) given to managers with high risk tolerance (high RT) almost doubles the magnitude of the effect on audit fees. Third, we speak to the self-selection concern that impacts all papers in this stream of literature; namely, the idea that the matching between CEO characteristics and firm characteristics can explain the association between CEO characteristics and corporate outcomes. We find that managers with low (high) RT are more likely to work for firms with low (high) vega compensation, consistent with self-selection. However, similar to arguments in Hirshleifer, Low, and Hong (2012), the endogenous selection of CEOs based on their risk tolerance only explains a very small part of our results.

Finally, we also address the potential causality concern by isolating firms that have experienced changes in CEOs and showing that increases in risk tolerance are associated with increases in audit fees. Overall, our results provide support for the upper echelons theory by showing that CEO inherent risk tolerance has an incremental impact on audit fees beyond risk induced from financial incentives.

Our research makes several contributions. First, to our knowledge we are the first study to utilize a machine learning software, IBM's Watson PI, to obtain the Big Five personality traits of CEOs and CFOs of large US companies. Effective measurement of variables of interest is essential for drawing valid statistical inferences from empirical samples. Inaccurately measuring or using noisy proxies and drawing inferences about the significance of personality characteristics on various outcomes can often result in type I errors (observing a difference when none exists) and type II errors (failing to observe a difference when one does exist). Minimizing these errors is not a simple or straightforward issue since, for any given sample size, the effort to reduce one type of error generally results in increasing the other. By utilizing a novel technique (machine learning software developed by IBM) with a high level of validity and objectivity to assess personality traits of executives in a large sample setting, we help to minimize both types of errors. We thereby add to the literature that seeks to find new ways to meaningfully measure managerial traits to facilitate a broad array of new studies on management personality (Demerijian, Lev, & McVay, 2012).

We also add to the growing literature on the use of textual analysis to measure individual personality traits. Dikolli, Keusch, Mayew, and Steffen (2019) and Patelli and Pedrini (2015) measure CEO integrity by examining the language used by CEOs in shareholder letters, while Larcker and Zakolyukina (2012) develop a classification model based on word categories to measure the level of deception by executives in conference calls. Most similar to our work is that of Gow, Kaplan, Larcker, and Zakolyukina (2016) who use linguistic features of CEOs during conference calls to develop measures of the Big Five personality traits for CEOs. Their study differs from ours in at least two ways. First, Gow et al. examine the relation between CEO personality traits and broader firm policies, including financing choices, investment choices, and operating performance rather than aspects of financial reporting. Second, and more important, the authors develop their own mapping of language to measure Big Five personality traits using a predictive scoring technique based on self-constructed word categories. This approach is more subjective than that by IBM and lacks a validation on a large sample.[2] The primary advantage of our approach is that it utilizes machine-learning software developed and validated by IBM against

[2] To validate their approach, Gow et al. (2016) rely on the sample by O'Reilly, Doerr, Caldwell, and Chatman (2014) who asked 250 employees to complete a survey to assess their CEO's personality using the Ten-Item Personality Inventory. Based on O'Reilly et al.'s sample of only 28 CEOs, Gow et al. find out-of-sample correlations between predicted and actual personality scores that range from 0.23 for agreeableness to 0.49 for neuroticism.

over 1,500 responses to traditional psychometric personality tests. We contribute to the textual analysis literature by utilizing software that continually evolves and improves over time, and that is available, at a reasonable cost, to other researchers.[3]

Finally, we add to the auditing literature by highlighting CEO inherent risk tolerance as an important determinant of audit fees. Prior literature provides evidence consistent with managers responding to financial incentives by increasing risk taking (Coles, Daniel, & Naveen, 2006; Armstrong, Larcker, Ormazabal, & Taylor, 2013) and auditors realizing the potential consequences of financial incentives and incorporating the increased risk in the fees charged. For example, Chen et al. (2015) document a strong positive association between the CEO equity risk-taking incentives (vega) and audit fees. However, prior literature is quiet with respect to how managers' risk aversion moderates the relationship between financial incentives and firm risk. This investigation is important given that a manager's response to financial incentives is a function of how costly risk taking is for the manager. We first replicate results in Chen et al. (2015) and find a positive association between vega and audit fees. We then extend Chen et al. (2015) by documenting findings consistent with auditors incorporating in fees managers' risk tolerance, beyond the effects of financial incentives provided by the firm. We thus contribute to this literature by documenting that the CEOs' inherent risk tolerance represents a significant determinant of audit fees over and above existing incentives to take risks reflected in vega. Overall, our findings show an important link between risk tolerance of the individual CEO and audit fees, supporting upper echelons theory in this context.

The remainder of the paper is organized as follows. Section 2 reviews prior literature. In section 3, we discuss our data and methodology. Section 4 presents the empirical results and

[3] For further details, please see: https://www.ibm.com/watson/services/personality-insights/

Section 5 concludes.

2. Related Literature

2.1 Literature on personality characteristics

A central tenet of the strategic leadership literature is that organizations are reflections of top executives' unique backgrounds and personalities (Finkelstein, Hambrick, & Cannella, 2009). In their pioneering work, Hambrick and Mason (1984, p. 193) define organizational outcomes as the "reflections of the values and cognitive biases of powerful actors" (i.e., of the "upper echelons") in organizations. According to the upper echelons theory, the way such actors interpret situations, challenges, or decisions they confront are influenced by the experiences, values and personalities of these individuals and these, in turn, influence their strategic choices and organizational effectiveness (Hambrick, 2007).

There is a considerable controversy in existing literature over whether the personal characteristics of firm executives affect corporate behavior. On the one hand, it is not obvious that the upper echelons proposition should empirically hold. First, top executives are hired to make the value-maximizing strategic and operational decisions in a given context. Therefore, shareholders expect management to put aside their idiosyncratic personal characteristics and preferences and to act in the firm's best interest. Second, as top management personality is only one of many factors influencing firm performance, it is possible that the nuances of managerial style are too weak to be discernable in firm-level data. As Ge et al. (2011, p. 1145) note, "In real-world situations, when person, task and environmental factors are allowed to vary simultaneously, it is possible that task and environmental factors play a larger role in determining decisions than person-related factors or style."

On the other hand, there is a vast empirical support for the upper echelons theory. Ge et al. (2011) provide evidence that CFO fixed effects are correlated with a set of accounting practices including operating lease classifications, discretionary accruals, the expected rate of return for pension plan assets, and earnings smoothness. The authors find that demographic characteristics such as age, gender, and education have limited ability to explain their fixed effects and conclude that other omitted CFO personality attributes likely explain the primary variation. However, they do not propose what these specific personalities are or how they relate to accounting outcomes. In their comprehensive review of relevant literature, Plöckinger et al. (2016) summarize 60 studies, most of which support the view that management executive characteristics are reflected in various financial reporting outcomes (we refer the reader to Table 2 by Plöckinger et al. that summarizes each study by highlighting managerial positions examined, proxies used for upper echelons characteristics, and what accounting choices/consequences were tested). Given the difficulty in measuring personality traits for large samples of top level executives (which often requires the administration of surveys or detailed interviews) and the significance of the upper echelons theory, Plöckinger et al. (2016) encourage future research in accounting to collect and utilize psychographic profiles of executives using established frameworks, such as "Big Five" personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism) measures to enable closer links between managerial idiosyncrasies and financial reporting choices.

Toegel and Barsoux (2012) describe leaders along the Big Five personality dimensions as follows: 1) Openness to experience reflects the degree of intellectual curiosity, creativity and a preference for novelty and variety. It also describes the extent to which a person is imaginative or independent and depicts a personal preference for a variety of activities over a strict routine. Moreover, high openness can be perceived as unpredictability or lack of focus, whereas low openness leaders seek to gain fulfillment through perseverance and are characterized as pragmatic and data-driven. 2) Conscientiousness reflects a tendency to be organized and dependable, where high conscientious leaders show self-discipline, act dutifully, aim for achievement, and prefer planned rather than spontaneous behavior. High conscientiousness is often perceived as stubbornness and obsession, whereas low conscientiousness is associated with flexibility and spontaneity, but can also appear as sloppiness and lack of reliability. 3) Extraversion is associated with high energy, positive emotions, assertiveness, sociability and talkativeness, and the tendency to seek stimulation in the company of others. High extraversion is often perceived as attention-seeking and domineering, whereas low extraversion causes a reserved and reflective personality. 4) Agreeableness is a tendency to be compassionate and cooperative rather than suspicious and antagonistic towards others. It also reflects one's trusting and helpful nature, and whether a person is generally good-tempered or not. More agreeable leaders are often perceived as naive or submissive, whereas less agreeable personalities are often competitive or challenging people, which can be seen as argumentative or untrustworthy. 5) Neuroticism is the tendency to easily experience unpleasant emotions, such as anger, anxiety, depression, and vulnerability. Neuroticism also refers to the degree of emotional stability and impulse control and is sometimes referred to by its low 'emotional stability'. A high need for stability manifests itself as a stable and calm personality but can be seen as uninspiring and unconcerned. A low need for stability causes a reactive and excitable personality, often very dynamic individuals, but they can be perceived as unstable or insecure.

2.2 Literature on Big Five personality traits and risk tolerance

Prior research provides relatively consistent guidance on the relation between the Big Five personality traits and an individual's appetite for risk. Therefore, we are able to combine Big Five personality traits to derive a measure for risk tolerance of executives. In particular, high risk tolerance is associated with high extraversion, high openness, low neuroticism, low agreeableness, and low conscientiousness (Nicholson et al., 2005). To provide an intuition for the relation, it is useful to consider the sub-characteristics that make up the Big Five personality traits. Each personality trait is composed of several sub-characteristics. For example, Watson IP provides the following personality traits related to openness: adventurousness or willingness to experiment, imagination, intellectual curiosity, as well as readiness to challenge authority, convention, and traditional values. A number of past studies document a positive association between openness to experience and risk tolerance or risk taking (Costa & McCrae, 1997; Lauriola & Levin, 2001; Dewett, 2007).

In contrast, individuals who score high on conscientious are described as deliberate rather than bold, dutiful rather than carefree, orderly rather than unstructured, persistent rather than intermittent, and self-assured rather than self-doubting. Conscientious people are more comfortable in predictable rather than in risky situations, and research finds that conscientious CEOs are more controlled and risk-averse (Goldberg, 1990) and less attracted to innovative cultures that value risk-taking and inventiveness (Judge & Cable, 1997). Prior research suggests that risk tolerance is negatively associated with conscientiousness.

Similar to the openness to experience, extraversion pertains to an individual's preference for exposure towards the outside world with a particular emphasis on social interactions. Extroverts are excitement-seeking, energetic, assertive, cheerful, outgoing, and sociable. We argue that seeking excitement as well as being energetic and assertive are likely to be positively related to one's propensity to take risk. For example, cheerful, outgoing, and sociable people tend to have denser social networks that can moderate the psychological discomfort resulting from adverse outcomes of one's risk taking (Clarke & Robertson, 2005). Furthermore, extraverted executives may pursue aggressive strategies (involving risk) and make premature changes if returns on such strategies do not materialize quickly (Judge, Piccolo, & Kosalka, 2009). Hence, consistent with prior literature, we posit a positive association between extraversion and risk tolerance.

Individuals who score high on agreeableness tend to be altruistic rather than self-focused, cooperative and accommodating, modest, sincere, empathetic and trusting. Many of these characteristics are not conducive with significant risk taking. Modesty and altruism suggest that agreeable people are likely to have concave marginal utility of wealth and so they tend to be quite risk averse. Similarly, sincerity, empathy and trust in others suggest that agreeable people may be uncomfortable with gambling especially when being in charge of other people's money. Hence, agreeableness is likely to be negatively associated with risk tolerance. Consistent with this proposition, past research finds that agreeable people (including managers) take less risk (Nicholson et al., 2005; Soane & Chmiel, 2005; Borghans et al., 2009).

Finally, people classified as neurotic have a tendency to be fiery, anxious, moody, prone to worry, depression and melancholy, hedonistic, self-conscious and prone to stress. These characteristics suggest that the psychological cost of failure is high for neurotic people, which suggests that they will likely be risk averse. Several empirical studies on the association between neuroticism and risk tolerance support the view that emotionally stable managers are less threatened by uncertainties, not afraid to challenge the status quo, and take risks (Judge & Bono, 2000; Nicholson et al., 2005; Nadkarni & Herrmann, 2010).

Using risk propensity scales and Big Five scales from a sample of 1,669 managers and professionals, Nicholson et al. (2005) find risk propensity to be strongly rooted in personality. They document strong associations between risk propensity and the Big Five personality traits, with risk propensity being negatively correlated with neuroticism, agreeableness and conscientiousness, and positive correlated with extraversion and openness.

2.3 Literature on auditing and risk

The auditing literature argues that because of potential litigation and reputation costs, auditors are sensitive to client risk and they require an audit fee premium for riskier clients. This premium may either offset the cost of the greater amount of audit work that is needed in riskier clients to achieve a given level of confidence or it reflects the expected losses from audit failures that are more likely for riskier clients. Bell, Landsman, and Shackelford, (2001, p. 36) argue that “In a competitive equilibrium, audit fees should reflect the expected costs of auditor business risk.” For riskier clients, the quality of the audit may be ex-post challenged by disenchanted shareholders who may require compensation for losses they incurred due to reliance on misleading financial accounting information. Prior research shows that the client firm’s litigation risk is positively associated with audit fees (Simunic, 1980; Simunic & Stein, 1996; Seetharaman, Gul, & Lynn, 2002; Khurana & Raman, 2004). Further, auditors may be concerned about the risk of impairment of their business reputation and a subsequent loss of business due to a discovered audit for failure. Prior research shows that even in environments that limit potential damages that could be won through litigation, such as in Germany or Japan, the auditors’ concern for its professional reputation is sufficient to assure audit quality (Weber, Willenborg, & Zhang, 2008; Skinner & Srinivasan, 2012). Auditors may also demand higher fees from higher-risk clients to cover the cost of greater auditor effort that is needed to reduce the inherent risk to an acceptable level (Mock & Wright, 1999; Bell et al., 2001; Hay, Knechel, & Wong, 2006). Prior research shows that large auditors who are more sensitive to both the litigation (due to their 'deep pockets') and reputation (due to their larger client base) risks put more emphasis on quality of the audit they perform (DeFond & Jiambalvo, 1991; Becker, DeFond, Jiambalvo, & Subramanyam, 1998; Eshleman & Guo, 2014).

However, prior research provides only limited evidence on the possible impact of top management's personal characteristics on firm risk affecting audit fees. Jha and Chen (2015) conclude that auditors charge clients more when they do not consider management trustworthy; however, they infer their clients' trustworthiness only indirectly by estimating the level of social capital in a region where the firm is headquartered. Beaulieu (2001) performs an experiment based on a sample of 63 Canadian audit partners and he finds that the audit partners propose higher audit fees when they evaluate the CFO's integrity to be below normal. Chen et al. (2015) consider the role of risk-taking incentives induced by CEO compensation on audit fees. They postulate that higher stock return volatility (Vega) is likely to induce managers to be more risk tolerant and, consequently, engage more in financial misreporting, which in turn will affect audit risks and audit fees. [4] Consistent with their expectations, Chen et al. (2015) find that audit fees are higher for firms where the CEOs' compensation is more sensitive to vega. We predict that a CEO's inherent risk tolerance will impact audit fees in a similar manner, namely that audit fees are increasing in a CEO's inherent likelihood to engage in risk behaviors. Further, because personality reflects inherent preferences whereas financial incentives are used to induce behavior, we consider whether

[4] CEO equity incentives have been shown to be associated with earnings management in terms of the likelihood of beating analyst forecasts (Bergstresser & Philippon, 2006; Cheng & Warfield, 2005). Armstrong et al. (2013) find that CEO equity incentives are positively associated with financial misreporting.

CEO risk tolerance is reflected in audit fees beyond the effects of CEO equity incentives for risk-taking.

3. Data and Methodology

3.1 Measuring personality

Several different approaches have emerged in recent years in the accounting literature to measure CEO and CFO personality. For example, Ge et al. (2011) and Dyreng et al. (2010) use a "black box" approach to capture characteristics of individual executives using managerial fixed effects. Other studies attempt to measure CEO personality more directly. Others, such as Hribar and Yang (2016) use option-exercise behavior and popular press characterizations of the CEO to infer CEO overconfidence; Bamber et al. (2010) use features of an individual's background, such as military experience and being born prior to World War II, to predict conservative traits; Olsen, Dworkis, & Young, (2014) measure CEO narcissism using CEO relative pay and the size and composition of the CEO's picture in the annual report; Sunder, Sunder, & Zhang (2017) estimate sensation seeking by CEO having a pilot license; and Ham et al. (2017) measure CFO narcissism by measuring signature size of notarized CFO signatures provided to the SEC. Patelli and Pedrini (2015) measure CEO integrity by examining the language used by CEOs in shareholder letters and characterize those that make excessive use of causation words as lower integrity, whereas Larcker and Zakolyukina (2012) develop a classification model based on word categories to measure CEO deception.

We adopt a different approach that relies on recent developments in machine learning and artificial intelligence to measure inherent personality traits. Specifically, we use the IBM Watson

PI to process transcripts of the Q&A sessions of conference calls made by CEOs and CFOs. The IBM technology is based on research that finds that the frequency with which speakers use certain categories of words can predict aspects of personality (Fast & Funder, 2008; Hirsh & Peterson, 2009; Yarkoni, 2010).[5] IBM developed several personality models based on this research – Big Five, Needs, and Values - using text from blogs, essays and tweets to predict aspects of personality.

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[5] IBM Watson is a question answer based supercomputer-artificial intelligence hybrid system capable of understanding and answering questions posed in natural language. It is based on the concept of Cognitive Computing, very different from the traditional programmable systems that came before it. Cognitive computing is a technique made up of several techniques: machine learning, natural language processing, artificial intelligence, human interaction, and reasoning. Watson mimics some of the key cognitive elements of a human expertise, trying to reason about problems like a human does. Unlike conventional computing that can only handle neatly structured data, Watson is able to understand and process unstructured data and relies on natural language instead of well-defined data containing well specified information to process this unstructured data. Watson reads and interprets texts like a human by breaking down a sentence grammatically, relationally and structurally, discerning meaning from semantics of the written material. Under the supervision and guidance of human experts, Watson collects the knowledge required to understand a particular domain in depth. It starts with the human experts loading a relevant body of literature into Watson, curating the content to ensure its authenticity and currency. Watson analyzes this data, pre-processes it to build indices and metadata to allow for faster lookup of data when required. Then the machine learning approach is used to train Watson to learn to interpret the information. A significant amount of training data in the form of question-answer pair is provided to Watson. It teaches Watson to analyze the linguistic pattern of meaning in the domain. This training process continues through ongoing interactions between users and Watson, periodically reviewed and curated by experts to ensure consistent and accurate learning. Likewise, as new information is published and made available, Watson is updated so that it is constantly adapting to shifts in knowledge and linguistic interpretation in any given field. Through this process, Watson automatically improves with time. After this process, Watson is ready to respond to complex questions and quickly provide a range of potential responses and recommendations that are backed by evidence.

Their approach is to break text into words, terms, and other meaning elements called 'tokens' to develop a representation in an n-dimensional space. They then use an open-source algorithm called GloVe to obtain vector representations for the words in the input text. These vector representations serve as input to a machine-learning algorithm that infers a personality profile of Big Five traits.

IBM validated their software by comparing survey-based scores of over 1,500 participants responding to traditional psychometric tests to scores derived from their personality software model using Twitter feeds of those participants.[6] Participants completed the 50-item Big Five standard psychometric test derived from the International Personality Item Pool. Based on these results, the average mean absolute error and average correlation between the inferred and actual scores for the different categories of personality characteristics were 0.12 and 0.33, respectively, placing this service at the cutting edge of personality inference from textual data as indicated by Schwartz et al. (2013) and Plank and Hovy (2015).

We use Watson PI to measure Big Five personality traits of the CEOs and CFOs. To identify inputs for IBM Watson, we utilize publicly available transcribed conference calls related to firms' fiscal year-end performance, as these calls represent an important voluntary disclosure mechanism (Davis, Ge, Matsumoto, & Zhang, 2015) and provide a common theme setting (i.e., discussing news about firm performance) necessary for objective inferences about executive personalities. Conference calls include both a formal presentation and a question and answer segment (Q&A). We focus on the Q&A portion of the call for our analysis, as the unstructured and unregulated nature of the Q&A period provides a more appropriate standardized setting for collecting the executives' personality profiles. Here, executives are more likely to speak in their

[6] See also: https://console.bluemix.net/docs/services/personality-insights/science.html#science

natural tone, expressing their opinions on questions posed by analysts.[7] As inputs for personality analysis, we isolate CEO's and CFO's responses to questions raised by analysts during conference calls, as IBM Watson requires a written text by the person in question, which should contain spoken words about experiences, thoughts, and responses.[8]

For each CEO/CFO call, we obtain a score from Watson PI for the five personality traits: openness (O), conscientiousness (C), extraversion (E), agreeableness (A) and neuroticism (N) that range from 1 to 100.[9] We then use the Big Five scores to compute an index of CEO/CFO risk tolerance. Nicholson et al. (2005) link risk propensity to personality and find it to be being negatively correlated with neuroticism, agreeableness and conscientiousness, and positively correlated with extraversion and openness. Therefore, we compute an *CEO/CFO-RT* based on a linear combination of the five personality traits as follows:

$$CEO/CFO\text{-}RT = [O + (100 - C) + E + (100 - A) + (100 - N)] / 5 \qquad (1)$$

Equation 1 follows the approach by Dawes (1979), who demonstrates that linear models (i.e., based on unit or equal weighting) are superior to clinical intuition when predicting a numerical

[7] Mehl, Gosling, and Pennebaker (2006) find evidence of Big Five traits manifesting in features of recorded language.

[8] For completeness and sensitivity analysis, we also isolate CEO's formal presentations (as CEOs are primarily responsible for presenting the highlights of their firm's financial and operating results) in order to compare the personality traits based on verbal communications that are more standardized and are prepared in advance under the supervision of accountants and lawyers. The results from this analysis are discussed in Section 4.2.

[9] Because the original term Neuroticism can have a specific clinical meaning, Watson PI uses the more general term Emotional Range for this personality trait. We use the original term here to be consistent with previous literature.

criterion from numerical predictors. [10] We reverse code the measure such that resulting values for our measure of executive risk tolerance, *CEO/CFO-RT*, range from 0 to 100, where higher values represent greater risk tolerance (or equivalently lower risk aversion).[11]

3.2 Sample selection

To construct the sample, we first hand-collect all year-end conference call transcripts from the Factiva from January 2002 – December 2012 (28,097 transcripts / firm-years). We then remove 6,786 calls applicable to foreign firms (with listing in foreign countries); 2,809 calls for financial and utility firms (following Lyon & Maher, 2005); 8,561 (9,291) calls with either no CEO (CFO) participation or when executives spoke less than 100 words during the Q&A period[12]; 510 observations with insufficient data to compute our firm specific control variables; and 3,754 (3,862) observations with insufficient data to compute CEO (CFO) specific gender, age, vega and

[10] Dawes' article "The robust beauty of improper linear models in decision making" (*American Psychologist*, 1979, 34, 571–582) became one of psychology's most cited papers (Fischhoff, 2012).

[11] Our results remain unchanged if we define CEO/CFO-RT = [O – C + E – A – N)] / 5. All of our results further remain unchanged if we follow Gow et al. (2016) and measure each Big Five personality trait for the fiscal year *t* as the median score over all yearly earnings conference calls up to (and including) the last call for the fiscal year *t*. We also test whether our *CEO-RT* and *CFO-RT* measures are stationary using the unit root test (Harris & Tzvalis, 1999). We find strong evidence against the null hypothesis of a unit root ($p < 0.001$) and therefore conclude that our measures of *CEO-RT* and *CFO-RT* are stationary. This further strengthens the premise that Big Five personality traits are stable for working-age adults over time and are unrelated to adverse events (Costa & McCrae, 1997; Cobb-Clark & Schurer, 2012).

[12] We use Watson PI to measure the Big Five personality traits based on CEO's and CFO's responses to questions raised by analysts during conference calls where Watson requires a minimum of 100 words to compute the personality measure.

Option variables. Thus, our sample for the first validation test relating RT to gender, age, vega and Option is 6,187 firm-year observations for CEO and 5,349 for CFOs; whereas the final sample for the remaining validation tests (including audit fee analysis) consists of 9,431 firm-year observations for CEOs and 8,701 firm-year observations for CFOs.

3.3 Methodology for validating personality measures

We validate the Watson PI personality traits in several ways. As a first validation test, we relate our risk tolerance to two inherent and two behavioral-based measures used in prior literature. We relate RT to gender (*Female* equals one if the CEO/CFO is a female, zero otherwise), as extensive literature documents that women are more risk averse on average than men (Powell & Ansic, 1997; Grable, 2000; Barnea et al., 2010). We further relate RT to *Age*. While risk tolerance is relatively stable, it has been shown to decline with age (Vroom & Pahl, 1971; Byrnes et al., 1999). For example, presenting hypothetical gambles to the same individuals over ten years, Sahm (2012) finds that risk tolerance declines modestly with age although persistent differences across individuals account for 70% of systemic variation in the measure. We also relate RT to *Vega* (the sensitivity of executive compensation to stock return volatility based on Chen et al., 2015). Since vega measures the increase in the value of the manager's portfolio due to an increase in firm risk, prior studies suggest that a higher vega is likely to encourage managerial risk-taking behavior (Coles et al., 2006; Armstrong et al., 2013). Finally, we follow Dezsö and Ross (2012) and Lee et al. (2017) and construct the natural log transformation of the ratio of a given manager's vested in-the-money option value to the total compensation value (*Option*). The option value is scaled by total compensation to remove the size effect. As executives' fortunes are intimately linked to those of their firms in terms of both human capital and financial wealth, rational executives will exercise their exercisable in-the-money options as early as possible (in order to diversify their wealth). The degree to which a CEO or CFO exercises his or her exercisable in-the-money options reflects risk aversion, as the more vested in-the-money option that he/she holds, the more risk he/she is taking.

Given that the input for our measures are transcripts of conference calls and as such comprised of words and structure of sentences made by the individual executives but firm-specific in content, we set out to demonstrate that our Watson PI personality measures are not mainly driven by firm performance.[13] As our second validation test, we regress each CEO/CFO personality trait variable on a measure of current performance:

$$Personality\_Trait_t = \beta_0 + \beta_1 ROA_{it} + \beta_j Controls_{jt} + Firm\ Fixed\ Effects_i + \\ + CEO/CFO\ Fixed\ Effects_{it} + Year\ Fixed\ Effects_t \quad (2)$$

We include six personality traits – the Big Five (*OCEAN*) plus our measure for risk tolerance described above. Return on assets (*ROA*) is measured as net income divided by total assets. The coefficient of interest in equation (2) is β_1, which measures the degree to which the personality measures are related to firm performance. We follow Ge et al. (2011) and control for a variety of firm characteristics, such as *SIZE* (natural logarithm of sales), *BTM* (book to market ratio), *GROWTH* (sales growth), *LEVERAGE* (firm's liabilities to assets ratio), and *CFF* (cash flow from financing activities) that might be correlated with personality measures, financial reporting, and with audit fees. The CEO/CFO fixed effects control for the static manager-specific

[13] Given the nature of the inputs to Watson's analysis (discussions related to year-end performance), this validation test further ensures that we identify the inherent executives' personality traits that are not influenced by firm performance.

component of personality, while the year fixed effects control for time-specific factors that might influence the personality measures. We predict that our personality measures are unrelated to changes in firm performance; that is, we expect the coefficient β_1 to equal 0.

Next, we examine how much of the variation in the CEO/CFO personality trait measures is driven by the individual executives. Following prior literature in corporate finance (e.g. Lemmon, Roberts, & Zender, 2008), we compare the adjusted R^2 of regression equation (2) to regression models that exclude the manager fixed effects and firm fixed effects, respectively. The increase of adjusted R^2 indicates the incremental contribution of the manager fixed effects in terms of explaining variation of the personality measures.

Finally, we examine whether the absolute value of year-to-year changes in firm-level CEO/CFO personality traits are significantly greater in years when a firm appoints a new executive by using the following regression:

$$|\Delta Personality\_Trait_t| = \delta_0 + \delta_1 \Delta CEO/CFO_{it} + \delta_j \Delta Controls_{jt} + Year\ Fixed\ Effects_t \quad (3)$$

We include an indicator variable *ΔCEO* (*ΔCFO*) that equals one if the firm appoints a new CEO (CFO), and zero otherwise. Because equation (3) is a changes analysis, the coefficient δ_1 captures the differential effect of the new CEO/CFO by comparing the personality measure from the same firm from the previous year to the current year, thus mitigating concerns related to unobservable firm factors. We expect that our personality measures are manager-specific, and therefore we predict that the coefficient $\delta_1 > 0$.

As our third and final validation test, we examine the impact of CEO personality on auditor behaviors. Following Simunic (1980), we use the following regression equation to model audit fees:

$$Log\_Audit\_Fees_t = \lambda_0 + \lambda_1 CEO\text{-}RT_{it} + \lambda_2 Vega_{it} + \lambda_j Controls_{jt} + + Industry\ Fixed\ Effects_i + Year\ Fixed\ Effects_t \quad (4)$$

Specifically, we utilize equation 4 to replicate results in Chen et al. (2015), who find a positive association between vega and audit fees. We then extend Chen et al. (2015) by testing whether auditors incorporate in fees managers' inherent risk tolerance beyond the effects of financial incentives provided by the firm (proxied by vega). Our main variables of interest are CEO risk tolerance (*CEO-RT*) and *Vega*, where we further consider their effects on audit fees for nine sub-samples based on low, medium and high levels. Apart from traditional control variables used in prior literature (Chen et al., 2015), we further include an additional control variable in this analysis, *10-K Tone*, to ensure that our personality measure is not simply capturing the tone of the current financial results. (We measure tone following Loughran & McDonald, 2011).

4. Results

4.1 Descriptive statistics

Descriptive statistics for executive personality traits (*OCEAN* and *RT*), proxies for risk tolerance (*Female*, *Age*, *Vega* and *Option*), and control variables used in our validation analysis are presented in Table 1. All of our personality measures vary between 0 and 100 and all variables follow a normal distribution. The risk tolerance levels for CEOs and CFOs in our sample are quite comparable with a mean *CEO-RT* of 51.79 and a range from 13.4 to 77.0, and mean *CFO-RT* of 50.98 and range from 16.4 to 78.8. Our CEO sample comprises of executives with average age 55 year and about 3 percent females and our CFO sample has average age of 50 years and about 8 percent of female CFOs.

[Insert Table 1 about here]

4.2 Validation tests

The first validation test considers whether our risk tolerance measure varies in predictable ways with other measures related to executive risk taking. We consider four measures from the previous literature: gender, age, the sensitivity of executive compensation to stock return volatility (Vega), and the ratio of a given executive's vested in-the-money option value to the executive's total compensation value (Option). While dominated by male CEOs and CFOs, our sample includes 175 firm-years with female CEOs and 448 firm-years with female CFOs allowing us to compare *RT* across gender. As illustrated in Figure 1a, mean *RT* for female CEO/CFO is 50.42 compared to 52.13 for male CEO/CFO, with the difference significant at 1%. Second, we also consider the effect of age on our measure. In Figure 1b, we report mean values for *RT* across five age quintiles and find that risk tolerance declines monotonically as age increases, with the difference between quintile 1 and 5 being significant at 1%.[14] Third, we relate vega to our measure of RT. Figure 1c

[14] Anecdotally, we also analyze *RT* for the two very different CEO's of Apple. Steve Jobs' reputation as a risk-taking product visionary relative to his successor (the CEO of Apple, Tim Cook) is reflected in the *RT* score. While Tim

reports mean values for *RT* across five vega quintiles and shows that risk tolerance increases monotonically with the sensitivity of executive compensation to stock return volatility, where the difference between quintile 1 and 5 is significant at 1%. Finally, the mean values for *RT* across five Option quintiles are reported in Figure 1d, which shows that risk tolerance increases monotonically with the ratio of a given executive's vested in-the-money option value to the executive's total compensation. The difference between quintile 1 and 5 is also significant at 1%.

[Insert Figure 1 about here]

In Table 2, we show how risk tolerance based on OCEAN varies with *Gender*, *Age*, *Vega*, and *Option* quintiles in the multi-variate setting. Results in columns I-IV show that there are significant associations between the RT based on OCEAN and all four existing proxies for risk tolerance, whereas column V shows that three out of the four measures are significantly associated with the RT measure. Therefore, the results of Tables 1 and 2 suggest that our RT measure successfully captures different dimensions of risk tolerance used in prior literature.

[Insert Table 2 about here]

Cook's *RT* score is 44 (in the first quartile of the distribution), the *RT* score of Steve Jobs is 52 (above the median of the sample). A closer look at the Big Five personality characteristics shows that Tim Cook is more organized and detail oriented (higher conscientiousness) than Steve Jobs, while Steve Jobs is more open to new ideas (higher openness).

The results of our second validation tests are reported in Panels A and B of Table 3. The goal of this analysis is to validate that our measures are capturing personality traits attributable to an individual CEO and CFO and not simply capturing firm-level characteristics. In Table 3, we regress firm-year CEO (Panel A) and CFO (Panel B) personality scores measured from conference call transcripts on a number of firm characteristics, including manager and year fixed effects. Columns (I) through (V) in Panel A report the results for the CEO's Big Five personality measures openness (*CEO-O*), conscientiousness (*CEO-C*), extraversion (*CEO-E*), agreeableness (*CEO-A*) and neuroticism (*CEO-N*), respectively. Column (VI) reports the results for our constructed measure CEO risk tolerance (*CEO-RT*). Panel B then reports results for the CFOs. Explanatory power, measured as adjusted R^2, ranges from 0.383 for openness to 0.520 for extraversion for CEOs and from 0.383 for consciousness to 0.320 for RT for CFOs. We note that most of the firm-year characteristics included in the model do not reach conventional levels of statistical significance in our regressions, and that *ROA* in particular is not significant in explaining any of the CEO/CFO personality score regressions, consistent with our predictions. These findings confirm that our personality measures are not driven by performance, including adverse events.

[Insert Table 3 about here]

In Table 3, we further consider the effect of the inclusion of CEO/CFO fixed effects and firm fixed effects in terms of their explanatory powers. For each personality characteristic, we report adjusted R^2 before and after including individual CEO/CFO fixed effects and firm fixed effects. In Panel A, the percentage increase in R^2 attributable to the CEO ranges from 17.8 percent for neuroticism (column Vc) to 25.1 percent for agreeableness (column IVc), providing evidence of a significant CEO-specific element. An even stronger CFO-specific element can be seen in Panel B, where percentage increase in R^2 attributable to the CFO ranges from 23.4 percent for conscientiousness (column IIc) to 40 percent for agreeableness (column IVc). In contrast, adding firm fixed effects to CEO's personalities increases R^2 only by 1 percent and to CFO's personalities increases R^2 only by 6.5 percent at the most. Therefore, even after controlling for firm-year characteristics, firm fixed effects, and year fixed effects, the CEO/CFO fixed effect explains a significant portion of the overall variation in personality scores.[15]

Table 4 provides additional evidence on whether personality measures are manager specific and presents a changes specification analysis. We regress the absolute value of changes in firm-level measures of CEO (Panel A) and CFO (Panel B) personality scores on changes in control variables and include indicator variables, *ΔCEO* and *ΔCFO,* that equal 1 if the firm appoints new CEO/CFO, and zero otherwise. We find that these indicator variables, *ΔCEO* (in Panel A) and *ΔCFO* (in Panel B) are statistically significant (at the 1% level) for all of the six reported personality measures, indicating that changes in firm-level personality measures are significantly higher in the year when a firm appoints a new executive. Overall, these tests validate that our

[15] For completeness and as a sensitivity analysis, we also measure the Big Five personality traits and RT using the formal portion of conference call (that is, presentations given by the CEO highlighting their firm's financial and operating results) in order to compare the personality traits based on verbal communications that are more standardized and are prepared in advance under the supervision of accountants and lawyers. Untabulated results reveal that CEO personalities explain smaller variation in the Big Five and RT traits here: the effect of the inclusion of CEO fixed effects improves the adjusted R^2 much less (ranging from 6 percent for neuroticism to 14.6 percent for agreeableness). Therefore, as we would expect, executive fixed effects explain less variation in the Big Five and RT traits when personality is based on more scripted dialogue compared to when executives speak in a more natural tone, expressing opinions on questions posed by analysts.

personality measures are related to individual CEOs and CFOs, and are not driven by firm performance.

[Insert Table 4 about here]

As a final validation, we investigate how inherent risk tolerance and increased risk appetite due to financial incentives affects audit fees. Chen et al. (2015) examine whether audit firms incorporate the risk-taking incentives of CEOs in their audit risk assessments and audit fees. The authors find that auditors increase their assessments of audit risks and charge higher fees for firms with higher vega. First, we replicate findings by Chen et al. (2015) and examine whether our inherent measure of risk tolerance remains a significant determinant of audit fees over and above vega. Table 5 Panel A reports results for a sample of 5,163 firm-years with available data to calculate vega. The explanatory power for our models is high, with adjusted R^2 ranging from 0.729 to 0.733, consistent with prior studies (Chen et al., 2015). Results for Model I confirm the findings of Chen et al. (2015), namely that *Vega* is significantly positively related to audit fees. Results in Model II demonstrate that audit fees are also significantly positively associated with inherent CEO risk tolerance, with the coefficient being significant at the 1% level. In Model III, we show that our measure for CEO risk-tolerance remains a significant determinant of audit fees over and above the previously documented vega.[16] These results further support the premise that CEO personality

[16] As a sensitivity test, we consider the intermediary role of the audit committee in the audit process and include two additional control variables for audit committee strength in our main regression. Although the number of observations decreases, we find that including control variables: a) a dummy variable equal one of there is a CPA on audit

has an incremental impact on auditors' assessment of client risk beyond the risk-taking incentives induced by their compensation portfolios.

[Insert Table 5 about here]

Second, we extend Chen et al. (2015) by examining the interplay between inherent risk tolerance and increased risk appetite created by financial incentives. Firms provide risk-averse CEOs with financial incentives to align manager' and shareholders' risk-taking preferences. However, the effect of financial incentives on managers is likely to be moderated by the individual's risk tolerance. Risk tolerant CEOs may take enough risk even without financial incentives, whereas managers with low risk-tolerance may need financial incentives to reach the risk-taking level desired by shareholders. In Model IV in Panel A, we categorize firms as providing high, medium and low risk-taking incentives (*Vega*) and by high, medium and low CEO risk tolerance (*CEO-RT*). Panel B illustrates the relative average audit fees, tests of difference (High – Low) as well as the number of observations in each group. The benchmark case (a) is based on firms with low financial risk-taking incentives and CEOs with low risk tolerance (*Low Vega / Low CEO-RT*). The other three groups have average audit fees higher than the benchmark, suggesting that not only financial incentives, but also inherent risk tolerance is associated with higher audit fees. More importantly, we find that the two effects are complementary to each other, so audit fees are highest for High *Vega* and High *CEO-RT* firms.

committee, and b) percentage of audit committee members who have CPA, do not significantly change the main results that risk tolerance of CEOs is positively associated with audit fees.

Third, we consider an alternative interpretation of the results so far: that riskier firms choose risk-taking CEOs. Hirshleifer et al. (2012) argue that the matching between CEO characteristics and firm characteristics can also explain the association between CEO characteristics and corporate outcomes, such as audit risk. In Table 5 Panel B, we document the frequencies of Low-Medium-High by risk tolerance and financial incentives. We find a higher than expected frequency in the matched Low-Low (n = 679; *E[n]* = 585) and High-High (n = 649; *E[n]* =564) cells than in the Low-High (n = 492; *E[n]* = 585) and High-Low (n = 457; *E[n]* = 564) cells. Indeed, the Chi square test for the 3 by 3 table is consistent with some degree of matching (Chi-Square = 65.093, p-value=0.000). However, the difference between actual and expected is approximately 15% and there are still significant observations in the non-matched cells. We also report the differential coefficients from the audit fee regression in Model IV of Panel A for each cell. Holding the financial incentives of a firm constant, audit fees are significantly higher (p-value of < 0.05) for high *CEO-RT* firms than for low *CEO-RT* firms, both when financial incentives are low and when they are high, providing some assurance that our main conclusions are driven by the characteristics of the CEO.

4.3 Supplementary tests

As a supplementary analysis, we address the potential causality concern by isolating firms that have experienced changes in CEOs and testing whether increases in risk tolerance are associated with increases in audit fees. We first isolate firms that have experienced changes in their CEOs and exclude firm-years surrounding the CEO departure (year 0). Table 6, Panel A reports results for a sample of 436 firms where the CEO has changed. Models I and II compare year t-2 to year t+1 and Models III and IV compare year t-2 to year t+2. We define a dummy variable for the increase in our variable of interest (equal to 1 if a *CEO-RT* increases surrounding the change and zero otherwise). We find that increases in CEO risk-tolerance are positively associated with increases in audit fees following a change in CEO. Interestingly, changes in Vega are not associated with changes in audit fees.

[Insert Table 6 about here]

In our analysis of audit fees reported in Table 5, we focused on CEOs to replicate Chen et al. (2015) and also because Graham, Harvey, & Puri, (2013) find that CEOs are the principal decision-makers of the firm. As a second supplementary test, we consider the role of CFOs in explaining audit fees, since CFOs may be in a position to influence audit fees given their financial reporting responsibilities. In Table 6, Panel B we include *CFO-RT* and *CFO-Vega* in the audit fee regressions. We find that *CEO-RT* and *CEO-Vega* remain significant in regressions that include all four measures (Model III), but that only *CFO-RT* is significant of the two CFO measures. This finding suggests that CFO personality is more relevant to audit risk than risk-taking incentives for CFOs, and is consistent with Beaulieu (2001) who finds that CFO integrity is priced by auditors. The lack of significance for *CFO-Vega* is also consistent with Feng, Ge, Luo, & Shevlin, (2011) who find that CFOs involved in material accounting manipulations succumb to misreporting because of pressure from CEOs rather than because they benefit personally through their own equity incentives.

5. Conclusion

In this paper, we measure the Big Five personality traits – Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism for a large sample of CEOs and CFOs, and compute a measure for risk tolerance based on these five traits. We conduct a number of validation tests to show that: our risk tolerance measure varies with the existing inherent and behavioral-based measures in predictable ways; that all of the firm-year level personality trait measures relate to are manager-specific, are not related to firm characteristics and firm performance; and, that our estimate of risk tolerance trait supports the association between CEO risk tolerance and audit fees. Specifically, we find that higher CEO risk tolerance is associated with significantly higher audit fees and that CEO personality has an incremental impact on auditors' assessment of client risk beyond the risk-taking incentives induced by their compensation portfolios.

To the best of our knowledge, we are the first to utilize the IBM Watson Personality Insights service to measure Big Five personality based on transcripts of Q&A sessions of conference calls, and to validate these measures for a large sample of CEOs. This dataset, which can only be constructed as the result of recent developments in computing and artificial intelligence, promises a wide range of research applications. Hence, testing the validity of these computer-generated measures is an important step towards their broader application in future research. Our research is also a response to the Plöckinger et al. (2016) call for continued development and validation of meaningful measures of management personality for further study of upper echelon theory in accounting.

We encourage future research to further consider the role of personality on issues relevant to accounting, including corporate governance, firm performance, and financial reporting. Understanding how the personality of managers affects their decision-making should be of interest to investors and other capital market participants who predict and evaluate corporate outcomes.

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TABLE 1
Descriptive statistics and bivariate analysis

Variables	n	Mean	Std. Dev.	Min	Max
CEO-O	9,431	95.16	4.78	72.00	100.00
CEO-C	9,431	77.96	12.87	39.00	98.00
CEO-E	9,431	41.98	18.73	6.00	86.00
CEO-A	9,431	17.63	14.88	1.00	77.00
CEO-N	9,431	82.55	8.95	53.00	97.00
CEO-RT	9,431	51.79	6.31	13.40	77.00
$Female_{CEO}$	6,187	0.03	0.17	0.00	1.00
Age_{CEO}	6,187	55.31	6.74	29.00	81.00
$Vega_{CEO}$	6,187	152.81	299.14	0.00	7,885.78
$Option_{CEO}$	6,187	0.63	0.80	0.00	16.88
CFO-O	8,701	92.73	7.80	56.00	100.00
CFO-C	8,701	73.07	15.00	28.00	96.00
CFO-E	8,701	37.54	19.11	3.00	85.00
CFO-A	8,701	14.24	12.24	1.00	62.00
CFO-N	8,701	88.00	7.89	60.00	99.00
CFO-RT	8,701	50.98	6.61	16.40	78.80
$Female_{CFO}$	5,349	0.08	0.28	0.00	1.00
Age_{CFO}	5,349	50.45	6.35	32.00	76.00
$Vega_{CFO}$	5,349	41.09	104.25	0.00	5,339.63
$Option_{CFO}$	5,349	0.41	0.56	0.00	4.24
Audit Fees	9,431	14.06	1.16	6.30	18.36
Assets	9,431	6.91	1.84	1.12	13.59
RI Intensity	9,431	0.25	0.18	0.00	0.96
ROA	9,431	0.03	0.15	-0.65	0.38
Loss	9,431	0.25	0.43	0.00	1.00
Litigation Risk	9,431	0.33	0.47	0.00	1.00
Leverage	9,431	0.30	0.30	0.00	1.52
Season	9,431	0.72	0.45	0.00	1.00
BusSeg	9,431	2.39	1.75	1.00	10.00
GeoSeg	9,431	2.36	2.34	1.00	28.00
Big4	9,431	0.86	0.35	0.00	1.00
BTM	9,431	0.53	0.43	-0.39	2.41
Size	9,431	6.71	1.93	1.41	10.99
Growth	9,431	0.13	0.32	-0.54	1.96
CFF	9,431	0.00	0.13	-0.34	0.59

TABLE 1 – continued

The variables are defined as follows: CEO/CFO characteristics are denoted by O [Openness]; C [Conscientiousness]; E [Extraversion]; A [Agreeableness]; N [Neuroticism]; RT [Risk Tolerance (as defined by equation 1]; *Female* [a dummy that equals 1 if the CEO/CFO is a female, and zero otherwise]; *Age* [the age of the executive in year t]; *Vega* [the sensitivity of executive compensation to stock return volatility (following definition by Chen et al., 2015)]; *Option* [the natural log transformation of the ratio of a given manager's vested in-the-money option value to the total compensation value, scaled by total compensation (following definition by Lee et al., 2017)]. *Audit Fees* [natural logarithm of annual audit fees]; *Assets* [natural logarithm of total assets (Compustat *AT*)]; *RI Intensity* [sum of account receivables and inventory (Compustat *RECT* and *INVT*) divided by total assets (Compustat *AT*)]; *ROA* [net income (Compustat *N*) divided by total assets (Compustat *AT*)]; *Loss* [indicator variable that equals to 1 if net income (Compustat *NI*) is less than 0, and 0 otherwise]; *Litigation Risk* [indicator variable that equals to 1 if the firm SIC code is one of the following: 2833-6, 3570-7, 3600-74, 5200-5961, or 7370-4, and 0 otherwise]; *Leverage* [total long-term debt (Compustat *DLTT*) divided by total assets (Compustat *AT*)]; *Season* [indicator variable that equals to 1 if the client's fiscal year-end month is December (the busy season for audits), and 0 otherwise]; *BusSeg* [number of business segments]; *GeoSeg* [number of foreign segments]; *Big4* [indicator variable that equals to 1 if the client's auditor is a Big4 audit firm, and 0 otherwise]; *BTM* [book value of equity (Compustat *AT – LT*) divided by market value of equity (Compustat *CSHO* * Compustat *PRCC_F*)]; *Size* [natural logarithm of sales (Compustat *SALE*)]; *Growth* [sales growth, percentage change in total sales]; *CFF* [cash flow from financing activities (Compustat *FINCF*) divided by total assets (Compustat *AT*)]. All variables are winsorised at the 1% levels for further analyses.

FIGURE 1
Gender, Age, Vega, Option, and Risk Tolerance

Figure 1a

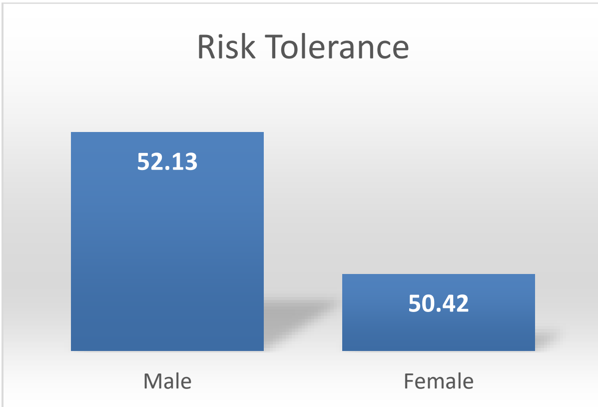

Figure 1b

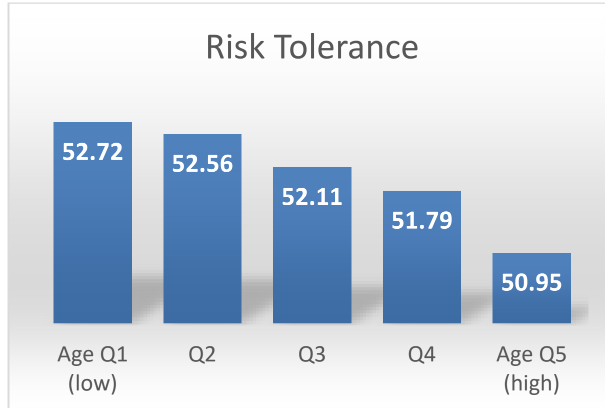

Figure 1c

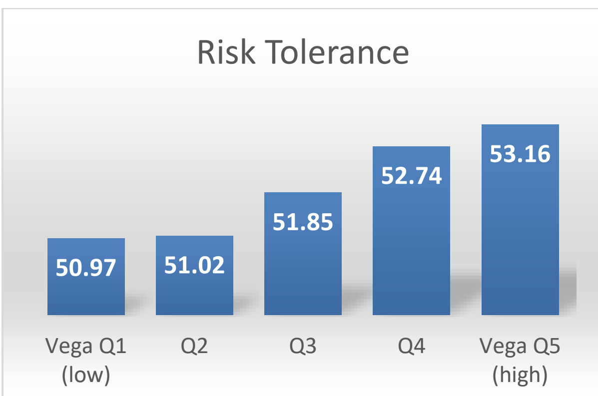

Figure 1d

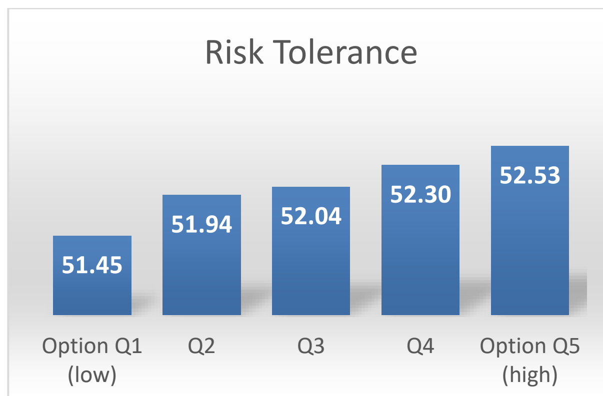

Figure 1 shows differences of risk tolerance levels of CEOs and CFOs between males and females (Figure 1a), and across five Age (Figure 1b), Vega (Figure 1c), and Option (Figure 1d) quintiles. The differences in risk tolerance between male and female executives and between Age, Vega, and Option extreme quintiles are all significant at 1% levels. All variables are defined in Table 1.

TABLE 2
Risk tolerance multivariate analysis

Variables	I CEO/CFO-RT	II CEO/CFO-RT	III CEO/CFO-RT	IV CEO/CFO-RT	V CEO/CFO-RT
Constant	51.640***	52.480***	50.100***	50.881***	51.213***
	(0.134)	(0.164)	(0.209)	(0.192)	(0.244)
Female	-1.380***				-1.595***
	(0.396)				(0.382)
Age Quintile		-0.577***			-0.616***
		(0.063)			(0.062)
Vega Quintile			0.572***		0.596***
			(0.069)		(0.074)
Option Quintile				0.232***	-0.007
				(0.055)	(0.057)
CEO	0.749***	1.355***	0.288*	0.734***	0.744***
	(0.147)	(0.153)	(0.162)	(0.148)	(0.168)
Observations	11,536	11,536	11,536	11,536	11,536
Adjusted R^2	0.007	0.020	0.020	0.008	0.040

This table reports the results of whether RT varies with Gender, Age, Vega, and Option quintiles in the multi-variate analysis. All variables are defined in Table 1. Robust standard errors (clustered by firm) are reported in parentheses. ***, **, and * denote significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

TABLE 3

Validation tests – Personality traits and firm characteristics

Panel A

Variables	(Ia)	(Ib)	(Ic)	(IIa)	(IIb)	(IIc)	(IIIa)	(IIIb)	(IIIc)
		CEO-O			CEO-C			CEO-E	
Constant	93.50 ***	93.90 ***	94.17 ***	82.58 ***	84.13 ***	83.39 ***	43.45 ***	45.10 ***	43.52 ***
	(1.056)	(1.335)	(1.439)	(2.697)	(3.415)	(3.621)	(4.001)	(4.498)	(4.766)
ROA	**0.063**	**-0.040**	**-0.079**	**0.036**	**0.691**	**0.783**	**0.958**	**2.412**	**2.606**
	(0.587)	**(0.674)**	**(0.684)**	**(1.487)**	**(1.814)**	**(1.844)**	**(2.299)**	**(2.716)**	**(2.746)**
Leverage	0.147	-0.128	-0.113	0.255	0.588	0.417	2.032	2.861 *	3.057 *
	(0.382)	(0.441)	(0.447)	(1.026)	(1.132)	(1.115)	(1.435)	(1.566)	(1.599)
BTM	-0.270	-0.234	-0.217	0.717	0.683	0.498	1.009	1.417	1.331
	(0.222)	(0.261)	(0.265)	(0.533)	(0.608)	(0.611)	(0.785)	(0.884)	(0.897)
Growth	-0.123	-0.125	-0.112	0.164	0.277	0.239	0.781	0.517	0.450
	(0.199)	(0.214)	(0.217)	(0.484)	(0.578)	(0.585)	(0.670)	(0.744)	(0.752)
CFF	-0.156	0.138	0.076	-0.883	-0.760	-0.730	-2.297	-2.901	-2.876
	(0.521)	(0.612)	(0.614)	(1.319)	(1.498)	(1.507)	(1.819)	(2.054)	(2.064)
Size	0.141	0.160	0.114	-0.507	-0.724	-0.554	-0.485	-0.521	-0.292
	(0.169)	(0.210)	(0.227)	(0.440)	(0.553)	(0.584)	(0.637)	(0.703)	(0.749)
Observations	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431
Firm FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
CEO FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.318	0.381	0.383	0.366	0.437	0.438	0.441	0.520	0.520
ΔR^2 (c / b)			**0.5%**			**0.2%**			**0.1%**
ΔR^2 (c / a)			**20.4%**			**19.7%**			**17.9%**

Panel B

Variables	(Ia)	(Ib)	(Ic)	(IIa)	(IIb)	(IIc)	(IIIa)	(IIIb)	(IIIc)
		CFO-O			CFO-C			CFO-E	
Constant	90.03 ***	88.84 ***	89.27 ***	81.07 ***	79.19 ***	84.92 ***	34.79 ***	28.64 ***	30.19 ***
	(2.234)	(1.881)	(3.334)	(4.680)	(3.677)	(6.373)	(5.449)	(4.516)	(7.917)
ROA	**-2.844 ****	**-2.154**	**-2.321**	**2.832**	**1.856**	**2.117**	**-0.413**	**0.154**	**2.392**
	(1.294)	**(1.526)**	**(1.636)**	**(2.310)**	**(2.845)**	**(3.054)**	**(2.970)**	**(3.577)**	**(3.765)**
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,701	8,701	8,701	8,701	8,701	8,701	8,701	8,701	8,701
Firm FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
CFO FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.202	0.264	0.263	0.209	0.251	0.258	0.246	0.310	0.322
ΔR^2 (c / b)			**-0.4%**			**2.8%**			**3.9%**
ΔR^2 (c / a)			**30.2%**			**23.4%**			**30.9%**

TABLE 3 – continued

Panel A – continued

Variables	(IVa)	CEO-A (IVb)	(IVc)	(Va)	CEO-N (Vb)	(Vc)	(VIa)	CEO-RT (VIb)	(VIc)
Constant	19.51 ***	19.15 ***	20.71 ***	91.41 ***	91.66 ***	90.59 ***	48.85 ***	48.94 ***	48.84 ***
	(3.695)	(4.173)	(4.374)	(2.069)	(2.298)	(2.485)	(1.340)	(1.598)	(1.650)
ROA	**-0.261**	**-0.916**	**-0.278**	**0.081**	**-0.499**	**-0.482**	**0.288**	**0.760**	**0.645**
	(2.006)	**(2.260)**	**(2.265)**	**(1.186)**	**(1.389)**	**(1.417)**	**(0.715)**	**(0.811)**	**(0.818)**
Leverage	1.405	1.979	2.099	0.528	0.467	0.515	-0.042	-0.059 *	-0.018
	(1.362)	(1.505)	(1.543)	(0.702)	(0.833)	(0.847)	(0.497)	(0.557)	(0.567)
BTM	0.151	0.648	0.574	0.496	0.658	0.566	-0.133	-0.191	-0.126
	(0.678)	(0.704)	(0.714)	(0.372)	(0.419)	(0.423)	(0.243)	(0.271)	(0.273)
Growth	-0.087	0.599	0.647	0.754 *	0.576	0.489	0.022	-0.156	-0.148
	(0.636)	(0.625)	(0.627)	(0.407)	(0.472)	(0.474)	(0.236)	(0.262)	(0.265)
CFF	-2.666	-4.101 **	-3.979 **	-0.944	-0.948	-0.907	0.398	0.593	0.538
	(1.636)	(1.772)	(1.777)	(1.000)	(1.155)	(1.163)	(0.605)	(0.682)	(0.685)
Size	-0.170	-0.334	-0.544	-1.014 ***	-0.956 **	-0.769 *	0.254	0.331	0.320
	(0.600)	(0.645)	(0.674)	(0.328)	(0.378)	(0.407)	(0.214)	(0.248)	(0.257)
Observations	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431
Firm FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
CEO FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.363	0.451	0.454	0.393	0.462	0.463	0.414	0.491	0.493
ΔR^2 (c / b)			**0.7%**			**0.2%**			**0.4%**
ΔR^2 (c / a)			**25.1%**			**17.8%**			**19.1%**

Panel B – continued

Variables	(IVa)	CFO-A (IVb)	(IVc)	(Va)	CFO-N (Vb)	(Vc)	(VIa)	CFO-RT (VIb)	(VIc)
Constant	21.85 ***	19.14 ***	22.58 ***	92.62 ***	91.62 ***	94.77 ***	45.71 ***	45.27 ***	43.45 ***
	(3.877)	(3.191)	(5.265)	(2.265)	(2.240)	(3.679)	(1.901)	(1.762)	(2.551)
ROA	**0.456**	**0.413**	**0.830**	**0.738**	**-0.209**	**-0.183**	**-1.593**	**-0.913**	**-0.642**
	(2.071)	**(2.254)**	**(2.410)**	**(1.234)**	**(1.507)**	**(1.625)**	**(1.032)**	**(1.215)**	**(1.306)**
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,701	8,701	8,701	8,701	8,701	8,701	8,701	8,701	8,701
Firm FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
CFO FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.215	0.283	0.301	0.219	0.269	0.282	0.267	0.328	0.340
ΔR^2 (c / b)			**6.4%**			**4.8%**			**3.7%**
ΔR^2 (c / a)			**40.0%**			**28.8%**			**27.3%**

This table reports the results of whether CEO (Panel A) and CFO (Panel B) personality traits (openness, conscientiousness, extraversion, agreeableness, neuroticism, and risk tolerance) are related to firm performance (ROA) and whether adding executive fixed effects significantly increases the explanatory power (Adjusted R^2). All variables are defined in Table 1. Robust standard errors (clustered by firm) are reported in parentheses. ***, **, and * denote significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

TABLE 4
Validation tests – Change in CEO/CFO on change in personality

Panel A

Variables	|ΔCEO-O|	|ΔCEO-C|	|ΔCEO-E|	|ΔCEO-A|	|ΔCEO-N|	|ΔCEO-RT|
Constant	3.208 ***	10.040 ***	14.000 ***	9.986 ***	6.781 ***	4.593 ***
	(0.067)	(0.145)	(0.187)	(0.208)	(0.104)	(0.064)
ΔCEO	**0.852 *****	**2.398 *****	**4.364 *****	**4.308 *****	**1.711 *****	**1.477 *****
	(0.162)	**(0.340)**	**(0.442)**	**(0.460)**	**(0.229)**	**(0.167)**
ΔControls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,434	7,434	7,434	7,434	7,434	7,434
Firm Fixed Effects	No	No	No	No	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.004	0.008	0.017	0.016	0.008	0.016

Panel B

Variables	|ΔCFO-O|	|ΔCFO-C|	|ΔCFO-E|	|ΔCFO-A|	|ΔCFO-N|	|ΔCFO-RT|
Constant	5.953 ***	13.703 ***	16.742 ***	10.154 ***	6.759 ***	5.682 ***
	(0.165)	(0.209)	(0.234)	(0.201)	(0.117)	(0.084)
ΔCFO	**0.982 *****	**1.084 *****	**2.825 *****	**2.224 *****	**1.034 *****	**1.040 *****
	(0.259)	**(0.379)**	**(0.440)**	**(0.352)**	**(0.211)**	**(0.153)**
ΔControls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,848	6,848	6,848	6,848	6,848	6,848
Firm Fixed Effects	No	No	No	No	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.003	0.004	0.010	0.008	0.008	0.008

This table reports the results of whether year-to-year changes in firm-level CEO and CFO Big Five traits (including risk tolerance) are significantly greater in years when a firm appoints a new executive. The dependent variable is the absolute change of CEO (Panel A) and CFO (Panel B) personality traits. All variables are defined in Table 1. Controls include the same set of variables as in Table 4. Robust standard errors (clustered by firm) are reported in parentheses. ***, **, and * denote significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

TABLE 5
Multivariate regressions – Firm financial risk-taking incentives, CEO risk tolerance and audit fees

Panel A Variables (levels)	I	II	III	IV
Constant	9.131 ***	8.823 ***	8.823 ***	9.193 ***
	(0.124)	(0.141)	(0.141)	(0.125)
CEO-RT		**0.007 *****	**0.007 *****	
		(0.002)	**(0.002)**	
Vega	**0.034 *****		**0.033 *****	
	(0.011)		**(0.011)**	
LowRT / MediumVega				**0.044**
				(0.038)
LowRT / HighVega				**0.118 ****
				(0.053)
MediumRT / LowVega				**0.073 ****
				(0.030)
MediumRT / MediumVega				**0.107 *****
				(0.037)
MediumRT / HighVega				**0.169 *****
				(0.053)
HighRT / LowVega				**0.102 ****
				(0.041)
HighRT / MediumVega				**0.139 *****
				(0.040)
HighRT / HighVega				**0.201 *****
				(0.049)
Controls	Yes	Yes	Yes	Yes
Observations	5,163	5,163	5,163	5,163
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.773	0.774	0.774	0.775

This table reports the results of several audit fee models (with Audit Fees as dependent variables) with the RT and Vega (as defined in Chen et al. 2015). Control variables include: Assets, RI Intensity, ROA, Loss, Litigation Risk, Leverage, Season, BTM, BusSeg, GeoSeg, Big4, and 10-K Tone (based on a definition in Loughran and McDonald (2011) and are defined in Table 1. Robust standard errors (clustered by firm) are reported in parentheses. ***, **, and * denote significance at p < 0.01, p < 0.05, and p < 0.10, respectively.

TABLE 5 – Continued

Panel B		Financial incentives (Vega)			Test of difference
		Low	Medium	High	High - Low
Risk tolerance	Low	**a** n = 679	**a + 0.044** n = 585	**a + 0.118**** n = 492	0.118**
	Medium	**a + 0.073**** n = 585	**a + 0.107***** n = 550	**a + 0.169***** n = 580	0.096*
	High	**a + 0.102**** n = 457	**a + 0.139***** n = 586	**a + 0.201***** n = 649	0.099*
Test of difference					
High - Low		0.102**	0.095**	0.083*	

This table reports the results of several audit fee models (with Audit Fees as dependent variables) with the risk tolerant personality trait (*CEO-RT*) in order to examine the incremental effect over the sensitivity of CEO compensation portfolio to stock return volatility (Vega, as defined in Chen et al., 2015). Models I-IV in Panel A are based on all firm-years with available ExecuComp data. Low/Medium/HighRT (Low/Medium/HighVega) are defined as dummy variables that equal to one if RT (Vega) is below/above the median, and zero otherwise. Panel B displays the coefficients of interest in Model IV (Panel A) and shows the tests of differences based on F-tests. All remaining variables are defined in Table 1 and Controls include the same set of variables as in Table 4. Robust standard errors (clustered by firm) in Panel A are reported in parentheses. ***, **, and * denote significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

TABLE 6
Supplementary tests

Panel A

Variables (Changes)	I (t–2, t+1)	II (t–2, t+1)	III (t–2, t+2)	IV (t–2, t+2)
Constant	0.969 ***	0.971 ***	1.004 ***	1.007 ***
	(0.050)	(0.064)	(0.047)	(0.046)
Increase_CEO-RT	**0.078 *****	**0.078 *****	**0.056 ***	**0.055 ***
	(0.021)	**(0.020)**	**(0.024)**	**(0.025)**
ΔVega		-0.000		-0.010
		(0.005)		(0.012)
ΔControls	Yes	Yes	Yes	Yes
Observations	436	436	350	350
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.600	0.600	0.649	0.650

This table reports the results of several audit fee models based on changes in variables to provide sensitivity analysis for firms that have experienced changes in their CEOs. We first isolate firms that have experienced changes in their CEOs and exclude firm-years surrounding the CEO departure and arrival [(t–2, t+1) in Models I and II and (t–2, t+2) in Models III and IV]. The dependent variable is the change of Log of Audit Fees. Then we define Increase_CEO_RT as a dummy variable (equal to 1 if a CEO-RT increases surrounding the change, and zero otherwise). All remaining variables are defined in Table 1 and Controls include the same set of variables as in Table 4. Robust standard errors (clustered by firm) are reported in parentheses. ***, **, and * denote significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

TABLE 6 – continued

Panel B

Variables (levels)	I Ln (Audit Fees)	II Ln (Audit Fees)	III Ln (Audit Fees)
Constant	9.811 ***	9.837 ***	9.608 ***
	(0.137)	(0.134)	(0.149)
CEO-RT	**0.006 *****		**0.005 *****
	(0.002)		**(0.002)**
CEO-Vega	**0.024 *****		**0.032 *****
	(0.001)		**(0.011)**
CFO-RT		**0.006 *****	**0.005 *****
		(0.002)	**(0.002)**
CFO-Vega		**0.018 ***	**-0.012**
		(0.009)	**(0.013)**
Controls	Yes	Yes	Yes
Observations	3,812	3,812	3,812
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Adjusted R^2	0.783	0.782	0.784

This table reports the results of several audit fee models (with Audit Fees as dependent variables) with the RT and Vega (as defined in Chen et al. 2015). Control variables include: Assets, RI Intensity, ROA, Loss, Litigation Risk, Leverage, Season, BTM, BusSeg, GeoSeg, Big4, and 10-K Tone (based on a definition in Loughran and McDonald (2011) and are defined in Table 1. Robust standard errors (clustered by firm) are reported in parentheses. ***, **, and * denote significance at $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.