Testosterone and Financial Misreporting

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Abstract

We examine the relation between a measure of CEOs' adolescent exposure to the hormone testosterone and financial misreporting. Testosterone is associated with a set of behaviors in males, including aggression, egocentrism, risk seeking, and a desire to maintain social status. Using a sample of CEOs from Standard and Poor's 1500 firms during 1996–2010, we document a positive association between our measure of CEO testosterone exposure and financial misreporting. Our primary evidence is based on a sample of financial restatements due to intentional irregularities. Additional analyses are based on misreporting proxies derived from the misstatement-prediction model proposed by Dechow et al. [2011]. The positive association between CEO testosterone exposure and financial misreporting is robust to the various misreporting proxies. We show that our measure of testosterone exposure is different from overconfidence, which prior studies have shown to be associated with misreporting. Finally, we demonstrate that testosterone exposure not only correlates with financial reporting decisions but also predicts the incidence of option backdating in the sample.

Testosterone and Financial Misreporting

1. Introduction

Testosterone, a steroid hormone, is receiving attention from researchers interested in financial decision-making and economic behavior.[1] The neuroendocrinological literature associates testosterone with a set of related behaviors that include aggression, egocentrism, risk seeking, and a desire to maintain social status.[2] Testosterone is thought to influence behavior because it shapes an individual's neural circuitry during puberty. Testosterone levels vary in the population and so does the extent to which individuals exhibit testosterone-related behaviors. An emerging stream of work in accounting and finance recognizes that personal characteristics of senior management predict corporate financial reporting practice [Davidson, Dey, and Smith 2011, Dikolli, Mayew, and Steffen 2012, Schrand and Zechman 2012]. We argue that testosterone is likely implicated in the relation between CEO personal characteristics and financial reporting. Following prior work on the role of manager characteristics, we focus on the risk of materially misstated financial statements and provide evidence that this risk varies systematically with a CEO's level of testosterone exposure.

One potential barrier to testing our hypothesis is that data on a given CEO's testosterone levels are not readily available. Recent developments in neuroendocrinology, however, provide us with a way to circumvent this problem. Adolescent testosterone not only affects brain development but also induces bone growth, including craniofacial growth, which can vary significantly between individuals [Lindberg, Vandenput, Movèrare Skrtic, Vanderschueren, Boonen, Bouillon, and Ohlsson 2005, Thornhill and Gangestad 1999, Thornhill and Møller 1997,

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[1] See, for example, Coates and Herbert [2008], Coates, Gurnell, and Rustichini [2009], Sapienza, Zingales, and Maestripieri [2009], Kastlunger, Dressler, Kirchler, Mittone, and Voracek [2010].

[2] These effects have been documented in studies such as Dabbs and Morris [1990], Mehta and Beer [2009], Eisenegger, Naef, Snozzi, Heinrichs, and Fehr [2010], and Wright, Bahrami, Johnson, Di Malta, Rees, Frith, and Dolan [2012].

Verdonck, Gaethofs, Carels, and de Zegher 1999]. Recent empirical evidence, discussed more fully later in this article, links testosterone levels to craniofacial features, which are used as a marker for the neural circuits associated with a person's predilection for aggression and related behaviors. This body of work proposes that a CEO's facial features are a valid measure to infer his testosterone exposure during puberty.[3] Clearly, behavior is a very complex and "plastic" expression of a multitude of factors, only partly hormonal or even biological.[4] Nevertheless, we expect that variations in CEO hormones have a salient effect on behavior (holding constant firm level and other CEO characteristics).

Our study reflects a broader recent question in the literature of how biochemical, neural, and genetic factors influence economic decisions.[5] It also has parallels with contemporaneous work that uses unfakeable physical characteristics (such as a person's height or body mass index) to infer personality characteristics [Bodenhorn, Moehling, and Price 2012, Case and Paxson 2008, Korniotis and Kumar 2012]. Some other authors have used facial features in economic and/or corporate settings [Graham, Harvey, and Puri 2010, Rule and Ambady 2008], but their studies focus on *perceptions* of how competent a CEO looks rather than use of the face to infer testosterone exposure. Wong et al. [2011] is the only study that we are aware of that uses testosterone-related facial features to predict a firm-level outcome (namely, financial performance).

Our main set of analyses focuses on the relation between our measure of CEO testosterone levels and several proxies for financial misreporting. We collect pictures of CEOs of Standard and Poor's 1500 companies in 2009, measure their facial structures, and gather data on

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[3] Our sample comprises male CEOs only. Thus, throughout the paper, we only consider men and use the pronoun he.
[4] In particular, socio-cultural practices can reshape behaviors, which highlights the need to include a range of environmental control variables in the empirical tests [Jablonka, Lamb, and Zeligowski 2005].
[5] See, for example, Harlow and Brown [1990], Kuhnen and Knutson [2005], Cesarini, Dawes, Johannesson, Lichtenstein, and Wallace [2009], and Cesarini, Johannesson, Lichtenstein, Sandewall, and Wallace [2010].

various measures of financial misreporting in these CEOs' firms in the period between 1996 and 2010. One important research design issue in studies that focus on misreporting is the identification of misreporting firms. Our main analysis uses a sample of firms with financial restatements due to intentional accounting irregularities. Since this sample probably does not capture all firms that have misreported financial statements, we also use a prediction model of misreporting to cross-validate our findings. We present evidence that CEOs with higher levels of testosterone have an increased probability of misreporting. This finding is not sensitive to the specific misreporting proxy we use. The effect size of the CEOs' testosterone level on misreporting is substantial. We document, based on a median-split, that the odds of high-testosterone CEOs intentionally misstating financial reports are about 1.4 times higher than those of low-testosterone CEOs. A similar effect size is obtained when we measure misreporting by a prediction model.

We then ask whether CEO testosterone levels are related to overconfidence, which has been identified in prior work as an explanatory factor of financial misreporting [Schrand and Zechman 2012]. Overconfident individuals tend to be too optimistic about future performance. A priori it seems plausible that our testosterone measure, a sexual dimorphic facial feature [Weston, Friday, and Liò 2007], is associated with overconfidence and/or optimistic biases since earlier work has documented that males on average are more overconfident than females [Barber and Odean 2001, Niederle and Vesterlund 2007]. Using measures of overconfidence taken from prior studies, we find evidence that overconfidence is associated with misreporting measured by a prediction model. More importantly, however, the relation between CEO testosterone levels and misreporting is unaffected after controlling for overconfidence. Thus, we conclude that the testosterone-based measure and the measures of overconfidence reflect separate and distinct aspects of a CEO's personality.

Finally, we extend our logic to a non-misreporting setting. We argue that testosterone-driven behaviors should not only manifest themselves in financial reporting outcomes, but may also increase the likelihood of CEOs engaging in other risky decisions. We concentrate our analyses on the stock option grants to top executives. Recent studies [Bizjak, Lemmon, and Whitby 2009, Heron and Lie 2009, Lie 2005] have documented that a large number of firms in the United States engaged in the practice of backdating these grants. When an option grant is backdated, the board of directors retrospectively chooses the most favorable date to grant the option, even though the award was actually approved at a later date. We predict that high-testosterone CEOs are more likely to exhibit greater assertiveness during negotiations with their boards and, for that reason, are more likely than low-testosterone CEOs to reap the benefits implied by backdating [Wright, et al. 2012]. Based on an analysis of unusual stock price patterns around the option grant date in the sample period, we identify firms that have backdated stock option grants to executives and show that the odds of backdating are significantly (about 1.5 times) higher for CEOs with high testosterone levels than for CEOs with low levels.

Our study contributes to the literature in at least three ways. First, prior literature has documented the existence of CEO fixed effects on corporate decision making [Bertrand and Schoar 2003, Fee, Hadlock, and Pierce 2013]. We introduce the idea that testosterone levels are important in describing the specifics of the "style" of a CEO's decision-making. Although the literature has recognized that variations in style exist among CEOs, little progress has been made so far in describing and understanding these different styles. While important first steps in prior work have linked style to a CEO's military experience, overconfidence, religious beliefs, integrity, or criminal record, the question remains unanswered what makes a CEO overconfident (having military experience, etc.). Testosterone is a fundamental biological factor that is likely a "primitive" of these characteristics. We provide a neuroendocrinological basis for arguing that one productive way of thinking about variations in managerial style is to consider CEO testosterone levels.

Second, we add to the literature on financial misreporting by documenting that firms with a CEO who has high (low) levels of testosterone are more (less) likely to have misstated financial statements. Our study is one of few that associate financial misreporting practices with well-defined CEO-specific (as opposed to firm-level) characteristics [Davidson, et al. 2011, Dikolli, et al. 2012, Schrand and Zechman 2012]. While we do not claim to demonstrate causality, our tests mitigate potential concerns about biases stemming from correlated "unobservables" or endogenous matching [Ackerberg and Botticini 2002, Prendergast 2002]. For example, earlier work suggests a match between CEO characteristics and the firms that hire them [Graham, Harvey, and Puri 2012]. Testosterone is the underlying driver of a set of behaviors that together describe salient CEO personal characteristics. Thus, many potentially relevant unobservables should be captured by our measure of testosterone exposure. By using information from both sides of the match between manager and firm in our tests, our estimates should suffer less from these biases [Bandiera, Guiso, Prat, and Sadun 2010]. Indeed, we also include in our tests a comprehensive set of firm-level control variables that range from contractual arrangements to corporate governance structures and the firm's competitive environment.[6] By showing that CEO testosterone exposure is not only associated with misreporting but also with

[6] Including a range of environmental controls is also important to provide a more realistic approach to the complexity of the association between physical attributes (such as facial structures) and specific behaviors [see, Gómez-Valdés, Hünemeier, Quinto-Sánchez, Paschetta, de Azevedo, González, Martínez-Abadías, Esparza, Pucciarelli, Salzano, Bau, Bortolini, and González-José 2013].

backdating, we further confirm that the relevant unobservables are well-captured by our testosterone proxy, given that such unobservables are predictors of both misreporting and backdating. Since our measure of testosterone is based on the CEOs' exposure during adolescence, we are also less vulnerable to reverse causality threats.[7]

Third, we introduce a proxy that has been validated in prior biology and psychology studies to measure an individual's exposure to testosterone during formative years, which can be used in broad samples and does not rely on a researcher's access to the individual. Our proxy does not infer a CEO's personal characteristics from firm-level outcomes (such as firm-level investment and/or financing decisions), as has been the practice in prior work [Malmendier and Tate 2005b]. We show that our proxy does not capture overconfidence, a behavior that some earlier studies have associated with misreporting [Schrand and Zechman 2012] and other firm decisions [Malmendier and Tate 2005a].

2. Hypothesis development

2.1 CEO personal characteristics and financial reporting

While a vast literature has examined the determinants of misreporting [see, e.g., Dechow, Ge, and Schrand 2010, Fields, Lys, and Vincent 2001], the number of studies that link accounting practices to the personal characteristics of senior management is small. Nevertheless, a growing literature originating in accounting, finance, and economics considers "managerial styles" and their effect on corporate actions [Bolton, Brunnermeier, and Veldkamp 2008, Borghans, Duckworth, Heckman, and Ter Weel 2008, Davidson, et al. 2011, Malmendier and Tate 2005b]. This trend follows up on a longer tradition in the management field, which has

[7] We concede, however, that we cannot exclude the possibility that some other unobserved characteristic exists that is related to both testosterone exposure and financial misreporting.

always been interested in the individual characteristics of managers [see, e.g., Hambrick and Mason 1984] and how these influence firm policy.

Some studies, following Bertrand and Schoar [2003], document the existence of CEO fixed effects in financial reporting decisions and interpret this finding as evidence of a managerial style [Bamber, Jiang, and Wang 2010, Brochet, Faurel, and McVay 2011, DeJong and Ling 2010, Dyreng, Hanlon, and Maydew 2010, Feng, Ge, Luo, and Shevlin 2011, Ge, Matsumoto, and Zhang 2011, Zhang, Davis, Ge, and Matsumoto 2012]. However, this style is often hypothesized to be the outcome of the incentives these managers are facing [Chava and Purnanandam 2010, Jiang, Petroni, and Wang 2010] rather than their personal characteristics. Fee et al. [2013] document abnormally large firm policy changes after endogenous CEO departures, which they believe suggest the presence of causal-selected style effects anticipated by the board.

Other studies take the next step and examine a specific managerial style rather than document managerial fixed effects in financial reporting. For example, Dikolli et al. [2012] and Law and Mills [2013] use a CEO's "integrity" and document that integrity is associated with accruals quality and with tax avoidance, respectively. Likewise, Schrand and Zechman [2012] provide evidence that "overconfident" managers are more likely to be involved in intentional misstatements of earnings. These results are intriguing and suggest that a CEO's personal characteristics are associated with financial reporting [Davidson, et al. 2011]. Nevertheless, given the available measures it proves difficult to determine whether integrity or overconfidence are the *outcome* of corporate governance practices, incentives, and other situational factors or of something that is innate; that is, a stable, unfakeable individual characteristic of the manager.[8]

[8] See also, Francis et al. [2008] who show that managers with high media reputation have better quality accruals.

Graham et al. [2012] take a significant step forward in ferreting out whether characteristics, hard-wired into the personality of individuals,[9] matter in corporate policies by administering psychometric tests of personality to a broad sample of CEOs. These authors find that CEOs are significantly more risk tolerant than the lay population. They also show that CEO risk aversion is related to corporate financial policies. The Graham et al. method requires access to CEOs as well as the latter's willingness to submit to psychological testing. This condition makes it difficult for other researchers to follow their approach.

In sum, prior work suggests that personal characteristics of senior management are associated with financial reporting practices. Risk aversion, integrity, and overconfidence have been offered as salient aspects of a CEO's personality. We rely on recent evidence from the neurosciences to suggests that testosterone-related traits (and hence between-CEOs variation in testosterone exposure) predict misreporting. Not only is this proposal grounded in neuroendocrinological theory and evidence, but it also allows us to rely on a measure of CEO personal characteristics that is not based on (firm-level) outcomes and is observable for a large sample.

2.2 Testosterone, facial structure, and behavior

Prior studies have documented an association between the steroid hormone testosterone and a set of related behaviors. A schematic representation of this literature is presented in Fig. 1. Individuals with higher levels of circulating or baseline testosterone have an enhanced motivation for competition and dominance, display reduced fear, and are more likely to engage in extremely risky behavior such as gambling and alcohol use [Mehta, Jones, and Josephs 2008, Pound, Penton-Voak, and Surridge 2009, Zuckerman and Kuhlman 2000]. These individuals also

[9] There is some evidence that risk tolerance (or sensation-seeking behavior) is genetic [Robert and Avshalom 1998]. For example, Ebstein et al. [1996] report an association between the D4 dopamine receptor (D4DR) exon III and the closely related personality trait of novelty seeking.

are more egocentric and have a higher propensity to cheat as well as a stronger desire to maintain social status [Eisenegger, et al. 2010, Haselhuhn and Wong 2011, Wright, et al. 2012].

The exact mechanisms that link androgens, such as testosterone, with behavior is subject of ongoing research in the neurosciences [Carré, McCormick, and Hariri 2011]. One possible explanation suggests that testosterone exerts organizational effects on the brain both prenatally, during the fetal sexual differentiation, and during puberty [Morris, Jordan, and Breedlove 2004, Sisk, Schulz, and Zehr 2003]. In particular, the amygdala, a cluster of nerve cells that plays a role in processing memory and emotional reactions, is seen as the mediator between testosterone and other brain regions involved in evaluating complex social interactions [Adolphs, Tranel, and Damasio 1998, Bos, Hermans, Ramsey, and van Honk 2012, Klein, Shepherd, and Platt 2009, Mehta and Beer 2009]. Some neurons in the amygdala express androgen receptors that testosterone acts upon [Johnson and Breedlove 2010]. The neurons may respond to testosterone by reducing the communication to the orbitofrontal cortex, a region that is associated with an individual's ability of self-regulation and impulse control [Mehta and Beer 2009], and increasing communication with brainstem systems [Bos, Terburg, and van Honk 2010].[10] The amygdala activity activates defense responses to interpersonal provocation and status threats, reduces interpersonal trust, and lowers the ability to self-regulate [van Honk, Terburg, and Bos 2011], which in turn engenders the testosterone-related behaviors described earlier. It is because of testosterone's organizing effect on the brain that Dabbs [2000, p. 23] remarks:

> "We can count on [testosterone] to affect behavior in the long run. In the short run, on any given occasion, its effects are likely to be relatively mild, one of many influences on our behavior."

[10] Another mechanism discussed in the literature suggests that changes in testosterone during aggressive behavior are a marker of the intrinsic reward value of the behavior in specific situations. If so, then it is not testosterone that *causes* aggressive behavior, but rather it is elevated when aggression yields intrinsic rewards. And since aggression yields intrinsic rewards, it is more likely to occur again [Carré, Gilchrist, Morrissey, and McCormick 2010a].

Testosterone also regulates the adolescent growth spurt in the presence of growth hormone [Johnston, Hagel, Franklin, Fink, and Grammer 2001]. In particular, testosterone causes craniofacial growth in adolescents [Lindberg, et al. 2005, Nie 2005, Thornhill and Gangestad 1999, Thornhill and Møller 1997, Verdonck, et al. 1999]. At puberty, the growth trajectories of men and women diverge for bizygomatic width (the distance between the most lateral exterior points of the two cheekbones) but not for upper facial height (from upper lip to the highest point of the eyelid). Weston et al. [2007] propose that this sexual dimorphism in facial width-to-height ratio may reflect sexual selection pressures. This idea is captured in the *immunocompetence handicap hypothesis*, which posits that testosterone is responsible for the development of male secondary sex traits (such as the facial structure), but it has a negative impact on the immune system [Folstad and Karter 1992]. Only healthy men can afford to display masculine traits without suffering the costs of reduced disease resistance (due to testosterone's deleterious effect on the immune system). Thus, women may prefer men with sexually dimorphic facial characteristics when choosing a mate. While warning that the use of the facial width-to-height ratio needs to be paired with social-cultural controls, Gómez-Valdés et al. [2013] show that craniofacial measurements are indeed sexually dimorphic in 69 out of 90 tested modern human populations.[11] There is also evidence that the masculinizing effect of testosterone on the facial structure is due to the magnitude of the hormonal response to (competitive) events; that is, to the size of the change in circulating testosterone [Penton-Voak and Chen 2004, Pound, et al. 2009]. Large and frequent hormonal responses can have a larger effect on facial tissue than baseline testosterone levels, and thus the facial structure can also be a measure of the (circulating) hormonal response to competitive situations.

[11] Although for some of the populations the evidence is significant only at the 10 percent level, see also Özener [2012].

Thus, testosterone may shape both the facial structure and the neural structures during puberty, including the neural circuits relevant for the behaviors already described. Using brain scans, Carré et al. [2011] show that the amygdalae of persons with large facial width-to-height ratios have a more pronounced reaction to a signal of interpersonal provocation, viz. angry facial expressions, than the amygdalae of those with lower ratios. This study provides direct evidence for the proposed neural link between the facial structure and testosterone-related behaviors. Nevertheless, the exact causality of the relation is not yet fully understood.

The final set of evidence that we rely on in this paper relates facial structure to testosterone-related behaviors. Based on laboratory evidence as well as data from naturalistic settings, studies show that high facial width-to-height ratio (as a measure of high adolescent testosterone exposure) predicts actual aggression [Carré and McCormick 2008, Christiansen and Winkler 1992], cheating and deception [Haselhuhn and Wong 2011], exploitation of others [Stirrat and Perrett 2010], sensation seeking [Campbell, Dreber, Apicella, Eisenberg, Gray, Little, Garcia, Zamore, and Lum 2010], and a predilection for competition and/or risk taking [Apicella 2011, Apicella, Dreber, Campbell, Gray, Hoffman, and Little 2008].[12] Wong et al. [2011] report a positive association between a firm's financial performance and the CEO's facial width-to-height ratio, while Lewis et al. [2012] show that the same measure predicts achievement drive in US presidents. Thus, CEOs with high testosterone levels can be beneficial to firms, despite a potential increased risk for misreporting, which we discuss next.

[12] Evidence also exists that individuals use facial structures to guide judgments of aggression in others [Carré, Morrissey, Mondloch, and McCormick 2010b]. In particular, estimates of aggressive potential from faces are highly consistent across viewers [Carré, McCormick, and Mondloch 2009a, Carré, et al. 2010b] and are not dependent on culture or "race" [Undurraga, Eisenberg, Magvanjav, Wang, Leonard, McDade, Reyes-García, Nyberg, Tanner, Huanca, Godoy, and Taps Bolivia Study Team 2010]. Since both children and adults appear to use the facial structure to make estimates of aggression in others, humans may be "hard-wired" to rapidly and accurately detect a propensity for testosterone-related behaviors in other individuals [Short, Mondloch, McCormick, Carré, Ma, Fu, and Lee 2011]. Facial structures may provide what biologists call an "honest signal"; i.e., a signal that reliably predicts something that is useful to the receiver [Short, et al. 2011].

2.3 Testosterone and financial misreporting

An individual's testosterone exposure affects the outcome of the cost/benefit analyses that economic theory argues underlie the decision to engage in misreporting (and ultimately even to commit fraud [Becker 1968]). There are several possible mechanisms that link testosterone and financial misreporting. We offer five alternatives supported by earlier work.

First, individuals with high levels of testosterone are more likely to exhibit aggressive behavior, which in turn increases their propensity to cheat [Stirrat and Perrett 2010]. Financial misreporting is cheating and should therefore be more common among CEOs with high rather than low levels of testosterone.

Second, testosterone has been implicated in risk-seeking behaviors that include extremes such as gambling as well as more moderate manifestations such as making more risky financial decisions [Apicella, et al. 2008, Zuckerman and Kuhlman 2000]. Thus, high-testosterone individuals are more likely to engage in more risky firm strategies per se (including those involving aggressive financial reporting practices). Economic theory predicts that a person's risk preferences also play a considerable role in understanding how he or she responds to incentives [Baker 2000, Garen 1994, Indjejikian 1999]. Incentives, in turn, have been linked to misreporting [Dechow, et al. 2010].

Third, testosterone may have an influence on the orbitofrontal cortex of the brain, and criminology studies have documented that low self-control explains white collar crime [Evans, Cullen, Burton, Dunaway, and Benson 1997, Gottfredson and Hirschi 1990]. While only a small subset of financial misreporting is illegal, it is nevertheless plausible that testosterone is implicated in both "ordinary" misreporting as well as accounting fraud [cf. Davidson, et al. 2011].

Fourth, it is possible that testosterone-related behaviors increase a given CEO's performance on the job [Wong, et al. 2011]. Indeed, being aggressive and risk tolerant might propel the firm forward and push boundaries, with positive outcomes. If so, then testosterone's effect on the individual's desire to maintain the social status [Eisenegger, et al. 2010] associated with high performance, could increase his incentive to engage in accounting manipulation. Consistent with this conjecture, prior research has shown that "superstar" CEOs are more likely to engage in misreporting *after* they achieve superstar status to maintain their performance record [Malmendier and Tate 2009]. More generally, to the extent that status maintenance can be achieved by artificially providing a rosy view in the financial statements, high-testosterone individuals are more likely to misreport.

Finally, testosterone engenders egocentric behavior, which makes it more likely that high-testosterone individuals exploit others for their own personal financial benefits [Wright, et al. 2012]. As misreporting has been linked to the compensation packages of senior management [Dechow, et al. 2010], testosterone's influence on misreporting may occur through the effect of elevated egocentrism on the CEO's eagerness to obtain higher payouts.

Taking all of these arguments together, we formulate the following main hypothesis.

H1: The testosterone exposure of CEOs is positively associated with the risk of materially misstated financial statements of their firm.

3. CEO facial structure data and measure

In this section, we describe how we measure CEOs' testosterone exposure by using an unfakeable facial feature, and we discuss the validity of our measure. We then outline how we construct our pictorial database.

3.1 Measurement of testosterone exposure: the facial width-to-height ratio

As discussed in Section 2.2, we measure each CEO's testosterone exposure as the distance between the left and right zygion (bizygomatic width) relative to the distance between the upper lip and the highest point of the eyelid (height of upper face). We refer to the ratio of these width and height measurements as *WHR*. Prior studies show that *WHR* is a valid cue to testosterone-related behaviors in males [Carré, Putnam, and McCormick 2009b, Short, et al. 2011, Weston, et al. 2007, Wong, et al. 2011]. Carré and McCormick [2008] show that *WHR* can be measured from photographs (instead of measuring the skull directly) and that this ratio predicts aggressive behavior inside and outside the laboratory.

An important caveat applies; whether individual differences in the facial width-to-height ratio vary according to testosterone levels at puberty is still speculation at this point and subject to debate. However, the relation between *WHR* and aggression or deception propensity, as already discussed, has been well documented and, ultimately, it is this cue to aggression and/or deception that we need to derive our predictions regarding misreporting.[13]

3.2 Collecting the photographs of CEOs

We obtain the initial list of CEOs from Standard and Poor's Execucomp database for 2009. Table 1 shows how each step in collecting the CEO pictures affects the sample. From the original S&P 1500 firms, 22 firms are missing on Execucomp. We exclude 47 firms that have female CEOs because *WHR* is only a valid cue of testosterone-related behaviors in men. We first identify the semblance of the CEO from the company website, Forbes's website, or the company's annual report. We then use each CEO's family name together with his company's name to search for the best available picture of the CEO's face on Google Images. If there is more than one picture on Google Images for the same CEO, we identify the best photograph in

[13] Deaner et al. [2012] question whether *WHR* is a predictor of aggression in highly selective samples, such as professional hockey players. While the effect size of *WHR* is reduced after controlling for body size and mass in their study, *WHR* and aggression continue to be positively correlated at $p = 0.06$.

terms of resolution, whether the picture is facing forward, and whether the individual has a neutral expression. If no picture is found, we use Google video to search for a movie fragment in which the CEO is present. We then obtain the CEO's face from the movie and include this in our picture database. In total, we are able to identify 1,136 male CEOs with measurable pictures.

3.3 Obtaining the facial width-to-height ratio

Following the procedure outlined in Carré et al. [2009a], we convert each picture into 8-bit images with a standard height of 400 pixels before taking the measurement. Two research assistants independently measured every picture using ImageJ software [Rasband 2008] provided by the National Institutes of Health. If the difference between the two measurements of a CEO's *WHR* is less than five percent, we use the average of the two measurements as our value of *WHR*. If the measurements diverge by more than five percent, a third research assistant measures the facial structures once more. If the difference between this third measurement and either of the first two measurements is less than five percent, we code the picture as "good quality" and use the average value of the two closest measurements as the value for *WHR*. If not, the picture is categorized as "lower quality" and we use the average of the two closest measurements as the value for *WHR*. We further code pictures as "lower quality" if they have low resolution; if the picture is tilted by more than 45 degrees (which compromises the accuracy of the bizygomatic width measurement); or if the individual's facial expression is not neutral.[14] After these screens, we have 763 "good quality" pictures and 1,136 "measurable quality" pictures. Panel A of Table 1 summarizes this procedure.

WHR is a measure of pubertal testosterone exposure, and therefore an individual's *WHR* value should not change after adolescence. Thus, for the purpose of our study, it should not

[14] Genuine smiles will lower the upper facial height. However, "fake" smiles do not affect the facial structure. We therefore code a fake smile as a neutral expression.

matter whether we use a recent or an older picture to obtain our data. We verify this statement for a sample for which we have two pictures for a given CEO taken at a young age and at an older age, respectively. We find no significant differences (p = 0.65) in *WHR* measurements between these two pictures of the same CEO.

4. Proxies for financial misreporting

We consider two measures of financial misreporting. We use *Restatement*, based on whether a firm restates its annual report in a given year due to (intentional) accounting irregularities. While this measure avoids potential problems of falsely classifying a non-misstating firms (type-II error), it is likely to under-identify the number of misreporting firms (type-I error). We therefore also use a *prediction* model of misreporting. Specifically, we use the *F-score* for predicting material accounting misstatements developed in Dechow et al. [2011]. These measures are described in greater detail in Sections 4.1 and 4.2.

4.1 Restatements

We obtain our sample of material misreporting by combining the sample of restatements due to intentional misstatements from the Audit Analytics database with the accounting irregularity sample in Hennes, Leone, and Miller [2008].[15] In Audit Analytics, we use the field name *RES_CLER_ERR* in this database to identify those firms that have intentional misstatements from those with unintentional misstatements, for example due to clerical errors [Hennes, et al. 2008]. We are interested in the (survival) time until the firm experiences the event of an intentional misstatement identified by the restated accounting period *(Time until violation)*. In addition, we use *D(Misstatement)*, an indicator variable that equals one if the firm's financial statements in any given year are affected by intentional misstatements, and zero otherwise.

[15] Audit Analytics covers all SEC registrants who have disclosed a financial statement restatement in electronic filings since 2001. Hennes et al. [2008] begin with the GAO database that compiles a list of restatements occurring between 1997 and 2002 and distinguish intentional accounting irregularities from unintentional clerical errors.

4.2 F-score based on Dechow et al. [2011]

The F-score is a composite measure of the likelihood of accounting manipulation based on the insight that financial statement information beyond accruals is useful for identifying earnings manipulation [Dechow, et al. 2011]. We use scores computed based on model 1 in Dechow et al. [2011], which relies on information about accruals quality, performance, and market-related incentives. In constructing our variables, we exploit the guidance in Dechow et al. [2011] on the critical values of the F-score in relation to identifying risk of financial misreporting. We consider the (survival) time until the firm first experiences an F-score that is greater than 1.85, indicating "substantial risk" of misstatement during a CEO's tenure (*Time until F-score>1.85)*. We also use an ordinal scale *F-risk*, which starts at 0 for F-scores smaller than 1 (i.e., the critical value for "normal risk" of misreporting) and extends to the value 3 if an F-score is greater than 2.45 (i.e., the critical value for "high risk" of misreporting). The intermediate values of F-risk, namely 1 and 2, are for F-scores that indicate "above normal risk" (greater than 1 but smaller than 1.85) and substantial risk, (greater than 1.85 but smaller than 2.45), respectively.

5. Sample, empirical design, and results

5.1 Sample selection and sample distribution

We include in our sample all firm-years for which we have a measurable picture of the CEO and nonmissing data in Execucomp for the period from 1996 to 2010.[16] We draw data from Compustat, CRSP, Risk Metrics, Thomson Reuters (Insiders data), and Execucomp to construct various CEO- and firm-level variables. The number of observations used in the analyses depends

[16] Thus, individuals can enter the database as the CEO of different firms (provided they were the CEO of one of the S&P 1500 firms in 2009 when we took their name from Execucomp).

on the data constraints imposed by the specification and varies between 2,643 and 4,685 firm-year observations. Table 1, in Panel B, details the sample selection process.

Table 2, Panel A presents the number of observations by year between 1996 and 2010. Recall, we include in the sample the full employment history of each CEO in the 2009 version of Execucomp. Panel B exhibits the number of firm-years in each industry, which ranges from a low of 12 (other services industry) to a high of 2,222 (manufacturing).[17]

5.2 Summary statistics and univariate tests

In Table 3 Panel A, we present the summary statistics (computed at the CEO level) for the facial width-to-height ratio in both the measurable pictures and the good quality pictures samples. The distribution of the width-to-height ratio is very similar in the two samples, with a mean value equal to 2.01. This finding is very similar to statistics reported in other studies [e.g., Lefevre, Lewis, Bates, Dzhelyova, Coetzee, Deary, and Perrett 2012].

Table 3 Panel B shows summary statistics for the financial misreporting variables separately for CEOs or firm-years associated with a CEO with above (below) median testosterone (as measured by the median *WHR*) using the sample with all measurable pictures. We also present a range of firm and CEO characteristics that we use as controls in our later regression models. For each variable, we present t-tests or log rank tests of the hypothesis that the difference between high- and low-testosterone CEOs is zero. The log rank test is appropriate for comparing the equality of estimated mean survival times.

We find that firms with high-testosterone CEOs have a significantly lower restricted mean *Time until violation*. The restricted mean is the nonparametric estimate of the mean survival time. Similarly, the restricted mean *Time until F-score>1.85* is significantly lower for

[17] Our results are not sensitive to excluding the banking and insurance industry from the sample.

firms with high-testosterone CEOs.[18] This pattern is mirrored in the descriptive statistics for the indicator variables *D(Misstatement)* and *D(F-score>1.85)* and the ordinal scale *F-risk*. For these variables, the average value is significantly lower in the low-testosterone sample, which suggests a lower incidence of misreporting in this sample. Note that we report these statistics at the CEO level (as opposed to the firm-year level summary statistics we report for the control variables). Thus, we document that 27.0 (21.9) percent of the CEOs in the high (low) testosterone group have experienced a misstatement at some point during their presence in the sample. This finding is somewhat lower than Scholz [2008] who shows that in a 10-year period between 1997 and 2006, 279 firms in the S&P500 reported a restatement.[19]

High-testosterone CEOs are present in firm-years with lower book-to-market ratios and have shorter tenure. They also have higher free cash flow and (marginally) higher R&D expenses and tend to be working for older firms. CEOs with high testosterone have significantly fewer directors who are among the top five most highly paid executives in the firm and have fewer directors appointed during the CEO's tenure. At the same time, these CEO have on average more independent directors as well as a larger board size. High-testosterone CEOs have higher salaries but less valuable equity holdings; at the same time, their pay for performance sensitivity in newly granted options is higher.

5.3 Main findings: Financial misreporting regressions

5.3.1 Empirical model

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[18] *Time until violation* (and *Time until F-score>1.85*) is a right-censored variable. More than 75 percent of firms in the sample have never had a misstatement (or have never obtained an F-score larger than 1.85). The restricted mean reflects that the Kaplan-Meier estimate is not defined beyond the largest observed failure time [Cleves, Gutierrez, Gould, and Marchenko 2008]. The right-censoring of this variable also explains why the average *Time until violation* and *Time until violation* are higher than the average CEO tenure measured at the firm-year level.

[19] Note, however, that Scholz's study includes restatements due to unintentional errors. Similarly, Badertscher and Burks [2011] mention that in 2006 about 10 percent of public companies issued a restatement.

We begin by testing how financial misreporting varies with CEO testosterone levels. Our regressions have the following generic specification:

$$Misreporting_{it} = f[D(WHR > median)_{it}, firm\ and\ market\ controls_{it},$$
$$CEO\ controls_{it}, corporate\ governance\ controls_{it}, CEO\ compensation\ controls_{it},$$
$$year\ fixed\ effects, industry\ fixed\ effects] \quad (1)$$

where i is an index across firms, and t is an index across years. *Misreporting* is either a misreporting proxy based on financial restatements (in Section 5.3.2) or on a misreporting prediction model (in Section 5.3.3). We test our hypothesis separately for the sample of all measurable pictures and the sample of good quality pictures. When we use the sample of all measurable pictures, we include in Equation (1) three variables that capture the potential measurement error associated with these pictures due to nonneutral facial expressions, facial tilt, and picture resolution (*D(GrtExp)*, *D(GrtPrfl*), and *D(LowRes)*, respectively).[20] In this manner, we can increase the sample size, while at the same time controlling for measurement error in the variable of interest. Our variable of interest is *D(WHR>median)*, an indicator variable that takes the value of one if a CEO's facial width-height ratio is above the median and zero otherwise.[21] Inferences are based on standard errors that are clustered at the CEO level throughout.[22]

5.3.2 Analysis of financial restatements due to intentional accounting irregularities

[20] *D(LowRes)* is also equal to one if the two raters provide measurements of WHR that diverge by more than five percent.

[21] We use the indicator variable transformation of *WHR* for two reasons. First, Greene [2000, p. 379] shows that this method can be used to reduce measurement error in the variable of interest. Second, the transformation helps to present the economic significance of the estimated effects. We find very similar results when using the untransformed *WHR* variable in the tests using the F-score; standard errors increase significantly in the misstatement tests, however, they are consistent with the untransformed variable being subject to measurement error.

[22] Our annual data yield too few observations to also cluster standard errors by year [see, Angrist and Pischke 2009, Petersen 2009]. Indeed, Petersen [2009] reports that when the number of clusters in a dimension is below 40, clustering the standard errors increases the bias. On the other hand, our variable of interest, *D(WHR>median)*, is fixed at the CEO level, which makes it imperative to account for potential within-CEO correlation [Angrist and Pischke 2009].

We first report the results of a Cox proportional hazard model, which reflects that our interest, in part, is in the time elapsed in a CEO's tenure until misreporting occurs (i.e., *Time until violation)*. Since not all CEOs have a misstatement during their tenure, our data are right-censored. Thus, rather than directly modeling the *Time until violation*, we use a Cox proportional hazard model. The dependent variable in this model is the hazard rate, defined as the probability of a firm experiencing the event (i.e., intentional misreporting) at time *t*, given that the firm has survived without such event until then. The proportional hazard model allows a nonparametric estimation of the baseline hazard function; i.e., the hazard function in the absence of covariates. The explanatory variables shift the baseline hazard as follows:

$$h(t) = h_0(t)\exp(\beta_1 x_1 + \cdots + \beta_k x_k),$$

where $x_1, \ldots, x_k$ is the set of explanatory variables described in equation (1), $\beta_1, \ldots, \beta_k$ are the slope parameters to be estimated, and $h_0(t)$ is the nonparametric baseline hazard function. The interpretation of the estimated parameters is facilitated by exponentiating the slope coefficients and subtracting 1. This transformation yields the percentage change in the hazard rate that is caused by a unit change in the explanatory variable.

We begin by estimating a Cox proportional hazard model of the time until a firm intentionally misstates its financial statements. The results are presented in columns 1 and 2 of Table 4. We find a significantly higher hazard rate for CEOs with high testosterone levels than for CEOs with low testosterone levels ($p < 0.01$ and $p < 0.05$, respectively). The coefficient estimate on *D(WHR>median)* in column 1 (column 2) implies a 60 (51) percent higher hazard rate for high-testosterone CEOs compared with low-testosterone CEOs.

For the control variables, we find some evidence that the volatility of monthly stock returns, the firm's free cash flow, sales growth, and the R&D expense are associated with financial misreporting. We also find a positive association between the number of the top five executives (in terms of compensation) who are also directors and the hazard rate as well as between the natural log of salary and the hazard rate. In contrast, the natural log of the dollar value of equity holdings reduces the hazard rate. The variable *%Misreporting industry members* intends to control for the industry-related incidence of fraud [Davidson, et al. 2011]. As expected, it is positively associated with a given firm's hazard rate of misreporting. For many variables, however, including those controlling for differences in corporate governance and operating environment, the results are either insignificant or not stable across the two samples. This instability likely reflects that financial misreporting, corporate governance, and executive compensation are endogenously determined. This finding reinforces the importance of controlling for these variables when examining the association between stable CEO traits and financial reporting. It is also important to highlight the association between CEO age and misreporting. The levels of circulating (baseline) testosterone drop with age, and for this reason, age is itself a proxy for testosterone. Thus, to some extent, by including CEO age in our regression, we are potentially underestimating the effect size of the facial width-to-height ratio. It also means that we should interpret the coefficient on *D(WHR>median)* as the effect of variations in testosterone levels unrelated to age.

We also estimate a logit regression using *D(Misstatement)* as the dependent variable. We find a significant positive coefficient on *D(WHR>median)* both in the measurable picture ($p < 0.05$) and the good quality picture samples ($p < 0.10$). Thus, during the period of a CEO's tenure, we find a higher probability of misstated financial statements for high-testosterone CEOs than for low-testosterone CEOs. In terms of economic significance, based on the entire measurable (good quality) pictures sample, the odds of a high-testosterone CEO having misstated financial statements are about 1.42 (1.44) times more than the odds for a low-testosterone CEO. This difference in odds is significant at the one percent level (in both samples).

With respect to the control variables in the logit regressions, we find again that the volatility of stock returns, the R&D expense, and sales growth affect the probability of misstated financial statements. The price-to-earnings ratio, sales growth, and the indicator variable for firms that report a negative net income (*Loss*) increase the misreporting probability. CEO age and the natural log of the pay-for-performance sensitivity of newly granted options lower the probability of a misstatement, but only in the sample of measurable pictures. Once more, we find a strong positive association between the percentage of misreporting industry members and the probability of an intentional misstatement.

5.3.3 Analysis based on misreporting prediction models

Our second set of results uses proxies based on the F-score prediction model of misreporting. These prediction model scores provide an indication that a given firm has a (substantial) risk of misstated financial statements. The restatement-based proxies we used up to this point minimize type-II errors of misclassifying firms that have no misstatements. The prediction model proxies, on the other hand, minimize type-I errors of misclassifying firms that have misstated financial statements.

Our regressions follow the spirit of the specification in Equation (1). We include (but for brevity do not report) the full set of control variables and year and industry fixed effects. Once more, we present separately the estimates for the sample of measurable pictures and of good quality pictures.

Table 5 shows our findings that relate the two financial misreporting proxies based on the F-score to the facial width-to-height ratio and the other variables. Columns 1 and 2 show the Cox proportional hazard regressions that model the *Time until F-score>1.85*. Columns 3 and 4 present the ordered logistic regressions using *F-risk*. We find very consistent results across the two F-score–based proxies for financial misreporting. The coefficient on $D(WHR > median)$ in the proportional hazard model in column 1 (column 2) is 0.606 (0.685), with $p = 0.01$ ($p < 0.01$). Thus, high-testosterone CEOs face an 83 (98) percent higher hazard of experiencing a "substantial" risk of misreporting than low-testosterone CEOs. Similarly, the coefficient on the variable of interest in column 3 (column 4) equals 0.434 (0.368), with $p < 0.01$ ($p < 0.05$) in the measurable pictures sample (good quality pictures sample). This finding provides further evidence that high-testosterone CEOs have substantially higher odds of having above-normal misreporting risk. Indeed, based on the sample of all measurable (good quality) pictures, the odds ratio of high versus low-testosterone CEOs is 1.54 (1.44). The difference in odds is significant at the one-percent (five-percent) level.

In summary, the empirical evidence on the link between a given CEO's testosterone levels (as measured by the facial width-to-height ratio) and financial misreporting is consistent across all the misreporting proxies examined. As hypothesized, we find that the probability of financial misreporting is higher for those firms with CEOs who have facial structures that indicate higher levels of adolescent testosterone exposure.

5.4 Is CEO testosterone exposure as measured by WHR different from overconfidence?

Schrand and Zechman [2012] provide evidence that links financial misreporting to an executive's overconfidence. They show that misreporting often originates in a given CEO being too optimistic about a firm's future performance. These authors then attempt to link this optimism bias to overconfidence by using proxies for this psychological trait based on compensation data and on investment and financing decisions made by the firm. Their evidence generally supports the relation between overconfidence and misreporting.

It is possible that facial structures (and the underlying levels of testosterone) are also related to optimism and/or overconfidence. Perhaps the documented appetite for risk taking among high-testosterone individuals is partially driven by their overly rosy estimate of how the future will unravel. If so, then our findings might just replicate those documented in this prior work.

Before we address this issue, we wish to highlight that the prevalent measures of overconfidence used in prior work are somewhat difficult to interpret. As Schrand and Zechman [2012] observe, these measures are computed at the firm level, not the CEO level. In addition, to the extent that these measures are based on firm-level investing and financing decisions, they are affected by the corporate governance mechanisms present in the firm. Thus, it is difficult to separate overconfidence explanations of misreporting based on these proxies from those stemming from poor corporate governance.

We provide details on the construction of the overconfidence proxies in Appendix A. In short, we follow Schrand and Zechman [2012] and use both the extent to which CEOs delay exercising options as a reflection of their overconfidence as well as a composite measure based on the extent to which a firm engages in certain financing and investment activities that prior research has also linked to overconfidence.

We first examine the correlation between these measures of CEO overconfidence and our measure of a CEO's testosterone exposure (i.e., *D(WHR>median)*). Correlations are computed at the CEO level (as opposed to at the firm-year level). Details are reported in Table 6, panel A. The proxies for overconfidence are not significantly correlated with *D(WHR>median)* and the magnitude of the correlation coefficient is negligible, implying that the overconfidence proxies and facial width-to-height ratio are distinct constructs.

We then include these overconfidence measures in our misreporting regressions. The results are summarized in Table 6, panels B and C. Regardless of the overconfidence proxy used, we find that *D(WHR>median)* remains positively and significantly associated with misreporting. The evidence is perhaps the strongest for the proxies based on the F-score, for which we find positive associations at the five percent level or better in both the measurable and good quality picture samples as well as in the Cox and the ordered logistic regressions. Ignoring for a moment the significance levels, the coefficient estimates on *D(WHR>median)* are very comparable across the models and the samples.

Overconfidence is also positively associated with the F-score proxies, consistent with the findings of prior work that overconfident managers tend to engage more in earnings manipulation [Schrand and Zechman 2012].[23]

We conclude that CEO testosterone exposure as measured by the facial width-to-height ratio is a distinct managerial trait, different from CEO overconfidence. Compared with the overconfidence proxies, a CEO's facial structure is measured at the CEO level and is not the endogenous outcome of corporate governance mechanisms.

6. Are CEOs who exhibit testosterone-related behaviors more likely to engage in option backdating?

The analysis presented in Section 4 provides important evidence but is limited to one particular managerial action, namely misreporting. A valid question is whether our findings about the role of a given CEO's testosterone-related behaviors are limited to accounting choices

[23] Our findings for the relation between the alternative overconfidence proxies and misreporting are not sensitive to the exclusion of *D(WHR>median)* from the regressions.

only. In considering a single setting, one could suspect that the CEO facial structure is correlated with some omitted factor that is also correlated with misreporting. To address such concerns, we examine the relation between the likelihood that a CEO engages in option backdating and his facial width-to-height ratio. We offer this evidence to further validate our measure of CEO testosterone exposure. If correlated omitted variables are driving our results on misreporting, then we should not be able to establish a relation between facial structure and backdating. By showing that the CEO's facial structure is not only associated with misreporting but also with nonaccounting behavior, we broaden the appeal of our findings. Finally, whereas the facial structure is potentially related to option backdating because managers who exhibit more testosterone-related behaviors are also more likely to cheat, such a prediction does not hold for overconfidence. Thus, by establishing that *WHR* is associated with backdating, we provide further evidence that *WHR* captures a trait distinct from overconfidence.

6.1 Backdating background

Bizjak et al. [2009, 4822] mention that "option backdating has become to be seen as one of the largest corporate scandals of recent times." The accumulated evidence suggests that perhaps as much as 30 percent of firms in the United States have "backdated" the stock option grants awarded to their CEO and other executives [Heron and Lie 2009]. When a firm backdates its executive options, it selects favorable past dates (i.e., when the stock price is particularly low) as the grant dates. Since the option's exercise price is usually equated to the stock price at the grant date, backdating increases the value of the award.

Formally, the board of directors decides on matters of executive compensation. Thus, if firms engage in backdating, the board of directors must play a role. Prior evidence suggests that testosterone is related to a greater assertiveness in social interactions [Wright, et al. 2012].

Consequently, we believe that high-testosterone CEOs will dominate the negotiations for favorable pay packages with the board of directors. These CEOs might more convincingly argue that the risks involved with backdating are small and that the practice provides firms with a low-cost possibility to increase executive compensation.

The finance literature has documented that stock prices are abnormally high immediately after executive stock option grants and abnormally low immediately preceding the grant [Heron and Lie 2007, Lie 2005, Narayanan and Seyhun 2008]. Heron and Lie [2007] further conclude that most of this pattern in the return data can be explained by option backdating. We follow the procedure outlined in Collins et al. [2009] to identify firms that are likely to have engaged in backdating.[24] These authors consider an option backdated if the stock price at the option grant date ranks in the bottom decile of the firm's stock price distribution over a 240-day window surrounding the option grant date.[25] We collect option grant data from the Thomson Reuters Insider Trading database for the period 1996–2010. Whenever at least one CEO stock option award within a given year satisfies the backdating criterion, we define *D(Backdating)*, an indicator variable to equal one.

6.2 Option backdating regressions

We use the following empirical model to examine the relation between CEO testosterone levels and option backdating:

$$Backdating_{it} = f[D(WHR > median)_{it}, firm\ and\ market\ controls_{it},$$
$$CEO\ controls_{it}, corporate\ governance\ controls_{it}, CEO\ compensation\ controls_{it},$$
$$backdating\ incentive\ controls_{it}\ \ year\ fixed\ effects,$$

[24] Our findings are robust to using different backdating identification procedures. Specifically, inferences are almost unchanged when using either the method described in Bizjak, Lemmon, and Whitby [2009] or in Bebchuk, Grinstein, and Peyer [2010].
[25] In separate analyses, we do not consider options that meet this criterion as backdated if they are granted within the 1-day anniversary of a prior grant. Excluding these cases does not materially affect our results.

$industry\ fixed\ effects]$, (2)

where *Backdating* is either the (survival) *Time until backdating*; that is, the number of years until any stock options award to the CEO is identified as likely backdated by the Collins et al. [2009] procedure already described or by *D(Backdating)*. We expand our set of controls to include some variables that earlier studies on backdating suggest as important determinants [see, Collins, et al. 2009]. In particular, we control for the existence of any fixed date option grants during the year (i.e., a grant date that is within one day of last year's grant). We also add controls for those cases in which at least one director receives options at the same date as the CEO, for the Black-Scholes value of the option award (scaled by total compensation), and for the percentage of shares owned by the CEO. In addition, similar to our misreporting analysis, we include *%Backdating industry members* to control for the industry-related incidence of backdating.

We identify that backdating is likely to have taken place in 8.15 percent of our sample of 4,685 observations. Our first evidence that high-testosterone CEOs differ from low-testosterone CEOs is presented in Table 3. The estimated mean survival time corresponding to the number of years in a CEO's tenure until he is first awarded backdated options is significantly lower for high-testosterone individuals ($p < 0.05$ in a log rank test). The mean for the indicator variable *D(Backdating)* is significantly higher for CEOs with above median testosterone exposure, implying a higher incidence of backdating in this sample.

We estimate Equation (2) separately for the sample of measurable pictures and for the sample of good quality pictures. Table 7 presents the results. We find a positive and significant association between *D(WHR>median)* and the hazard rate (presented in columns 1 and 2), irrespective of the sample that we use. The coefficient is significant at the one percent level in the regressions based on the measurable pictures sample and at the ten-percent level in the good quality pictures sample. The coefficient estimates are very similar, so these differences in significance are likely a power issue. In terms of economic significance, our estimates imply that, in the entire measurable (good quality) pictures sample, firms with a high-testosterone CEO have a 48 (38) percent higher hazard of backdating than firms with a low-testosterone CEO.

Turning to the logit regressions in columns 3 and 4, we find once more a positive and significant association between testosterone and the probability of backdating. The estimates are only significant (at the five percent level) in the measurable picture sample, however. In this sample, the odds of backdating are 1.42 higher for high-testosterone CEOs than for low-testosterone individuals. The difference in odds between these two groups is significant: p = 0.01.

Taken together, our results show that CEO testosterone exposure, as measured by *WHR*, is associated with the backdating of stock option grants. This finding is important in its own regard, but we present it to further support the case for *WHR* as a valid measure of a CEO's behavior that affects business decisions.

7. Additional analyses

Our measurement of testosterone levels of CEOs relies on the manual collection of pictures. To conserve on data collection costs, we use the year 2009 as our starting point, identify the CEO in each S&P1500 firm, and collect his picture. We then gather data for the complete employment record of the CEO with the firm from (potentially) 1996 to 2010. Doing so, the number of observations we have for each CEO in the sample varies. One concern with this procedure is that the period over which a CEO enters the sample could vary with some unobserved characteristics that are also associated with misreporting (or backdating). Our primary response to this concern is to include many potential CEO and firm characteristics (which we can observe), together with our variable of interest (*WHR*) in the empirical model. The inclusion of *WHR*, in particular, should mitigate concerns that we are not properly accounting for some unobservable CEO-level factors in the sample selection as many salient characteristics are theoretically linked to testosterone.

We further address this issue in three ways. First, we compare the low-testosterone and high-testosterone groups with respect to the distribution of the total number of observations for each CEO in the sample. Results of a Kolmogorov-Smirnov test show that there are no significant differences in the distributions between these two groups (corrected *p*-value = 0.681).

Second, we only use data from the year 2009 and run all (ordered) logit regressions of misreporting and backdating using this single cross-section. This approach also accounts for the potential concern that our variable of interest is fixed at the CEO level and can therefore only explain between-variation in the dependent variable. No matter whether we measure misreporting by using restatements or the F-score prediction model, we continue to find (but do not report details for brevity) a positive and significant association between *D(WHR>median)* and misreporting at the ten percent level or better.[26] Similarly, we find a significant positive association (using 2009 data only) between *D(Backdating)* and CEO testosterone levels ($p = 0.01$ in the all measurable picture sample and $p = 0.16$ in the good quality picture sample).

Third, for the misreporting regressions based on the restatement proxy, we implement a one-to-one matching procedure. For each restatement firm, we keep the first "misreporting year" in the sample. Then for each first misreporting year, we identify a non-misreporting firm matched on the basis of industry and firm size. Based on a logit regression of *D(Misstatement)* onto *D(WHR>median)* and the full set of controls, we continue to find (but do not tabulate) a

[26] The only exception is the following. When we consider the good quality picture sample, the *p*-value on *D(WHR>median)* in the logit regression using the restatement proxy for misreporting equals 0.12.

positive and significant association between our measures of CEO testosterone levels and intentionally misstated financial reports ($p < 0.05$).

8. Conclusions

Regulators, investors, academics, and managers do not need to be persuaded that financial misreporting can pose a very significant threat to the proper working of capital markets. Prior studies have examined in depth many firm-level and market factors that are associated with financial misreporting. The most recent work considers the role of senior managers in the financial reporting process and recognizes that these senior managers have “style.” A continuing challenge is to describe the relevant managerial styles and show their respective relation with reporting decisions. We draw attention to work in behavioral endocrinology and neuropsychology that links the hormone testosterone to a set of related behaviors. While this work is still in development and the understanding of the exact mechanisms that are responsible for the association between testosterone and these behaviors is less than complete, some results are available. To us, the most important of these results are the following: (1) testosterone is implicated in a set of human behaviors that include aggression, egocentrism behavior, risk seeking, and an individual’s propensity to cheat as well as the desire to maintain status, and (2) the facial width-to-height measure provides a valid proxy for exposure to testosterone during adolescence and perhaps also to levels of circulating testosterone. We use these findings to conjecture a relation between the facial structure of CEOs and their firm’s financial misreporting. Our results support that firms with high-testosterone CEOs have a higher incidence of misreporting than firms with low-testosterone CEOs. This result is obtained by using proxies for misreporting based on prediction models (which might misclassify some firms as misreporting) as well as using irregularity restatements (which might underestimate the number of misreporting firms).

We document that testosterone-related behaviors are different from overconfidence, a personality trait that has been examined in the context of misreporting as well, and in particular, that our results are not altered by including proxies for overconfidence taken from prior work. Finally, we extend our analysis to a nonaccounting setting and show that a given CEO's testosterone exposure during puberty is also associated with the incidence of option backdating.

Our results are subject to several caveats. First, while underpinned by substantial literature from several related fields, our measure of testosterone exposure is indirect and relies on inferring testosterone from differences in craniofacial growth. Ideally, one would like to draw saliva and serum samples from subjects to examine their biochemical composition (and (base) testosterone content) in a laboratory. Practical considerations make it unlikely that this will ever be possible for a broad cross-sectional sample of CEOs from listed US companies. Second, while the association between testosterone and the earlier described set of behaviors is strong and has been documented in many studies, the understanding of the mechanism that links hormones to human behavior is not complete. Hence, drawing inferences about the causality (or determinacy) of the relation between testosterone (and facial structure) and financial misreporting is not advisable. Finally, the literature has documented significant associations between testosterone and body mass index and between testosterone and intelligence [Azurmendi, Braza, Sorozabal, García, Braza, Carreras, Muñoz, Cardas, and Sánchez-Martín 2005]. Earlier studies in economics have used measures of obesity and intelligence to explain variation in financial decision making. We cannot exclude the possibility, therefore, that our measure of testosterone is partially reflecting the effects of obesity and intelligence. We draw some confidence from the fact that the relation between testosterone and intelligence is complex. For example, earlier studies have documented both positive and negative associations between the androgen and intelligence depending on whether one considers spatial, fluid, or crystallized intelligence and on whether one considers adults or children [Aleman, De Vries, Koppeschaar, Osman-Dualeh, Verhaar, Samson, Bol, and De Haan 2001, Davison and Susman 2001, Gouchie and Kimura 1991, Kutlu, Ekerbicer, Ari, Uyanik, Zeren, and Tan 2001]. Thus, if our measure of testosterone captures individual differences in intelligence rather than aggression, we should not find an unequivocal positive relation between misreporting and the facial width-to-height ratio. Nevertheless, an interesting avenue to explore in future research is how facial structure and "CEO ability" are associated. Regrettably, even the state-of-the-art proxy for managerial ability available for broad-based empirical work [Demerjian, Lev, Lewis, and McVay 2012] measures this construct at the level of the top management team rather than at the individual CEO level. Exploring the influence of managerial ability on the relations documented in this study will have to be postponed until an (exogenous) individual measure of ability becomes available.

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Appendix A: Variable definitions

Facial structure variables

- *WHR* is the CEO's facial width-to-height ratio. It is measured as the distance between the left and right zygion (bizygomatic width) relative to the distance between the upper lip and the highest point of the eyelids (upper facial height).
- *D(WHR>median)* is an indicator variable coded as 1 if a CEO's facial *WHR* is above the median in the CEO-level sample and 0 otherwise.
- *D(GrtExp)* is an indicator variable that takes the value of 1 if a CEO's face is nonneutral in the picture (i.e., the 83 pictures reported in Table 1) and 0 otherwise.
- *D(GrtPrfl)* is an indicator variable that takes the value of 1 if a CEO's face is tilted by more than 45° in the picture (i.e., the 136 pictures reported in Table 1) and 0 otherwise.
- *D(LowRes)* is an indicator variable that takes the value of 1 if the resolution of a CEO's picture is low (i.e., the 72 pictures reported in Table 1) or if the *WHR* measurement error generated by the two research assistants is greater than 5 percent (i.e., the 82 pictures reported in Table 1) and 0 otherwise.

Proxies for misreporting

- *D(Misstatement)* is an indicator variable coded as 1 for the misreporting firm-years identified by the restated period of intentional accounting irregularities and zero otherwise (sources: Audit Analytics and data from Hennes et al. [2008]).
- *F-score* is a scaled logistic probability derived from a misstatement-prediction model developed by Dechow et al. (2011), for the purpose of predicting accounting manipulations disclosed in the SEC Accounting and Auditing Enforcement Releases (AAERs). We use the prediction model 1 in Dechow et al. (2011) to compute the variable based on data from Compustat, CRSP, I/B/E/S, and Execucomp as needed. The Compustat variables are from the unrestated as-first-reported Compustat database to avoid data backfilling that occurs in the Compustat fundamentals database in the event of a restatement. Appendix B provides detailed information on the calculation of *F-score*.
- *D(F-score>1.85)* is an indicator variable coded as 1 if a firm-year's F-score is greater than 1.85, indicating "substantial risk" of financial misreporting (Dechow et al. 2011); and 0 otherwise (source: Compustat).
- *F-risk* is an ordinal scale classified according to the level of misreporting risk. We follow the critical values of the F-score documented in Dechow et al. (2011) to identify the misreporting risk level as below: "Normal or low" risk: if F-score < 1 then F-risk = 0; "Above normal" risk: if 1 < F-score ≤ 1.85 then F-risk = 1; "Substantial" risk: if 1.85<F-score ≤ 2.45 then F-risk = 2; "High" risk: if F-score > 2.45 then F-risk = 3 (source: Compustat).

Firm level control variables

- *Adjusted return* is the market adjusted buy-and-hold stock return defined as the annual buy-and-hold return inclusive of delisting returns minus the annual buy-and-hold value-weighted market return (source: CRSP).

- *Volatility* is the standard deviation of monthly stocks returns computed over the past 5 years (source: CRSP).
- *ROA* is defined as net income over beginning-of-period total assets (source: Compustat).
- *Book to market* is the book value of total assets relative to the sum of the market value of equity and the book value of liabilities (source: Compustat).
- *Price to earnings* is the market value of the company at the end of fiscal year divided by net income of the fiscal year (source: Compustat).
- *Loss* is an indicator variable that is equal to 1 when net income is negative and 0 otherwise (source: Compustat).
- *Leverage* is the ratio of long-term debt to total assets at the end of fiscal year (source: Compustat).
- *Market value* is the market value of the company at the end of fiscal year (in millions of dollars) (source: Compustat).
- *Sales growth* is the 1-year percentage change in sales for the year prior to the current fiscal year (source: Compustat).
- *Free cash flow* is the net cash flow from operating activities at fiscal year t less average capital expenditures of the 3 years prior to year t, scaled by current assets at $t-1$ (source: Compustat).
- *RD* is defined as total research and development expenses scaled by sales (source: Compustat).
- *Firm age* is measured as the fiscal year of the observation minus the year the firm first appeared on CRSP.

CEO level control variables

- *CEO age* is the CEO age reported in Execucomp.
- *CEO tenure* is the CEO tenure in years computed based on the start of employment as reported in Execucomp.

Governance variables

- *CEO power* is an ordinal scale variable that is equal to 1 if the CEO is also the chair of the board and is equal to 2 if the CEO in addition to being the chair is also the president of the company; in all other cases *CEO power* equals 0 (source: Execucomp).
- *Inside CEO* equals to 1 if the CEO is promoted from inside the company (source: Execucomp).
- *TopExDrct* is the number of the top five highly paid executives who are also directors (source: Execucomp).
- *CEO appoint* is the percentage of board members appointed during the CEO's tenure

(source: Riskmetrics).

- *Independent director* is the percentage of board members who are independent (source: Riskmetrics).
- *Board size* is number of directors sitting on board (source: Execucomp).

Compensation variables

- *Salary* is the annual salary in thousands of dollars (source: Execucomp).
- *Bonus* is the annual bonus in thousands of dollars for observations before December 15, 2005. After this date, following Hayes et al. [2012], *Bonus* is the sum of the annual bonus and nonequity incentives in thousands of dollars. (source: Execucomp).
- *New option PPS* is the sensitivity of the newly issued total value of options held by the CEO to a 1 percent change in stock price, and is measured at fiscal-year end. Appendix C provides detailed information on the calculation of option portfolio sensitivities.
- *New stock PPS* is the sensitivity of the total value of newly issued stocks held by the CEO to a 1 percent change in stock price, and is measured at fiscal-year end. Appendix C provides detailed information on the calculation of option portfolio sensitivities.
- *Equity holdings* is equal to the sum of in-the-money unexercised options (opt_unex_exer_est_val+opt_unex_unexer_est_val) and shares owned (shrown_excl_opts×prcc_f) in thousands (source: Execucomp).

Industry control variable:

- *%Misreporting industry members* is the number of misreporting firms (defined by the corresponding misreporting proxy) in the firm's two-digit SIC code divided by the total number of firms in that two-digit SIC code that year (sources: Audit Analytics, data from Hennes et al. [2008], and Compustat).
- *%Backdating industry members* is the number firms with a CEO backdating in the firm's two-digit SIC code divided by the total number of firms in that two-digit SIC code that year (sources: Insider Trading and Compustat).

Backdating variables and the additional control variables for backdating

- *D(Backdating)* is an indicator variable equal to 1 if a CEO engaged in stock option grant backdating and 0 otherwise. Backdating behavior is identified using a method following Collins et al. (2009). An option award is defined as backdated (nonbackdated) if the stock price at the option grant date ranks in (above) the bottom decile of the firm's stock price distribution over a 240-day window surrounding the option grant date. The backdating firm-years consist of firm-years that have at least one backdated CEO stock option granted (source: CRSP and Insider Trading).
- *Fixed date* is an indicator variable that equals to 1 if any of the CEO option grants is scheduled for within 1 day from the same date as the previous year's award and 0 otherwise.
- *Option to compensation* is the Black-Scholes value of stock options awarded to a CEO,

deflated by CEO total compensation (source: Execucomp).

- *Director same day* is an indicator variable that equals 1 if at least one director receives stock option awards concurrently with the CEO (i.e., within a 5-day window) during the fiscal year and zero otherwise (source: Insider Trading.)
- *CEO ownership* is measured as the number of shares held by the CEO relative to the total number of common shares outstanding (source: Execucomp and Compustat).

Proxies for overconfidence (Schrand and Zechman 2012):

The overconfidence proxies (i.e., *OC_OPTIONS*, *OC_FIRM4*, and *OC_FIRM5*) are constructed based on the following variables:

- *OPTIONDELAY* is the natural logarithm of in-the-money unexercised exercisable options held by the CEO, equal to opt_unex_exer_est_val, +.01 (source: Execucomp).
- *XSINVEST_INDADJ* is the residual from a regression of total asset growth on sales growth, adjusted for the industry median (source: Compustat).
- *ACQUIRE_INDADJ* is defined as net acquisitions from the statement of cash flows, adjusted for the industry median (source: Compustat).
- *DERATIO* is the debt to equity ratio defined as long-term debt plus short-term debt, scaled by the total market value of the firm. The total market value equals the sum of the market value of equity plus the book values of long-term debt and preferred stock (source: Compustat).
- *DERATIO_INDADJ* is equal to *DERATIO*, adjusted for the industry median.
- *RISKYDT* is an indicator variable coded as 1 if either convertible debt or preferred stock is greater than 0; and 0 otherwise (source: Compustat).
- *DIVYLD* is the dividend yield that is equal to dividends per share divided by share price for the firms that pay dividends and 0 otherwise source: Compustat).

The overconfidence proxies are defined as below:

- *OC_OPTIONS* is an indicator variable coded as 1 if *OPTIONDELAY* is greater than the industry median and 0 otherwise.
- *OC_FIRM4* is an indicator variable coded as 1 if the firm meets the requirements of at least two of the four criteria following and 0 otherwise:
    1) *XSINVEST_INDADJ* is greater than 0;
    2) *ACQUIRE_INDADJ* is greater than 0;
    3) *DERATIO_INDADJ* is greater than 0; and
    4) *RISKYDT* is equal to 1.
- *OC_FIRM5* is an indicator variable coded as one if the firm meets the requirements of at least three of the five criteria following and 0 otherwise: 1) – 4) are the same as for *OC_FIRM4* and 5) *DIVYLD* is equal to 0.

Appendix B. Calculating F-score

The F-score is a measure of propensity to financial misreporting for a firm. Dechow et al. (2011) developed this measure by constructing a logistic model. By statistical arguments seven variables are used to construct this measure. The following is the formula for computing *F-score*:

$$\begin{aligned} predicted\ \ value = & -7.893 + 0.790 \times (rsst\_acc) + 2.518 \times (ch\_rec) + 1.191 \times (ch\_inv) \\ & + 1.979 \times (soft\_assets) + 0.171 \times (ch\_cs) \\ & + (-0.932) \times (ch\_roa) + 1.029 \times (issue) \end{aligned}$$

$$probability = \frac{e^{predicted\ \ value}}{1 + e^{predicted\ \ value}}$$

$$F - score = \frac{probability}{unconditional\ \ probability}$$

The unconditional probability is equal total number of misstatement firms divided by the total number of firms in Dechow et al. (2011)'s sample.

The variable definition for the prediction model is listed as below.

Variable Name	Abbr.	Definition
RSST accruals	*rsst_acc*	(Δ *WC* + Δ NCO + Δ FIN)/Average total assets, where WC = (Current Assets − Cash and Short-term Investments) − (Current Liabilities − Debt in Current Liabilities); NCO = (Total Assets − Current Assets − Investments and Advances) − (Total Liabilities − Current Liabilities − Long-term Debt); FIN = (Short-term Investments + Long-term Investments) − (Long-term Debt + Debt in Current Liabilities + Preferred Stock); following Richardson, Sloan, Soliman, and Tuna [2005]
Δ Receivables	*ch_rec*	Δ Accounts Receivable / Average total assets
Δ Inventory	*ch_inv*	Δ Inventory / Average total assets
% Soft assets	*soft_assets*	(Total Assets − PP&E − Cash and Cash Equivalent)/ Total Assets
Δ Cash sales	*ch_cs*	Percentage change in cash sales (Cash sales = Sales − Δ Accounts Receivable)
Δ Return on assets	*ch_roa*	($Earnings_t$ / Average total $assets_t$) − ($Earnings_{t-1}$ / Average total $assets_{t-1}$)
Actual issuance	*issue*	An indicator variable coded one if the firm issued securities during year *t*

Appendix C. Calculating option portfolio sensitivities (Core and Guay [1999] method)

C.1. Black-Scholes [1973] sensitivities of individual stock options

Estimates of the sensitivity of a stock option's value to changes in price are calculated based on the Black and Scholes [1973] formula for valuing European call options, as modified to account for dividend payouts by Merton [1973].

Option value = $\left[Se^{-dT}N(Z) - Xe^{-rT}N(Z - \sigma T^{(1/2)}\right]$,

where $Z = \left[\log(S/X) + T(r - d + \sigma^2/2\right]/\sigma T^{(1/2)}$, N is the cumulative probability function for the normal distribution, S the price of the underlying stock, X the exercise price of the option, σ the expected stock-return volatility over the life of the option, r the risk-free interest rate (treasury yield corresponding to time-to-maturity), T the time-to-maturity of the option in years, and d is the expected dividend rate over the life of the option.

The partial derivative of the Black-Scholes value with respect to stock price is expressed as:

$\partial(\text{option value})/\partial(\text{price}) = e^{-dT}N(Z)$.

The sensitivity of stock option value with respect to a 1% change in stock price is defined as:

Sensitivity of option value to stock price = $e^{-dTN}(Z)$*(*price*/100).

C.2. Estimating the sensitivity of stock option portfolios

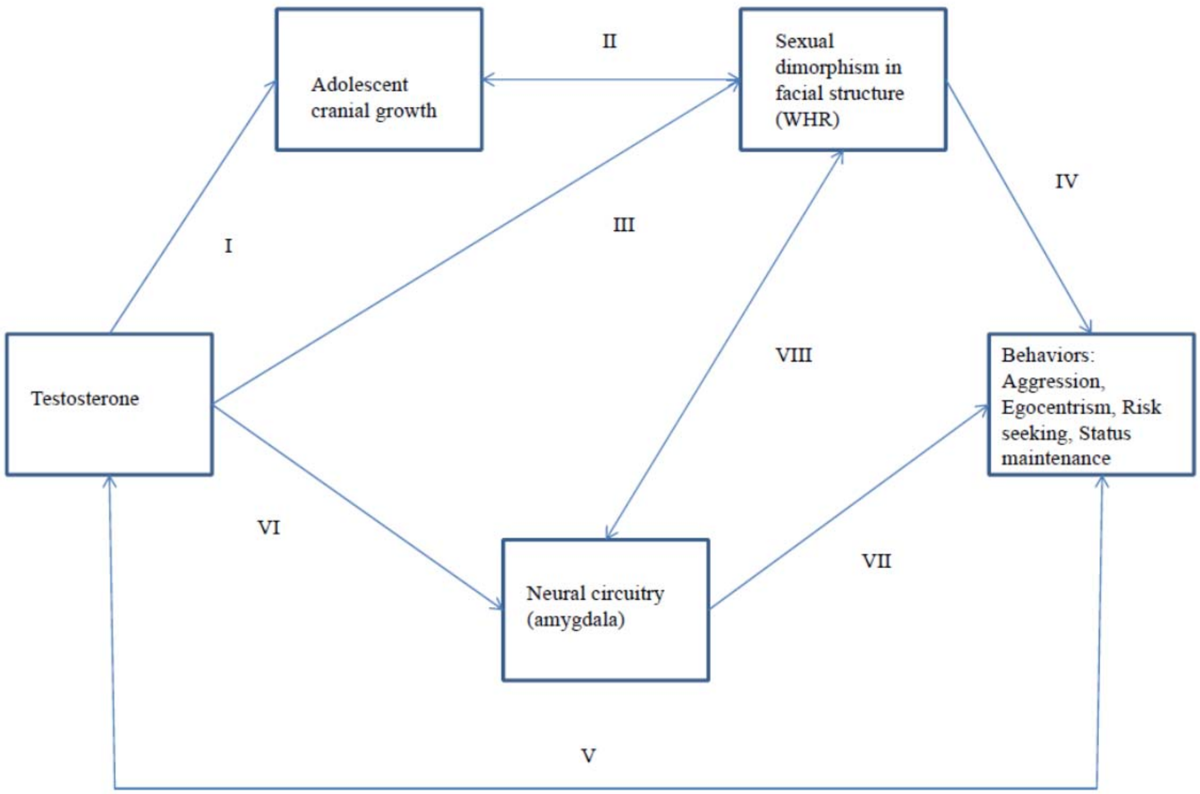
1. Obtain data on an executive's option portfolio from Execucomp or the most recent proxy statement:
   a) Data on most recent year's grant: (i) number of options, (ii) exercise price, and (iii) time-to-maturity.
   b) Data on previously granted options: (i) number of exercisable and unexercisable options outstanding, and (ii) current realizable value of exercisable and unexercisable options. To avoid double counting of the most recent year's grant, the number and realizable value of the *unexercisable* options is reduced by the number and realizable value of the current year's grant. If the number of options in the most recent year's grant exceeds the number of unexercisable options, the number and realizable value of the *exercisable* options is reduced by the excess of the number and realizable value of the current year's grant over the number and realizable value of the *unexercisable* options.
2. Compute the sensitivity of the executive's option portfolio to year-end stock price:
   a) Data format before year 2006
      1) Most recent year's grant: compute Black-Scholes sensitivity to year-end stock price—all input parameters are readily available.
      2) Previously granted options: (i) Compute average exercise price of exercisable and unexercisable options using current realizable value. The average exercise price is estimated as [year-end price − (realizable value/number of options)]. (ii) Set time-to-maturity of unexercisable options equal to 1 year less than time-to-maturity of most recent year's grant (or 9 years if no new grant was

made); set time-to-maturity of exercisable options equal to 3 years less than time-to-maturity of unexercisable options (or 6 years if no new grant was made). (iii) Compute Black-Scholes sensitivity to stock price. All remaining input parameters are readily available.

b) Data format from year 2006

   1) Dividend yield and stock return volatility are readily available in Execucomp. We calculate them using CRSP monthly data. Stock return volatility is calculated using past 60 months of stock returns. For firms without dividend and volatility data, we take sample mean.
   2) With new data format, all necessary inputs are available for both newly issued grants and previously granted options. The value of options is then calculated based on all the inputs needed.

Figure 1: The relation between testosterone, craniofacial features, and behavior



Underlying studies:

Mechanism [I] Testosterone → adolescent cranial growth

Verdonck et al. (1999); Nie (2005); Thornhill and Møller [1997]; Thornhill and Gangestad [1999]; Lindberg et al. (2005)

Mechanism [II] Adolescent cranial growth ↔ sexual dimorphism in facial structure

Weston et al. (2007); Gómez-Valdés et al. (2013)

Mechanism [III] (Circulating) testosterone → facial structure

Pound et al. [2009]; Penton-Voak and Chen (2004)

Mechanism [IV] Sexual dimorphism in facial structure → behaviors

Carré and McCormick (2008); Haselhuhn and Wong (2011); Stirrat and Perrett (2010), Apicella et al. (2008); Apicella (2011); Wong et al. (2011); Lewis et al. (2012); Campbell et al. (2010)

Mechanism [V] Testosterone ↔ behaviors

Mehta, Jones and Josephs (2008); Pound et al. (2009); Eisenegger et al. (2010); Wright et al. (2012);

Mechanism[VI] Testosterone → neural circuitry (amygdala)

Johnson and Breedlove [2010]; Sisk, Schulz and Zehr (2003); Morris, Jordan and Breedlove (2004); Bos et al. [2012]

Mechanism [VII] Neural circuitry (amygdala) → behaviors

Adolphs et al. (1998); Klein et al. (2009); Mehta and Beer (2009); Bos et al. (2012)

Mechanism [VIII] Neural circuitry (amygdala ↔ sexual dimorphism in facial structure
Carré et al. (2011)

Table 1: Sample selection

Panel A: CEO level

Sampling Procedure		N
Original sample (S&P 1500)		1,500
Less:	Observations with missing Execucomp data	22
	Female CEOs	47
	CEOs without measurable pictures	295
Male CEOs with measurable pictures		1,136
Less:	Pictures with bad resolution	72
	Observations with *WHR* measurement error > 5%	82
	Faces tilted by more than 45°	136
	Nonneutral faces	83
Pictures with good quality		763

Panel B: Firm-Year level

	N	
Sampling Procedure	Measurable pictures	Good quality pictures
Total firm-year observations with the *WHR* data and in Execucomp from 1996 to 2010	6,868	4,611
Less:		
Missing data for variables required for the regressions	2,183	1,436
Final restatement sample	4,685	3,175
Missing data for F-score	776	532
Final F-score sample	3,909	2,643

This table reports the sample construction for the CEO level sample (in Panel A) and the firm-year level sample (in Panel B). The CEO level sample comprises 1,136 male CEOs with measurable pictures and 763 male CEOs with good quality pictures. The firm-year level restatement sample comprises 4,685 (3,175) observations for the analyses using all measurable pictures (good quality pictures). The firm-year level F-score sample comprises 3,909 (2,643) observations for the analyses using all measurable pictures (good quality pictures).

Table 2: Composition of firm-year level restatement sample with measurable pictures (N = 4,685) by fiscal year and industry

Sample by fiscal year:			Sample by industry:			
Year	N	%	2-digit NAICS	Industry	N	%
1996	29	0.62	11	Agriculture, forestry, fishing, and hunting	21	0.45
1997	58	1.24	21	Mining, quarrying, and oil and gas extraction	258	5.51
1998	75	1.60	22	Utilities	362	7.73
1999	104	2.22	23	Construction	20	0.43
2000	132	2.82	31-33	Manufacturing	2,222	47.43
2001	172	3.67	42	Wholesale trade	224	4.78
2002	207	4.42	44-45	Retail trade	330	7.04
2003	253	5.40	48	Transportation	187	3.99
2004	299	6.38	49	Warehousing	25	0.53
2005	364	7.77	51	Information	286	6.10
2006	439	9.37	52	Finance and insurance	108	2.31
2007	552	11.78	53	Real estate and rental and leasing	32	0.68
2008	655	13.98	54	Professional, scientific, and technical services	201	4.29
2009	751	16.03	56	Admin. and support and waste mgmt. and remed. services	143	3.05
2010	595	12.70	61	Educational services	39	0.83
			62	Health care and social assistance	76	1.62
			71	Arts, entertainment, and recreation	18	0.38
			72	Accommodation and food services	121	2.58
			81, 99	Other services (except public administration)	12	0.26
Total	4,685	100			4,685	100

This table reports frequency counts by fiscal year and industry for the 4,685 firm-years in the restatement sample relating to the 1,136 measurable pictures. Two-digit NAICS codes are used to classify industries.

Table 3: Summary statistics

Panel A: Descriptive statistics for facial width-to-height ratios across the CEO level sample

	Facial width-to-height ratio (WHR)							
Sample	N	Mean	SD	P95	Q3	Median	Q1	P5
All measurable pictures	1,136	2.013	0.149	2.267	2.106	2.011	1.906	1.780
Good quality pictures	763	2.009	0.142	2.258	2.104	2.006	1.901	1.789

Panel B: Analysis of differences in misreporting proxies, firm-level characteristics, and CEO-level characteristics between high- and low-testosterone samples

	High testosterone			Low testosterone			T-test/Log-rank test	
Variable	N	Mean	SD	N	Mean	SD	Diff. in Mean	*p-value*
Time until violation (years)	418	10.574	7.502	375	11.357	6.891	−0.783	0.097
Time until F-score>1.85 (years)	374	12.029	6.717	346	12.520	6.320	−0.491	0.066
Time until backdating (years)	418	8.410	6.260	375	9.827	7.285	−1.417	0.035
D(Misstatement)	418	0.270	0.445	375	0.219	0.414	0.052	0.091
D(F-score>1.85)	374	0.187	0.391	346	0.139	0.346	0.048	0.023
D(Backdating)	418	0.378	0.485	375	0.307	0.462	0.071	0.035
F-risk	1,996	0.536	0.668	1,913	0.477	0.652	0.059	0.005
Adjusted return	2,432	0.091	0.334	2,253	0.088	0.345	0.003	0.790
Volatility	2,432	0.387	0.164	2,253	0.391	0.169	−0.004	0.387
ROA	2,432	0.065	0.078	2,253	0.064	0.086	0.001	0.544
Book to market	2,432	0.625	0.235	2,253	0.639	0.257	−0.014	0.045
Price to earnings	2,432	16.710	40.097	2,253	17.742	39.892	−1.032	0.378
Loss	2,432	0.119	0.324	2,253	0.133	0.339	−0.014	0.152
Leverage	2,432	0.183	0.146	2,253	0.182	0.151	0.002	0.728
Market value ($ million)	2,432	8.777	22.950	2,253	8.608	28.127	0.168	0.822

Table 3 *continued*

Sales growth	2,432	0.102	0.210	2,253	0.110	0.229	−0.008	0.227
Free cash flow	2,432	0.207	0.260	2,253	0.190	0.275	0.017	0.034
RD	2,432	0.042	0.077	2,253	0.038	0.071	0.003	0.117
Firm age	2,432	28.871	17.407	2,253	27.698	16.178	1.174	0.017
CEO age	2,432	54.109	6.824	2,253	54.284	6.577	−0.176	0.371
CEO tenure	2,432	6.668	6.035	2,253	8.582	8.568	−1.914	0.001
CEO power	2,432	0.811	0.836	2,253	0.809	0.816	0.002	0.930
Inside CEO	2,432	0.318	0.466	2,253	0.314	0.464	0.004	0.743
TopExDrct	2,432	1.458	0.688	2,253	1.547	0.781	−0.089	0.001
CEO appoint	2,432	0.345	0.287	2,253	0.386	0.308	−0.040	0.001
Independent director	2,432	0.747	0.148	2,253	0.733	0.152	0.014	0.001
Board Size	2,432	9.387	2.298	2,253	9.203	2.289	0.184	0.006
Salary ($ thousand)	2,432	773	331	2,253	751	319	22	0.019
Bonus ($ thousand)	2,432	1,436	1,331	2,253	1,424	1,383	12	0.763
New option PPS ($ thousand)	2,432	45.336	78.089	2,253	37.521	66.123	7.814	0.001
New stock PPS ($ thousand)	2,432	14.559	26.365	2,253	14.849	24.705	−0.290	0.698
Equity holdings ($ thousand)	2,432	60,770	198,716	2,253	101,451	303,781	−40,681	0.001

This table presents descriptive statistics for facial width-to-height ratio across the CEO level sample (in Panel A) and for misreporting proxies and firm (CEO) level characteristics defined in Appendix A using the high- and low-testosterone samples (in Panel B). High-testosterone (low-testosterone) sample comprises CEOs with above (below) median *WHR*. The univariate tests in Panel B are based on the firm-years or CEOs with all measurable pictures (i.e., 4,685 firm-years [793 CEOs] for the restatement sample and 3,909 firm-years [720 CEOs] for the F-score sample). *Time until violation*, *Time until F-score>1.85*, and *Time until backdate* measure the number of years within a CEO's tenure, respectively, until a firm has its first misstated financial statements due to intentional accounting irregularities, until a firm's F-score is greater than 1.85 (indicating substantial misreporting risk), and until a firm's CEO backdates stock option grants. Log-rank test examines the difference in restricted mean survival times between the high- and low-testosterone samples. *D(Misstatement)*, *D(F-score>1.85)*, and *D(Backdating)* are measured at the CEO level. The "Diff. in Mean" column in Panel B reports differences in the variable means between the high- and low-testosterone samples. Two-tailed probability values are reported for log-rank test or two-sample t-test.

Table 4: Coefficient estimates and summary statistics for Cox proportional hazard regressions and logistic regressions relating a misreporting proxy based on financial restatements to CEO testosterone level

		Hazard Rate (Misstatement)		D(Misstatement)	
Variable	Pred. Sign	Measurable pictures (1)	Good quality pictures (2)	Measurable pictures (3)	Good quality pictures (4)
Intercept				−27.233 ***	−22.847 ***
				(4.773)	(4.361)
D(*WHR*>median)	+	0.473 ***	0.413 **	0.362 **	0.372 *
		(0.162)	(0.209)	(0.184)	(0.222)
D(GrtExp)	−	−0.504		−0.842 *	
		(0.349)		(0.430)	
D(GrtPrfl)	?	−0.278		−0.271	
		(0.251)		(0.297)	
D(LowRes)	?	0.258		0.064	
		(0.226)		(0.279)	
Adjusted return		0.216	−0.196	0.096	−0.154
		(0.213)	(0.271)	(0.154)	(0.183)
Volatility		1.058	1.743 **	1.426 **	1.763 **
		(0.680)	(0.854)	(0.685)	(0.816)
ROA		−0.703	−1.566	0.627	−0.043
		(1.611)	(1.933)	(1.201)	(1.385)
Book to market		0.156	−0.340	0.786	0.370
		(0.485)	(0.661)	(0.556)	(0.710)
Price to earnings		0.002	0.001	0.005 ***	0.004 **
		(0.002)	(0.002)	(0.002)	(0.002)
Loss		0.360	0.073	0.795 ***	0.650 *
		(0.409)	(0.491)	(0.296)	(0.358)
Leverage		−0.357	0.636	−0.635	0.041
		(0.635)	(0.764)	(0.680)	(0.828)
Ln (Market value)		−0.082	−0.026	−0.072	0.020
		(0.101)	(0.128)	(0.162)	(0.176)
Sales growth		0.866 ***	0.767 *	0.580 **	0.510
		(0.294)	(0.405)	(0.254)	(0.326)
Free cash flow		−0.569	−0.730 *	−0.388	−0.323
		(0.374)	(0.436)	(0.350)	(0.416)
RD		−3.944 **	−5.255 **	−3.902 **	−5.064 *
		(1.634)	(2.129)	(1.918)	(2.661)
Ln (Firm age)		0.003	−0.280	0.078	−0.173
		(0.155)	(0.201)	(0.173)	(0.212)
Ln (CEO age)		−1.101	−0.986	−1.899 **	−1.280
		(0.727)	(0.896)	(0.885)	(1.094)
Ln (CEO tenure)		0.027	−0.003	0.068	0.076
		(0.055)	(0.068)	(0.060)	(0.065)
CEO power		0.105	0.028	−0.049	−0.175
		(0.109)	(0.142)	(0.119)	(0.144)
Inside CEO		0.131	0.194	0.172	0.211
		(0.174)	(0.216)	(0.196)	(0.238)

Table 4 *continued*

	(1)		(2)		(3)		(4)	
TopExDrct	0.244	**	0.122		0.125		0.061	
	(0.114)		(0.159)		(0.141)		(0.172)	
CEO appoint	0.049		0.247		0.250		0.233	
	(0.401)		(0.534)		(0.425)		(0.508)	
Independent director	0.754		0.298		−0.215		−0.439	
	(0.629)		(0.863)		(0.731)		(0.895)	
Board size	−0.069		−0.029		−0.081		−0.078	
	(0.051)		(0.061)		(0.058)		(0.068)	
Ln (Salary)	0.493	*	0.490		0.407		0.313	
	(0.277)		(0.345)		(0.468)		(0.520)	
Ln (Bonus)	−0.063		0.007		−0.051		−0.044	
	(0.125)		(0.149)		(0.106)		(0.132)	
Ln (New option PPS)	−0.001		0.002		−0.030	*	−0.024	
	(0.022)		(0.027)		(0.017)		(0.020)	
Ln (New stock PPS)	−0.001		−0.003		−0.001		−0.008	
	(0.025)		(0.033)		(0.023)		(0.027)	
Ln (Equity holdings)	−0.099	*	−0.152	*	−0.064		−0.141	*
	(0.059)		(0.080)		(0.074)		(0.086)	
%Misreporting industry members	6.071	***	6.746	***	8.018	***	8.646	***
	(0.642)		(0.875)		(0.906)		(1.156)	
Year fixed	*yes*		*yes*		*yes*		*yes*	
Industry fixed	*yes*		*yes*		*yes*		*yes*	
Clustered std errors	*CEO level*		*CEO level*		*CEO level*		*CEO level*	
Pr > χ^2	0.001		0.001		0.001		0.001	
Pseudo adjusted R^2					18.65%		19.90%	
Log pseudolikelihood	−1,093.592		−701.928		−1,333.587		−931.596	
% correctly classified					89.20		88.00	
N	3,810		2,547		4,685		3,175	

This table presents analysis of association between CEO testosterone level measured by *D(WHR>median)* and misreporting proxies measured by (1) *Hazard Rate (Misstatement)*, the probability of a firm experiencing intentional accounting irregularity in a given year, conditional upon the firm having survived to the beginning of the year, and (2) *D(Misstatement)*, an indicator variable coded as one for the misreporting firm-years identified by the restated period of intentional accounting irregularities and zero otherwise. Columns 1 and 2 (columns 3 and 4) show coefficient estimates and model summary statistics for Cox proportional hazard regressions (logistic regressions) relating *Hazard Rate (Misstatement)* (*D(Misstatement)*) to *D(WHR>median)* and a vector of control variables. Variable definitions are provided in Appendix A. We winsorize the variables at 1% and 99%, with the exception of *RD* and *Leverage* where only the top percentile observations were winsorized. We run separate regressions for the sample of all measurable pictures (columns 1 and 3) and for the sample of good quality pictures (columns 2 and 4). The Cox proportional hazard model estimates how soon in the CEO's tenure a financial misreporting (identified by the restated accounting period) occurs. Once the misstatement occurred, we truncate all further observations for that CEO from the sample. Hence, the number of observations is reduced to 3,810 (2,547) for all measurable pictures (good quality pictures). Two-tailed probability values computed using standard errors clustered by CEO are reported in parentheses.

Table 5: Coefficient estimates and summary statistics for Cox proportional hazard regressions and ordered logistic regressions relating misreporting proxies based on F-score to CEO testosterone level

Variable	Pred. Sign	Hazard Rate (F-score>1.85) Measurable pictures (1)	Hazard Rate (F-score>1.85) Good quality pictures (2)	F-risk Measurable pictures (3)	F-risk Good quality pictures (4)
Intercept 1				5.393 *	20.217 ***
				(2.908)	(3.447)
Intercept 2				8.580 ***	23.360 ***
				(2.926)	(3.419)
Intercept 2				10.067 ***	24.813 ***
				(2.936)	(3.436)
D(*WHR*>median)	+	0.606 ***	0.685 ***	0.434 ***	0.368 **
		(0.203)	(0.256)	(0.136)	(0.161)
D(GrtExp)	−	−0.795		−0.801 **	
		(0.512)		(0.313)	
D(GrtPrfl)	?	−0.909 **		0.084	
		(0.382)		(0.197)	
D(LowRes)	?	−0.207		0.033	
		(0.339)		(0.220)	
Controls		*yes*	*yes*	*yes*	*yes*
Year fixed		*yes*	*yes*	*yes*	*yes*
Industry fixed		*yes*	*yes*	*yes*	*yes*
Clustered std errors		*CEO level*	*CEO level*	*CEO level*	*CEO level*
Pr > χ^2		0.001	0.001	0.001	0.001
Pseudo adjusted R^2				22.37%	23.99%
Log pseudolikelihood		−577.119	−378.223	−2707.119	−1826.657
N		3,417	2,282	3,909	2,643

This table presents analysis of association between CEO testosterone level measured by *D(WHR>median)* and misreporting proxies measured by (1) *Hazard Rate (F-score>1.85)*, the probability of a firm's F-score being greater than 1.85 (indicating substantial misreporting risk) in a given year, conditional upon the firm having survived to the beginning of the year, and (2) *F-risk*, an ordinal scale classified according to the level of misreporting risk (see Appendix A). Columns 1 and 2 (columns 3 and 4) reports statistics results for Cox proportional hazard regressions (ordered logistic regressions) relating *Hazard Rate (F-score>1.85)* (*F-risk*) to *D(WHR>median)* and a vector of control variables reported in Table 4. Variable definitions are provided in Appendix A. We winsorize the variables at 1% and 99%, with the exception of *RD* and *Leverage* where only the top percentile observations were winsorized. We run separate regressions for the sample of all measurable pictures (columns 1 and 3) and for the sample of good quality pictures (columns 2 and 4). The Cox proportional hazard model estimates how soon in the CEO's tenure a substantial risk of financial misreporting occurs (i.e., F-score>1.85). Once this threshold of risk has been passed, we truncate all further observations for that CEO from the sample. Hence, the number of observations is reduced to 3,417 (2,282) for all measurable pictures (good quality pictures). Two-tailed probability values computed using standard errors clustered by CEO are reported in parentheses.

Table 6: CEO testosterone exposure versus CEO overconfidence

Panel A: Pearson and Spearman correlation matrix of CEO testosterone level and CEO overconfidence proxies for the CEO level sample of all measurable pictures (N = 1,136)

	D(*WHR*>median)	OC_OPTIONS	OC_FIRM4	OC_FIRM5
D(*WHR*>median)	1	0.011 (0.721)	0.002 (0.944)	0.018 (0.536)
OC_OPTIONS	0.009 (0.752)	1	0.053 (0.073)	0.025 (0.402)
OC_FIRM4	−0.008 (0.790)	0.042 (0.153)	1	0.723 (0.001)
OC_FIRM5	0.023 (0.434)	0.024 (0.412)	0.729 (0.001)	1

Panel B: Coefficient estimates and summary statistics for Cox proportional hazard regressions and logistic regressions relating a misreporting proxy based on financial restatements to CEO testosterone level and proxies of CEO overconfidence

		Hazard Rate (Misstatement)		D(Misstatement)	
Variable	Pred. Sign	Measurable pictures (1)	Good quality pictures (2)	Measurable pictures (3)	Good quality pictures (4)
Intercept				-11.981 *** (3.977)	-22.804 *** (4.829)
D(*WHR*>median)	+	0.472 *** (0.162)	0.404 * (0.210)	0.366 ** (0.184)	0.369 * (0.222)
OC_OPTIONS	+	0.069 (0.182)	0.146 (0.246)	-0.019 (0.160)	0.048 (0.206)
D(GrtExp)	−	−0.506 (0.349)		−0.847 ** (0.429)	
D(GrtPrfl)	?	−0.281 (0.250)		−0.270 (0.297)	
D(LowRes)	?	0.256 (0.227)		0.060 (0.280)	
Controls		*yes*	*yes*	*yes*	*yes*
Year fixed		*yes*	*yes*	*yes*	*yes*
Industry fixed		*yes*	*yes*	*yes*	*yes*
Clustered std errors		*CEO level*	*CEO level*	*CEO level*	*CEO level*
Pr > χ^2		0.001	0.001	0.001	0.001
Pseudo adjusted R^2				18.56%	19.90%
Log pseudolikelihood		−1,093.52	−701.928	−1355.090	−931.546
% correctly classified				89.30	88.00
N		3,810	2,547	4,685	3,175
Summary of main results for the other two overconfidence proxies					
D(*WHR*>median)	+	0.473 *** (0.162)	0.414 ** (0.210)	0.363 ** (0.184)	0.372 * (0.222)
OC_FIRM4	+	0.016 (0.171)	0.029 (0.212)	-0.021 (0.153)	0.011 (0.177)
(*WHR*>median)	+	0.474 *** (0.163)	0.413 ** (0.209)	0.360 * (0.183)	0.369 * (0.221)
OC_FIRM5	+	0.183 (0.168)	0.209 (0.198)	0.141 (0.144)	0.143 (0.169)

Table 6 *continued*

Panel C: Coefficient estimates and summary statistics for Cox proportional hazard regressions and ordered logistic regressions relating misreporting proxies based on F-score to CEO testosterone level and proxies of CEO overconfidence

		Hazard Rate (F-score>1.85)		F-risk	
Variable	Pred. Sign	Measurable pictures (1)	Good quality pictures (2)	Measurable pictures (3)	Good quality pictures (4)
Intercept 1				5.530 **	20.278 ***
				(2.901)	(2.430)
Intercept 2				8.725 ***	23.429 ***
				(2.919)	(2.496)
Intercept 3				10.218 ***	24.886 ***
				(2.929)	(2.543)
D(*WHR*>median)	+	0.595 ***	0.672 ***	0.433 ***	0.363 **
		(0.203)	(0.252)	(0.136)	(0.161)
OC_OPTIONS	+	0.689 **	0.705 *	0.286 **	0.278 **
		(0.285)	(0.362)	(0.114)	(0.140)
D(GrtExp)	−	−0.767		−0.785 **	
		(0.500)		(0.315)	
D(GrtPrfl)	?	−0.956 **		0.074	
		(0.391)		(0.197)	
D(LowRes)	?	−0.202		0.030	
		(0.345)		(0.220)	
Controls		*yes*	*yes*	*yes*	*yes*
Year fixed		*yes*	*yes*	*yes*	*yes*
Industry fixed		*yes*	*yes*	*yes*	*yes*
Clustered std errors		*CEO level*	*CEO level*	*CEO level*	*CEO level*
Pr > χ^2		0.001	0.001	0.001	0.001
Pseudo adjusted R^2				22.52%	24.11%
Log pseudolikelihood		−573.593	−375.761	−2,702.048	−1,823.600
N		3,417	2,282	3,909	2,643
Summary of main results for the other two overconfidence proxies:					
D(*WHR*>median)	+	0.616 ***	0.701 ***	0.441 ***	0.389 **
		(0.202)	(0.257)	(0.135)	(0.160)
OC_FIRM4	+	1.572 ***	1.538 ***	0.832 ***	0.840 ***
		(0.319)	(0.371)	(0.115)	(0.141)
D(*WHR*>median)	+	0.650 ***	0.766 ***	0.442 ***	0.387 **
		(0.201)	(0.254)	(0.134)	(0.158)
OC_FIRM5	+	1.506 ***	1.486 ***	0.763 ***	0.717 ***
		(0.270)	(0.326)	(0.111)	(0.131)

Panel A of this table presents the Pearson (upper triangle) and Spearman (lower triangle) correlation matrix of CEO testosterone level (measured by *D(WHR>median)*) and means of the CEO overconfidence proxies (measured by OC_OPTIONS, OC_FIRM4, and OC_FIRM5) during the sample period using the CEO level sample of all measurable pictures (N = 1,136). Similar results obtains when we use the sample of good quality pictures (N = 763). Variable definitions of *D(WHR>median)* and the CEO overconfidence variables are provided in Appendix A. Panel B (Panel C) repeats the analyses in Table 4 (Table 5) with the CEO overconfidence proxies as additional control variables.

Table 7: Coefficient estimates and summary statistics for Cox proportional hazard regressions and logistic regressions relating CEO stock option backdating to CEO testosterone level

Variable	Pred. Sign	Hazard Rate (Backdating) Measurable pictures (1)		Hazard Rate (Backdating) Good quality pictures (2)		D(Backdating) Measurable pictures (3)		D(Backdating) Good quality pictures (4)	
Intercept						−9.140	***	−5.852	
						(2.846)		(3.603)	
D(*WHR*>median)	+	0.393	***	0.323	*	0.349	**	0.226	
		(0.139)		(0.180)		(0.141)		(0.176)	
D(GrtExp)	−	−0.263				−0.205			
		(0.284)				(0.280)			
D(GrtPrfl)	?	−0.139				0.077			
		(0.226)				(0.214)			
D(LowRes)	?	0.498	**			0.345	*		
		(0.198)				(0.197)			
Adjusted return		−0.116		−0.155		−0.320		−0.203	
		(0.194)		(0.252)		(0.202)		(0.257)	
Volatility		1.552	***	1.784	**	1.675	***	1.693	**
		(0.537)		(0.701)		(0.547)		(0.690)	
ROA		1.024		1.683		2.095		2.241	
		(1.639)		(2.167)		(1.517)		(1.981)	
Book to market		0.227		0.007		0.069		−0.290	
		(0.426)		(0.533)		(0.462)		(0.564)	
Price to earnings		0.005	**	0.003		0.002		0.002	
		(0.002)		(0.003)		(0.002)		(0.003)	
Loss		0.339		0.400		0.193		0.237	
		(0.336)		(0.431)		(0.323)		(0.429)	
Leverage		−0.112		0.084		−0.071		−0.164	
		(0.499)		(0.684)		(0.509)		(0.686)	
Ln (Market value)		−0.161	*	−0.059		−0.160	*	−0.201	*
		(0.093)		(0.104)		(0.096)		(0.108)	
Sales growth		−0.133		0.234		−0.329		0.348	
		(0.340)		(0.476)		(0.343)		(0.457)	
Free cash flow		0.107		0.422		−0.249		−0.121	
		(0.282)		(0.310)		(0.299)		(0.387)	
RD		0.398		−0.008		1.388		2.400	*
		(1.268)		(1.480)		(1.158)		(1.439)	
Ln (Firm age)		−0.082		−0.301	*	0.061		0.149	
		(0.132)		(0.165)		(0.130)		(0.170)	
Ln (CEO age)		−1.390	**	−0.801		−1.104	*	−1.020	
		(0.650)		(0.823)		(0.620)		(0.846)	
Ln (CEO tenure)		−0.017		−0.029		0.035		0.047	
		(0.054)		(0.067)		(0.056)		(0.071)	
CEO power		−0.057		−0.128		−0.100		−0.171	
		(0.092)		(0.119)		(0.098)		(0.123)	
Inside CEO		−0.162		−0.122		−0.097		−0.024	
		(0.149)		(0.182)		(0.155)		(0.189)	

Table 7 *continued*

	(1)		(2)		(3)		(4)	
TopExDrct	0.039		0.100		0.005		0.047	
	(0.115)		(0.142)		(0.117)		(0.141)	
CEO appoint	−0.041		−0.136		0.385		0.039	
	(0.312)		(0.425)		(0.344)		(0.438)	
Independent director	1.188	*	1.262		0.803		1.006	
	(0.641)		(0.789)		(0.606)		(0.872)	
Board size	0.053		0.044		0.018		0.061	
	(0.043)		(0.052)		(0.040)		(0.047)	
Ln (Salary)	0.414	*	0.409		0.652	***	0.940	***
	(0.238)		(0.285)		(0.249)		(0.339)	
Ln (Bonus)	0.044		0.000		0.089		0.031	
	(0.109)		(0.142)		(0.112)		(0.135)	
Ln (New option PPS)	0.092	***	0.078	**	0.106	***	0.063	*
	(0.028)		(0.035)		(0.028)		(0.035)	
Ln (New stock PPS)	0.047	**	0.038		0.015		0.022	
	(0.022)		(0.026)		(0.023)		(0.029)	
Ln (Equity holdings)	−0.152	**	−0.115		−0.146	*	−0.061	
	(0.077)		(0.092)		(0.078)		(0.094)	
%Backdating industry members	6.325	***	5.511	***	10.555	***	10.730	***
	(0.324)		(0.345)		(0.595)		(0.677)	
Fixed date	0.435	***	−0.685	***	0.592	***	−0.918	***
	(0.147)		(0.190)		(0.146)		(0.188)	
Option to compensation	1.310	***	0.719	*	0.986	***	0.912	**
	(0.303)		(0.382)		(0.331)		(0.428)	
Director same day	0.589	***	0.499	***	0.686	***	0.554	***
	(0.146)		(0.183)		(0.147)		(0.187)	
CEO ownership	3.039		0.980		3.691	*	1.091	
	(2.028)		(2.619)		(2.166)		(3.139)	
Year fixed	*yes*		*yes*		*yes*		*yes*	
Industry fixed	*yes*		*yes*		*yes*		*yes*	
Clustered std errors	*CEO level*		*CEO level*		*CEO level*		*CEO level*	
Pr > χ^2	0.001		0.001		0.001		0.001	
Pseudo adjusted R^2					27.79%		34.00%	
Log pseudolikelihood	−1,336.207		−805.261		−941.878		−580.919	
% correctly classified					86.70		90.00	
N	3,559		2,410		4,631		3,145	

This table presents analysis of association between CEO testosterone level measured by *D(WHR>median)* and CEO stock option backdating measured by (1) *Hazard Rate (Backdating)*, the probability of a CEO stock option backdating in a given year, conditional upon the firm having survived to the beginning of the year, and (2) *D(Backdating)*, an indicator variable coded as 1 if a CEO engaged in stock option grant backdating and 0 otherwise. The event of option backdating is defined in Appendix A. The number of observations in the backdating sample is reduced to 4,631 (3,145) for all measurable pictures (good quality pictures) due to missing data for *CEO ownership*, an additional control variable for backdating. Columns 1 and 2 (columns 3 and 4) reports coefficient estimates and model summary statistics for Cox proportional hazard regressions (logistic regressions) relating *Hazard Rate (Backdating)* (*D(Backdating)*) to *D(WHR>median)* and a vector of control variables. Variable

Table 7 *continued*

definitions are provided in Appendix A. We winsorize the variables at 1% and 99%, with the exception of *RD* and *Leverage* where only the top percentile observations were winsorized. We run separate regressions for the sample of all measurable pictures (columns 1 and 3) and for the sample of good quality pictures (columns 2 and 4). The Cox proportional hazard model estimates how soon in the CEO's tenure a CEO option backdating occurs. Once it occurred, we truncate all further observations for that CEO from the sample. Hence, the number of observations is reduced to 3,559 (2,410) for all measurable pictures (good quality pictures). Two-tailed probability values computed using standard errors clustered by CEO are reported in parentheses.