The Face of Risk:

CEO Facial Masculinity and Firm Risk

Shinichi Kamiya[1] Y. Han (Andy) Kim[2] Soohyun Park[3]

02/11/2018

Abstract

We examine whether a male CEO's facial masculinity, measured by facial width-to-height ratio (fWHR), predicts the riskiness of his firm. Using the face pictures of 1,162 CEOs in the Execucomp database, we find supporting evidence. Firms with more masculine-faced CEOs have higher stock return volatility and higher financial leverage and are more acquisitive. Their frequency of acquisitions, the dollar amount spent on acquisitions, and the takeover premium are all higher. We find that more masculine-faced CEOs' compensation is more sensitive to the risk of the firm. The result is robust when we use AI (artificial intelligence)-measured fWHR of the CEOs.

Keywords: masculinity, testosterone, risk, CEO, leverage, M&A, fWHR, VEGA

JEL Classification: G02, G32, G34, M1, Z1

[1] Assistant professor of Finance, Nanyang Business School, skamiya@ntu.edu.sg, +65-6790-5718, S3-B1B-64 Nanyang Business School, Nanyang Technological University, Nanyang Avenue, Singapore 639798.
[2] Corresponding author. Associate Professor of Finance, SKKU, email: ayhkim@skku.edu . Tel: +82-2-760-0622. Business School Building #524, Sungkyunkwan University, Seoul, Korea. A significant part of the data collection was done when I was working at Nanyang Business School in Singapore.
[3] Soohyun Park is a student at SKKU Business School majoring in Global Business Administration. Email: tngusqkr1@skku.edu. We thank the session participants at the AFA 2017 in Chicago, FMA Asian Conference in Seoul, 2015, Korea Finance Association Annual Meeting 2015, Cambridge University, SKKU, University of Edinburgh, and UNIST. We thank Malcolm Baker, Jong-bom Chay, Henrik Cronqvist, Stephen Dimmock, John Doukas, John Griffin, Umit Gurun, Gerard Hoberg, Jarrad Harford, Mark Humphrey-Jenner, Jennifer Lerner, Christian Leuz, Angie Low, Jun-Koo Kang, Ulrike Malmendier, Chris Parsons, Richard Roll, Burkard C. Schipper, and Jungwon Seo for insightful comments. We also thank the great research assistantship of Yujing Ma, Matthew Lim, Nico Dharmawan, You Ye, Li Rui, Yong Mei Ling, Loo Pei Yu, Liew SiQi, Fam Suen Li, Goh Hui Min, Youngjae Jay Choi, Tae Hoon Jeon, Seung Deok Shin, Liang Sihui, Lim Shi Bin, Goh Le Min, and Xu Fuqui. All errors are our own. Our Python code is available upon request.

I. INTRODUCTION

In the upper echelon of corporate management, the literature stemming from Bertrand and Schoar (2003) finds a significant impact of the traits of the CEO on firm decision making. On the behavioral front, the association between CEO overconfidence and corporate performance has been widely studied. For example, the impact of CEO overconfidence or self-attribution bias on corporate investment (Malmendier and Tate (2005); Ben-David, Graham, and Harvey (2007)); acquisitions (Doukas and Petmezas (2007); Malmendier and Tate (2008); Y. H. A. Kim (2013)); innovation (Hirshleifer, Low, and Teoh (2012)) and many other areas have been examined. Recently, researchers find that the biological traits of the CEOs, especially, facial masculinity, are linked to corporate financial policies and performance (Wong, Ormiston, and Haselhuhn (2011); Jia, Lent, and Zeng (2014); and Gomulya, Wong, Ormiston, and Boeker (2016)).[4]

Recent literature in neuroendocrinology established that men's facial width-to-height ratio (fWHR, hereafter) predicts masculine social behaviors that are linked to occupying dominant positions under competition. Carré and McCormick (2008) and Christiansen and Winkler (1992) find that high fWHR is associated with more aggressive behavior. Campbell et al. (2010) find that fWHR predicts sensation-seeking behavior. Haselhuhn and Wong (2011) find that high fWHR persons are more likely to cheat their negotiation partners for financial gain. Thus, Stirrat and Perrett (2010) find that men with high fWHR are perceived as less trustworthy. However, Stirrat and Perrett (2012) find that in an inter-group competition setting, the men with high fWHR cooperate more with other in-group members and show more self-sacrificing cooperation to win the competition against the other groups. Hence, Wong et al. (2011) find that male CEOs with high fWHR achieve better financial performance than male CEOs with low fWHR do. Jia et al. (2014) find that masculine-faced CEOs are more likely to misreport accounting statements. Gomulya et al. (2016) interpret the masculine face as less trustworthy and find that executives with high fWHR are less likely to be appointed as the CEO after the dismissals of CEOs

[4] Adams, Keloharju, and Knüpfer (2016) study finds that some traits are related to career success to become CEOs as in Du, Gao, and Levi (2012)

with financial misconduct. Extending the literature, we study whether the CEOs with more masculine faces make the firms more risky and spend more resources in acquisitions to achieve dominant positions in the industry.

Whether facial masculinity is directly affected by testosterone, a steroid hormone that drives a person to take more risk to occupy a dominant position in a competitive setting, is still in debate in the literature. Verdonck, Gaethofs, Carels, and de Zegher (1999), Nie (2005), Thornhill and Møller (1997), Thornhill and Gangestad (1999), and Lindberg et al. (2005) document that more testosterone during the pubertal stage makes the facial bone grow to be more masculine with higher fWHR. Pound, Penton-Voak, and Surridge (2009) find that more masculine-faced males show higher circulating testosterone level after winning a competitive task than less masculine-faced males do. In contrast, experimenting with 91 Tsimane tribe adolescents in South American jungle, Hodges-Simeon, HansoSobraske, Samore, Gurven, and Gaulin (2016) document that fWHR is not affected by pubertal testosterone level. However, once they control for the age of the subjects, they still find significant association between fWHR and testosterone. Moreover, an individual's fWHR does not change significantly over time, particularly after puberty (Jia et al. (2014)). Lefevre, Lewis, Perrett, and Penke (2013) find that fWHR is significantly positively correlated with both the levels of baseline (circulating) and reactive testosterone. Additionally, Penton-Voak and Chen (2004) find that males with facial masculinity have higher testosterone levels in their saliva.

The level of testosterone is thought to be associated with the person's behaviors through neural mechanisms (Dabbs and Mallinger (1999); and Mehta and Beer (2010)). Studies have uncovered that a set of related behavioral characteristics are associated with testosterone levels. Those include aggression (Archer (2006)), sensation seeking (Roberti (2004)), hostility (Hartgens and Kuipers (2004)), dominance (Mazur and Booth (1998); G. D. Sherman, Lerner, Josephs, Renshon, and Gross (2016)), egocentrism

(Eisenegger, Naef, Snozzi, Heinrichs, and Fehr (2010)), and risk seeking (Apicella et al. (2008)).[5] Apicella et al. (2008) find that men with masculine faces as a proxy for higher testosterone exposure during puberty are more likely to make risky financial decisions. Sapienza, Zingales, and Maestripieri (2009) and Stenstrom, Saad, Nepomuceno, and Mendenhall (2011) show that risk aversion is negatively related to prenatal testosterone exposure measured by the ratio of the length of the 2nd (index) finger to the length of the 4th (ring) finger (2D:4D ratio).[6] Coates, Gurnell, and Rustichini (2009) find that a lower 2D:4D ratio of male traders delivers better trading performance.[7, 8]

Our argument is slightly different from proposing more gender diversity as in Huang and Kisgen (2013), Adams and Ragunathan (2015), or Faccio, Marchica, and Mura (2016). Instead, we study whether, within the same gender (specifically male) group, the different levels of masculinity of the CEO drive the firm to be systematically different in terms of risk and dominance, supporting behavioral consistency theory (Epstein (1979); Funder and Colvin (1991)). The CEOs of large corporations and the bankers around the world have been criticized for their masculinity-driven culture, particularly after the financial crisis in 2008, because of their excessive risk taking behavior before the crisis (Adams and Ragunathan (2015); G. Sherman (2012)).[9] A recent report by Perman (2012) reveals that testosterone therapy became popular among Wall Street traders and some corporate CEOs, because it helps them to be more masculine and be more willing to take risks. Therefore, it is imperative to study the impact of the masculinity of the CEO on the risk of the firm: Just how much does masculinity make the firm more risky?

Based on our hand-collected face pictures of 1,162 unique CEOs in Execucomp (largest 1,500 public US firms) in the non-financial industry, our multiple regression analyses show a significantly

[5]Other studies include Mehta, Jones, and Josephes (2008), Pound, Penton-Voak, and Surridge (2009), and Zuckerman and Kuhlman (2000) for risky behavior; Wright, Bahrami, Johnson, Di Malta, Rees, Frith, and Dolan (2012) for egocentric behavior. Other studies include Van Honk and Schutter (2007), Wirth and Schultheiss (2007), Josephes, Sellers, Newman, and Mehta (2006).

[6] Higher (lower) prenatal testosterone causes lower (higher) 2D:4D ratio.

[7] Coates, Gurnell and Sarnyai (2010) summarize their findings and provide an excellent survey of the relationship between steroid hormones and financial risk-taking.

[8] However, whether testosterone is really driving the risk taking behavior is also debated. Schipper (2014) fails to find a significant relationship between testosterone and risk aversion in competitive bidding experiments.

[9] Some people in the Wall Street Journal noted that Lehman Brothers might have been safer if it was Lehman Sisters or Lehman Brothers and Sisters (Kristoff, 2009).

positive association between fWHR and the risk of the firm measured by return volatility of the firm controlling for CEOs' overconfidence (Malmendier and Tate (2005)). In addition, to make sure that what we find is not driven by some extreme values of our explanatory variable, we use alternative measures of fWHR, such as the inverse rank of fWHR (the highest fWHR CEO having the largest ordinal number), the dummy variables that are one if the CEO belongs to the highest quantiles of fWHR and find consistent results. Moreover, for the first time in the literature, we use artificial intelligence (AI) to measure the fWHR automatically to steer clear of human error in measuring fWHR and find consistent results in our robustness check section.

For CEOs to influence the risk of the firm, the channel should be either through the capital structure decision or the capital budgeting decision (Brealey, Myers, Allen, and Mohanty (2012)). Therefore, we first look at the leverage ratio and find that more masculine CEOs influence the leverage ratio to be higher. An interquartile range of increase in fWHR predicts a 3.35%-point increase in leverage ratio. Because the CFO is one of the top-level executives who are in charge of financing decisions, we also collect the fWHR of male CFOs and find that both the CEO's and CFO's masculinity equally increases the financial leverage of the firm.[10] For capital budgeting decisions, we look at the acquisitions, because more masculine CEOs would strive for a dominant position (Mazur and Booth (1998); G. D. Sherman et al. (2016)).[11] We find that more masculine CEOs are more acquisitive in terms of the frequency of the deals and the dollar amounts spent on acquisitions and the premium paid to the target shareholders. Moreover, we find that investor response to an acquisition announcement is more negative when the deal is done by more masculine-faced CEOs.

To the extent that a CEO's masculinity affects risk taking in his corporate decisions, the compensation contract should also be affected by his risk preference. Graham, Harvey, and Puri (2013) find that CEOs' risk aversion is associated with their compensation structure. Thus, we analyze the

[10] We deeply appreciate the advice of Christian Leuz for this part of our study.
[11] Based on the saliva sample of 74 male participants in the Education Program at Harvard University, G. D. Sherman et al. (2016) find that persons with high testosterone attain more dominant social status (larger number of subordinates), particularly when their stress hormone (cortisol) level is low, because the latter inhibits testosterone.

compensation structure of the CEO and find that more masculine CEOs' compensation packages are significantly more sensitive to risk (higher VEGA), using Coles, Daniel, and Naveen (2006) measures.

One limitation in our study is that one CEO has one fWHR value, and CEOs are not replaced frequently, which makes it difficult to control for firm fixed effects. Thus, in every regression, we control for industry (4 digit SIC code) and year fixed effects. One might interpret our result as masculine-faced CEOs sorting into more risky firms. However, throughout the paper, we run lead-lag regressions to show intertemporal causality and restrict the sample to the firm years in which the tenure of the CEO is longer than the estimation window of risk.

Moreover, for the firms in which two consecutive CEOs' face pictures are not only available in Google but also of measurable quality, we perform difference-in-difference tests regarding the firm risk. One tricky part is that CEO turnover increases the risk of the firm transitorily due to increased uncertainty coming from a new CEO (Clayton, Hartzell, and Rosenberg (2005)). Despite the empirical regularity, we find that the CEO transitions from less masculine-faced CEOs to more masculine-faced CEOs increase the firm risk (and the number of acquisitions) significantly more than the CEO transitions the other way around (from more masculine-faced CEOs to less masculine-faced CEOs).

We contribute to the research about facial features and social behavior. Todorov, Mandisodza, Goren, and Hall (2005) find that people's inferences about person's competence from looking at his/her facial picture for only one (1) second is correct for approximately 70% of the time.[12] Hamermesh and Biddle (1994) find that a good-looking face commands premium in the labor market, and Halford and Hsu (2014) confirm such a finding in the CEO labor market using a semi-computerized facial beauty scoring system, Anaface.com. Haselhuhn, Ormiston, and Wong (2015) summarize that fWHR is a small but a significant predictor of men's aggression. In contrast, Stoker, Garretsen, and Spreeuwers (2016) run principal component analysis (PCA) based on the intensities of pixels of the face pictures, using a sample of CEOs and non-CEOs. Then, they find that CEO faces are significantly different from non-CEO faces.

[12] For more detailed discussion about faces as major source of information about other people, please refer to Todorov (2017).

However, they fail to find a correlation between firm performance and the principal component that separates the CEO faces from non-CEO faces. Nevertheless, they recognize that they "do not know precisely what facial attributes discern CEOs from Non-CEOs" in the first place. We specifically focus on one feature of the male CEO's face (fWHR) that is well known to be associated with his risk preference, and we find that fWHR has a significant influence on corporate decisions.

The rest of the paper is organized as follows: In Section II, we develop hypotheses to test throughout the paper, and review the literature. Section III is allocated for methodology, such as the data collection process, and key variables in empirical testing. Then, we discuss empirical results in Section IV. We conclude in Section V. We implement extensive robustness checks in the Online Appendix.

II. HYPOTHESES DEVELOPMENT AND LITERATURE

In CEO's style literature (Bertrand and Schoar (2003); Fetscherin (2015)), Cain and McKeon (2011) find that risky hobby of the CEO is associated with the risk of the firm. Bernile, Bhagwat, and Rau (2017); Malmendier, Tate, and Yan (2011) document that the early life experience of the CEO affects the risk of the firm and compensation structure of the CEO. H.-D. Kim, Oh, and Park (2017) find that CEOs with military officer experience are less likely to commit corporate fraud and more likely to adopt conservative corporate policies. Nguyen, Hagendorff, and Eshraghi (2017) find that CEOs' cultural heritage has a significant impact on bank performance in the US. Cronqvist and Yu (2016) find that CEOs with daughters in their family have better CSR (corporate social responsibility) performance due to the female socialization effect. Wong et al. (2011) find more masculine CEOs have a higher ROA, especially for firms that are less cognitively complex firms. They argue that high fWHR CEOs demonstrate more cooperative behavior to the employees and subordinates to win the competition against the other firms.

Given that fWHR is correlated with testosterone, aggressions, and social dominance, all of which are deeply related to risk-preference, it is a natural next step to look at firm risk from the perspective of

behavioral consistency theory (Epstein (1979); Funder and Colvin (1991)).[13] Jia et al. (2014) find that more masculine-faced CEOs are more likely to misreport financial statements, to conduct opportunistic insider trading, and to backdate the option grant. In comparison, we directly link the masculinity of the CEO to the risk of the firm. Therefore, our first hypothesis is as follows:

H1: Masculine-faced CEOs increase the risk of the firms.

To the extent that a CEO could influence the risk level of the firm, he could do so in either financing decisions or investment decisions. For financing decisions, we focus on leverage ratio. A higher leverage ratio increases the financial risk of the firm (Hamada (1972)), and managers have a significant influence on capital structure (Ben-David et al. (2007); Malmendier et al. (2011); Cronqvist, Makhija, and Yonker (2012); Huang and Kisgen (2013)). Chava and Purnanandam (2010) find that the CEO's incentive is strongly correlated with the capital structure of the firm. Therefore, we hypothesize the following:

H2: Masculine-faced CEOs increase the leverage ratio (financial risk) of the firms.

For investment decisions, we focus on acquisitions. The pursuit of the dominant position is one of the most the commonly found traits of high testosterone male in the literature (Mazur and Booth (1998); Alrajih and Ward (2014)). Based on the face photos of 93 male CEOs in the UK FTSE100 index and those of 93 non-CEO males on the Internet, Alrajih and Ward (2014) find that CEOs (presumably in more socially dominant position) have higher fWHR (average fWHR=2.04, SD=0.16) than lay men do (average fWHR=1.87, SD=0.15). They also employ 20 persons to rate the personality impression of the person in the face pictures. They find that face pictures of the CEOs (anonymous and randomly assigned) give a more dominant impression than those of non-CEOs give. Within the CEO group, one of the salient ways of becoming a more dominant figure is to take over other companies. Graham et al. (2013) find that the decision-making authority for acquisitions typically belongs to the CEOs. Moreover, they find that a

[13] Cen and Doukas (2017) find that CEOs with low risk aversion revealed in deferred compensation funds manage riskier firms.

CEOs' preference for risk is an important factor in merger decisions. Cain and McKeon (2011) find that acquisitions driven by the CEOs who have a sensation-seeking tendency increase the risk of the firm. Masculinity may be another factor that drives the CEO to acquire another firm to occupy a dominant position. Therefore, our third hypothesis is as follows:

H3: More masculine CEOs are more acquisitive.

If masculinity of the CEO affects the risk of the firm, it should also affect the incentive contract of the CEO because of the relationship between risk and compensation (Holmstrom and Milgrom (1991); Lambert and Larcker (1987); Yermack (1995); Bushman, Dai, and Wang (2010); Aggarwal and Samwick (1999); Core and Guay (2002); Jin (2002); Prendergast (2002); and Oyer and Schaefer (2005)). Since compensation is an outcome of a contract between the CEO and the board of directors (Shleifer and Vishny (1997)), it would reflect the CEO's risk preference, which in turn is affected by his masculinity. Since more masculine CEOs are more risk seeking, they would prefer to have compensation packages that are more sensitive to the risk of the firm. Empirically, the sensitivity of compensation to the risk is measured with the Vega of the compensation (Core and Guay (2002); Coles et al. (2006)). Thus, our fourth hypothesis is as follows:

H4: More masculine CEOs prefer compensation packages with a high VEGA.

In fact, Mills (2014) also find fWHR is positively correlated with financial leverage. However, his study is largely focused on the financial risk of the firm and uses contemporaneous regressions based on S&P 500 CEOs. In contrast, we investigate comprehensive aspects of firm risk in a coherent manner: total risk, idiosyncratic risk (online appendix), financial risk, M&A, and the sensitivity of CEO compensation upon firm risk. We also link fWHR to various aspects of M&A (Roll (1984); Malmendier and Tate (2005); Doukas and Petmezas (2007); Y. H. A. Kim (2013)), such as the frequency, the dollar amount spent on acquisitions, merger premium, and investor response to acquisition announcements. In addition, we use various alternative measures of fWHR, such as the dummy variable for being in the widest tercile of fWHR. To be clear about the influence of the CEO's masculinity upon firm risk, we

control for various measures of CEO overconfidence, including media-based ones. We use Execucomp CEOs, which cover the 1,500 largest public firms in the US, which makes our study more extensive. We also control for CFOs' fWHR to check whose masculinity matters more in financial leverage decisions. Finally, we use an AI-based measure of fWHR to steer clear of the concern of human errors in measurement.

III. DATA AND KEY VARIABLES

We hand collect the face pictures of 2,683 persons that were identified as the CEO (CEOANN="CEO") in Execucomp data in any of the fiscal years 2007, 2008, or 2009 using a Google search.[14] The procedure of collecting the pictures and measuring fWHR is explained in detail in Appendix A. After screening for better quality pictures for measurement, we are left with 1,418 CEOs. We remove the firms in the financial industry (SIC code=6XXX) because the governance and risk characteristics of financial institutions are very different from non-financial firms. Finally, we are left with 1,162 unique CEOs with good quality facial pictures. We match merge these CEOs to the Execucomp database over the sample period of 1993-2009, so that all the firm years when these CEOs were in the position are in our sample.

We transform the pictures into a standardized gray scale picture with 400 pixels of height and use ImageJ software to measure fWHR, following the literature (Carré and McCormick (2008)). To make sure that the measuring persons are not subconsciously influenced by the risk characteristics of the company, we enforce several steps. First, the research assistants that collect photographs in Google Images are different from the research assistants that measure the photos using ImageJ software. Second, when the picture collecting RA saves the picture file, she saves it as the serial number of the CEOs, which

[14] Since 2008 is the year of the financial crisis, we tried to extensively cover the persons that were in the CEO position before the crisis as well as the persons in CEO positions after the crisis to solve the potential problem that our fiscal year criterion to search CEO picture in the web is driving the result we report. In comparison, Jia, van Lent, and Zeng restrict it to the executives who were in the CEO positions in Execucomp in 2009 only.

are assigned randomly:, i.e., removing any information about the name of the company or the name of the CEO. Thus, when a measuring RA opens the picture file in ImageJ, he has no idea about the company or the CEO. Third, the research assistants are foreign to US corporations in that they are either Singaporeans at Nanyang Business School or South Koreans at SKKU Business School.

As in Appendix Figure 1, for each picture, a research assistant has to pick a point in the face photo and drag the mouse to another point to measure the distance in ImageJ. To minimize human errors in measurement, two RAs measure the same picture independently, and take the average of the two as our key explanatory variable fWHR. Whenever the absolute difference between the two fWHR measures is greater than 5% of the maximum of the two, we employ a third RA and have the picture measured one more time. Then, we take the average of the pair with the minimum difference. Because we cannot be completely free from the concern of human error, we develop a Python/C code to measure fWHR automatically and use it in our last section as a set of robustness checks. In untabulated regressions, we take the average of human measured fWHR and machine measured fWHR, and we find consistent results.

The average fWHR of the CEOs in our sample (non-financial industry) is 2.015 (N=1162, SD=0.153). When we include the CEOs of the financial industry, it is 2.014 (N=1,418, SD=0.154, p25=1.912, median=2.01, p75=2.117). The average fWHR of CEOs in the financial industry and that of CEOs in non-financial industry are not statistically significantly different from each other (p-value of t-test=0.32). Our average fWHR is close to what is reported in the literature (2.04 in Alrajih and Ward (2014)).

We show the breakdown of observations (firm-years) that have non-missing values for the regression in Table 2 with the largest number of observations (N=4,114) in Panels A and B of Table 1. Panel A shows an industry breakdown. Some 34.6% of our sample comes from the manufacturing industry, in particular electronics, metal, and machinery. In addition, more observations are concentrated on wholesale and retail trades (14.5%) and business services (11.2%). In yearly distribution, our sample

shows only until fiscal year 2008 although our original sample period is until 2009, because our dependent variable is the lead value (t+1) whereas our right-hand side variables are as of the concurrent year (t). More than 50% of our sample comes from years after 2004. The industry and yearly breakdowns of our sample are largely similar to those in Cain and McKeown (2014) and Jia, van Lent, and Zeng (2014).

The summary statistics (mean, standard deviation, median, 10th percentile, and 90th percentile) of the dependent variables and right-hand side variables except fWHR are shown in Panel C. Note that the total risk in this Panel A are raw numbers, not annualized or logged ones. In contrast, in regressions in the next subsection, we take the natural log of these risk variables due to the skewness of the distributions. For two-year total risk, when we annualize the average monthly return volatility estimated over the trailing two years (0.11), we obtain 38.1% ($= 0.11 * \sqrt{12}$), which is close to what Cain and McKeown (2014) report (38.8%). Book value based leverage ratio (mean=0.22, SD=0.185) is close to what is documented in Chava and Purnanandam (2010) (mean=0.22, SD=0.17). The market value-based leverage ratio is higher in that its mean is 0.493. However, the median is closer to what is typically reported in the literature 0.197. We believe this skewness comes from the uniqueness in our data that is more concentrated on 2008 financial crisis, where market value of equity was almost halved. Total assets (average=$7 billion, SD=$32 billion), sales growth (average=13.5%, SD=32.4%), ROA (average=14%, SD=10.9%) tell us that our firm characteristics are largely close to the literature. The CEO characteristics such as CEO age (average=53.6, SD=6.7)[15], tenure (average=7.1, SD=6.5), and overconfidence (CEO's call option being in the money yet not exercised at 67% threshold: average=0.61, SD=0.49) show that the sample CEOs are close to what is typically studied in the literature (Hirshleifer, Low, and Teoh, 2012).[16]

[15] One could interpret CEO age as an alternative measure of testosterone, because Harman, Metter, Tobin, Pearson, and Blackman (2001) show that male testosterone level peaks in the early thirties and decrease with age.

[16] We control for overconfidence, because there is a concern that what we report as the impact of fWHR may actually be coming from overconfidence, although Jia et al. (2014) report that fWHR is not significantly correlated with overconfidence.

We follow Malmendier and Tate (2005) in constructing the overconfidence measure by using four different thresholds (67%, 100%, 150%, and 200%) of being in the money at the end of the fiscal year and report in the Online Appendix.

IV. EMPIRICAL MODELS AND RESULTS

Our empirical model in testing H1~H3 are generally as follows:

$$Y_{i,t+1} = \beta_0 + \beta_1 fWHR_{i,t} + \gamma X_{i,t} + Industry.FE + Year\ FE + \epsilon_{i,t} \ldots\ldots\ldots\ldots (1)$$

$Y_{i,t+1}$ represents the dependent variable of firm *i* in year *t+1* (lead value) that we are interested in (risk, leverage, and acquisition in each subsection). $fWHR_{i,t}$ is the facial width to height ratio of the CEO of the firm *i* in fiscal year *t*. X_{it} is a vector of controls, such as CEO characteristics and firm characteristics that are listed in the previous subsection[17]. Note that the right-hand side variables are all in fiscal year t, but the dependent variable is in fiscal year t+1 (lead-lag regression). The purpose of the setup is to establish intertemporal causality.[18] One CEO has a time invariant value of fWHR, which makes it impossible to control for CEO fixed effects. Only a small subset of Execucomp data has non-missing value of CEO fWHR, and CEOs' turnover rate is low in general. Thus, taking firm fixed effects would over-control and soak up the effect of CEOs' masculinity. Therefore, we control for industry fixed effects based on four-digit SIC codes in all of our regressions.

A. Facial Masculinity and Firm Risk

We first investigate whether more masculine-faced CEOs drive the firm to be riskier. Our dependent variable is the total stock return volatility. Since it is highly skewed to the positive, we take the natural log. In the first regression, we use the monthly stock return volatility over the two fiscal years that ended in t+1. When a new CEO is appointed, half of this measure would reflect the risk preference of the

[17] In untabulated tests, we also investigate whether the relationship between fWHR and risk is curve-linear by including a square term of fWHR. However, we do not find strong support.

[18] In untabulated regressions, we try contemporaneous regressions and find consistent results for most of the regressions throughout the paper.

predecessor. Thus, we eliminate the CEOs whose tenure is less than two years in the regression. We use the control variables in Cain and McKeown (2014), such as overconfidence, CEO age, tenure, and the sensitivities of CEO compensation to firm performance (DELTA) and to firm risk (VEGA). We also control for firm characteristics, such as firm size, financial leverage (book value based), sales growth, ROA, market to book, and the natural log of firm age. We control for industry (4 digit SIC code) and year fixed effects. The result in Column [1] of Table 2 confirms H1 that masculine-faced CEOs drive up the risk level of the company. The coefficient of fWHR is 0.129 (t-stat=3.08). When we consider the unconditional mean of average annualized return volatility of 38.1%, an increase in fWHR from the 25th percentile to the 75th percentile of fWHR is associated with a 1% point increase in annualized volatility. To put the economic magnitude into perspective, Cain and McKeown (2014) find that having a CEO with the risky hobby of being a pilot is associated with a 2.2-3.5% point increase in annualized return volatility. While the economic magnitude might not seem that large, the impact on derivative securities through VEGA could still be non-trivial.

The coefficients of the controls generally follow the results in Cain and McKeown (2014), e.g., negative association with firm CEO compensation Vega, size, sales growth, ROA, and firm age; and positive association with compensation delta, leverage, and market to book. Interestingly, we do *not* a find statistically significant correlation between our fWHR measure and overconfidence measure (Pearson correlation=-0.038 with statistical insignificance). Still, we find a separate impact of CEO overconfidence upon the level of firm risk. This assures us that the effect of our facial masculinity upon the firm risk is uniquely different from the effect of CEO overconfidence, which is common in the literature (Jia, van Lent, and Zeng (2014); Johnson et al. (2006)).[19]

[19] In an untabulated testing, we fail to find a correlation between narcissism and testosterone, using the transcripts of the CNBC interviews and the transcripts of quarterly earnings conference calls. Again, this reaffirms that testosterone is a trait distinct from narcissism.

In our Online Appendix Chapter One, we use alternative measures of risk, facial masculinity and CEO overconfidence. As an alternative risk measure, we use a one year daily return-based total risk, a three year monthly return-based total risk, and a three year monthly return-based idiosyncratic risk that is the root mean squared error of market model with S&P 500 index return as the market return. As an alternative fWHR measure, we use the inverse rank of fWHR (the largest value being the largest rank number), the dummy variable that is one if the CEO belongs to the larger quantile (decile, tercile, and half). As alternative measures of overconfidence, we use different thresholds of 'in-the-money-ness' as well as media-based overconfidence variable as in Malmendier and Tate (2008). We downloaded 123,270 news articles from Factiva for all the CEOs in non-financial industry in Execucomp over our sample period in XML format (having CEO name and firm name in the article).[20] Then, for any given year, we counted the number of articles that contained the words "(over)confident" or "(over)confidence" or "(over)optimistic" or "(over)optimism". We subtracted the number of articles that had "reliable," "cautious," "conservative," "practical," "frugal," or "steady." We counted these words using Java code and considered the negation of these words as well. We show that the results are robust.

B. AI-based measure of fWHR and firm risk – A Robustness Check

With the advent of technology in image processing and artificial intelligence, computers can not only recognize human faces in any given picture but also identify 68 different and uniquely numbered 'landmarks' (important points for face analysis) in the identified face in the photograph. Please see Appendix Figure 2. This technique is used in the process of obtaining an average face picture based on the face pictures of many different persons. Using our sample of CEO face pictures, we generate the average face of our sample CEO pictures in Panel C, which uses the largest number of CEO face pictures in the literature. In the face-averaging algorithm, to be able to take the average of the coordinates of the landmarks of all the faces, the computer has to identify the landmarks from any given face and obtain the (X, Y) coordinates. At this stage, we interrupt and extract the coordinates of the points needed to measure

[20] Factiva stopped providing XML based news data after 2011.

fWHR. We use PYTHON coding based on the Anaconda platform, which is described in Chapter 2 of the Online Appendix. We provide our Python code upon request.

We input the 1,418 good quality CEO pictures to the algorithm. However, the computer drops 218 of them because it cannot detect faces correctly nor identify landmarks. Hence, with the remaining 1,200 CEO pictures (982 non-financial CEOs and 218 financial CEOs), we obtain the mean fWHR: fWHR=1.877 with an SD of 0.138 for 982 non-financial CEOs and fWHR=1.876, SD=0.147 for 218 non-financial CEOs. Interestingly, AI-measured fWHR is systematically and significantly smaller than human-measured fWHR (p-value < 0.001), yet the correlation coefficient is 0.784 (p-value<0.001). Again, we compare the difference in mean fWHR between the CEOs in financial firms and those in non-financial firms, and we do not find a significant difference (p-value of t-test=0.21). Then, in Column [2] of Table 2, we replicate the regression of risk on AI-measured fWHR. The coefficient is very close (0.13 vs. 0.129), and the statistical significance is preserved (t-stat=2.50).

C. Whose masculinity matters more: CEO vs. CFO?

While the CEO's traits are important determinants in external financing, Frank and Goyal (2007) document that the CFOs "play at least as important a role as" the CEOs in capital structure decisions. Ben-David et al. (2007) find that the CFO's overconfidence is an important factor in financing decisions. Chava and Purnanandam (2010) find that the CEO's incentive is strongly related to capital structure decisions, while the CFO's incentive is strongly related to debt maturity decisions. Motivated by the literature on "CEO vs. CFO," we test whether the CFO's fWHR has any influence on firm risk. Thus, we hand collect the face pictures of the CFOs in the Execucomp database.

We use a two-step approach to identify CFOs in Execucomp. First, Execucomp has been identifying CFOs since 2006, using the CFOANN variable. Thus, we first identify any executives in those firm years in which CFOANN="CFO" as the CFOs. Then, we eyeball all the title strings (TITLEANN) of these CFOs in these years to infer the typical title strings of CFOs in general. We find

that “CFO,” “Chief Financial Officer,” “Chief Fin. Officer,” and “Treasurer,” etc. are most commonly included in the official titles. However, sometimes, the companies have multiple executives with these words in string of TITLEANN. In such cases, the one with the highest compensation is typically labeled the CFO of the fiscal year. Hence, for the fiscal years until 2005, we find the highest paid executives with the above-mentioned words in TITLEANN and identify them as the CFOs. Through this process, we identify 6,278 unique CFOs. Then, we search their face photos in Google Images again and go through the same process as in Appendix A. For 1,870 CFOs, we were able to obtain good quality face pictures. Note that the proportion of CFOs whose face pictures are found (29.3%=1,870/6,278) is much lower than the proportion of CEOs we found in the previous subsection (52.9%=1,418/2,683). This is because CEOs are much more exposed to the outside media and are more prominent figures as the representatives of their companies than CFOs are. Additionally, we find that 84 of these CFOs were eventually promoted to CEOs in our sample.

Therefore, we have three classes of executives as follows: [1] Pure CFOs that were not promoted to CEO in the same firms during our sample period (N=1,786, average fWHR=1.975, SD=0.164). [2] CFOs that were promoted to CEOs in the same firms in our sample period (N=84, average fWHR=1.994, SD=0.167). [3] Pure CEOs who were not CFOs before in the same firms (N=1,334, average fWHR=2.015, SD=0.155). We first compare the mean fWHR of [1] and [3] and find pure CEOs have more masculine faces than pure CFOs do. The t-statistic of the difference of mean is 6.91, which gives a p-value of less than 0.0001. When we test the difference of mean between [1] and [2] or between [2] and [3], we do not find a significant difference (p-values of t-test being 0.295 and 0.225, respectively). Thus, we find that within the same organization, the CEO’s face is more masculine than the CFO’s face, which reaffirms that higher fWHR is associated with dominance in a corporate hierarchical setting (Alrajih and Ward (2014)).

For the firm years that have non-missing values for both the CEO's fWHR and the CFO's fWHR, we regress the total risk of the firm on the CEO's fWHR and the CFO's fWHR and show the result in Column [3] of Table 2. The result shows that the impact of the CFO's facial masculinity on firm risk is non-trivial and no different from that of the CEO's facial masculinity. The coefficient of fWHR (CFO) is 0.194 with a t-statistic of 3.06, while that of fWHR (CEO) is 0.208 with a t-stat of 2.93. We run F-tests of equality of coefficients in each regression but fail to reject the null that they are the same. In untabulated regressions, we use various alternative measures of CEO overconfidence as controls and still obtain consistent results. Our results confirm that the impact of the CFO's characteristics on leverage and firm risk is at least as big as that of the CEO's.

D. Facial Masculinity and Financial Risk

If the masculinity of the CEO increases the risk of the firm, one possible empirical channel could be the CEO's decision on financial leverage (Frank and Goyal (2007); Ben-David et al. (2007); Malmendier et al. (2011); Cronqvist et al. (2012); Huang and Kisgen (2013)). Thus, in this subsection, we investigate whether masculine CEOs increase the leverage ratios of the firms. We start by regressing book value based leverage ratio in year $t+1$ upon the fWHR of the CEO and controls in year t with industry and year fixed effects. Following Cain and McKeon, (2014), our vector of controls are as follows: (1) CEO overconfidence dummy; (2) CEO age; (3) log of CEO tenure; (4) compensation delta; (5) compensation VEGA; (6) sales growth; (7) ROA; (8) market to book ratio; (9) firm size (log of assets); and (10) collateral, for which the gross property, plant, and equipment divided by total assets serves as proxy.

Consistent with our H2, we find that more masculine CEOs significantly increase the leverage ratio of the firm in Column [4] of Table 2. An increase in fWHR by interquartile range (0.205) is associated with an increase in leverage ratio by a 1.05% point from the unconditional mean leverage ratio of 22% (t-stat = 2.96 and p-value < 0.01). The impact is both statistically and economically significant. The coefficients of control variables are largely consistent with the literature in that leverage ratio is

higher for larger firms and the firms with more collateral. In Column [5], we do a robustness check by replacing the dependent variable with market value based leverage ratio and find consistent results. An increase in fWHR by interquartile range is associated with an increase in leverage ratio by a 3.35% point. In Column [6] of Table 2, we include fWHR(CFO) to test whether the impact of the CFO's masculinity is larger than that of the CEO's masculinity. Again, as in Column [3], we find that the impact of the CFO is as large as the impact of the CEO in financial risk decisions. Chapter 1 of Online Appendix shows our robustness checks using alternative measures of fWHR and overconfidence.

E. Facial Masculinity and Acquisitions

Masculinity – particularly fWHR – is associated with the pursuit of social dominance (Mazur and Booth (1998); G. D. Sherman et al. (2016)). One of the legitimate ways to pursue social dominance in the profession of CEO is to take over another company. Indeed, acquisition is an important capital budgeting decision that could affect the risk of the firm. Thus, in this subsection, we test whether masculine-faced CEOs are more acquisitive. Using SDC Platinum data, we obtain the information about completed acquisitions in which more than 50% of target shares were acquired and in which the deal value was at least five million dollars. As in Guner, Malmendier, and Tate (2008), leveraged buyouts, recapitalizations, self-tenders, subsidiary acquisitions, spin-offs, exchange offers, repurchases, minority stake purchases, privatizations, and remaining interest acquisitions are excluded.

We first run logistic regressions, in which the dependent variable is the dummy variable that is one if the firm acquired a target or more in fiscal year *t+1* and zero otherwise. Our key explanatory variable is fWHR of the CEO. Following Cain and McKeown (2014), the control variables (X_{it}) are CEO overconfidence, age, tenure, compensation DELTA and VEGA of the CEO, leverage ratio, dividend yield, ROA, firm size, cash flow (=(net income + depreciation)/lagged property, plant, and equipment), Tobin's Q ((book value of assets + market value of equity - book value of equity)/book value of assets), and investment (=capital expenditure/ lagged property, plant, and equipment). The result is shown in Column [1] of Table 3. The coefficient of fWHR is 1.326 with a t-statistic as much as 4.15, supporting that more

masculine-faced CEOs are significantly more acquisitive than average CEOs are. The result is robust when we use alternative measures of fWHR (Online Appendix). The coefficients of the control variables are consistent with the literature in that overconfident CEOs and more profitable firms are more acquisitive. In Column [2], we replace the dependent variable with the logged value of one plus the count of acquisitions in fiscal year *t+1* and run OLS with the same controls and fixed effects. We find that masculine-faced CEOs are significantly more frequent acquirers, which is consistent with our hypothesis of social dominance and fWHR. In Column [3], we replace the dependent variable with the logged value of aggregate dollar amount spent on acquisitions during fiscal year *t+1*. We use the deal value (either cash or stock value) as the dollar amount for each acquisition. We find that masculine-faced CEOs spend significantly more resources to acquire other firms and achieve social dominance. In Column [4], we replace the dependent variable with the average dollar amount spent (deal value) per deal in fiscal year *t+1*. We consistently find the coefficients of fWHR or its equivalents are statistically significant. The result may indicate that the masculine-faced CEO's appetite for social dominance makes him spend more dollars on each deal on average. At the same time, it may indicate that masculine-faced CEOs indeed go for a larger target than non-masculine-faced CEOs to become a dominant figure faster.

Since there is a chance that the high fWHR CEOs overspend for acquisitions for social dominance, we further analyze the acquisition premium whose data is available in SDC Platinum (N=264). We regress the premium on fWHR and other control variables (overconfidence, age, tenure, firm age, cash flow, capital expenditure, size, ROA, leverage, dividend yield, cash deal dummy that is one if the deal is done by 100% cash payment, log of deal value to assets, and diversification merger dummy). The premium is measured as the deal value announced per share relative to the stock price of the target four weeks before. As robustness checks, in the second regression, we use the one-week premium. In the third regression, we use the one-day premium. Since the premium is highly skewed to the right, we take the natural log of it before we use it as the dependent variable. The results are shown in Panel I of Table 4 in Chapter 1 of Online Appendix. The results show that more masculine-faced CEOs tend to pay higher

merger premiums (t-stat ranges from 1.7 to 2.48), which may be value destroying.[21] Thus, in Panel J of Table 4 in Chapter 1 of the Online Appendix, we analyze the acquisition announcement returns as being significantly more negative if they was driven by masculine CEOs.

F. Difference-in-difference test of risk and fWHR

Due to the fact that one CEO has only one fWHR value, we cannot take CEO fixed effects in our regressions. In addition, infrequent occurrence of CEO turnover and restriction to the CEOs with measurable (good) quality face pictures on the web further narrows down our capability of showing consistent results with firm fixed effects. Instead, in this subsection, we run difference-in-difference analysis for the cases where both of the consecutive CEOs have good quality pictures available on the web.[22] We have 206 CEO turnover cases (200 cases where the firm risk variables are non-missing). First, we classify the CEO turnover into fWHR-increasing turnovers and fWHR non-increasing turnovers. Then, we test whether the change in total risk from the last fiscal year of incumbent CEO to the first fiscal year of new CEO is significantly larger if the turnover is fWHR-increasing. The total risk is daily return volatility over the fiscal year, and we find strongly supportive evidence. While the total risk increases regardless of the change in fWHR surrounding turnover, we find that the increase is significantly larger by 0.87% on a daily basis if it is fWHR-increasing (t-stat=2.88). (Panel A of Table 5 of Chapter 1 in the Online Appendix)

When we do the same test using two-year total risk based on monthly stock returns for the sample where tenure of both of the CEOs is at least two years, we find consistent results. The fWHR-increasing turnover results in 1.05% higher volatility on monthly basis than fWHR-non-increasing turnovers (t-stat=2.096). Some readers may wonder why the difference in volatility spike is subsiding as we expand the event window from one year to two years. Clayton et al. (2005) document that CEO turnover results

[21] Here, we use the dummy variable that is one if the CEO belongs to top decile in terms of fWHR and zero otherwise. In untabulated regressions, we also use other fWHR variables and find largely consistent results, but the statistical significance is not as strong.
[22] We thank the anonymous referee for the suggestion.

in a spike of volatility in the first year of turnover but that it subsides afterwards. We add to the literature that the spike of volatility is higher and subsiding of volatility is weaker for fWHR-increasing turnover (Panel B of Table 5 of Chapter 1 in Online Appendix). We also subdivide the incumbent CEOs into the ones whose fWHR is higher than median and the ones whose fWHR is not. We also subdivide the new CEOs into the ones whose fWHR is higher than median and the ones whose fWHR is not. Then, we compare the CEO transition from the low fWHR incumbent CEO group to the high fWHR new CEO group and *vice versa*. The results are similar. In addition, we run the same tests for acquisition counts and find consistent results. Thus, our difference-in-difference tests suggest that a masculinity increasing CEO turnover increases the total risk and acquisition count of the firm.

G. Facial Masculinity and Compensation VEGA

Thus far, we find that masculine-faced CEOs increase the risk of the firms. Given that compensation contract is a mechanism to align the interest of the CEO with that of the shareholders (Holmstrom and Milgrom (1987), Shleifer and Vishny (1997)), the choice of compensation package by the CEO may be significantly affected by the preference – namely, masculinity – of the CEO. Specifically, since more masculine-faced CEOs are more risk seeking, they would choose the compensation that increases in the risk of the firm. Compensation VEGA measures the dollar amount change in CEO option holdings when the volatility of the stock changes by one percentage point (Coles, Daniel, and Naveen, 2006).[23] Our prediction is that masculine-faced CEOs would prefer high VEGA compensation. We do not have a specific prediction about the relationship between DELTA (sensitivity of CEO compensation to the sock performance) and fWHR, partly because our argument is focused on the risk-seeking aspect of facial masculinity, and partly because masculine CEOs may know that his risk-seeking decisions might not necessarily lead to better performance. Since the VEGA and DELTA of CEO compensation are jointly determined, we use a simultaneous equation model (SEM). However,

[23] DELTA measures the dollar amount change in compensation when the stock return increases by one percentage point.

since the determinants of DELTA and VEGA are identical in the literature, we use seemingly unrelated regression (Wooldridge (2010)). We use the following empirical model.

$$\ln(1+\text{VEGA})_t = \beta_0 + \beta_1 fWHR_{it} + \gamma X_{it} + \delta Industry\ FE + \psi Year\ FE + \epsilon \ldots.(2),$$

$$\ln(1+\text{DELTA})_t = \beta_0 + \beta_1 fWHR_{it} + \gamma X_{it} + \delta Industry\ FE + \psi Year\ FE + \epsilon \ldots.(3),$$

where X_{it} is a vector of the following control variables guided by the literature in CEO compensation (Frydman and Saks (2010); Benmelech and Frydman (2015); Deng and Gao (2013); Chen, Harford, and Lin (2015); Humphery-Jenner, Lisic, Nanda, and Silveri (2016)): overconfidence, tenure, chairman CEO duality dummy, dummy variable for high ownership of the CEO, CEO age, quarterly ROA volatility over past five years, ROA, leverage ratio, firm size, and market to book ratio.

The results in Table 4 show that masculine-faced CEOs indeed prefer to have high-VEGA compensation. An increase in fWHR by an interquartile range of 0.205 is associated with an increase in VEGA by $7,814 from the unconditional sample mean VEGA of $129,729 (t-stat of 2.11), which is a 6% increase. Thus, the impact of masculinity on VEGA is both statistically and economically significant. The result is robust when we use alternative measures of fWHR. Interestingly, we do not find a consistently significant relationship between facial masculinity and DELTA. However, we confirm that overconfident CEOs tend to have higher DELTA and VEGA compensation packages, which is consistent with the literature.[24] Table 6 of Chapter 1 in the Online Appendix shows our robustness check using alternative measures of facial masculinity.[25]

H. Robustness check: fWHR(AI) for financial leverage and acquisitiveness

In Section C, we showed that the association between fWHR and firm risk is robust when we use an AI-based measure of fWHR. In this section, we use fWHR(AI) as an alternative masculinity measure

[24] Here we use a media-based overconfidence measure. We also try an option-based overconfidence measure, but the results are generally in the same direction with weaker statistical significance.
[25] We also perform a robustness check by controlling for the risky hobbies of the CEO for a subset of the CEOs who had CNBC interviews (tables available upon request).

in regression of leverage ratio and acquisitiveness. Column [1] of Table 5 is the replication of Column [4] of Table 2 in that the dependent variable is the book value based leverage ratio. The coefficient of fWHR(AI) is 0.072 with a t-statistic of 3.23, which reaffirms our finding before that masculine-faced CEOs keep the leverage ratio higher. Columns [2]-[5] of Table 5 are replications of Table 3. The coefficients of fWHR(AI) are statistically significant at the 1%-10% level, depending on the specification, while the economic magnitude is somewhat reduced. Table 7 of Chapter 1 in the Online Appendix shows our robustness check of fWHR(AI) and firm risk, controlling for alternative measures of overconfidence. In Chapter 2 of Online Appendix, we provide the algorithm of measuring fWHR(AI).

V. CONCLUSION

The global financial crisis in 2008 gave a severe lesson about the downside risk of masculine or high-testosterone corporate culture (Adams and Ragunathan, 2012; and Sherman, 2012; Karolyi (2016); Pan, Siegel, and Wang (2016)). Borrowing from the literature of neuroendocrinology, we measure the facial width-to-height ratio of male CEOs as a proxy for the masculinity of the CEOs (Wong, Ormiston, Haselhuhn, 2011; Carré and McCormick, 2008). The empirical channels we find are through leverage increase and acquisitions. Naturally, we find high-fWHR CEOs prefer volatility-inducing compensation packages. Because of our industry fixed effects specification, some readers might interpret our result as either that the influence of masculine CEO on corporate culture is significant or that CEOs with a certain degree of masculinity sort into similar masculine culture corporations. However, our difference-in-difference analyses, in addition to the fact that we use lead-lag regressions throughout the paper with industry-fixed effects, and the fact that fWHR is largely determined in the twenties support the causal argument that CEOs' masculinity is associated with more riskiness in the firms.

We are the first in the literature to use an AI-based fWHR measure and find consistent results that masculinity is deeply related to risk seeking and dominance pursuing. The reasons behind machine-measured fWHR being significantly lower than human-measured fWHR could be an interesting future

research topic in machine learning. Our finding has a profound implication for practitioners as well. Recently, with significant development in FinTech (Philippon (2016); Yermack (2017)), fully Internet-based banks have been opening in various countries. Some of them require the customers to send an accurate picture of photo IDs using their smart phones, which opens up a potential avenue to utilize the Big Data of facial masculinity of retail customers in studying their deposit and borrowing behavior as well as default rate, depending on the legal approval by the government authorities. If nothing else, these Internet banks could perform proprietary research to develop their own model of default prediction.

In addition, our comparison between CEOs' fWHR and CFOs' fWHR opens the gate of contribution to the study of organizational culture. We could consider a two-by-two matrix based on more or less masculine-faced CEOs and more or less masculine-faced CFOs. Which quadrant of combination of top two executives provides better firm performance and risk? Based on the literature about Homophily (McPherson, Smith-Lovin, and Cook (2001)), masculine-faced CEOs would prefer masculine-faced CFOs and generate better performance. On the other hand, the association of high fWHR with aggression and the pursuit of dominant positions would predict more of a "boardroom brawl" or power struggle within the organization, which may be detrimental to firm performance. We leave this as a future research agenda.

Appendix A. Procedure of selecting best quality CEO pictures

We start with 2,683 unique executives that were identified as CEO in any of the fiscal years of 2007, 2008, and 2009 in Execucomp. For each of the CEOs, we collect the facial pictures of the person using his name string in Execucomp and company name string in Compustat using Google Images. We are able to obtain facial pictures for 1,440 CEOs. We follow Carré, McCormick, and Mondloch (2009) to measure the facial width to height ratio. First, each photo was converted to 8-bit, gray scale image with a standard height of 400 pixels. When a picture is big and contains more than the face and upper chest of the CEO, we cut the picture to focus on the facial part and convert it similarly. Then, with the converted picture files two research assistants independently measure the bizygomatic distance and upper facial height (fWHR). Upper facial height is the distance between the midpoint of inner-most point of eyebrows and the center of the upper lip.

Not all pictures are of high quality for our research purpose (directly facing the front, high resolution, neutral expression, and big size). For example, some pictures are too small and have low resolution. We eliminated pictures if the size was smaller than 120x150 pixels. Additionally, since the human face is a 3-dimensional object, while fWHR is measured through a 2-dimensional photo, the measure could be affected by the head posture of the CEO and the angle of the camera. Some pictures are taken from the side (approximately 30-45 degrees) or angled from below or above, which makes it difficult to measure the bizygomatic distance. In some pictures, although the camera angle was directly from the front, the CEO rotated his face clockwise or counterclockwise, but in this case, we treat it as high-quality picture, because we can reverse the rotation and measure correctly. Therefore, two research assistants independently give quality scores of the photograph from zero to three based on the following guidelines:

> 0: Poor posture in which (1) only one ear is visible, because the person is facing sideways; or (2) the photographer took the picture from below or from above so that the measurement of facial height could be problematic.
>
> 1: One ear is perfectly visible, but only half of the other ear is visible because the person is facing slightly sideways.
>
> 2: Both ears are clearly visible to their roots in the face, and the person is looking straight to the front, but the head is slightly rotated either clockwise or counterclockwise.
>
> 3: Perfect posture in which both ears are clearly visible to their roots in the head, and the person is looking straight to the front.

If the rating is zero by any of the RA, we eliminate the picture. By adhering to these guidelines, we narrowed down the total to 1,418 pictures. Then, we eliminated the CEOs in the financial industry (1st digit of SIC=6), and we were finally left with 1,162 unique CEO pictures.

Appendix B. Variable Definition

Variable	definition
Firm Characteristics	
1 year daily return volatility	Standard deviation of daily return over the fiscal year
2 year monthly return volatility	Standard deviation of monthly return over the trailing two years
3 year monthly return volatility	Standard deviation of monthly return over the trailing three years
Cash Flow	The net income plus depreciation divided by lagged property, plant, and equipment
Collateral	Net PP&E divided by total assets
Dividend Yield	Dividend divided by share price as of fiscal year end (DVPSP_F / PRCC_F) following Cain and McKeown (2014)
Firm Age	Fiscal year minus the minimum of two: the first year that the company appeared in Compustat or the first year the company appeared in CRSP
Investment	The capital expenditure divided by lagged property, plant, and equipment
BV Leverage	Book value of leverage ratio is defined as (DLC+DLTT)/AT
MV Leverage	Market value based leverage ratio that is computed as total debt/(total debt + market value of equity). We compute market value of equity as the number of common shares outstanding times the stock price as of the fiscal year end.
M/B	Market value of equity divided by book value of equity
R&D	Research and development expenditure divided by total assets
ROA	Operating income before depreciation and amortization divided by assets
Sales Growth	REVT(t)-REVT(t-1) in Compustat
Tobin's Q	Book value of assets plus market value of equity minus book value of equity divided by book value of assets
Total Assets ($Million)	Compustat data item AT

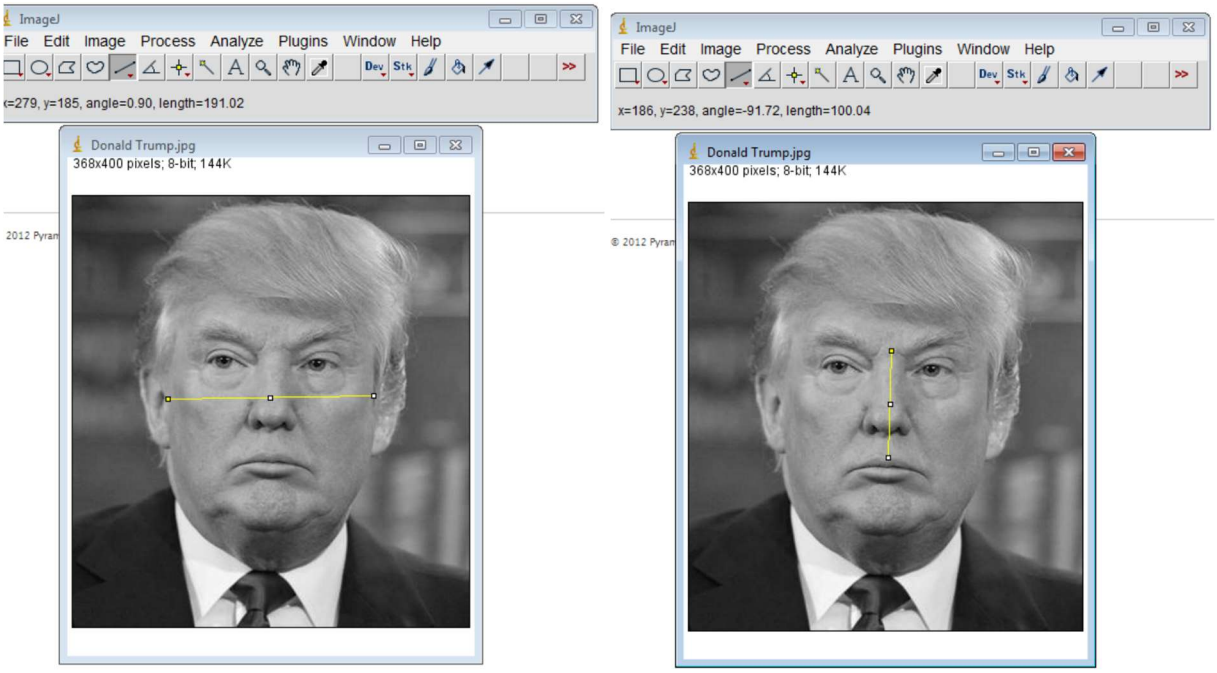
CEO Characteristics

1{Widest Half}	A dummy variable that is one if the fWHR of the CEO belongs to the largest 1/2 of the sample
1{Widest Tercile}	A dummy variable that is one if the fWHR of the CEO belongs to the largest 1/3 of the sample
1{Widest Decile}	A dummy variable that is one if the fWHR of the CEO belongs to the largest 1/10 of the sample
CEO age	Age of the CEO
Delta	Dollar change in CEO's wealth for a 1% change in stock price, following Coles, Daniel, and Naveen (2006)
fWHR	Facial width-to-height ratio. Appendix A describes the detailed procedure of obtaining the facial pictures of the CEOs and measuring fWHR
Inverse Rank of WHR	Inverse of the ranking of the fWHR. Smallest fWHR being rank number 1 and largest fWHR being largest rank number
Overconfidence (ITM X%)	A dummy variable that is one if the unexercised option holding of the CEO is on average more than X% in the money for a second time or more over the sample period. We follow Campbell, Gallmeyer, Johnson, Rutherford, and Stanley (2011)
Overconfidence (Media)	Media-based overconfidence measure as in Malmendier and Tate (2008)
Tenure	Tenure is the number of years the CEO has been in the position. For the CEOs who were captured in turnover classification process, we hand collected the year of appointment. For the CEOs who did not have turnover, we attribute the first year of the CEO in Execucomp as the year of appointment
Vega	Dollar change in CEO's wealth for a 0.01 change in standard deviation of returns, following Coles, Daniel, and Naveen (2006)

M&A Related Variables

1{Cash Deal}	A dummy variable that is one if the merger is 100% financed with cash
1{diversifying merger}	A dummy variable that is one if the two digits SIC codes of the target and the acquirer are different.
1{private target}	A dummy variable that is one if the target firm is a private company
CAR[-1,1]	Cumulative abnormal return over the event window of [-1, 1] trading days using market model based on CRSP VWRETD.
ln(deal value/assets)	Natural log of deal value (SDC Platinum) divided by total assets (Compustat, AT)

Appendix Figure 1. Measuring fWHR using CEO pictures and ImageJ software



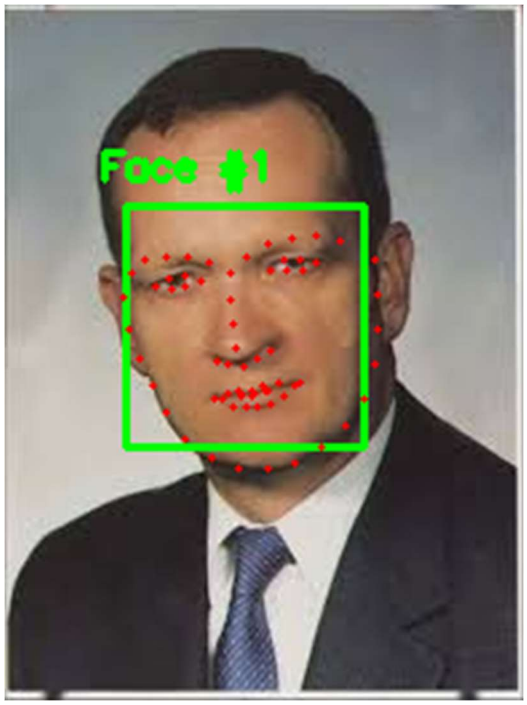
Counting pixels of bizygomatic distance (width) and counting pixels of upper facial height using President Donald Trump's picture.

We follow Carré and McCormick (2008) and Mayew, Parsons, and Venkatachalam (2013) in measuring the facial width-to-height ratio. Specifically, it is the distance between the left and the right zygion (bizygomatic width) divided by the distance between upper lip and the midpoint of the inner ends of the eyebrows (upper facial height). Some researchers, such as Jia, van Lent, and Zeng (2014) and Lefevre, Lewis, Perrett, and Penke (2013), measure the upper facial height in a slightly different manner, in that they measure the distance between the upper lip and the heights point of the eyelids.

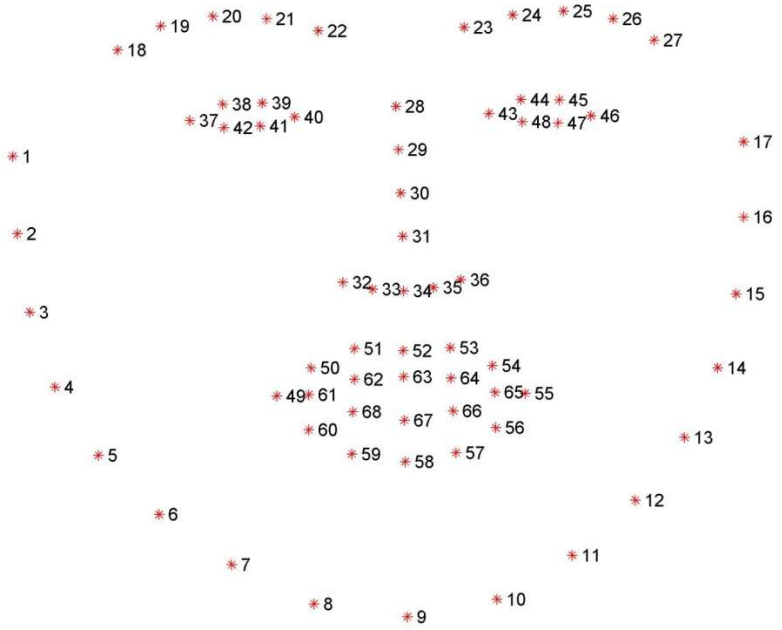
Some readers may question why sometimes, the pictures are squeezed horizontally or vertically, which may bring about unwanted noise. We have three answers: (1) such manipulation biases against finding the results; (2) it is very difficult to believe that the modifiers of risky firms are intentionally flattening the face; and (3) Google image search gives us many different pictures of the same CEO, which enables us to throw out some potentially manipulated pictures.

Appendix Figure 2. Landmarks on a machine recognized face in a picture and average picture of the CEOs.

Panel A. An example of a CEO's face picture in which the landmarks are identified.



Panel B. A diagram showing the 68 landmarks of a face with a fixed sequence number



fWHR is the distance between 2 and 16 divided by the distance between the midpoint of 22 and 23 and point 52.

Panel C. The average face of 1,200 US CEOs in Execucomp

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Table 1. Breakdown of sample and summary statistics

Panel A. Breakdown of firm-year observations by the industry

1 digit SIC code	Industry Description	Freq.	Percent
0	Agriculture, Forestry, Fishing	15	0.36
1	Mining, Construction	278	6.76
2	Manufacturing [food, textile, furniture]	676	16.43
3	Manufacturing [metal, electronic, machinery]	1,425	34.64
4	Transportation & Public Utilities	497	12.08
5	Wholesale & Retail Trade	595	14.46
7	Services [hotels, business svc, recreation]	462	11.23
8	Services [legal, accounting, engineering]	160	3.89
9	Public Administration	6	0.15
Total		4,114	100

Panel B. Breakdown of observations by the year

Fiscal Year	Freq.	Percent
1993	17	0.41
1994	31	0.75
1995	41	1
1996	56	1.36
1997	84	2.04
1998	108	2.63
1999	136	3.31
2000	170	4.13
2001	208	5.06
2002	244	5.93
2003	317	7.71
2004	378	9.19
2005	454	11.04
2006	546	13.27
2007	665	16.16
2008	659	16.02
Total	4,114	100

Panel C. Summary statistics

variable	N	mean	sd	p10	p50	p90
Total Risk 2yr (monthly)	4114	0.110	0.060	0.055	0.098	0.177
BV Leverage	4114	0.220	0.185	0.000	0.213	0.446
MV Leverage	4114	0.493	2.307	0.000	0.197	1.037
Overconfidence	4114	0.614	0.487	0	1	1
CEO Age	4114	53.605	6.688	45	54	62
Tenure	4114	7.103	6.499	1	5	16
Delta	4114	613.168	2095.212	35.360	221.419	1396.097
Vega	4114	129.763	235.015	6.153	56.069	312.886
Sales Growth	4114	0.135	0.324	-0.077	0.098	0.358
Total Assets ($M)	4114	7007.401	32108.380	237.645	1412.773	14272.500
R&D Margin	4114	0.051	0.158	0.000	0.000	0.153
ROA	4114	0.140	0.109	0.057	0.134	0.246
M/B	4114	2.827	8.930	0.973	2.174	5.335
Collateral	4114	0.298	0.231	0.056	0.227	0.675

For variable definition, please refer to Appendix B.

Table 2. Facial Masculinity, Risk and Leverage of the Firm

Column	[1]		[2]		[3]		[4]		[5]		[6]	
DV:	Total Risk		Total Risk		Total Risk		BV Leverage$_{t+1}$		MV Leverage$_{t+1}$			
fWHR	0.129	***			0.208	***	0.051	***	0.163	**	0.271	*
	(3.08)				(2.93)		(2.96)		(1.99)		(1.77)	
fWHR(AI)			0.13	**								
			(2.50)									
fWHR(CFO)					0.194	***					0.264	**
					(3.06)						(1.97)	
Overconfidence	0.026	*	-0.001		0.026		0.018	***	-0.024		-0.094	*
	(1.77)		(-0.06)		(1.01)		(3.16)		(-0.86)		(-1.78)	
CEO Age	-0.001		-0.001		-0.003		0.001	**	0.001		0	
	(-1.05)		(-0.97)		(-1.32)		(2.03)		(0.32)		(-0.07)	
ln(Tenure)	0.02	*	0.01		0.066	***	0.014	***	0.057	***	0.074	*
	(1.69)		(0.67)		(2.83)		(3.23)		(3.04)		(1.74)	
Delta	-0.004		-0.012		-0.025	*	-0.023	***	-0.092	***	-0.067	**
	(-0.47)		(-1.41)		(-1.94)		(-8.69)		(-6.19)		(-2.10)	
Vega	-0.05	***	-0.054	***	-0.03	***	0.003		-0.018		-0.009	
	(-8.69)		(-8.28)		(-3.05)		(1.61)		(-1.49)		(-0.40)	
Size:ln(Assets)	-0.062	***	-0.062	***	-0.044	***	0.036	***	0.102	***	0.055	*
	(-8.10)		(-7.04)		(-3.43)		(13.79)		(7.22)		(1.86)	
Leverage	0.276	***	0.272	***	0.191	**						
	(6.15)		(5.22)		(2.55)							
R&D	0.087	*	-0.03		0.202	*						
	(1.80)		(-0.47)		(1.77)							
Sales Growth	0.08	***	0.074	**	0.17	***	0.019	*	-0.068		-0.103	
	(3.17)		(2.30)		(2.85)		(1.86)		(-1.64)		(-1.46)	
ROA	-0.948	***	-0.892	***	-1.129	***	-0.18	***	-1.213	***	-1.386	***
	(-10.60)		(-8.86)		(-5.81)		(-4.13)		(-6.96)		(-2.96)	
M/B	0.004	*	0.006	**	-0.001		-0.001		-0.006		0	
	(1.69)		(2.03)		(-0.27)		(-0.72)		(-0.79)		(0.01)	
ln(Firm Age)	-0.002	***	-0.001	*	-0.003	***						
	(-3.63)		(-1.68)		(-3.12)							
Collateral							0.087	***	0.082		-0.002	
							(3.65)		(0.68)		(-0.01)	
Constant	-2.015	***	-2.038	***	-2.635	***	-0.098	*	-0.091		-0.874	**
	(-17.73)		(-15.31)		(-8.61)		(-1.95)		(-0.40)		(-2.14)	

Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	3737	2988	1287	4114	4114	1423
Adj.R2	0.641	0.651	0.65	0.515	0.393	0.417

OLS regressions. All regressions control for industry (4 digit SIC code in columns [1], [2], [4], and [5]. 3 digit SIC code in column [3] and [6]) fixed effects and year fixed effects. The t-statistics are based on heteroskedasticity robust standard errors. +, *, **, and *** represent statistical significance at the 15%, 10%, 5%, and 1% levels, respectively. All the continuous variables are winsorized at the 1% and 99% levels except fWHR. For variable definition, please refer to Appendix B.

Table 3. Facial masculinity and M&A

Model	Logit		OLS		OLS		OLS	
Dependent Variable:	$1\{Acquired\}_{t+1}$		$ln(1+\#acquisitions)_{t+1}$		$ln(Agg.\ \$\ Spent\ on\ M\&A)_{t+1}$		$Avg.\$Amt\ on\ M\&A_{t+1}$	
fWHR	1.326	***	0.271	***	1.209	***	1.046	***
	(4.15)		(5.22)		(4.13)		(3.77)	
Overconfidence	0.208	*	0.042	**	0.073		0.044	
	(1.86)		(2.43)		(0.72)		(0.45)	
CEO Age	0		0		-0.001		-0.001	
	(0.05)		(-0.03)		(-0.11)		(-0.08)	
ln(Tenure)	-0.318	***	-0.055	***	-0.253	***	-0.224	***
	(-3.92)		(-4.36)		(-3.66)		(-3.44)	
Delta	0.171	***	0.031	***	0.15	***	0.132	***
	(2.93)		(3.82)		(3.16)		(2.89)	
Vega	0.031		0.004		0.042		0.04	
	(0.70)		(0.67)		(1.12)		(1.12)	
Leverage	-0.575		-0.092	*	-0.588	**	-0.554	**
	(-1.62)		(-1.81)		(-2.01)		(-1.98)	
Dividend Yield	-1.185		-0.096	**	-0.268		-0.216	
	(-0.80)		(-1.98)		(-1.01)		(-0.86)	
ROA	1.127	*	0.126		1.254	**	1.234	**
	(1.68)		(1.24)		(2.12)		(2.19)	
Size:ln(Assets)	0.202	***	0.04	***	0.329	***	0.308	***
	(3.92)		(4.90)		(6.77)		(6.66)	
Cash Flow	0.055		0.006		0.027		0.026	
	(1.49)		(1.02)		(0.86)		(0.87)	
Q	-0.114	**	-0.012		-0.052		-0.049	
	(-2.16)		(-1.51)		(-1.15)		(-1.13)	
CapEx	0.208		0.025		0.164		0.166	
	(1.08)		(0.84)		(1.01)		(1.07)	
Constant	-4.858	***	-0.636	***	-3.773	***	-3.355	***
	(-5.01)		(-4.38)		(-4.70)		(-4.44)	
Industry & Year FE	Yes		Yes		Yes		Yes	
N	3893		4108		4108		4108	
Pseudo R2 or Adj.R2	0.156		0.219		0.189		0.17	

All regressions control for industry (4 digit SIC code) fixed effects and year fixed effects. The t-statistics are based on heteroskedasticity robust standard errors. +, *, **, and *** represent statistical significance at the 15%, 10%, 5%, and 1% levels, respectively. All the continuous variables are winsorized at the 1% and 99% levels except fWHR. For variable definition, please refer to Appendix B.

Table 4. Facial Masculinity and Compensation VEGA

Model:	SUR			
DEPENDENT VARIABLE:	DELTA		VEGA	
fWHR	-0.205	*	0.285	**
	(-1.91)		(2.11)	
Overconfidence (Media)	0.046	***	0.056	**
	(2.59)		(2.53)	
1year stock perf.	0.374	***	-0.08	**
	(11.87)		(-2.01)	
ROA	2.596	***	1.42	***
	(12.57)		(5.47)	
ROA volatility	0.001		-0.002	
	(0.13)		(-0.15)	
Size:ln(total assets)	0.531	***	0.635	***
	(31.38)		(29.88)	
M/B	0.057	***	0.027	***
	(9.86)		(3.74)	
Leverage ratio	-0.69	***	-0.236	*
	(-6.08)		(-1.65)	
Cash/total assets	0.323	*	0.058	
	(1.90)		(0.27)	
R&D/total assets	0.742	*	2.462	***
	(1.65)		(4.34)	
CAPEX/total assets	2.202	***	-0.791	
	(5.56)		(-1.59)	
ln(firm age)	-0.005	***	-0.002	
	(-3.30)		(-1.26)	
CEO age	-0.005	*	-0.016	***
	(-1.81)		(-4.51)	
CEO tenure	0.815	***	0.283	***
	(33.74)		(9.32)	
Constant	-0.482		-2.728	***
	(-1.15)		(-5.18)	
Industry FE	Yes			
Year FE	Yes			
N	3900			

All regressions include industry (4 digit SIC code) fixed effects and year fixed effects. The t-statistics are based on heteroskedasticity robust standard errors. +, *, **, and *** represent statistical significance at the 15%, 10%, 5%, and 1% levels, respectively. All the continuous variables are winsorized at the 1% and 99% levels except fWHR. For variable definition, please refer to Appendix B.

Table 5. CEO's facial masculinity measured by artificial intelligence, leverage, and acquisitiveness of the firm

Column	[1]		[2]		[3]		[4]		[5]	
Dependent Variable:	BV Leverage$_{t+1}$		1{Acquired}$_{t+1}$		ln(1+#acquisitions)$_{t+1}$		ln(Agg. $ Amt on M&A)$_{t+1}$		Agg.$Amt on M&A Rel. to Firm Size$_{t+1}$	
fWHR(AI)	0.072	***	0.984	**	0.183	***	0.651	*	0.031	*
	(3.32)		(2.39)		(2.98)		(1.88)		(1.74)	
Overconfidence	0.014	**	0.253	*	0.053	***	0.117		-0.002	
	(2.03)		(1.91)		(2.72)		(1.04)		(-0.32)	
CEO Age	0.001	*	-0.005		-0.001		-0.009		0	
	(1.74)		(-0.49)		(-0.89)		(-1.05)		(-0.11)	
ln(Tenure)	0.021	***	-0.304	***	-0.047	***	-0.189	**	-0.005	
	(4.21)		(-3.12)		(-3.18)		(-2.42)		(-1.46)	
Delta	-0.026	***	0.094		0.017	*	0.064		0	
	(-8.26)		(1.40)		(1.93)		(1.28)		(0.09)	
Vega	0.005	**	0.034		0.007		0.071	*	0.004	**
	(2.14)		(0.66)		(1.02)		(1.82)		(2.54)	
Leverage			-0.708	*	-0.129	**	-0.835	***	-0.017	
			(-1.75)		(-2.26)		(-2.62)		(-1.10)	
Dividend Yield			-0.745		-0.106	*	-0.304		-0.012	
			(-0.94)		(-1.75)		(-0.89)		(-1.44)	
Sales Growth	0.028	**								
	(2.41)									
ROA	-0.176	***	1.388	*	0.122		1.287	*	0.017	
	(-3.56)		(1.79)		(1.05)		(1.90)		(0.40)	
M/B	-0.001		-0.071		-0.004		-0.008		0.002	
	(-0.60)		(-1.22)		(-0.41)		(-0.16)		(0.74)	
Size:ln(Assets)	0.038	***	0.167	***	0.032	***	0.27	***	-0.007	***
	(12.35)		(2.85)		(3.50)		(5.24)		(-3.06)	
Collateral	0.093	***								
	(3.62)									
Cash Flow			0.047		0.006		0.026		0.003	
			(1.24)		(1.05)		(0.83)		(1.41)	
CapEx			0.3		0.018		0.184		0.017	
			(1.40)		(0.58)		(1.06)		(1.28)	
Constant	-0.147	***	-3.374	***	-0.373	**	-2.109	**	-0.012	
	(-2.69)		(-2.99)		(-2.34)		(-2.40)		(-0.27)	
Industry & Year FE	Yes		Yes		Yes		Yes		Yes	

N	3299	3034	3293	3293	3289
Adj.R2 or Pseudo R2	0.527	0.164	0.18	0.177	0.042

All regressions control for industry (4 digit SIC code) fixed effects and year fixed effects. The t-statistics are based on heteroskedasticity robust standard errors. +, *, **, and *** represent statistical significance at the 15%, 10%, 5%, and 1% levels, respectively. All the continuous variables are winsorized at the 1% and 99% levels except fWHR. For variable definition, please refer to Appendix B.