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# Executive gender, age, and corporate financial decisions and performance: The role of overconfidence

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ABSTRACT

This paper analyzes the interactive effects of executive gender and age on corporate financial decisions and performance using a sample of non-financial US-listed firms. The analysis finds that firms run by young male executives have the worst operating performance, although they raise more external funds and invest more than firms run by old male, young female, and old female executives. Firms run by old female executives have the best operating performance, although they invest the least. Further analysis demonstrates that these variations in decisions and performance are due to differences in executives' overconfidence levels that affect the quality of their investments and, subsequently, their operating performance. The analysis also finds that overconfidence drives risk-taking, suggesting that these two behaviors are not independent of each other, as some researchers claim. However, we find, on average, insignificant differences in firm values among the executive groups due to the different leverage levels employed by them that offset the differences in their operating performance. But at firms that set their leverage ratio close to their target, such that leverage differentials among these firms do not lead to significant differences in their values, old female executives emerge again as the best value creators, followed by young female and old male executives.



## 1. Introduction

Male executives have always dominated top managerial positions. Weak social connections, women's stereotypes, and the glass ceiling are usually cited as the reasons behind the low representation of women in these senior positions. Therefore, it is not surprising that the appointment of a female to a senior managerial position attracts greater public attention and scrutiny than the appointment of a male to a similar position. While female representation in top managerial positions in the United States remains low, many women have risen to the top of the corporate ladder in recent decades, excelled in their positions, and served as role models for women worldwide. Yet, despite the efforts of female executives to demonstrate that they can match the performance of male executives, the literature has found significant differences in financial decisions between the two genders (e.g., Huang and Kisgen, 2013; Faccio et al., 2016), though it is still unclear which gender outperforms the other (e.g., Khan and Vieito, 2013; Kolev, 2012; Wolfers, 2006). Separate from gender, differences in financial decisions have also been observed between young and old executives (e.g., Yim, 2013; Serfling, 2014; Li et al., 2017), but again, it remains unclear which age group outperforms the other (e.g., Chevalier and Ellison, 1999; Serfling, 2014; Eduardo and Poole, 2016).

The literature sometimes attributes gender or age differences in decisions and performance to differences in executives' overconfidence levels (e.g., Huang and Kisgen, 2013; Forbes, 2005), and other times to differences in their risk-taking levels (e.g., Faccio et al., 2016; Serfling, 2014). According to some researchers, overconfidence and risk-taking are two distinct behaviors that lead to different outcomes (e.g., Malmendier and Tate, 2005; Huang and Kisgen, 2013). Overconfident executives overestimate the returns on their projects, leading to overinvestment in unprofitable projects and underperformance, whereas risk-taking executives undertake risky, high-expected return projects, resulting in outperformance. However, recent research has linked differences in risk-taking and overconfidence between the two genders to testosterone levels, a hormone that influences human behaviors, including risk-taking and overconfidence (Apicella et al., 2008; Johnson et al., 2006). Biological studies have found that males have higher testosterone levels than females (e.g., Dabbs, 1990), and testosterone levels decrease with age for both genders

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(e.g., Samaras et al., 2014), with men continuing to have higher testosterone levels than women in old age (e.g., Hogervorst et al., 2010). Since both risk-taking and overconfidence are affected by the same hormone, the two behaviors are most likely correlated rather than independent.

This paper investigates how top executives' gender and age affect their key financial decisions and performance, identifies which of the two behaviors – overconfidence and risk-taking – is the cause of the variations in decisions and performance, verifies whether they change with age for each gender and are independent of each other, and explains the literature controversy over which gender or age group outperforms the other. To that end, the analysis will proceed as follows: In the first stage, we examine the separate effects of executive gender and age on financing and investing decisions and performance to see how each predictor influences the outcome variables and to gain insight into the reasons for variations in executives' decisions and performance. In the second stage, we investigate the interactive effect of executive gender and age on key financial decisions and performance. According to a survey by Rolison et al. (2014), financial risk-taking decreases with age for males but not for females, contrary to biological findings that the hormone that drives overconfidence and risk-taking decreases with age for both genders. Because people make different decisions in real life than they do in surveys, examining the interactive effect of gender and age tells us whether financial decisions and performance change with age for each gender and whether age plays a role in narrowing or widening differences among various executives, allowing us to identify the best-performing executive group. In the third stage, we conduct a formal analysis of executives' overconfidence and risk-taking to determine which of these two behaviors drives the variations in executives' decisions and performance, as well as to determine whether these two behaviors change with age for each gender and are independent of each other, as some researchers claim. Finally, we conduct a robustness test using a different performance measure to explain the literature's debate over which gender or age group outperforms the other.

Using a large sample of non-financial US-listed firms from 1992 to 2018, we find significant differences in financial decisions and operating performance between female-run firms and male-run firms. Female-run firms raise fewer external funds and invest less, but their operating performance outperforms that of male-run firms. We also observe that while external funds raised and investment decrease with executive age, operating performance improves. An examination of the interaction of executive gender and age reveals significant differences in decisions and performance among the executive groups. Firms run by young male executives raise more external funds and invest more than firms run by old male, young female, and old female executives, but their operating performance is the worst. Despite investing the least, firms run by old female executives have the best operating performance, followed by firms run by young female and old male executives. These findings are robust to endogeneity concerns and imply that differences in decisions and performance among executive groups are most likely driven by differences in their overconfidence levels rather than risk-taking levels.

To formally validate our findings, we examine executives' risk-taking and overconfidence using the volatility of stock returns and the overconfidence indicator of Hirshleifer et al. (2012) as proxies for risk-taking and overconfidence, respectively.[1] Young male executives are found to have the highest risk-taking and overconfidence levels, followed by old male and young female executives, while old female executives have the lowest risk-taking and overconfidence levels. These findings support the biological finding that the hormone that influences human behavior, testosterone, is higher in men and decreases with age in both genders. It is also observed that when risk-taking is controlled for, overconfidence has a significant positive effect on investment, whereas risk-taking has an insignificant effect on investment when overconfidence is controlled for. Interestingly, the interaction of overconfidence and risk-taking increases investment significantly. These findings suggest that overconfidence drives risk-taking and that these two behaviors are not independent of each other, as some researchers claim. Since overconfident managers take on low-quality projects, the finding that overconfidence drives both risk-taking and investment explains why young male (old female) executives have the worst (best) operating performance, as these two groups have the highest (lowest) overconfidence levels when compared to other executive groups.

We also test the robustness of our findings using another performance metric, firm value. We find insignificant differences in firm values among the executive groups due to different leverage levels employed by them, which offset the differences in their operating performance. But at firms that set their leverage ratios close to their targets, such that leverage differentials among these firms do not lead to significant differences in their values, old female executives emerge again as the best performers, followed by young female and old male executives.

This paper contributes to the literature in several ways. To begin, we employ an integrated approach to determine the root cause of differences in executives' decisions and performance. Researchers in this field usually rely on differences in one of the decision variables, such as investment or financing, and then attribute the gender differences in decisions to differences in their overconfidence levels (e.g., Estes and Hosseini, 1988; Barber and Odean, 2001; Huang and Kisgen, 2013) or risk-taking levels (e.g., Schubert et al., 2000; Khan and Vieito, 2013; Faccio et al., 2016). Our finding that female executives underinvest but outperform male executives implies that the differences in decisions and performance between the two genders are most likely due to an overconfidence differential rather than a risk-taking differential. The formal analysis we conduct for overconfidence and risk-taking confirms this initial conjecture: male executives are found to have a higher level of overconfidence than female executives, which explains why male executives, despite their higher level of investment, underperform female executives. Furthermore, the analysis finds that overconfidence drives both risk-taking and investment decisions, suggesting that overconfidence and risk-taking are not independent of each other, as some researchers claim.

Second, the literature is still divided on whether female-run firms outperform male-run firms; some researchers found a positive relation between firm performance and female executives (e.g., Welbourne, 1999; Smith et al., 2006; Krishnan and Parsons, 2008; Weber and Zulehner, 2010; Khan and Vieito, 2013), while others documented a negative relation (e.g., Kolev, 2012). Others, however, observed an insignificant gender difference in performance (e.g., Wolfers, 2006; Lam et al., 2013). Our analysis provides a plausible explanation for these mixed results. Female executives, owing to their lower overconfidence and superior investment quality, outperform male executives when using an accounting-based measure of performance that directly captures the return on invested capital. But male executives, who are more overconfident, offset their inferior operating performance by employing more leverage in their firms, resulting in an insignificant difference in the value of their firms and the value of female-run firms. Thus, the overconfidence differential and the performance

[1] Hirshleifer et al. (2012) identify overconfident executives as those whose firm's stock price relative to the strike price of their vested stock options minus one is at least 67%. Thus, if the ratio is equal to or greater than 67%, the overconfidence indicator takes the value of unity, and zero otherwise.

measure used could be the causes of the mixed results. At firms that set their leverage ratio close to their target, such that leverage differentials among these firms do not lead to significant differences in their values, female executives outperform male ones in terms of value creation due to their superior operating performance.

Thirdly, like the literature on gender, the literature on age sometimes attributes the differences in decisions between young executives and old executives to differences in their risk-taking (e.g., Yim, 2013; Serfling, 2014; Li et al., 2017), other times to differences in their overconfidence (e.g., Menkhoff et al., 2013; Forbes, 2005). Our finding that old executives underinvest but outperform young executives indicates that the differences in decisions and performance between the two age groups are most likely due to an overconfidence differential rather than a risk-taking differential. The formal analysis we conduct for risk-taking and overconfidence confirms this initial conjecture; young executives are found to have a higher overconfidence level than old executives, which explains why young executives, despite their higher level of investment, underperform old executives. Fourthly, the analysis finds that overconfidence drives risk-taking, and that these two behaviors decrease with age for both genders, in contrast to the survey findings of Rolison et al. (2014). Indeed, our results show that female executives' overconfidence and risk-taking decline more sharply with age than male executives'.

Fifthly, it is unclear whether young executives outperform older executives; some researchers find that young executives outperform older executives (e.g., Chevalier and Ellison, 1999; Serfling, 2014), while others find insignificant differences in performance between the two age groups (e.g., Eduardo and Poole, 2016). In this analysis, we show that old executives, owing to their lower overconfidence and superior investment quality, outperform young executives when using an accounting-based measure of performance that directly captures the return on invested capital. But young executives, who are more overconfident, offset their inferior operating performance by employing more leverage in their firms, leading to an insignificant difference between the value of their firms and the value of firms run by old executives. At firms that set their leverage ratios close to their targets, such that leverage differentials among these firms do not lead to significant differences in their values, old executives outperform young executives in terms of value creation due to their superior operating performance.

Finally, this analysis identifies the best and the worst-performing executive groups on average under certain conditions. To the best of our knowledge, executive gender and age and their interaction have never been thoroughly investigated at this level. The empirical findings of this study can assist various parties, such as corporate boards of directors in making the right hiring decisions, shareholders in forming their expectations of the firm's performance based on the demographics of its executives, and policymakers in changing negative stereotypes about women and enforcing their gender equality policies and quotas.

The remainder of the paper is structured as follows: Section 2 summarizes the extant literature on the topic and develops our predictions. Section 3 describes the data used in the analyses and the empirical design. Section 4 reports and discusses the results. Finally, Section 5 concludes and discusses the limitations of this study and the scope for future research.

## 2. Literature review

### 2.1. Executive gender and corporate financial decisions

Numerous reasons have been mentioned to explain the scarcity of women at top executive levels. Weak social connections (Medland, 2004), negative stereotypes of women (Broverman et al., 1972; Heilman et al., 1989), and the glass ceiling, an unseen barrier to progression based on an attitudinal or organizational bias (Morrison et al., 1988), are usually cited as the reasons behind the low representation of women in these senior positions. The negative stereotypes of women may explain why women who have successfully climbed the corporate ladder choose to conform to the behaviors and qualities associated with men; they try to demonstrate that they can match the performance of male executives (Offermann and Beil, 1992). Yet, despite these efforts, the literature has found significant differences in financial decisions between the two genders. There are explanations other than the traditional ones, such as agency costs and informational asymmetry, which could explain the differences in decisions and performance between male and female executives. For example, this could be due to differences in their risk-taking and overconfidence levels, disparities in their unemployment risks (Phelps and Mason, 1991; Faccio et al., 2016), variations in their incentive packages (e.g., Hersch, 1998; Mohan and Ruggiero, 2003; Shehu et al., 2017), differences in their incentive structures (Manning and Saidi, 2010), and societal standards and expectations (e.g., Eagly and Karau, 2002; Rudman and Glick, 2001).

Gender differences in risk-taking and overconfidence are the most frequently cited reasons for gender variations in decisions and performance. Psychology and economics literature have noticed significant differences in risk preference between the two genders (e.g., Powell and Ansic, 1997; Vandegrift and Brown, 2005). In a lottery experiment, Schubert et al. (2000) document that, when it comes to investing, females are usually more risk-averse than males when there is uncertainty and ambiguity in investment. Other experiments find similar results: females are more risk-averse than males when making financial decisions (e.g., Charness and Gneezy, 2012). The same applies to corporate decisions; Khan and Vieito (2013) observe that female-run firms have a smaller risk level than male-run firms. Faccio et al. (2016) also document a similar finding using two measures of risk: leverage and earnings volatility.

The conservative financial decisions of female executives are sometimes attributed to their lower overconfidence compared with male executives. An experiment by Estes and Hosseini (1988) finds that women have significantly lower confidence in an investment task than men. Barber and Odean (2001) also document that men trade common stocks more than women but end up yielding lower returns. Huang and Kisgen (2013) also attribute the higher acquisitions and debt issuances of male executives to their higher overconfidence level.

The literature usually distinguishes between overconfidence and risk-taking (e.g., Malmendier and Tate, 2005; Huang and Kisgen, 2013). According to these researchers, risk-taking managers invest in risky, high-expected return projects, which will add value to the firm, while overconfident managers overestimate the return on their projects, which will lead to overinvestment in negative NPV projects and a reduction in firm value. This argument is true if the two behaviors, overconfidence and risk-taking, are independent of each other, but a survey by Nosić and Weber (2010) reports that overconfidence positively affects risk-taking. Besides, recent studies have linked differences in risk-taking and overconfidence levels between the two genders to differences in their testosterone levels, a hormone that affects human behavior (e.g., Apicella et al., 2008; Johnson et al., 2006). Since risk-taking and overconfidence are influenced by the same hormone, it is highly likely that these two behaviors are correlated rather than independent. This analysis aims to identify which of the two behaviors, risk-taking and overconfidence, drives the gender differences in decisions and performance and verify if these two behaviors are independent of each other, as some researchers claim.

### 2.2. Executive age, and corporate financial decisions

Studies have also documented that older executives take on less risk than younger executives due to the financial anxieties that affect the elderly (e.g., Vroom and Pahl, 1971). Yim (2013) finds that young CEOs have a higher probability of performing acquisitions than old CEOs. According to Li et al. (2017), young CEOs are more likely than older ones to enter new lines of business, exit from established ones, and make riskier investments and divestments. Chowdhury and Fink (2017) find that not only do old CEOs underinvest in risky investments, but they also make suboptimal investment decisions. However, overconfidence could also influence the investment decision, where overconfident executives usually invest more than rational ones (Roll, 1986; Heaton, 2002; Malmendier and Tate, 2005, 2008). The literature finds evidence that young adults and executives are more overconfident than older ones (e.g., Menkhoff et al., 2013; Forbes, 2005). Therefore, it is important to find out which of the two behaviors is the reason behind the variations in decisions and performance between the two age groups.

### 2.3. The gap: gender–age interaction

Prior studies have primarily focused on the separate effects of executive gender or age on a certain decision or performance, with little emphasis on the interactive effects of gender and age. We believe executive age plays an important role in how a firm is run and performs. Age could explain the differences in decisions and performance among executives of different genders or age groups, tell us if overconfidence and risk-taking change with age for both genders, and help in identifying the best performing executive group. Levi et al. (2010) find young male CEOs, due to their higher testosterone levels, are more likely to do acquisitions than older ones, and young male CEOs of target firms are more likely to force an acquirer to resort to a tender offer.

The positive association between the testosterone level and risk-taking was initially documented by Apicella et al. (2008). The literature has also found evidence that testosterone levels have a positive effect on overconfidence (e.g., Johnson et al., 2006). Biological studies have found that males have higher testosterone levels than females (e.g., Dabbs, 1990), and testosterone levels decrease with age for both genders (e.g., Samaras et al., 2014), with men continuing to have a higher testosterone level than women in old age (Hogervorst et al., 2010). Finance literature gives support to some of these biological findings; male executives have been found to have higher risk-taking and overconfidence levels than female executives (e.g., Khan and Vieito, 2013; Faccio et al., 2016; Barber and Odean, 2001; Huang and Kisgen, 2013), whereas young executives have been found to have higher risk-taking and overconfidence levels than old executives (e.g., Vroom and Pahl, 1971; Yim, 2013; Li et al., 2017; Chowdhury and Fink, 2017; Menkhoff et al., 2013; Forbes, 2005). However, although overconfidence and risk-taking are found to be affected by the same hormone, the finance literature usually treats the two as distinct behaviors with different outcomes and does not investigate whether these two behaviors change with age for both genders. An exception here is the survey by Rolison et al. (2014), which reports a decrease in financial risk-taking in the later stages of life for men but not for women.

The finding of Rolison et al. (2014) is surprising because if the testosterone level decreases with age for both genders, risk-taking should also decrease with age for both genders. One possible explanation for their finding is that people make different decisions in real life than they do in surveys. As a result, we expect that the biological findings will hold true in real-world corporate decisions. Due to their highest testosterone levels, young male executives are expected to have the highest levels of overconfidence and risk-taking and, as a result, to invest more and raise more external funds to finance excess investments than other executive groups. Furthermore, because testosterone levels in both genders decline with age, we anticipate that younger female executives will invest more than older female executives. Furthermore, because males maintain higher testosterone levels than females even in old age, we expect that old male executives will invest more than old female executives, with the latter investing the least of any executive group. Accordingly, we make the following predictions:

*Prediction 1. Firms run by young male executives are expected to raise more external funds and invest more than firms run by all other executives.*

*Prediction 2. Firms run by old female executives are expected to raise less external funds and invest less than firms run by all other executives.*

A central question in this literature is whether there are gender or age differences in performance, where the literature is still inconclusive. Some studies have found a positive link between top female executives and firm performance (e.g., Welbourne, 1999; Smith et al., 2006; Krishnan and Parsons, 2008; Weber and Zulehner, 2010; Khan and Vieito, 2013). Others have reported a negative relation between firm performance and female executives (Kolev, 2012). Others have discovered an insignificant gender difference in performance (e.g., Atkinson et al., 2003; Wolfers, 2006; Lam et al., 2013). Similarly, the evidence on age differences in performance is mixed; some researchers have found that young CEOs outperform old CEOs (Chevalier and Ellison, 1999; Serfling, 2014); others have documented an insignificant age difference in performance (e.g., Eduardo and Poole, 2016). The contradictory evidence of gender or age differences in performance may be due to differences in executives' levels of overconfidence and risk-taking. While male executives' higher risk-taking may encourage them to undertake projects that add value to the firm, their higher overconfidence may encourage them to invest in negative NPV projects, which would erode the firm's value. Similarly, the value added by young executives as a result of their higher risk-taking may be offset by the value lost as a result of their higher overconfidence. Because young male (old female) executives are expected to have the highest (lowest) levels of overconfidence and risk-taking, we make the following predictions:

*Prediction 3. The performance of firms run by all other executives is expected to be at least as good as the performance of firms run by young male executives.*

*Prediction 4. The performance of firms run by old female executives is expected to be at least as good as the performance of firms run by all other executives.*

## 3. Data source and description

### 3.1. Sample selection

The analysis in this study spans the period from 1992 to 2018 and includes all non-financial firms that have executive information in the Compustat's ExecuComp database. This database reports the title, age, and gender of each executive. For this study, we follow Huang and Kisgen (2013) and focus on the top executives, namely, the CEOs and the CFOs, for two reasons. First, these executives are usually the ones who make the most important, value-relevant financial decisions. Second, we found only 745 firm-year observations for female CEOs, which make inferences drawn from this small sample unreliable. Including observations for CFOs increases the number of female executives to 2,608 firm-year observations.

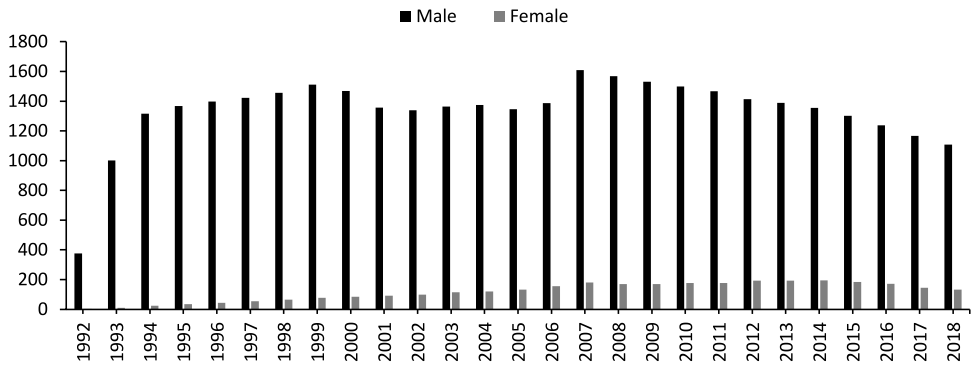


**Fig. 1.** The number of top female and male executives over the sample period.

All financial data are drawn from the Compustat database, except for the volatility of stock returns, whose data are drawn from the CRSP database. Firms for which the database does not have information on the dependent and explanatory variables are discarded. We also exclude financial firms from the analysis. We control for other variables believed to influence firm performance and decisions, like prior studies. Our final sample is made of 28,306 firm-year observations that represent 2,564 firms over the sample period. The descriptive statistics for the variables used in this analysis and their definitions are reported in Table 1 and Table A.1 of the Appendix, respectively. The following subsections explain how each variable is calculated.

### 3.2. Variable definitions

#### 3.2.1. The dependent variables

In this analysis, we focus on financing and investment decisions in addition to firm performance. The financing decision or total external funds raised is calculated as the change in total debt (i.e., long-term debt plus debt in current liabilities) plus share issuance minus share repurchase, scaled by lagged total assets. The investment decision is calculated as the sum of capital expenditure, acquisition, and R&D expenditure, scaled by lagged total assets. In the initial analysis, we shall use the return on invested capital (ROC) as an accounting-based measure of operating performance, calculated as earnings before interest and taxes, scaled by lagged invested capital. Later, we will use a market-based measure of performance, Tobin's Q, when we extend the analysis to measure the value added by different executive groups.

#### 3.2.2. The explanatory variables

The main explanatory variables used in this analysis are the gender and age of the top executives (the CEOs and CFOs). The database reports the title, gender, and age of each executive. However, we found only 745 firm-year observations for female CEOs over the sample period, which represent less than 2.6% of the overall sample. Therefore, to draw reliable inferences, we follow Huang and Kisgen (2013) by expanding the sample to include observations of the CFO, who actively participates with the CEO in making value-relevant financial decisions and may act on behalf of the CEO in his or her absence. By doing this, we obtain 2,608 firm-year observations for female top executives, which represents around 9.2% of the overall sample. A binary variable that takes the value of unity is created for the case when the CEO or CFO is a female (or both are females) and zero otherwise. The average age of the two executives (the CEO and CFO) is used as another explanatory variable.[2] Subsection 3.5 explains in detail how the main and interactive effects of executive gender and age are captured.

[2] Controlling for the age of each of the top executives in the initial analysis does not qualitatively change any of the results.

#### 3.2.3. The control variables

Several control variables that are usually used in the literature are included in this study. First, given the importance of the compensation granted to top executives, we use the average total compensation granted to the CEO and CFO scaled by firm total assets as a control variable. The natural logarithm of total assets, Ln(assets), is used to control for firm size. We also use the ratio of net property, plant, and equipment (NPPE) to total assets to control for asset tangibility. The ratio of cash and short-term investments to total assets is used to control for liquidity. Tobin's Q, the market value of equity plus book liabilities, scaled by the book value of total assets, is used to control for firm future growth opportunities. Additionally, we control for the risk faced by the executive using the volatility of monthly stock returns over the past three years. We also include leverage, calculated as debt in current liabilities plus long-term debt, scaled by total assets, as a control variable. Finally, we will use cash flow from operations scaled by NPPE to control for internally generated funds.

### 3.3. Descriptive statistics for all variables

Panel A of Table 1 reports the descriptive statistics for all firms over the sample period of 1992–2018. The means of our main variables, such as investment, ROC, age, Tobin's Q, and leverage, are like those reported by related studies such as Huang and Kisgen (2013) and Chen et al. (2019). Panel B reports the descriptive statistics for firms run by at least one female executive, while Panel C reports the statistics for firms run by male executives. Panel D reports the results of a comparative analysis made between female-run firms and a randomly selected sample of male-run firms chosen over the sample period.

The statistics in Panels B and C show that firms run by at least one female executive issue fewer external funds and invest less, but have a higher return on capital (ROC) than firms run by male executives. These results hold in Panel D for the randomly selected male-run firms, where female-run firms continue to raise fewer external funds, invest less, and perform better than male-run firms. However, it is also notable that there are differences in some other areas between female-run firms and male-run firms, such as size, cash holding, asset tangibility, and riskiness, which might have driven the differences in their financial decisions and performance. As a result, until we control for other variables, we cannot draw reliable inferences about the reasons for the differences in outcome variables between the two subsamples.

### 3.4. Trend in gender and age

Fig. 1 illustrates the trend in the number of male and female top executives over the sample period of 1992–2018. From the figure, it is notable that female representation in top managerial

**Table 1**
Descriptive statistics for all firms (Panel A), firms run by at least one female executive (Panel B), and firms run by male executives (Panel C)

| | Mean | Std. Deviation | 25th Percentile | Median | 75th Percentile |
|---|---|---|---|---|---|
| Panel A: Descriptive statistics for all firms (28,306 firm-year observations) | | | | | |
| External funds raised | 0.024 | 0.169 | −0.047 | −0.003 | 0.038 |
| Investment | 0.145 | 0.167 | 0.051 | 0.093 | 0.171 |
| Return on capital (ROC) | 0.147 | 0.166 | 0.076 | 0.138 | 0.219 |
| Female dummy | 0.092 | 0.289 | 0.000 | 0.000 | 0.000 |
| Executive age | 53.451 | 5.448 | 50.000 | 53.500 | 57.000 |
| T. Compensations/Assets | 0.0046 | 0.0060 | 0.0011 | 0.0027 | 0.0056 |
| Ln(Assets) | 7.470 | 1.640 | 6.304 | 7.359 | 8.544 |
| NPPE/Assets | 0.290 | 0.235 | 0.102 | 0.215 | 0.428 |
| Cash/Assets | 0.149 | 0.165 | 0.026 | 0.086 | 0.216 |
| Tobin's Q | 1.965 | 1.231 | 1.198 | 1.569 | 2.248 |
| Stock return volatility | 0.125 | 0.080 | 0.076 | 0.108 | 0.148 |
| Leverage | 0.235 | 0.191 | 0.066 | 0.223 | 0.353 |
| CFO/NPPE | 0.745 | 1.449 | 0.165 | 0.398 | 0.914 |
| Panel B: Descriptive statistics for firms run by at least one female executive (2,608 firm-year observations) | | | | | |
| External funds raised | 0.002 | 0.140 | −0.058 | −0.010 | 0.023 |
| Investment | 0.122 | 0.142 | 0.046 | 0.083 | 0.140 |
| Return on capital (ROC) | 0.170 | 0.168 | 0.084 | 0.149 | 0.236 |
| Executive age | 52.931 | 5.104 | 49.500 | 53.000 | 56.000 |
| T. Compensations/Assets | 0.0046 | 0.0056 | 0.0012 | 0.0027 | 0.0057 |
| Ln(Assets) | 7.631 | 1.735 | 6.389 | 7.414 | 8.766 |
| NPPE/Assets | 0.265 | 0.213 | 0.095 | 0.199 | 0.388 |
| Cash/Assets | 0.167 | 0.161 | 0.035 | 0.117 | 0.250 |
| Tobin's Q | 2.020 | 1.247 | 1.215 | 1.618 | 2.381 |
| Stock return volatility | 0.115 | 0.072 | 0.071 | 0.099 | 0.137 |
| Leverage | 0.206 | 0.180 | 0.024 | 0.189 | 0.324 |
| CFO/NPPE | 0.960 | 1.510 | 0.215 | 0.514 | 1.077 |
| Panel C: Descriptive statistics for firms run by male executives (25,698 firm-year observations) | | | | | |
| External funds raised | 0.026 | 0.171 | −0.045 | −0.003 | 0.040 |
| Investment | 0.147 | 0.169 | 0.051 | 0.094 | 0.175 |
| Return on capital (ROC) | 0.144 | 0.166 | 0.076 | 0.137 | 0.218 |
| Executive age | 53.504 | 5.479 | 50.000 | 53.500 | 57.000 |
| T. Compensations/Assets | 0.0046 | 0.0060 | 0.0011 | 0.0027 | 0.0056 |
| Ln(Assets) | 7.454 | 1.629 | 6.297 | 7.351 | 8.521 |
| NPPE/Assets | 0.292 | 0.237 | 0.103 | 0.217 | 0.432 |
| Cash/Assets | 0.147 | 0.165 | 0.025 | 0.083 | 0.211 |
| Tobin's Q | 1.959 | 1.230 | 1.196 | 1.564 | 2.239 |
| Stock return volatility | 0.126 | 0.081 | 0.077 | 0.108 | 0.149 |
| Leverage | 0.238 | 0.191 | 0.071 | 0.225 | 0.357 |
| CFO/NPPE | 0.723 | 1.440 | 0.161 | 0.389 | 0.896 |
| Panel D: Comparative analysis between female-run firms and a sample of randomly selected male-run firms. | | | | | |
| | Male-mean | Std.Dev. | Female-mean | Std.Dev. | Difference *t*-statistic |
| External funds raised | 0.024 | 0.166 | 0.002 | 0.140 | 5.34 |
| Investment | 0.145 | 0.167 | 0.122 | 0.142 | 5.27 |
| Return on capital (ROC) | 0.142 | 0.159 | 0.170 | 0.168 | −6.34 |
| Executive age | 53.449 | 5.426 | 52.931 | 5.104 | 3.55 |
| T. Compensations/Assets | 0.005 | 0.006 | 0.005 | 0.006 | 0.38 |
| Ln(Assets) | 7.421 | 1.614 | 7.631 | 1.735 | −4.53 |
| NPPE/Assets | 0.289 | 0.230 | 0.265 | 0.213 | 3.98 |
| Cash/Assets | 0.147 | 0.167 | 0.167 | 0.161 | −4.30 |
| Tobin's Q | 1.919 | 1.197 | 2.020 | 1.247 | −2.98 |
| Stock return volatility | 0.128 | 0.082 | 0.115 | 0.072 | 5.80 |
| Leverage | 0.239 | 0.192 | 0.206 | 0.180 | 6.28 |
| CFO/NPPE | 0.745 | 1.475 | 0.960 | 1.510 | −5.20 |

See Table A.1 in the Appendix for variable definitions. All ratio variables are winsorized at the 1st and 99th percentile.

positions witnessed a persistent increase over the sample period, similar to the observations of Matsa and Miller (2011).

Fig. 2 depicts the average age of top executives for each year of the sample. The trend shows a decrease in the average age before the 2001 crisis year, then a slight increase after this year, followed by a decrease from 2006 to 2008, when the global financial crisis hit. The average age has risen steadily after this crisis.

Panel A of Table 2 reports the descriptive statistics for firms run by young executives (CEOs and CFOs), while Panels B and C, respectively, report the descriptive statistics for firms run by old executives and those run by mixed-age executives (one of them is young and the other is old). For two reasons, age 55 is used as the cutoff point to delineate young executives from old ones. First, it is very close to the average and median age of our sample. Second, age 55 in the US is usually considered the cutoff age for early retirement; therefore, this age is an important turning point in a person's life. Serfling (2014) also uses this age as a cutoff point between young and old executives. When comparing the statistics in Panel A with those in Panel B, we notice that firms run by young executives raise more external funds, invest more, but have a lower return on capital (ROC) than firms run by old executives. From this comparison, therefore, it appears that young executives behave differently than old executives. However, it is also notable that differences exist in some other

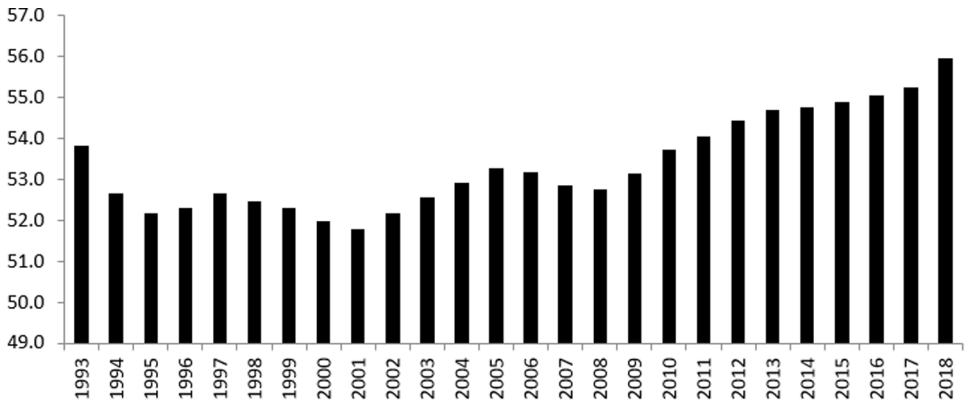


**Fig. 2.** The average age of top executives over the sample period.

**Table 2**
Descriptive statistics for firms run by young, old and mixed-age executives.

| | Mean | Std. Deviation | 25th Percentile | Median | 75th Percentile |
|---|---|---|---|---|---|
| Panel A: Descriptive statistics for firms run by young executives (9,088 firm-year observations) | | | | | |
| External funds raised | 0.035 | 0.191 | −0.048 | 0.000 | 0.049 |
| Investment | 0.166 | 0.190 | 0.054 | 0.104 | 0.200 |
| Return on capital (ROC) | 0.140 | 0.177 | 0.065 | 0.133 | 0.218 |
| Female dummy | 0.099 | 0.298 | 0.000 | 0.000 | 0.000 |
| Executive age | 48.056 | 3.400 | 46.000 | 48.500 | 50.500 |
| T. Compensations/Assets | 0.0057 | 0.0070 | 0.0014 | 0.0033 | 0.0068 |
| Ln(Assets) | 7.135 | 1.575 | 6.012 | 7.026 | 8.151 |
| NPPE/Assets | 0.273 | 0.233 | 0.088 | 0.194 | 0.399 |
| Cash/Assets | 0.170 | 0.179 | 0.029 | 0.103 | 0.257 |
| Tobin's Q | 2.066 | 1.359 | 1.206 | 1.617 | 2.387 |
| Stock return volatility | 0.137 | 0.086 | 0.085 | 0.119 | 0.161 |
| Leverage | 0.225 | 0.196 | 0.034 | 0.206 | 0.352 |
| CFO/NPPE | 0.805 | 1.589 | 0.164 | 0.431 | 1.058 |
| Panel B: Descriptive statistics for firms run by old executives (5,750 firm-year observations) | | | | | |
| External funds raised | 0.015 | 0.149 | −0.046 | −0.007 | 0.031 |
| Investment | 0.125 | 0.143 | 0.049 | 0.083 | 0.145 |
| Return on capital (ROC) | 0.155 | 0.155 | 0.084 | 0.144 | 0.223 |
| Female dummy | 0.074 | 0.262 | 0.000 | 0.000 | 0.000 |
| Executive age | 60.135 | 3.618 | 57.500 | 59.500 | 62.000 |
| T. Compensations/Assets | 0.0040 | 0.0052 | 0.0010 | 0.0024 | 0.0048 |
| Ln(Assets) | 7.730 | 1.693 | 6.483 | 7.605 | 8.798 |
| NPPE/Assets | 0.289 | 0.223 | 0.112 | 0.225 | 0.417 |
| Cash/Assets | 0.136 | 0.154 | 0.025 | 0.080 | 0.189 |
| Tobin's Q | 1.933 | 1.152 | 1.202 | 1.577 | 2.205 |
| Stock return volatility | 0.114 | 0.073 | 0.068 | 0.097 | 0.135 |
| Leverage | 0.232 | 0.181 | 0.082 | 0.223 | 0.344 |
| CFO/NPPE | 0.707 | 1.319 | 0.185 | 0.394 | 0.844 |
| Panel C: Descriptive statistics for firms run by mixed-age executives (13,468 firm-year observations) | | | | | |
| External funds raised | 0.020 | 0.160 | −0.046 | −0.004 | 0.036 |
| Investment | 0.139 | 0.158 | 0.050 | 0.091 | 0.164 |
| Return on capital (ROC) | 0.148 | 0.162 | 0.079 | 0.138 | 0.218 |
| Female dummy | 0.095 | 0.294 | 0.000 | 0.000 | 0.000 |
| Executive age | 54.239 | 3.107 | 52.500 | 54.000 | 56.000 |
| T. Compensations/Assets | 0.0042 | 0.0055 | 0.0010 | 0.0025 | 0.0052 |
| Ln(Assets) | 7.586 | 1.623 | 6.419 | 7.476 | 8.677 |
| NPPE/Assets | 0.301 | 0.240 | 0.106 | 0.226 | 0.450 |
| Cash/Assets | 0.140 | 0.158 | 0.025 | 0.079 | 0.200 |
| Tobin's Q | 1.910 | 1.168 | 1.192 | 1.536 | 2.183 |
| Stock return volatility | 0.122 | 0.077 | 0.075 | 0.105 | 0.145 |
| Leverage | 0.243 | 0.190 | 0.085 | 0.230 | 0.358 |
| CFO/NPPE | 0.945 | 1.742 | 0.203 | 0.505 | 1.209 |

See Table A.1 in the Appendix for variable definitions. All ratio variables are winsorized at the 1st and 99th percentile.

areas between firms run by young executives and those run by old executives, which might have driven the differences in their decisions and performance. As a result, until we control for other variables, we cannot draw reliable inferences about the reasons for the differences in outcome variables between firms run by the two age groups.

### 3.5. Empirical design

We begin the analysis by examining the main effects of executive gender and age on financial decisions and performance as follows:

$$Y_{i,t} = \alpha + \beta_1(Female_{i,t-1}) + \beta_2(Age_{i,t-1}) + \sum_{j=3}^{N} \beta_j(X_{j,i,t-1}) + \varepsilon_{i,t} \quad (1)$$

Where;
$Y_{i,t}$ : represents external funds raised, investment or performance of firm $i$ in year $(t)$.
$Female_{i,t-1}$: is a binary variable that takes the value of unity if the CEO or CFO of firm $i$ in year $(t-1)$ is a female (or both are females), and zero otherwise.
$Age_{i,t-1}$: is the average age of the CEO and CFO of firm $i$ in year $(t-1)$.
$X_{j,i,t-1}$ : are the control variables of firm $i$ in year $(t-1)$.

For the reasons stated before, we use age 55 as the cut-off point to distinguish between young and old executives when analyzing the interactive effects of executive gender and age on financial decisions and firm performance. The following specification is used to accomplish this:

$$\begin{aligned} Y_{i,t} = {} & \alpha + \beta_1\left(Old\ male_{i,t-1}\right) + \beta_2\left(Young\ female_{i,t-1}\right) \\ & + \beta_3\left(Old\ female_{i,t-1}\right) + \beta_4\left(Mixed\ gender/age_{i,t-1}\right) \\ & + \sum_{j=5}^{N} \beta_j(X_{ji,t-1}) + \varepsilon_{i,t} \end{aligned} \quad (2)$$

Where;
$Y_{i,t}$ : represents external funds raised, investment or performance of firm $i$ in year $(t)$.
$Old\ male_{i,t-1}$: is a binary variable that takes the value of unity if both the CEO and the CFO of firm $i$ in year $(t-1)$ are males and the age of each is equal to or greater than 55 years, and zero otherwise.
$Young\ female_{i,t-1}$: is a binary variable that takes the value of unity if the CEO or CFO of firm $i$ in year $(t-1)$ is a female (or both are females) and the age of each is less than 55 years, and zero otherwise.
$Old\ female_{i,t-1}$: is a binary variable that takes the value of unity if the CEO or CFO of firm $i$ in year $(t-1)$ is a female (or both are females) and the age of each is equal to or greater than 55 years, and zero otherwise.
$Mixed\ gender/age_{i,t-1}$: is a binary variable that takes the value of unity if, regardless of gender, the age of one of the top executives of firm $i$ in year $(t-1)$ is less than 55 years and the other's is equal to or greater than 55 years, and zero otherwise.
$X_{j,i,t-1}$: are the control variables of firm $i$ in year $(t-1)$.

Industry and year dummies will also be used when estimating Eqs. (1) and (2). The benchmark in Eq. (1), captured by the constant, represents firms run by male executives. The benchmark in Eq. (2), captured by the constant, represents firms run by young male executives (CEOs and CFOs) whose ages are less than 55 years. In this model, young male executives are used as our benchmark because they are expected to be the most overconfident and/or the most risk-taking relative to all other executives. If the differential intercept coefficient of any executive indicator is significant, it means that firms run by this executive group are significantly different from the benchmark firms captured by the constant.

In the second part of the analysis, we shall also use a specification like Eq. (2) to analyze executives' risk-taking and overconfidence to find out which of the two drives investment and to ascertain if these two behaviors – risk-taking and overconfidence – are independent of each other, as some researchers claim. We shall use the volatility of stock returns as a proxy for risk-taking. And for overconfidence, we borrow its proxy from Hirshleifer et al. (2012), where overconfident executives are those whose firm's stock price relative to the strike price of their vested stock options minus one is at least 67%.

The specification in Eq. (2) is useful in many ways; it captures the joint effect of gender and age and the effect of each when the other is held constant. For example, when compared with the benchmark, the coefficient of the old male dummy captures the effect of age only, as the two executive groups are of the same gender. When compared with the benchmark, the coefficient of the young female dummy captures the effect of gender only, as the two executive groups belong to the same age group. The coefficient of the young female dummy can also be compared with that of the old male dummy to observe whether gender and age jointly make a difference. When compared with the benchmark, the coefficient of the old female dummy captures the effects of gender and age jointly, but when compared with that of the old male dummy, it captures the effect of gender only, as the two executives belong to the same age group. Moreover, when compared with that of the young female dummy, the coefficient of the old female dummy captures the effect of age only, as the two groups contain female executives. The last dummy is of secondary importance, but it can also give some useful information. For example, the coefficient of the mixed gender/age dummy captures the effect of gender and age diversity at top executive levels when compared with the benchmark group.

## 4. Empirical analysis

### 4.1. The main effects of gender and age

We initially analyze the main effects of executive gender and age on corporate decisions and operating performance, as specified in Eq. (1). Table 3 reports the results from estimating our three equations *jointly* using seemingly unrelated regressions (SUR). We use the SUR model because we have a system of related equations: external funds are usually raised to finance investments, and the latter subsequently affects the return on invested capital.

As shown in the first column of Table 3, the coefficient of the *female dummy* is negative and statistically significant at the 1% level for the external funds raised, suggesting that firms run by female executives, on average, raise fewer external funds than firms run by male executives. Notably, the coefficient of *executive age* is also negative and statistically significant, which means that external funds raised decrease with executive age.

Since external funds are usually raised to finance new investments, we now turn to the investment equation in the second column of Table 3. As shown in the table, the coefficient of the *female dummy* is also negative and statistically significant at the 1% level, suggesting that firms run by female executives, on average, invest less than firms run by male executives. Again, the coefficient of *executive age* is negative and statistically significant, which means that investment decreases with executive age.

The third column of Table 3 reports the results for the operating performance function. The coefficient of the *female dummy* is positive and significant at the 1% level, suggesting that firms run by female executives, on average, outperform firms run by male executives. The coefficient of *executive age* is also positive and statistically significant, which means that firm performance improves with executive age.

The results reported in Table 3 draw a comprehensive picture, unlike prior works that have investigated the effect of gender or age on firm performance or one of the financial decisions.

**Table 3**
The main effects of executive gender and age on corporate financial decisions and operating performance.

| | External funds raised | Investment | Return on capital |
|---|---|---|---|
| Constant | 0.2621*** | 0.5255*** | −0.2140*** |
| | (5.49) | (11.63) | −(5.07) |
| Female dummy$_{(t-1)}$ | −0.0115*** | −0.0146*** | 0.0191*** |
| | −(3.44) | −(4.60) | (6.45) |
| Ln(Executive age)$_{(t-1)}$ | −0.0542*** | −0.0899*** | 0.0431*** |
| | −(5.61) | −(9.83) | (5.04) |
| (T. Compensation/Assets)$_{(t-1)}$ | 2.5851*** | 2.2553*** | −3.5359*** |
| | (11.73) | (10.81) | −(18.17) |
| Ln(Assets)$_{(t-1)}$ | −0.0049*** | −0.0082*** | 0.0078*** |
| | −(6.16) | −(10.90) | (11.16) |
| (NPPE/Assets)$_{(t-1)}$ | 0.0084 | 0.0873*** | −0.0445*** |
| | (1.41) | (15.44) | −(8.69) |
| (Cash/Assets)$_{(t-1)}$ | −0.0455*** | 0.1318*** | −0.2238*** |
| | −(6.07) | (18.59) | −(33.77) |
| Tobin's Q$_{(t-1)}$ | 0.0047*** | 0.0231*** | 0.0718*** |
| | (5.22) | (26.99) | (91.52) |
| Stock return volatility$_{(t-1)}$ | 0.0826*** | 0.0261* | −0.2977*** |
| | (5.82) | (1.95) | −(23.81) |
| Leverage$_{(t-1)}$ | −0.0092 | −0.0375*** | −0.0329*** |
| | −(1.58) | −(6.82) | −(6.40) |
| (CFO/NPPE)$_{(t-1)}$ | −0.0065*** | 0.0003 | – |
| | −(8.80) | (0.37) | – |
| Industry dummy | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes |
| Adjusted-$R^2$ | 0.053 | 0.174 | 0.325 |

This table reports the results from seemingly unrelated regressions (SUR) of external funds raised, investment, and return on capital on executive gender and age over the sample period of 1992–2018. The benchmark group in this table, captured by the constant, represents male-run firms. All variables are defined in Table A.1 of the Appendix. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2,564 firms over the sample period. The *t-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Our results indicate male executives raise more external funds and overinvest relative to female executives, but their extra investments seem to be of lower quality at the expense of firm performance. Similarly, external funds raised and investment, on average, decrease with age, but these decreases are not detrimental to the firm; rather, they are associated with an improvement in firm performance. Since overconfident executives usually overinvest in poor-quality investments that adversely affect firm performance, one can take away from the results in Table 3 that gender or age differences in decisions and performance between executives are driven by differences in their overconfidence levels rather than risk-taking levels. Female executives are less overconfident than male executives, and overconfidence decreases with age. These findings, however, do not tell us whether overconfidence decreases with age for both genders, nor do they explain the role of risk-taking in executive decisions. As a result, in the following subsection, we broaden the analysis by including gender–age interaction. Later, we will conduct a formal analysis for all executive groups' overconfidence and risk-taking to see if these two behaviors change with age for both genders and are independent of each other, as some researchers claim.

### 4.2. The interactive effects of executive gender and age

In this subsection, the interactive effects of executive gender and age on corporate financial decisions and operating performance are explored. We use the interaction variables defined in Section 3.5 for old male, young female, old female, and mixed gender/age executives. Since young male executives are expected to have the highest level of overconfidence and/or risk-taking, we use this group as our benchmark in the analysis outlined in this subsection, which is captured by the constant as specified in Eq. (2). The results from the estimations of our functions are reported in Table 4. As shown in the first column of Table 4, all executives raise fewer external funds than the benchmark group of young male executives. According to the Wald tests, the coefficient of the old male dummy is not significantly different from that of the young female dummy, and their coefficients are not significantly different from that of the old female dummy, although the coefficient of the latter is the smallest of all executive groups.

The results for the investment function are reported in the second column of Table 4. The results show that all executives invest less than young male executives. The Wald tests find the coefficient of the old male dummy is not significantly different from that of the young female dummy, but their coefficients are significantly different from that of the old females, who invest the least among all executive groups. These results are inconsistent with the finding that young executives are less willing to take on more risks to avoid underperformance that may result in early job termination (e.g., Chevalier and Ellison, 1999).

In the third column of Table 4, the results for the operating performance are reported. Notably, all executives outperform the benchmark group of young male executives. The Wald tests find the coefficient of the old male dummy is not significantly different from that of the young female dummy, but their coefficients are significantly different from that of the old female dummy, whose coefficient is the highest. Thus, although old female executives raise fewer external funds and invest less than all other executives, they are the best performers among all executive groups, followed by young female and old male executives.[3]

### 4.3. Endogeneity

The analysis of the relations between gender and age on the one hand and corporate financial decisions and performance on the other raises some endogeneity concerns, the most important of which is the selection bias. It is likely that firms with certain characteristics would select executives of a certain gender and/or age, and vice versa. In this subsection, we address endogeneity concerns using two methods: the instrumental variables (IV) and the system-GMM. The IV method uses a suitable instrument for the endogenous one. A valid instrument should meet two conditions. Firstly, it should be correlated with the endogenous variable (the relevance condition). Secondly, it should not be directly correlated with the error term (the exclusion restriction). Empirically, it has been difficult to find an instrument that meets both conditions. Fortunately, local labor supply-based measures have recently gained popularity as a solution to endogeneity issues in studies that have investigated board gender diversity (e.g., Knyazeva et al., 2013). We follow suit and use the local supplies of managers as instruments for our executive indicators. For the female indicator used in Table 3, the instrument is calculated as follows: for each firm-year, we calculate the number of all executives of all firms located within a three-digit ZIP code of the underlying firm's headquarters using the addresses of firms available on Compustat's ExecuComp database. Then, we divide the number of female executives found within the three-digit ZIP code of the underlying firm's headquarters by the number of all executives found within this area and use this ratio as an instrument for the female indicator variable; the higher the ratio, the more likely a firm would employ a female top executive.

[3] We repeat the analysis in Table 4 for a more recent sample, from 2009 to 2018, to take into consideration changes in business and society following the GFC. The results are reported in Table A.2, which are not qualitatively different from those reported in Table 4.

**Table 4**
The interactive effects of executive gender and age on corporate financial decisions and operating performance.

| | External funds raised | Investment | Return on capital |
|---|---|---|---|
| Constant | 0.0515* | 0.1753*** | −0.0456* |
| | (1.88) | (6.71) | −(1.87) |
| Old male dummy$_{(t-1)}$ | −0.0138*** | −0.0227*** | 0.0075*** |
| | −(4.79) | −(8.30) | (2.92) |
| Young female dummy$_{(t-1)}$ | −0.0186*** | −0.0137** | 0.0143*** |
| | −(3.30) | −(2.57) | (2.87) |
| Old female dummy$_{(t-1)}$ | −0.0247*** | −0.0395*** | 0.0270*** |
| | −(3.00) | −(5.07) | (3.71) |
| Mixed gender/age dummy$_{(t-1)}$ | −0.0084*** | −0.0123*** | 0.0053*** |
| | −(3.72) | −(5.75) | (2.62) |
| (T. Compensation/Assets)$_{(t-1)}$ | 2.6052*** | 2.2840*** | −3.5577*** |
| | (11.82) | (10.95) | −(18.27) |
| Ln(Assets)$_{(t-1)}$ | −0.0050*** | −0.0083*** | 0.0080*** |
| | −(6.29) | −(11.12) | (11.40) |
| (NPPE/Assets)$_{(t-1)}$ | 0.0086 | 0.0877*** | −0.0448*** |
| | (1.44) | (15.49) | −(8.74) |
| (Cash/Assets)$_{(t-1)}$ | −0.0452*** | 0.1317*** | −0.2240*** |
| | −(6.03) | (18.55) | −(33.76) |
| Tobin's Q$_{(t-1)}$ | 0.0048*** | 0.0232*** | 0.0718*** |
| | (5.31) | (27.16) | (91.37) |
| Stock return volatility$_{(t-1)}$ | 0.0852*** | 0.0308** | −0.3010*** |
| | (6.01) | (2.29) | −(24.09) |
| Leverage$_{(t-1)}$ | −0.0088 | −0.0366*** | −0.0341*** |
| | −(1.51) | −(6.64) | −(6.62) |
| (CFO/NPPE)$_{(t-1)}$ | −0.0065*** | 0.0003 | – |
| | −(8.82) | (0.37) | – |
| Industry dummy | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes |
| Adjusted-$R^2$ | 0.052 | 0.173 | 0.324 |

This table reports the results from seemingly unrelated regressions (SUR) of external funds raised, investment, and return on capital on the interaction of executive gender and age over the sample period of 1992–2018. The benchmark group in this table, captured by the constant, represents young male-run firms. All variables are defined in Table A.1 of the Appendix. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2,564 firms over the sample period. The *t-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

**Table 5**
Endogeneity test 1: 3SLS estimation of the main effects of executive gender and age on corporate financial decisions and operating performance.

| | External funds raised | Investment | Return on Capital |
|---|---|---|---|
| Constant | 0.4114*** | 1.0804*** | −0.6944*** |
| | (3.01) | (8.33) | −(5.71) |
| Female dummy$_{(t-1)}$ | −0.0566*** | −0.0569*** | 0.0710*** |
| | −(4.01) | −(4.24) | (5.65) |
| Ln(Executive age)$_{(t-1)}$ | −0.0914*** | −0.2278*** | 0.1628*** |
| | −(2.76) | −(7.24) | (5.52) |
| (T. Compensation/Assets)$_{(t-1)}$ | 2.4242*** | 2.0931*** | −3.4420*** |
| | (10.90) | (9.91) | −(17.44) |
| Ln(Assets)$_{(t-1)}$ | −0.0043*** | −0.0071*** | 0.0068*** |
| | −(5.20) | −(9.02) | (9.24) |
| (NPPE/Assets)$_{(t-1)}$ | −0.0027 | 0.0837*** | −0.0455*** |
| | −(0.45) | (14.67) | −(8.80) |
| (Cash/Assets)$_{(t-1)}$ | −0.0423*** | 0.1309*** | −0.2228*** |
| | −(5.56) | (18.14) | −(32.97) |
| Tobin's Q$_{(t-1)}$ | 0.0059*** | 0.0233*** | 0.0722*** |
| | (6.44) | (26.90) | (90.75) |
| Stock return volatility$_{(t-1)}$ | 0.0657*** | 0.0052 | −0.2825*** |
| | (4.49) | (0.38) | −(21.81) |
| Leverage$_{(t-1)}$ | −0.0151** | −0.0452*** | −0.0259*** |
| | −(2.52) | −(7.95) | −(4.87) |
| (CFO/NPPE)$_{(t-1)}$ | −0.0120*** | −0.0022*** | – |
| | −(15.95) | −(3.07) | – |
| Industry dummy | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes |

This table reports the results from three-stage least squares regressions (3SLS) of external funds raised, investment, and return on capital on executive gender and age over the sample period of 1992–2018. The benchmark group in this table, captured by the constant, represents male-run firms. All variables are defined in Table A.1 of the Appendix. The regressions are estimated *jointly* using the ratio of the local supply of female executives and the average age of the local supply of all executives as instruments for the female indicator and executive age, respectively. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2,564 firms over the sample period. The *t-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Moreover, for each firm-year, we also use the average age of the local supply of all executives located within the three-digit ZIP code of the underlying firm's headquarters as an instrument for executive age used in Table 3.

Table 5 reports the results from re-estimating the regressions in Table 3 jointly using three-stage least squares (3SLS), a model that combines both two-stage least squares and SUR.[4] In this model, the ratio of the local supply of female executives and the average age of the local supply of all executives are used as instruments for the female indicator and executive age, respectively. As shown in Table 5, the results confirm our earlier findings reported in Table 3; firms run by female executives raise fewer external funds, invest less, but perform better than firms run by male executives. Similarly, external funds raised and investments decrease with executive age, but firm performance improves.

For the results reported in Table 4, we again use the local supplies of executives to ascertain the results reported in this table. Initially, we use our cutoff age of 55 to delineate young executives from old executives. Then, for young and old male executives and young and old female executives, we use the ratio of the local supply of each executive group (the number of executives in each group to the number of all executives) as an instrument. For the mixed gender/age indicator variable, the instrument for this indicator is calculated as the product of the ratios of the local supplies of young and old male executives plus the product of the ratios of the local supplies of young and old female executives. Table 6 reports the results from estimating our three equations jointly using the three-stage least squares model. As shown in the table, all the results reported in Table 4 continue to hold—specifically, all executives raise fewer external funds and invest less, but perform better than the benchmark group of young male executives. Furthermore, old female executives continue to be the best performers among all executive groups, followed by young female and old male executives.[5]

However, Bernile et al. (2018) raise concerns about the use of local supplies of directors as instruments because a firm's access to local supplies of directors reflects its headquarters' location choice, which may in turn depend on the firm's profile. This means that local supply-based instruments may violate the exclusion restriction, an important condition for an instrument to be valid. Because this argument may also apply to our instruments, and since it is hard to find a suitable instrument for each of our variables of interest, we augment our results in Table 6 with the system-GMM model, where lagged first differences of the endogenous variables are used as instruments for the endogenous variables.[6] The results from the System-GMM are reported in

[4] See Table A.3 in the Appendix for the results of the first-stage regressions. The F-statistics and p-values in this table suggest that our instruments are jointly significant first stage.

[5] See Table A.4 in the Appendix for the results of the first stage regressions. The F-statistics and p-values in this table suggest that our instruments are jointly significant first stage.

[6] The system-GMM estimator was initially developed by Arellano and Bover (1995), then extended by Blundell and Bond (1998). According to this model,

**Table 6**
Endogeneity test 2: 3SLS estimation of the interactive effects of executive gender and age on corporate financial decisions and operating performance.

| | External funds raised | Investment | Return on Capital |
|---|---|---|---|
| Constant | 0.0611** | 0.1942*** | −0.0615** |
| | (2.15) | (7.10) | −(2.41) |
| Old male dummy$_{(t-1)}$ | −0.0306** | −0.0787*** | 0.0321*** |
| | −(2.45) | −(6.55) | (2.88) |
| Young female dummy$_{(t-1)}$ | −0.1015*** | −0.1220*** | 0.1043*** |
| | −(3.02) | −(3.77) | (3.46) |
| Old female dummy$_{(t-1)}$ | −0.1611*** | −0.1725*** | 0.2332*** |
| | −(3.33) | −(3.70) | (5.38) |
| Mixed gender/age dummy$_{(t-1)}$ | −0.0106 | −0.0044 | 0.0234 |
| | −(0.59) | −(0.26) | (1.46) |
| (T. Compensation/Assets)$_{(t-1)}$ | 2.4718*** | 2.2185*** | −3.5131*** |
| | (11.01) | (10.28) | −(17.50) |
| Ln(Assets)$_{(t-1)}$ | −0.0043*** | −0.0075*** | 0.0069*** |
| | −(5.11) | −(9.26) | (9.17) |
| (NPPE/Assets)$_{(t-1)}$ | −0.0009 | 0.0834*** | −0.0491*** |
| | −(0.14) | (13.93) | −(9.18) |
| (Cash/Assets)$_{(t-1)}$ | −0.0404*** | 0.1321*** | −0.2261*** |
| | −(5.21) | (17.72) | −(32.60) |
| Tobin's Q$_{(t-1)}$ | 0.0060*** | 0.0238*** | 0.0720*** |
| | (6.43) | (26.71) | (88.70) |
| Stock return volatility$_{(t-1)}$ | 0.0689*** | 0.0164 | −0.2909*** |
| | (4.74) | (1.18) | −(22.42) |
| Leverage$_{(t-1)}$ | −0.0169*** | −0.0486*** | −0.0263*** |
| | −(2.71) | −(8.07) | −(4.71) |
| (CFO/NPPE)$_{(t-1)}$ | −0.0123*** | −0.0026*** | – |
| | −(15.93) | −(3.54) | – |
| Industry dummy | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes |

This table reports the results from three-stage least squares (3SLS) regressions of external funds raised, investment, and return on capital on the interaction of executive gender and age over the sample period of 1992–2018. The benchmark group in this table, captured by the constant, represents young male-run firms. All variables are defined in Table A.1 of the Appendix. The regressions are estimated jointly using the ratios of the local supplies of young male, old male, young female, and old female executives as instruments to the indicator variables of these executives. The product of the ratios of the local supplies of young and old female executives plus the product of the ratios of the local supplies of young and old male executives is used as an instrument for mixed gender/age dummy. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2,564 firms over the sample period. The *t-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

**Table 7**
Endogeneity test-3: System-GMM estimation of the interactive effects of executive gender and age on corporate financial decisions and operating performance.

| | External funds raised | Investment | Return on Capital |
|---|---|---|---|
| Constant | 0.0504*** | 0.1024*** | 0.0256** |
| | (2.79) | (4.64) | (2.06) |
| Old male dummy$_{(t-1)}$ | −0.0106** | −0.0152*** | 0.0145*** |
| | −(2.41) | −(3.63) | (3.85) |
| Young female dummy$_{(t-1)}$ | −0.0162*** | −0.0140*** | 0.0124*** |
| | −(3.53) | −(3.76) | (2.86) |
| Old female dummy$_{(t-1)}$ | −0.0172*** | −0.0238*** | 0.0242*** |
| | −(4.65) | −(6.84) | (5.06) |
| Mixed gender/age dummy$_{(t-1)}$ | 0.0002 | −0.0076** | 0.0124*** |
| | (0.06) | −(2.11) | (3.29) |
| (T. Compensation/Assets)$_{(t-1)}$ | 2.3023*** | 1.2736*** | −0.6792*** |
| | (10.24) | (5.68) | −(3.92) |
| Ln(Assets)$_{(t-1)}$ | −0.0079*** | −0.0099*** | 0.0005 |
| | −(8.77) | −(10.82) | (0.83) |
| (NPPE/Assets)$_{(t-1)}$ | 0.0565*** | 0.1043*** | −0.0193*** |
| | (7.05) | (14.78) | −(5.45) |
| (Cash/Assets)$_{(t-1)}$ | −0.1078*** | 0.1859*** | −0.0711*** |
| | −(10.72) | (17.89) | −(12.15) |
| Tobin's Q$_{(t-1)}$ | 0.0115*** | 0.0225*** | 0.0242*** |
| | (8.69) | (17.08) | (21.40) |
| Stock return volatility$_{(t-1)}$ | 0.0534*** | −0.0238** | −0.0594*** |
| | (4.15) | −(1.98) | −(5.84) |
| Leverage$_{(t-1)}$ | −0.1512*** | −0.0892*** | 0.0306*** |
| | −(18.05) | −(12.72) | (6.71) |
| (CFO/NPPE)$_{(t-1)}$ | −0.0046*** | −0.0017** | – |
| | −(4.18) | −(1.99) | – |
| Dependent variable$_{(t-1)}$ | 0.0002 | 0.0842*** | 0.6761*** |
| | (0.02) | (6.69) | (49.00) |
| Dependent variable$_{(t-2)}$ | | | −0.0652*** |
| | | | −(6.18) |
| Industry dummy | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes |
| $m_1$ | 0.000 | 0.000 | 0.000 |
| $m_2$ | 0.173 | 0.280 | 0.319 |
| Hansen test *p-value* | 0.907 | 0.862 | 0.252 |

This table reports the results from System-GMM regressions of external funds raised, investment, and return on capital on the interaction of executive gender and age over the sample period of 1992–2018. The benchmark group in this table, captured by the constant, represents young male-run firms. All variables are defined in Table A.1 of the Appendix. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2,564 firms over the sample period. *Z-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7.[7] Again, the results reported in this table are not qualitatively different from those reported in Tables 4 and 6; old female executives are the best performers among all executive groups, followed by young female and old male executives.

### 4.4. Risk-taking vs. Overconfidence: are they independent?

In the previous analysis, we found significant variations in decisions and performance among different executive groups. Some researchers attribute these variations to differences in executives' risk-taking levels, while others attribute the variations to differences in their overconfidence levels. Theoretically, overconfidence and risk-taking may lead to similar decisions, but the outcome of each is different (e.g., Huang and Kisgen, 2013). Overconfident managers overestimate the payoff of a project, which would lead to overinvestment in negative NPV projects and a reduction in firm value. In contrast, risk-taking managers invest more than others do, as they, on top of the regular investments needed to earn the required return, invest in risky projects that have high expected returns, which would add value to the firm. However, this argument is true if the two behaviors, overconfidence and risk-taking, are independent of each other, but a survey by Nosić and Weber (2010) finds that risk-taking is positively influenced by overconfidence. Besides, recent studies have noticed that risk-taking and overconfidence are positively affected by the same hormone, testosterone. Since young male (old female) executives underperform (outperform) all other executives, although they invest the most (least), these results are most likely driven by overconfidence differentials among the executive groups rather than risk-taking differentials. In this subsection, we conduct a formal test of executives' risk-taking and overconfidence to see if they change with age for both genders and are independent of each other, as some researchers claim.

variables in levels are instrumented with their own first differences. Two conditions must be met to have consistent estimates from the system GMM model. First, no second order and higher autocorrelations in the error term should exist. Second, the instruments for the endogenous variables should be valid. In Table 7, $m_1$ and $m_2$ are the *p-values* obtained from testing for the first and second-order autocorrelations in the residuals under the null of no autocorrelation in the first and second-order residuals, respectively. Instruments lagged 2 and deeper are used for the endogenous variables. The endogenous variables in this model are the lagged dependent variable and the executive indicators. To test the validity of our instruments, we use the robust 'Hansen test' under the null that the instruments are exogenous and valid.

[7] For the return on capital equation, we were unable to remove the second-order autocorrelation in the residuals without using the second lag of the dependent variable as a control variable.

**Table 8**
Risk-taking, overconfidence and the investment decision.

| | Risk-Taking | Overconfidence | Investment |
|---|---|---|---|
| Constant | 0.2091*** | 0.1182*** | 0.2242*** |
| | (23.47) | (2.92) | (6.40) |
| Old male dummy | −0.0205*** | −0.1057*** | −0.0768*** |
| | −(10.20) | −(5.69) | −(6.36) |
| Young female dummy | −0.0354*** | −0.1257** | −0.1096*** |
| | −(4.04) | −(2.25) | −(3.43) |
| Old female dummy | −0.0932*** | −0.4172*** | −0.1603*** |
| | −(8.26) | −(4.30) | −(3.49) |
| Mixed gender/age | −0.0163*** | 0.0800** | −0.0040 |
| | −(3.23) | (2.47) | −(0.23) |
| Overconfidence | **0.0089*** ** | – | **0.0134*** ** |
| | **(16.73)** | – | **(3.25)** |
| Volatility of stock return | – | **0.2675*** ** | **−0.0040** |
| | – | **(8.64)** | **−(0.26)** |
| Overconfidence × Volatility of stock return | – | – | **0.1288*** ** |
| | – | – | **(4.42)** |
| (T. Compensation/Assets) | 1.8563*** | −26.2935*** | 1.2697*** |
| | (24.45) | −(51.34) | (5.04) |
| Ln(Assets) | −0.0092*** | −0.0216*** | −0.0103*** |
| | −(55.10) | −(13.06) | −(13.36) |
| (NPPE/Assets) | −0.0097*** | −0.0842*** | 0.0809*** |
| | −(6.20) | −(6.76) | (13.49) |
| (Cash/Assets) | 0.0677*** | −0.1029*** | 0.1435*** |
| | (35.20) | −(6.17) | (19.53) |
| Tobin's Q | −0.0031*** | 0.1402*** | 0.0222*** |
| | −(12.59) | (76.31) | (23.95) |
| Leverage | 0.0436*** | −0.1423*** | −0.0451*** |
| | (27.81) | −(11.58) | −(7.51) |
| (CFO/NPPE) | −0.0037*** | 0.0080*** | −0.0034*** |
| | −(19.44) | (5.05) | −(4.64) |
| Industry dummy | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes |

Regressions of our risk measure, the volatility of stock return, overconfidence, and investment. We use 2SLS regressions to address endogeneity concerns using labor-supply-based instruments for the executive indicators. Concurrent explanatory and control variables are used in the first and second regressions, and one-year-lagged explanatory and control variables are used in the third. The benchmark group in each panel, captured by the constant, represents young male-run firms. The overconfident indicator takes the value of unity if the stock price of a firm run by one of the executive groups relative to the strike price of their vested stock options minus one is at least 67% and zero otherwise. All variables are defined in Table A.1 of the Appendix. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2,564 firms over the sample period. The *t-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 8 reports these results. In the first column, we regress our measure of risk, the volatility of stock returns, on the executive groups and the controls. As shown in the table, all executives exhibit lower risk-taking relative to young male executives. Notably, the risk-taking of old male executives is not significantly different from that of young female executives, which explains why the two have insignificant differences in their decisions and operating performance. Interestingly, old female executives appear to be the least risk-taking. Collectively, these results confirm that risk-taking appetite varies among the executive groups and decreases with age for both genders. The finding that risk-taking by male executives decreases with age supports the survey finding of Rolison et al. (2014), but the finding that risk-taking by female executives also decreases with age does not support the finding of Rolison et al. (2014). Indeed, the results in the first column show that risk-taking decreases with age more steeply for female executives compared with male executives. Notably, overconfidence has a significant positive effect on risk-taking.

In the second column of Table 8, we regress the overconfidence indicator on our indicator variables and the controls. As shown in the table, all executives exhibit a lower overconfidence level relative to young male executives. Like the results for risk-taking, the overconfidence of old male executives is not significantly different from that of young female executives. Old female executives emerge again as the least overconfident of all the executive groups. These results confirm that overconfidence also varies among the executive groups and decreases with age for both genders. Notably, risk-taking has a significant positive effect on overconfidence.

In the third column of Table 8, we regress investment on the overconfidence indicator, risk-taking, and their interaction to verify if overconfidence and risk-taking are independent of each other. As shown in the table, overconfidence has a significant positive effect on investment when controlling for risk-taking, but risk-taking has an insignificant effect on investment when controlling for overconfidence. Notably, the interaction of overconfidence and risk-taking has a significant positive effect on investment. These findings support our earlier inference that overconfidence is the primary driver of differences in executives' decisions and performance; it drives their risk-taking and investment decision. Thus, overconfidence and risk-taking are not two distinct behaviors independent of each other, as some researchers claim. These results explain the differences in operating performance; since overconfident executives usually undertake poor-quality projects that adversely affect firm performance, it is not surprising to find that young male (old female) executives have the worst (best) operating performance, as these two have the highest (lowest) level of overconfidence among all executive groups.

**Table 9**
Regressions of firm value and leverage on executive groups.

| | Tobin's Q Full Sample | Leverage Full Sample | OLS: Tobin's Q Sub-sample | 2SLS: Tobin's Q Sub-sample |
|---|---|---|---|---|
| Constant | 1.2025*** | 0.0618** | 1.3959*** | 1.0846*** |
| | (9.75) | (2.39) | (13.96) | (3.52) |
| Old male dummy$_{(t-1)}$ | 0.0042 | −0.0242*** | 0.0409*** | 0.4336*** |
| | (0.31) | −(8.80) | (4.26) | (3.07) |
| Young female dummy$_{(t-1)}$ | −0.0437 | −0.0333*** | 0.0767*** | 1.0303** |
| | −(1.53) | −(5.43) | (3.58) | (2.31) |
| Old female dummy$_{(t-1)}$ | −0.0100 | −0.0484*** | 0.1603*** | 1.6725*** |
| | −(0.28) | −(5.69) | (5.54) | (2.82) |
| Mixed gender/age dummy$_{(t-1)}$ | −0.0323*** | −0.0122*** | −0.0192** | −0.4505** |
| | −(3.31) | −(6.07) | −(2.57) | −(2.16) |
| (T. Compensation/Assets)$_{(t-1)}$ | 36.2965*** | −0.9841*** | 55.6416*** | 62.9935*** |
| | (25.07) | −(5.38) | (48.05) | (21.83) |
| Ln(Assets)$_{(t-1)}$ | 0.0300*** | 0.0246*** | 0.0230*** | 0.0120 |
| | (6.19) | (26.88) | (6.89) | (1.15) |
| (NPPE/Assets)$_{(t-1)}$ | 0.0473 | 0.0871*** | −0.1983*** | −0.2399*** |
| | (1.40) | (11.16) | −(10.70) | −(3.57) |
| (Cash/Assets)$_{(t-1)}$ | 1.7356*** | −0.2864*** | 1.8772*** | 2.0721*** |
| | (34.19) | −(37.67) | (54.63) | (24.91) |
| Sales growth rate$_{(t-1)}$ | 0.3796*** | 0.0054** | 0.2180*** | 0.2977*** |
| | (24.54) | (2.34) | (16.94) | (6.37) |
| Stock return volatility$_{(t-1)}$ | −1.1297*** | 0.1937*** | −1.8442*** | −2.1960*** |
| | −(16.32) | (12.08) | −(45.75) | −(14.01) |
| (CFO/NPPE)$_{(t-1)}$ | 0.0947*** | −0.0052*** | 0.0667*** | 0.0788*** |
| | (16.81) | −(7.78) | (19.50) | (10.11) |
| Leverage$_{(t-1)}$ | 0.0055 | – | 0.9625*** | 1.7110*** |
| | (0.16) | – | (30.66) | (17.53) |
| Industry dummy | Yes | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes | Yes |
| Adj-$R^2$ | 0.418 | 0.613 | 0.670 | |

Regressions of firm value and leverage on the executive indicators and the controls for the full sample are shown in the first and second columns, and for the subsample of firms whose leverage ratio is within 3% of their target in the third and fourth columns. The subsamples in the third and fourth columns include 10,407 observations that represent 1,619 firms over the sample period. The benchmark group in each panel, captured by the constant, represents young male-run firms. All variables are defined in Table A.1 of the Appendix. The *t-statistics* are reported in brackets below the coefficients. Robust standards errors clustered at firm level are used in the first three regressions. The two-stage least squares (2SLS) model is used in the fourth regression, using labor-supply-based instruments for the executive indicators. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

### *4.5. Executive gender and age, and firm value*

So far, we have found significant differences in the operating performance of the executive groups that are driven by differences in their overconfidence levels that affect the quality of their investments. However, while operating performance is important, it is the value created that ultimately counts because it encompasses all aspects of efficiency, including the value added from the investments made by each group. In this subsection, we regress firm value, Tobin's Q, on our variables of interests and the controls to find out the best value creator.[8]

The results in the first column of Table 9 find insignificant differences in the value of firms run by young male executives and the values of firms run by other executive groups, implying that each group has an advantage over the others that offsets the differences in their operating performance. One possibility is that these executives employ different leverage levels that neutralize the differences in their operating performance. The results in the second column give support to this conjecture; executive groups use different levels of leverage, with young male executives using the most leverage in comparison to other groups.

To formally verify if the leverage differential is the variable that offsets the operating performance differentials, we forecast the target leverage ratio for each firm-year from the model in the second column, then estimate Tobin's Q for the subsample of firms whose actual leverage ratio is within 3% of the target. The idea here is that leverage differentials among firms that set their leverage ratios close to their targets are less likely to cause significant differences in their values. Therefore, any significant differences in the values of these firms would be due to their operating performance differentials. The third and fourth columns of Table 9 report the results for our subsample using OLS and 2SLS specifications. As shown in these columns, there are significant differences in firm values among the executive groups who set their leverage ratio close to the target, where old female executives again emerge as the best value creators, followed by young female and old male executives. Interestingly, leverage has a significant positive effect on the value of firms that set their leverage close to their target.

The results in this subsection might explain the mixed evidence found in the literature. The choice of the performance measure makes a difference; if one uses an accounting-based measure that directly captures the return on invested capital, as we did in Tables 3 and 4, one will find female (old) executives outperforming male (young) executives in terms of operating performance. However, if one uses a market-based measure of performance, as we did in Table 9, no significant differences in firm values are found among the executives, as male (young) executives offset their inferior operating performance by employing more leverage in their firms. However, once leverage differentials are neutralized, we find significant differences in firm values among executive groups as a result of differences in their operating performance.

## 5. Conclusion

This study examines how executive gender, age, and their interaction affect corporate financial decisions and performance. The analysis finds that firms run by female executives, although they raise fewer external funds and invest less, outperform firms

[8] Since Tobin's Q is used as a proxy for firm performance in Table 9, we use the sales growth rate to control for growth in this table.

run by male executives, implying that female executives are less overconfident than male executives and do not waste their firms' cash flows on negative NPV projects. The analysis of executive age finds that external funds raised and investment decrease, but firm performance improves with age, implying that overconfidence decreases with age. These results emphasize the importance of accounting for gender–age interaction to see if financial decisions and performance change with age for both genders and to identify the best-performing executive group. In conducting the next set of analyses for the interactive effect of gender and age, we find that firms run by young male executives raise more external funds and invest more, but perform worse than firms run by old male, young female, and old female executives. Moreover, although they invest the least among all executive groups, old female executives have, on average, the best operating performance, followed by young female and old male executives. These results are robust to endogeneity concerns.

Since overconfidence and risk-taking affect the quality of investments undertaken by executives, we conduct a formal analysis of these two behaviors. Young male (old female) executives have the highest (lowest) risk-taking and overconfidence levels. Thus, both risk-taking and overconfidence decrease with age for both genders. The analysis also finds that risk-taking per se is not the driver of investment; rather, it is the overconfidence level that drives both risk-taking and investment. Accordingly, these two behaviors, overconfidence and risk-taking, are not independent of each other, as some researchers claim.

We also extend the analysis to verify if our results hold when we use firm value as a proxy for performance. We find insignificant differences in firm values among the executive groups due to the different leverage levels employed by them that offset the differences in their operating performance. But at firms that set their leverage ratio close to their target, such that leverage differentials among these firms do not lead to significant differences in their values, old female executives emerge again as the best value creators due to their superior operating performance, followed by young female and old male executives.

Notwithstanding these important findings, there are some limitations in this study. First, the sample is drawn from US firms, which exposes the findings to sample selection bias. Specifically, the results could be country-specific; therefore, the results should not be generalized without replication across other countries and sample periods. Second, cultural exposure and backgrounds could contribute to the types of financial decisions executives make. Indeed, some studies have found differences in risk tolerance and willingness to take risk among people of different ethnicities (e.g., Yao et al., 2005). Therefore, analyzing the impacts of other demographics on corporate financial decisions and performance would be good topics for future research.

## CRediT authorship contribution statement

**Mahmoud Agha:** The leading author who came up with the research ideas, Did all the analyses in Subsections 4.1 to 4.5, Expanded the sample, Added new novel predictions, Wrote all the paper, Did all the editing and proofreading. **Shivani Pramathevan:** Did the analyses in Subsections 4.1 and 4.2 for a smaller sample under guidance and supervision of Dr. Agha.

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## Appendix

**Table A.1**
Variable definition.
*Source of data items:* Compustat and CRSP databases.

| Variable | Definition |
|---|---|
| *Financial variables* | |
| External funds raised | [$\Delta$(Long-term debt + debt in current liabilities) + stock issuance - stock repurchase]/lagged total assets. |
| Investment | (Capital expenditure + acquisition + R& D)/lagged total assets. |
| Return on capital | Earnings before interest and tax/lagged invested capital. Invested capital, as defined by Compustat, is equal to long-term debt + preferred equity + minority interest + common equity.[9] |
| T. Compensation/Assets | The total compensation granted to the top executives (the CEO and CFO)/total assets. |
| Ln(Assets) | Natural logarithm of total assets. |
| NPPE/Assets | Net property, plant, and equipment/total assets. |
| Cash/Assets | Cash and short-term investments/total assets. |
| Tobin's Q | (Market value of equity + book liabilities)/total assets. |
| Sales growth rate | The percentage growth rate in sales from year (t-1) to year t. |
| Stock return volatility | Volatility of monthly stock returns over the past three years. |
| Leverage | (Long-term debt + debt in current liabilities)/total assets. |
| CFO/NPPE | Cash flow from operations/net property, plant, and equipment. |
| *Executive Characteristics* | |
| Female dummy | A binary variable that takes the value of unity if the CEO or the CFO of firm $i$ in year $t$ is a female (or both are females), and zero otherwise. |

(*continued on next page*)

**Table A.1** (*continued*).

| Variable | Definition |
|---|---|
| Executive age | Is the average age of the CEO and CFO of firm *i* in year *t*. |
| Young male dummy | A binary variable that takes the value of unity if both the CEO and the CFO of firm *i* in year *t* are males and the age of each is less than 55 years old, and zero otherwise. |
| Old male dummy | A binary variable that takes the value of unity if both the CEO and the CFO of firm *i* in year *t* are males and the age of each is equal to or greater than 55 years old, and zero otherwise. |
| Young female dummy | A binary variable that takes the value of unity if the CEO or CFO of firm *i* in year *t* is a female (or both are females) and the age of each is less than 55 years old, and zero otherwise. |
| Old female dummy | A binary variable that takes the value of unity if the CEO or CFO of firm *i* in year *t* is a female (or both are females) and the age of each is equal to or greater than 55 years old, and zero otherwise. |
| Mixed gender/age | A binary variable that takes the value of unity if, regardless of gender, one of the top executives is less than 55 years old and the other is equal to or greater than 55 years old, and zero otherwise. |
| Local supply of any executive group (ratio) | The ratio of the number of executives in a group that are located within a three-digit ZIP code of the underlying firm's headquarters to the number of all executives within this area. |
| Overconfidence indicator | A binary indicator that takes the value of unity if the stock price of a firm run by one of the executive groups relative to the strike price of their vested stock options minus one is at least 67%, and zero otherwise. |

[9]When common equity is negative, we set it equal to zero to avoid incorrectly inflating the return on capital.

**Table A.2**
The interactive effects of executive gender and age on corporate financial decisions and operating performance.

| | External funds raised | Investment | Return on Capital |
|---|---|---|---|
| Constant | 0.0620** | 0.1696*** | −0.0399*** |
| | (2.50) | (7.39) | −(5.28) |
| Old male dummy$_{(t-1)}$ | −0.0107*** | −0.0132*** | 0.0041*** |
| | −(2.74) | −(3.65) | (3.54) |
| Young female dummy$_{(t-1)}$ | −0.0202*** | −0.0144** | 0.0139*** |
| | −(2.64) | −(2.04) | (5.78) |
| Old female dummy$_{(t-1)}$ | −0.0239*** | −0.0367*** | 0.0221*** |
| | −(2.74) | −(4.56) | (7.87) |
| Mixed gender/age dummy$_{(t-1)}$ | −0.0071** | −0.0045 | 0.0029*** |
| | −(2.21) | −(1.50) | (3.07) |
| (T. Compensation/Assets)$_{(t-1)}$ | 2.2850*** | 2.3271*** | −2.2818*** |
| | (7.08) | (7.80) | −(12.49) |
| Ln(Assets)$_{(t-1)}$ | −0.0043*** | −0.0088*** | 0.0076*** |
| | −(3.83) | −(8.49) | (19.33) |
| (NPPE/Assets)$_{(t-1)}$ | −0.0105 | 0.0598*** | −0.0416*** |
| | −(1.27) | (7.84) | −(17.49) |
| (Cash/Assets)$_{(t-1)}$ | −0.0173* | 0.1334*** | −0.1366*** |
| | −(1.71) | (14.24) | −(32.26) |
| Tobin's Q$_{(t-1)}$ | 0.0023* | 0.0187*** | 0.0794*** |
| | (1.71) | (15.27) | (122.49) |
| Stock return volatility$_{(t-1)}$ | 0.0571*** | −0.0323* | −0.1160*** |
| | (2.99) | −(1.83) | −(15.19) |
| Leverage$_{(t-1)}$ | −0.0028 | −0.0288*** | −0.0110*** |
| | −(0.37) | −(4.04) | −(4.12) |
| (CFO/NPPE)$_{(t-1)}$ | −0.0102*** | −0.0017** | – |
| | −(10.90) | −(2.02) | – |
| Industry dummy | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes |
| Adjusted-$R^2$ | 0.0466 | 0.153 | 0.354 |

This table reports the results from seemingly unrelated regressions (SUR) of external funds raised, investment, and return on capital on the interaction of executive gender and age over a sample period of 2009–2018. The benchmark group in this table, captured by the constant, represents young male-run firms. All variables are defined in Table A.1 of the Appendix. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2,564 firms over the sample period. The *t-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

**Table A.3**
First stage regressions of female dummy and executive age on their respective instruments.

| | Female Dummy | Log (Executive age) |
|---|---|---|
| Local supply of female executives (ratio) | 1.2063*** | 0.0265 |
| | (12.55) | (1.32) |
| Ln(Avg. age of local supply of all executives) | −0.0345** | 0.9943*** |
| | −(2.27) | (32.25) |
| (T. Compensation/Assets)$_{(t-1)}$ | −0.9804 | −0.6787*** |
| | −(1.35) | −(2.62) |
| Ln(Assets)$_{(t-1)}$ | 0.0053 | 0.0051*** |
| | (1.49) | (4.73) |
| (NPPE/Assets)$_{(t-1)}$ | 0.0065 | 0.0086 |
| | (0.27) | (1.00) |
| (Cash/Assets)$_{(t-1)}$ | 0.0384 | −0.0068 |
| | (1.34) | −(0.63) |
| Tobin's Q$_{(t-1)}$ | −0.0043 | −0.0014 |
| | −(1.18) | −(1.18) |
| Stock return volatility$_{(t-1)}$ | −0.0580 | −0.0648*** |
| | −(1.52) | −(4.15) |
| Leverage$_{(t-1)}$ | −0.0651*** | −0.0262*** |
| | −(2.92) | −(3.28) |
| (CFO/NPPE)$_{(t-1)}$ | 0.0034 | −0.0010 |
| | (1.26) | −(1.16) |
| Industry dummy | Yes | Yes |
| Year dummy | Yes | Yes |
| F-statistic | 81.84 | 87.67 |
| P-value | 0.000 | 0.000 |

This table reports the results from OLS regressions of female dummy and executive age on their respective instruments over the sample period of 1992–2018. All variables are defined in Table A.1 of the Appendix. The ratio of the local supply of female executives and the average age of the local supply of all executives are used as instruments for the female indicator and executive age, respectively. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2,564 firms over the sample period. The *t-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

**Table A.4**
First stage regressions of executive indicators on their respective instruments.

| | Young male dummy | Old male dummy | Young female dummy | Old female dummy | Mixed gender/ age dummy |
|---|---|---|---|---|---|
| Local supply of young male (%) | 0.9984*** | 0.0791 | 0.0144 | −0.0436 | −0.0483 |
| | (9.46) | (0.75) | (0.52) | −(1.28) | −(0.44) |
| Local supply of old male (%) | 0.1559 | 0.9541*** | −0.0260 | 0.0009 | −0.0849 |
| | (1.50) | (8.41) | −(0.80) | (0.02) | −(0.74) |
| Local supply of young female (%) | −0.0715 | −0.0595 | 0.6052*** | −0.0261 | 0.5519*** |
| | −(0.55) | −(0.49) | (7.88) | −(0.66) | (3.95) |
| Local supply of old female (%) | 0.0683 | −0.0296 | −0.1482** | 0.6651*** | 0.4445** |
| | (0.40) | −(0.18) | −(2.28) | (6.40) | (2.27) |
| Local supply of mixed gender/age (%) | −1.0844*** | −0.5999*** | −0.0424 | −0.0605 | 1.7872*** |
| | −(11.17) | −(5.44) | −(0.89) | −(1.37) | (14.56) |
| $(\text{T. Compensation/Assets})_{(t-1)}$ | 2.5524** | −1.2631 | −0.6138 | 0.0394 | −0.7149 |
| | (2.53) | −(1.56) | −(1.25) | (0.21) | −(0.67) |
| $\text{Ln(Assets)}_{(t-1)}$ | −0.0191*** | 0.0073* | −0.0014 | 0.0041*** | 0.0092** |
| | −(4.87) | (1.95) | −(0.93) | (3.22) | (2.19) |
| $(\text{NPPE/Assets})_{(t-1)}$ | −0.0478 | −0.0179 | −0.0089 | 0.0233** | 0.0513 |
| | −(1.44) | −(0.68) | −(0.77) | (2.49) | (1.57) |
| $(\text{Cash/Assets})_{(t-1)}$ | 0.0252 | −0.0546* | 0.0404** | 0.0085 | −0.0195 |
| | (0.64) | −(1.65) | (2.11) | (1.02) | −(0.50) |
| $\text{Tobin's Q}_{(t-1)}$ | 0.0075 | 0.0024 | −0.0015 | −0.0008 | −0.0075* |
| | (1.61) | (0.64) | −(0.77) | −(0.82) | −(1.75) |
| $\text{Stock return volatility}_{(t-1)}$ | 0.2419*** | −0.0785 | −0.0130 | −0.0162 | −0.1342** |
| | (4.23) | −(1.57) | −(0.58) | −(1.38) | −(2.16) |
| $\text{Leverage}_{(t-1)}$ | 0.0901*** | −0.0813*** | −0.0323*** | −0.0158* | 0.0393 |
| | (3.01) | −(3.28) | −(3.10) | −(1.75) | (1.31) |
| $(\text{CFO/NPPE})_{(t-1)}$ | 0.0019 | −0.0057** | −0.0011 | 0.0009 | 0.0040 |
| | (0.52) | −(2.09) | −(1.06) | (0.93) | (1.15) |
| Industry dummy | Yes | Yes | Yes | Yes | Yes |
| Year dummy | Yes | Yes | Yes | Yes | Yes |
| F-statistic | 178.10 | 103.56 | 18.380 | 9.75 | 52.16 |
| P-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

This table reports the results from OLS regressions of the executive indicators on their respective instruments over the sample period of 1992–2018. All variables are defined in Table A.1 of the Appendix. Each executive group is instrumented by the ratio of the local supply of this group. The product of the ratios of local supplies of young and old female executives plus the product of the ratios of local supplies of young and old male executives is used as an instrument for mixed gender/age dummy. Each regression pertains to a sample of 28,306 firm-year observations, which represents 2564 firms over the sample period. The *t-statistics* are reported in brackets below the coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

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