CEO Gender, Corporate Risk-Taking, and the Efficiency of Capital Allocation

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Abstract

We show that CEO gender helps explain corporate decision making. In particular, we document that firms run by female CEOs have lower leverage, less volatile earnings, and a higher chance of survival than firms run by male CEOs. The results are robust to various tests for endogeneity, including firm fixed effects and change specifications, propensity score matching, a switching regression analysis with endogenous switching, and a treatment effects model. We further document that this risk-avoidance behavior appears to lead to distortions in the capital allocation process. These results have important macroeconomic implications for long-term economic growth.

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I. Introduction

In this paper, we provide evidence that gender diversity plays an important role in corporate choices. We document that female CEOs tend to avoid riskier investment and financing opportunities. We further show that the risk-avoidance behavior of female CEOs appears to lead to distortions in corporate investment policies.

Our results have important implications, as the degree of efficiency of the capital allocation process is a fundamental underpinning of economic growth (Bagehot, 1873, Beck, Levine and Loayza, 2000, Greenwood and Jovanovic, 1990, John, Litov and Yeung, 2008). Under perfect capital markets, managers should choose investments so as to maximize the market value of the firm. Equivalently, managers should undertake all (and only) positive expected net present value projects (Fama and Miller, 1972). In this framework, neither the preferences of managers nor those of the firm's owners play any role in the investment selection choice. Traditional explanations for why decision makers' preferences and characteristics play a role in the investment selection choice include agency (Jensen and Meckling, 1976, Jensen, 1986), asymmetric information (Myers and Majluf, 1984), and behavioral considerations (Roll, 1986, Malmendier and Tate, 2005, 2008, and Malmendier, Tate, and Yan, 2011).

Our story builds upon the experimental economics and psychology literature, as surveyed by Croson and Gneezy (2009) and Bertrand (2011). This literature documents gender-related differences in risk-aversion. Bruce and Johnson (1994) and Johnson and Powell (1994) study how betting behavior varies with gender. They provide evidence that women display a lower propensity for risk-taking than men. Hudgens and Fatkin (1985) document that gender related differences in risk-taking are also present in a military framework. Sundén and Surette (1998) and Bernasek and Shwiff (2001) document that women are significantly more risk-averse in their allocation of wealth to pensions.

Evidence that gender diversity affects corporate decisions or outcomes includes Adams and Ferreira (2009), Ahern and Dittmar (2012), and Weber and Zulehner (2010). For example, Adams and Ferreira (2009) provide evidence that CEO turnover correlates more strongly with poor performance when the *board of directors* is more gender-diverse. Ahern and Dittmar (2012) document that the introduction of mandatory board member gender quotas led to an increase in acquisitions and performance deterioration in Norwegian publicly traded firms.[1] Weber and Zulehner (2010) document that start-ups with *female first hires* display a higher likelihood of survival.

There is, however, very little evidence that these differences extend to corporate decision-makers, i.e. *managers*, as women rarely serve as top managers of publicly traded corporations.[2] While it is well documented for the general population that women are more risk-averse than men, given the specific and rare combination of skills needed to ascend to a high management position, there should not be a difference between males and females among top executives. Further, there is no direct evidence as to whether gender-driven differences in risk-taking choices lead to misallocation of capital.

This body of evidence on differences in risk aversion leads to two testable hypotheses. First, firms run by female CEOs will make less risky corporate choices and experience less volatile outcomes. This prediction is a direct consequence of women's higher risk aversion. Second, the avoidance of risky projects with positive expected net present values will reduce the efficiency of the capital allocation process.

To test our predictions, we employ *"Amadeus Top 250,000*," a database covering a large number of European privately-held and publicly-traded companies. Disclosure requirements in

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[1] Other work focusing on gender diversity in corporate boards includes Levi, Li and Zhang (2011) and Matsa and Miller (2012).
[2] An exception is Huang and Kisgen (2009), who document that the propensity to make acquisitions is lower in companies with female CFOs. Their sample includes 73 female CFOs.

Europe require private companies to publish annual information. As a consequence, the database allows us to gather a large sample of firms run by female CEOs. In support of our first prediction, we document that firms run by female CEOs have lower leverage, less volatile earnings and a higher chance of survival than firms run by male CEOs. These results are robust to controlling for standard determinants of risk-taking.

To assess the efficiency of capital allocation, we estimate the sensitivity of corporate investment to the industry's marginal (Tobin's) Q. We borrow the basic idea from Wurgler (2000), and use the procedure developed by Durnev, Morck and Yeung (2004) to measure marginal Q – the change in firm value associated with an unexpected change in investments. We focus on the sensitivity to *marginal Q* as theory states that this measures the value created by the investment decision. We document that male CEOs invest more in industries that have higher marginal Q, i.e., in projects that create more value for well diversified shareholders. However, investments of firms run by female CEOs are not significantly related to marginal Q. Thus, female CEOs do not appear to allocate more funds to projects that create more value for well diversified shareholders. From this perspective, female CEOs do not appear to allocate capital efficiently. Similar conclusions are reached if value added growth is instead used as a proxy for the quality of investment opportunities, as in Wurgler (2000).

A caveat in the interpretation of our results, as in any empirical study, is the issue of endogeneity. In particular, gender could be a selection criterion for the CEO. Thus, owners of firms with less risky investment opportunities may choose female CEOs while owners of firms with riskier investment opportunities may choose male CEOs. Self-selection is a tricky issue, as identifying the role of gender on risk-taking choices requires an exogenous shock to CEO gender that is independent of other determinants of risk-taking. In this regard, finding a natural experiment is highly unlikely.

Additionally, if one could identify a natural experiment, it is unlikely that the results would generalize to the majority of CEOs.

We nevertheless take a number of steps to address the issue of endogeneity. First, we include a number of control variables to reduce the possibility of spurious correlation. In particular, we control for CEO ownership and block ownership to address agency considerations. Further, we control for size and industry to address asymmetric information concerns. Our results are robust to adding these (and other) control variables.

Second, we include firm fixed effects in our panel regressions. Adding fixed effects to a panel regression controls for *any* firm-specific time-invariant omitted variables that may affect the firm's decision in terms of attitude toward risk. Our conclusions are unaffected by the addition of firm fixed effects. (The conclusions are unchanged if we alternatively use change regression specifications.)

Third, we employ a propensity score matching procedure to compare firms run by female CEOs to a group of similar peers run by male CEOs. As the control firms are restricted to a set of peers that are virtually indistinguishable in terms of observable firm characteristics, the firms run by female CEOs should take as much risk as firms run by male CEOs if CEO gender was indeed irrelevant for risk-taking preferences. However, even after matching using a propensity score approach, we continue to find statistically significant differences in corporate risk-taking depending on CEO gender.

Fourth, we employ a switching regression analysis with endogenous switching. This allows us to control for endogenous self-selection regarding appointing a male or a female CEO and the possibility that self-selection alone might explain the risk-taking choices. One advantage of this methodology is that it allows us to perform a counterfactual analysis. In other words, ceteris paribus, it allows us to infer what the leverage (or volatility of earnings or survival rate) of a company run by a male CEO would have been had it been run by a female CEO. Once again, after controlling for the potential endogenous matching between firms and CEOs, we still find that female CEOs tend to take on less risk than their male counterparts.

Fifth, we employ a treatment effects model. This allows us to explicitly test whether CEO gender still plays a role in financial and investment policies after any kind of self-selection due to unobservables has been explicitly controlled for. Even after controlling for unobservable private information that leads certain firms to select a female CEO, the results of the treatment effects model confirm the strong effect of CEO gender on corporate risk-taking choices.

Last but not least, we note that while some kind of *endogenous* matching between firms and CEOs takes place (at least to some extent) in our sample, in the presence of *optimal* matching (from the standpoint of well diversified shareholders) we should find a positive association between investments and marginal Q. This should occur for firms run by either male or female CEOs. The gender associated difference in the efficiency of capital allocation that we document is, in this sense, inconsistent with *optimal* matching.

Why does such suboptimal capital allocation behavior persist in equilibrium? As we document, most of the firms in our sample are private firms with concentrated ownership. This precludes traditional corporate control mechanisms such as incentives (stock options etc.) or disciplinary takeovers, as there is no organized, liquid capital market in which the shares of these firms can be freely bought or sold. Further, since the wealth and human capital of this risk-averse CEO are largely concentrated in the firm she manages[3], she will seek to avoid increasing firm-

[3] To validate this claim, we reconstruct the stock portfolios of a random sample of 3,000 CEOs using data in *Amadeus*. We start by searching across all firms in the database for each CEO's name. In each firm where the CEO's name appears, we record his/her ownership in the firm and calculate the euro value of

specific risk which would decrease her expected utility. This behavior distorts the capital allocation process. With this in mind, matching may be endogenous in the sense that relatively undiversified owners who have a preference for less risky investments opportunities may choose female CEOs (or serve as the CEO themselves) while owners who have a preference for riskier investment opportunities may choose male CEOs. At the same time, this matching is not *optimal* in a "traditional" sense as corporate choices depend on the preferences of undiversified utility-maximizing decision-makers as opposed to responding to a market value maximization rule.

This paper complements the literature of how managerial traits affect corporate decision making. Those studies include Bertrand and Schoar (2003), Cain and McKeon (2012), Cronqvist, Makhija and Yonker (2012), and Malmendier and Tate (2005, 2008) and Malmendier, Tate, and Yan (2011). We add to this literature by showing that CEO gender is yet another important trait leading to differences in corporate choices. The paper also contributes to the literature on the efficiency of capital allocation (Durnev, Morck and Yeung, 2004, McLean, Zhang, and Zhao, 2012, Morck, Yavuz and Yeung, 2011, Wurgler, 2000). Our paper is the first to provide evidence that differences in managerial traits, in particular gender, have implications for the quality of the capital allocation process.

The rest of the paper is organized as follows. Section II describes the data. Sections III and IV present the regression results and discuss the source of the inefficiencies observed. Section V discusses alternative interpretations of the results. Section VI concludes.

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his/her ownership position. Assuming that these positions represent the CEO's entire portfolio, we calculate the fraction of the CEO's portfolio invested in each firm. Based on the investments that we observe in *Amadeus*, on average, 91.5% of the selected CEOs' observed wealth is invested in the company they manage. Given this evidence, CEOs appear to be largely undiversified.

II. Data

Most of the data used in the paper are taken from *Amadeus Top 250,000* and *Worldscope*. *Amadeus* is maintained by Bureau Van Dijk. From this database we gather information on the name of the CEO, ownership data, and accounting data for every European privately-held and publicly-traded company that satisfies a minimum size threshold.[4] Disclosure requirements in Europe require private companies to publish annual information. Consequently, we are able to gather accounting, ownership and gender information for a very large set of firms. The quality of data in *Amadeus Top 250,000* is discussed in detail in Faccio, Marchica and Mura (2011). We gather the data from the annual *Amadeus Top 250,000* DVDs.[5] Our sample period starts in 1999 (the first year for which we can gather ownership data from the DVDs) and ends in 2009 (the most recent year for which accounting and ownership data are available).

Later in the paper, we use *Worldscope* to gather stock price data and additional accounting data for publicly-traded firms. Those data are employed to estimate the marginal Q of each 3-digit SIC industry in each country, as described in detail in Appendix A.

To select our sample, we start with the 41 countries covered in *Amadeus*. From these, we exclude countries that are not covered in *Worldscope* in the earlier years. Those are primarily Eastern European countries and smaller countries such as Liechtenstein and Monaco. This leaves us with a sample of 21 countries. Finally, we exclude the Czech Republic, Poland and the Russian Federation

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[4] For France, Germany, Italy, Spain, and the United Kingdom, the database includes all companies that meet at least one of the following criteria: (1) revenues of at least €15m, (2) total assets of at least €30m, (3) at least 200 employees. For the other countries, the database includes all companies that meet at least one of the following criteria: (1) revenues of at least €10m, (2) total assets of at least €20m, (3) at least 150 employees.

[5] *Amadeus* removes firms from the database five years after they stop reporting financial data. These drawbacks are also discussed in Klapper, Leaven and Rajan (2006) and Popov and Roosenboom (2009). In order to avoid potential survivorship bias, we collect data starting with the 2011 DVD and progressively move backward in time. By doing so, no firms are dropped from the sample.

as, for these countries, the *World Bank* provides GDP deflators only starting in 1990.[6] After these exclusions, the final sample used throughout the paper consists of the following 18 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

II.A. CEO Gender

We identify the gender of a CEO primarily based on his/her first name, as reported in "*Amadeus Top 250,000.*" Since 2007, DVDs indicate the gender of the CEO. As a starting point, we use this information to classify CEOs from 2007 forward. We also use this information to classify those same individuals in the prior years. Prior to 2007, *Amadeus* does not indicate the gender of the CEO. However, at least in some instances, *Amadeus* reports a salutation. We use the salutation when it indisputably allows identifying the gender of the CEO.[7] If these methods do not conclusively identify the CEO's gender, we employ country-specific internet-based sources to classify gender based on each individual's first name.[8] Using country-specific sources is important to avoid misclassification. For example, Simone is used for women in France but for men in Italy. Finally, when we could not identify the gender from the names lists found on the web, we used *OneSource*, *LinkedIn*, *Google* and *Facebook* to further research the CEO and assess whether a specific name is a male or female name.

When we are unable to classify the gender of an individual, we drop the observation. Across all countries and all years, this procedure allows us to identify the gender of the CEO in 338,397 firm-year observations. As shown in Table 1, 9.4% of the CEOs in the sample are women. While this

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[6] The procedure employed to construct marginal Qs requires data starting from 1983 (see Appendix A).
[7] For instance, "Mr" versus "Ms/Mrs/Miss" or "Dr." versus "Dr.ª" (more commonly used in Portugal).
[8] For instance, www.babynology.com, www.nordicnames.de, babynamesworld.parentsconnect.com, www.namepedia.org/en/firstname.

figure might appear high at first, it is important to keep in mind that most of the firms in our sample (95.4%) are private companies. [9]

II.B. Risk-Taking

We consider three measures of risk-taking. The first measure, *Leverage*, is a measure of the riskiness of corporate financing choices. The intuition is simple: given a (negative) shock to a firm's underlying business conditions, the higher the leverage, the greater the (negative) impact of the shock on the firm's net profitability (including a higher probability of default). *Leverage* is defined as the ratio of financial debt divided by the sum of financial debt plus equity. Financial debt is the sum of long term debt (excluding "other non-current liabilities") and short term loans. Across the firms in our sample, the average *Leverage* ratio is 37.4%. This ratio is 32.4% for firms with a female CEO and 37.9% for firms with a male CEO (the p-value of the difference between the two is less than 0.001).

The other two risk-taking variables are measures of the riskiness of outcomes. *σ(ROA*) is the volatility of the firm's operating return on assets, defined as the ratio of earnings before interest and taxes to total assets. Volatility of returns is a standard proxy for risk in the financial economics literature. This variable captures the riskiness of investment decisions. Further, earlier work by John, Litov, and Yeung (2008) establishes that the volatility of firm-level operating profits has a positive impact on long term economic growth. We focus on the volatility of accounting returns (as opposed to stock market returns) as the vast majority of firms in our sample are privately held. We calculate the standard deviation of the returns over 5-year overlapping windows (1999-2003, 2000-2004, 2001-2005, 2002-2006, 2003-2007, 2004-2008 and 2005-2009). Across all firms in the sample, the

[9] Our data show that the percentage of women CEO is higher among private firms (10.2%) than for publicly traded firms (7.2%). Huang and Kisgen (2009) document that only 2% of the CEOs of large publicly traded U.S. companies are women.

average volatility of ROA is 4.8%. As with *Leverage*, there is a significant difference in this variable (p-value < 0.001) between firms run by female CEOs (2.7%) and firms run by male CEOs (5.0%).

Third, we exploit the notion that riskier firms are less likely to survive, and focus on the likelihood of surviving over a 5-year period. For a firm to enter this analysis, we only require that CEO gender, ownership, and accounting data be available for at least one year during 1999-2005. Since firms that enter our sample in 2005 or earlier could have up to five years or more of data, we focus on these observations to assess the likelihood of survival. This specification has two main advantages. First, there is no survivorship bias, as both surviving and non-surviving companies are included in the analysis. Second, this measure of risk-taking is unaffected by accounting manipulation. We find that 51.7% of the firms in the sample survive at least 5 years. The likelihood of survival is 61.4% for firms with a female CEO and 50.5% for firms with a male CEO. The difference between female and male CEOs is statistically significant with a p-value of less than 0.001.

II.C. Control Variables

We include a number of control variables in each of the risk-taking regressions. The data used to construct these control variables are taken from *Amadeus*. *CEO Ownership* is calculated as the cash flow rights of the CEO on the firm's earnings. Since a high level of ownership aligns the CEO's incentives with those of minority shareholders, we use CEO ownership to control for agency conflicts. *Cash flow rights* is the ownership rights of the largest ultimate shareholder.[10] The higher the ownership of a large shareholder, the greater the incentive to monitor the CEO. This would in turn mitigate agency conflicts. *Ln (Size)* is the natural log of total assets (in thousands US$), expressed in 2000 prices. Total assets is the sum of fixed assets (tangible and intangible fixed assets

[10] To identify the largest ultimate shareholder, for each company that has available ownership data in *Amadeus*, we identify its owners, the owners of its owners, and so on.

and other fixed assets) and current assets (inventory, receivables, and other current assets). *ROA* is defined as the ratio of earnings before interests and taxes to total assets. We include firm profitability to control for differences in management quality. *Sales Growth* is calculated as the annual rate of growth of sales. We use sales growth as our control variable (rather than the market-to-book ratio) as most of the firms in the sample are private. *Ln (1+Age)* is the natural logarithm of (1 + the number of years since incorporation). This variable controls for differences in the life cycle of a firm. *Tangibility* is calculated as the ratio of fixed to total assets. *Private firm* is an indicator denoting firms that are not publicly traded. We use this variable as a proxy for capital constraints. Summary information for all control variables is reported in Table 1. The sample includes 132,590 firms and 338,397 firm-year observations.

III. CEO Gender and Risk-Taking: Regression Results

To assess the relation between gender and corporate risk-taking, we start by regressing our measures of risk-taking on CEO gender and other determinants of risk-taking that, if excluded, could induce spurious correlations. In particular, we control for ownership concentration, profitability, sales growth, firm size, firm age, asset tangibility, and a private firm indicator along with country, industry, and year fixed effects. The results are reported in Table 2.

Leverage is the dependent variable in Regression (1). Regression (1) is a panel ordinary least squares (OLS) regression with standard errors clustered at the firm level. The results of Regression (1) indicate that firms run by female CEOs use significantly less leverage and therefore take less financial risk than firms run by male CEOs. The coefficient of *Female CEO* indicates that after controlling for several other determinants of capital structure choices, the leverage of firms run by female CEOs is lower on average than the leverage of firms run by male CEOs by 0.034. This appears to be a sizeable difference, given an average value of *Leverage* of 0.374 for the entire sample. The coefficient on the gender variable has a p-value of less than 0.001. This result provides direct evidence that male CEOs are willing to take greater firm-level risk than female CEOs.

The *volatility* of firm-level profitability is the dependent variable in Regression (2). We again employ a panel OLS specification with standard errors clustered at the firm level. In this Model (as well as in Regression (3)), all independent variables are measured at the first year-end of the sample period over which the volatility of earnings (or the likelihood of survival) is measured.

The results show that the volatility of a firm's ROA is significantly lower when the firm is run by a female CEO (p-values $\leq$ 0.001). As with *Leverage*, the difference in the *volatility* of firm-level profitability between firms run by female and male CEOs is sizeable (1.998/100=0.020) relative to the sample mean (0.048).

Regression (3) is a cross-sectional Probit regression of the likelihood that a firm survives at least 5 years. To analyze the likelihood of survival, we employ Probit models, in which the outcome is 1 if a company survives at least 5 years, and 0 otherwise. The results in Table 2 indicate significantly higher survival rates for companies run by female CEOs. To the extent that firms that take more risk are less likely to survive through time, this result is consistent with the notion that companies managed by women tend to engage in less risky projects.

Thus, both corporate choices (such as leverage) and corporate outcomes (volatility of profitability and the likelihood of survival) are significantly different depending on the gender of the CEO.

III.A. Endogeneity Concerns

As with any empirical study, a caveat in the interpretation of our results is the issue of endogeneity. In the following sub-sections, we take a number of steps to address this concern.

III.A.1 Firm Fixed Effects

Our first endogeneity concern arises from the possibility that our results could be influenced by omitted variables. In particular, the documented correlation between CEO gender and corporate risk-taking may simply reflect unobservable characteristics that affect both CEO gender choice and corporate risk-taking choices. The specific concern is that the omission of these factors might lead us to incorrectly attribute the differences in risk-taking to differences in CEO gender.

In this section, we exploit the panel dimension of our dataset to control for *time-invariant* firm specific characteristics which may be correlated with omitted explanatory variables. More specifically, we add firm fixed effects to the (panel) regression specifications. The inclusion of firm fixed effects removes any purely cross-sectional correlation between gender and risk-taking, greatly reducing the risk of spurious correlation.

In Panel A of Table 3 we replicate our earlier analysis (with firm fixed effects now included) for leverage and the *volatility* of firm-level profitability. These results strongly corroborate the previous evidence. The magnitude of the effect of gender on risk-taking is again both economically and statistically significant, with p-values of less than 0.001.

In Panel B of Table 3 we use change regression specifications to identify the effect of gender on risk-taking. Since the level of risk-taking observed at a given point in time reflects cumulative past decisions, tests based on risk-taking *levels* may have low power to explain marginal decisions. In contrast, the change specifications focus on year-to-year changes in gender and risk-taking, making them more powerful for explaining incremental decisions. Importantly, these change specifications support our conclusion that CEO gender affects risk-taking choices.

III.A.2 Propensity Score Matching

A second concern stems from the idea that gender could be a selection criterion for the CEO. For example, owners of firms with less risky investment opportunities may choose female CEOs while owners of firms with riskier investment opportunities may choose male CEOs. It is evident from Table 1 that firms run by male and firms run by female CEOs differ across several characteristics. Simply controlling for these attributes (as in the previous analyses) might be insufficient.

To address this concern, in this section we employ a propensity score matching procedure (Rosenbaum and Rubin, 1983) to identify a control sample of firms that are run by male CEOs and that exhibit no observable differences in characteristics relative to the firms run by female CEOs. Thus, each pair of matched firms are virtually indistinguishable from one another except for one key characteristic: the gender of the CEO. We then compare the *Leverage*, *σ(ROA)* and the likelihood of survival between the two groups. As the control firms are restricted to a set of peers that is almost identical in terms of observable characteristics, firms run by female CEOs are expected to make the same risk-taking choices as firms run by male CEOs.

To implement this methodology, we first calculate the probability (e.g., the propensity score) that a firm with given characteristics is run by a female CEO. This probability is calculated using firm characteristics that we included in the previous regression analyses. More specifically, the propensity score is estimated as a function of ROA, sales growth, the natural log of total assets, the natural log of firm age, asset tangibility, a private firm dummy, the ownership of the CEO, the ownership of the largest ultimate shareholder, country, industry and year dummies. We also control for leverage in the volatility of ROA and survival analyses. To ensure that the firms in the control sample are sufficiently similar to the firms run by a female CEO, we require that the maximum difference between the propensity score of the firm run by a female CEO and that of its matching peer does not exceed 0.1% in absolute value.

The results in Table 4 indicate that, even when holding observable firm characteristics virtually identical between the two groups, firms run by female CEOs tend to take less risk in comparison to firms run by male CEOs. The average leverage of firms run by female CEOs is 32.3%

compared with 35.5% for otherwise similar firms run by male CEOs. The average volatility of ROA is 2.7% for firms run by female CEOs and 4.8% for firms run by male CEOs. The likelihood of survival over a 5-year period is 61.2% for firms run by female CEOs and 51.6% for firms run by male CEOs. All differences in risk-taking between the two groups are statistically significant with p-values less than 0.001. Further, after matching the two groups based on firm characteristics, the observed differences in risk-taking are even greater than in the regressions analyses. More importantly, these results indicate that the previously documented gender-related differences in risk-taking are not due to observed differences in firm characteristics.

III.A.3 Switching Regression Analysis

A third concern is that firms may non-randomly self-select into appointing a male or a female CEO and that this self-selection alone might explain the risk-taking choices. We address this concern by employing a switching regression analysis with endogenous switching. This analysis is based on Heckman's (1979) two-step procedure.

The model consists of three equations. First, we have a binary outcome equation which, in our case, models the choice of the CEO gender. We then have two regressions for the variable of interest *conditional* on the choice of gender. In our case, we perform this test for all three measures of risk-taking: leverage, *volatility* of firm-level profitability and probability of survival.

Following Maddala (1991) the binary choice model is expressed as:

$$I_i^* = \gamma' \cdot Z_i + u_{\mathrm{i}} \qquad (1)$$

where Z_i is a vector of exogenous variables that influence the choice of firm *i* to appoint either a female or a male CEO: $I_i = 1$ if $I_i^* > 0$ *and* $I_i = 0$ if $I_i^* \leq 0$. Accordingly, the two regressions for the variable of interest are expressed as:

$$y_{1i} = \beta_1' \cdot X_{1i} + u_{1\mathrm{i}} \quad (2)$$

$$y_{2i} = \beta_2' \cdot X_{2i} + u_{2\mathrm{i}} \quad (3)$$

Consequently, $y_i = y_1 \; if \; I_i = 1$ and $y_i = y_2 \; if \; I_i = 0$. The presence of the selection bias lies in the non-zero correlation between the error term in Equation (1) and the error terms in Equations (2) and (3). Therefore, estimating (2) and (3) via OLS may lead to inconsistent estimates of the regression parameters. Consistent OLS estimators can be instead obtained with a two-stage method following Lee (1978), Heckman (1979) and Maddala (1983).

We first estimate Equation (1) using a probit model. This is instrumental in obtaining consistent estimates of γ. These coefficient estimates are used to compute the inverse Mills ratio for Equations (2) and (3). These terms adjust for the conditional mean of u and allow the equations to be consistently estimated by OLS. Following Maddala (1991) the two inverted Mills ratio parameters are: $\lambda_1(\gamma Z_i) = \frac{-\phi(\gamma Z_i)}{\Phi(\gamma Z_i)}$ and $\lambda_2(\gamma Z_i) = \frac{\phi(\gamma Z_i)}{1-\Phi(\gamma Z_i)}$ where ϕ represents the standard normal density function while Φ represents the standard normal cumulative distribution function.

Equations (2) and (3) are then augmented with the inverse Mills ratios λ_1 and λ_2 as additional regressors. One of the appealing features of this procedure is that it allows us to conduct a counterfactual analysis; put more simply, we can use this procedure to investigate alternative, “what if” scenarios. For instance, it allows us to infer what the leverage of a company run by a male CEO would have been had it instead been run by a female CEO. This counterfactual is calculated by multiplying the estimated coefficients from Equation (3) (the leverage regression for firms run by male CEOs) by the observed values of the right hand side variables of companies run by female CEOs, excluding the inverse Mills ratio (see Maddala, 1991).

To avoid multicollinearity issues in the estimation of the model, we include two exogenous variables in the first stage.[11] Our first exogenous variable is the *local supply of educated women* in a given geographic subdivision. As the supply of educated (i.e., qualified) women increases, the likelihood that a firm will appoint a woman as CEO is likely to increase.[12] Our second exogenous variable is the region-specific *attitude towards women* participating to the labor force.[13] (These variables are described in detail in Appendix B).

Results reported in Table 5 compare observed values for our three proxies of risk-taking with the counterfactuals for both groups: firms run by male CEOs and firms run by female CEOs. For firms run by female CEOs, leverage would have been 38.4% had the firms been run by a male CEO, compared to the actual average leverage of 31.5%. The mean difference in leverage is 6.9 percentage points, which is significant with a p-value of less than 0.001. Similarly, for firms run by male CEOs, leverage would have been 27.2% had the firms been run by a female CEO, compared to the actual average leverage of 37.9%. The difference between the two (10.7 percentage points) is again highly statistically and economically significant.

Similar conclusions are obtained for the other proxies of corporate risk-taking. These tests confirm the previous evidence that, even after controlling for self-selection, women CEOs tend to take on less risk compared to their male counterparts.

[11] Technically speaking, the inclusion of exogenous variables is not strictly necessary as identification is achieved by non-linearity in this model.
[12] There are strong reasons to expect the local supply of educated women to impact the likelihood that a woman will be appointed as the firm's CEO. First, higher education appears to be an almost necessary condition to be appointed as CEO. For example, Pérez-González (2006) documents that over 90% of the CEOs of U.S. publicly traded firms hold a bachelor's degree or higher. Second, we focus on the *local* supply of qualified women, as Yonker (2011) documents that U.S. publicly traded firms are five times more likely to hire CEOs from their own state.
[13] We argue that the more favorable the attitude towards female labor force participation, the higher the probability that a woman may be hired as the CEO. Countries with a less favorable attitude towards women participating to the labor force do indeed exhibit lower female labor force participation in general (Fernández, 2011).

III. A.4 Treatment Effects Model

As a last attempt to try to address potential endogeneity concerns, we employ a variation of the Heckman two step approach: the treatment effects model. The first stage of this model is identical to the one outlined above, Equation (1). However, from Equation (1) we calculate only one inverse Mills ratio: the combination of the λ_1 for firms run by male CEOs and λ_2 for firms run by female CEOs. In the second step we include this inverse Mills ratio alongside the dummy variable characterizing CEO gender (and other controls). In this manner, we can explicitly test whether CEO gender still plays a role in financial and investment policies after controlling for self-selection due to unobservable private information.

In Table 6 we report the estimates of the probit coefficients and the treatment effects model coefficients. Once again, we include the *local supply of educated women* in a given geographic subdivision and the *attitude towards women* participating to the labor force in the probit model to minimize multicollinearity problems. More importantly, after we add the inverse Mills ratio to correct for self-selection, the coefficient of the CEO gender indicator maintains the same sign as in the earlier specifications. Thus, after accounting for unobserved private information that makes certain firms select a female CEO, there is still a large effect of CEO gender on risk-taking choices. In particular, female CEOs lead to less corporate risk-taking.

IV. CEO Gender and the Efficiency of Capital Allocation

So far we have documented that female CEOs make less risky corporate choices than male CEOs. The observed differences in corporate risk-taking do not appear to be the outcome of endogenous matching between firms and CEOs. If this outcome is driven by female CEOs imposing their preferences on corporate choices, the efficiency of the capital allocation process will be undermined. In this section, we investigate whether this is the case.

To measure the efficiency of capital allocation, we look at the degree to which investment is related to the marginal Q, as advocated by theory. Under perfect capital markets, optimal decision making requires that managers undertake *all* projects with positive expected net present value, and reject *all* projects with negative expected net present value. If projects were to be ranked based on their expected net present value per dollar of capital invested, managers should invest up to the point where, for the next project in line, the net present value is zero. By doing so, managers would maximize firm value. Equivalently, managers should invest up to the point where the firm's marginal Q is 1. A firm's marginal Q ($\dot{q}$) measures the change in the market value of firm, $\Delta\mathrm{V}$, associated with an (unexpected) change in capital investment, $\Delta\mathrm{I}$. In other words,

$$\dot{q} = \frac{\Delta\mathrm{V}}{\Delta\mathrm{I}} = \frac{1}{\mathrm{C}}\{\mathrm{E[NPV]} + \mathrm{C}\} \tag{4}$$

where C represents the set-up cost for the capital investment, and E[NPV] is its expected net present value or, equivalently, the present value of all incremental cash flows yielded by the project in the future (net of its set-up cost). For any given C > 0, E[NPV] > 0 implies a $\dot{q}$ >1. Conversely, E[NPV] < 0 implies a $\dot{q}$ < 1. Stated differently, value maximization implies $\dot{q}$ = 1. A $\dot{q}$ > 1 implies underinvestment, while a $\dot{q}$ < 1 implies overinvestment.

To estimate $\dot{q}$, we largely follow Durnev, Morck and Yeung (2004). A few changes to their methodology are necessary because of differences in corporate disclosure in Europe. For clarity, in Appendix A we describe each step employed in the estimation procedure, largely borrowing from Durnev, Morck and Yeung's (2004) paper. As shown earlier in Table 1, the average $\dot{\hat{\mathrm{q}}}_{\mathrm{t}}^{\mathrm{i,c}}$ is 1.117, and the median is 0.929. We find a great deal of variation in the estimates of the marginal Q across industries. Interestingly, the marginal Q does not cluster around 1, as we would expect if, across all industries, firms were investing up to the "optimal point." Rather, there is evidence of both underinvestment and overinvestment in different industries.

To assess the efficiency of capital allocation, for all companies in *Amadeus* we estimate a simple version of the q-model of investment as in Fazzari, Hubbard and Petersen (1988), augmented by an indicator denoting a female CEO and the interaction of this indicator with the marginal Q:[14]

$$\frac{\Delta \text{ Gross PPE}_{j,t}}{\text{Total Fixed Assets}_{j,t-1}} = \alpha + \beta \cdot \dot{\hat{q}}_{t}^{i,c} + \gamma \cdot \frac{\text{Cash Flow}_{j,t}}{\text{Total Fixed Assets}_{j,t-1}} + \qquad (5)$$

$$+\delta \cdot Female\ CEO_{j,t} + \theta \cdot \dot{\hat{q}}_{t}^{i,c} \cdot Female\ CEO_{j,t} + u_{j,t}^{i}$$

where $\frac{\Delta \text{ Gross PPE}_{j,t}}{\text{Total Fixed Assets}_{j,t-1}}$ represents the capital expenditures of firm j at time t, relative to the capital stock; $\Delta\ Gross\ PPE_{j,t}$ is the annual change in net *Total Fixed Assets*, with depreciation added back; *Total Fixed Assets* is the sum of tangible fixed assets, intangible fixed assets, and other fixed assets (all net of accumulated depreciation); $\dot{\hat{q}}_{t}^{i,c}$ is the proxy for the marginal Q and it reflects the quality of the firm's investment opportunities; $Cash\ Flow_{j,t}$ is net income plus depreciation. β represents the sensitivity of investments to growth opportunities. *Ceteris paribus*, the better (worse) the growth opportunities, the more a value maximizing-value manager should invest (divest). θ is our coefficient of interest which measures the difference in the investment sensitivity to growth opportunities between firms run by female and male CEOs. If CEO gender is irrelevant to investment efficiency, then $\theta = 0$.

Table 7, Panel A, presents regressions of firm investment on marginal Q, CEO gender, the interaction between these two variables, and other controls. (In this Panel, we use bootstrapped standard errors as marginal Qs are estimated.) We include country, industry and year fixed effects to mitigate measurement error problems in the estimation of marginal Q. As we pointed out above, under perfect capital markets, optimal capital budgeting requires that managers undertake all (and

[14] See Hubbard (1998) and Bond and van Reenen (2007) for extensive surveys on alternative models on investment. As in Wurgler (2000), we rely on a relatively simple regression specification as more elaborate specifications give similar results.

only) positive expected net present value projects. Equivalently, managers should undertake all investments with $\dot{q}$ >1, and avoid (or divest) those with $\dot{q}$ < 1. As a consequence, given the presence of differences in the quality of investment opportunities across industries, optimal capital budgeting implies a positive relation between investments and each industry's marginal Q.

Consistent with optimal capital budgeting, the results in Table 7 show that there is a positive and significant association between investments and Tobin's Q for firms run by male CEOs. For example, Regression (1) shows that, for male CEOs, the coefficient of the sensitivity of investment to marginal Q is 0.013, with a p-value of less than 0.001. In other words, these results are consistent with male CEOs investing more when their firm is operating in an industry with good prospects, and divesting capital (or invest less) when the prospects of their firm are poor.

By contrast, the coefficient on the interaction between CEO gender and marginal Q is negative and significant (coeff. = -0.020, p-value < 0.001), implying that, corporate investments are less responsive to marginal Q in firms run by female CEOs. Surprisingly, the magnitude of the coefficient on the interaction term when combined with the coefficient on the marginal Q term implies that firms run by female CEOs fail to invest more when their industry has good prospects, and fail to divest capital when prospects are poor. From Regression (1) we can determine that the sensitivity of investment to marginal Q for firms run by female CEOs is -0.007 (=0.013-0.020), with a p-value of 0.330. This result suggests that women do not appear to allocate capital efficiently.

In unreported tests we find that the results are robust to including other controls such as ownership concentration, profitability, sales growth, firm size, firm age, asset tangibility, and a private firm indicator along with country, industry, and year fixed effects. Ever more importantly, as Regression (2) indicates, the results are also robust to using a treatment effects specification to control for the endogeneity of the CEO selection choice.

To assess whether risk-avoidance drives inefficient capital allocation in firms run by female CEOs, in Regression (3) we augment our specification with both an index that measures the degree of risk-avoidance and the interaction of this index with marginal Q. If risk-avoidance explains our earlier results, the interaction term between female CEOs and marginal Q should lose its significance due to the explanatory power of the new interaction term. We construct an index based on the three variables used to measure the degree of risk-avoidance. In particular, the index is constructed by adding 1 when (1) a firm's leverage is in the bottom 20% of the distribution; (2) the volatility of firm-level profitability is in the bottom 20% of the distribution; and (3) if the firm survives at least 5 years. The index ranges from 0 to 3, with higher scores denoting greater risk-avoidance.

As shown in Regression (3), the risk-avoidance index is negatively correlated with the level of investment, indicating that more risk-averse CEOs invest less. In addition, the index's interaction with marginal Q indicates that investment is less sensitive to marginal Q when risk-avoidance is high. Most importantly, the results are consistent with our premise that the inefficient capital allocation exhibited by female CEOs is due to risk-avoidance.

IV. A. Value Added Growth

Marginal Q is a theoretically grounded measure of the quality of investment opportunities. However, the empirical procedure used to compute marginal Q may introduce a lot of estimation error. This error may undermine the credibility and interpretation of the results. Additionally, using Q becomes problematic if we allow for the possibility that mispricing occurs in capital markets. A third problem with the methodology used above arises because we use the estimated marginal Q for publicly traded firms to proxy for the quality of investment opportunities faced by (predominantly) private firms.

In this section, we attempt to circumvent these issues by employing the procedure of Wurgler (2000) to assess the efficiency of the capital allocation process. He suggests that higher firm-level investment in industries with faster value added growth is associated with greater efficiency in the capital allocation process. We thus estimate the sensitivity of investment to the growth in value added (instead of marginal Q). Value added growth is computed as the natural log of the change in value added between year t and year t-1. Value added, in constant US dollars (year 2000 prices), is defined as earnings before interest and taxes plus the cost of employees. The richness of our data allows us to measure value added growth at the firm level. In the estimation, we add firm and year fixed effects to mitigate endogeneity concerns from omitted variables. Results from these robustness tests (see Panel B of Table 7) confirm the Panel A results that show that the sensitivity of investment to value added growth is lower for firms run by female CEOs. As with Panel A, Regression (2) indicates that the results are robust to using a treatment effects specification to control for the endogeneity of the CEO selection choice.

V. Alternative Interpretations

V.A. Agency

In an agency context, CEOs act as to maximize their own utility, rather than the utility of (presumably well diversified) shareholders. As a consequence, they make choices that do not (necessarily) maximize firm value (Berle and Means, 1932, Jensen and Meckling, 1976). This behavior would lead to inefficiencies in the capital budgeting process and would result in a lesser (or even negative) sensitivity of investments to growth opportunities (La Porta, Lopez-de-Silanes, and Shleifer, 2008, McLean, Zhang, and Zhao, 2012).

While agency considerations likely affect corporate decisions and outcomes, three pieces of evidence are inconsistent with an agency interpretation of *our results*. First, for agency to explain our results, it must be the case that women are more likely to act at the expense of shareholders than men. In other words, it has to be the case that female CEOs are less likely to fulfill their fiduciary duties than male CEOs (or, at the extreme, commit corporate crime). However, a number of legal studies document that, if anything, women are less likely to commit crimes (of any kind) than men (Hill and Harris, 1981, Shover, Norland, James and Thornton, 1979, Steffensmeier and Allan, 1996, Gërxhani, 2007). As such, it appears unlikely that female CEOs be more prone to undertake actions that are detrimental to shareholders.

Second, in an agency framework, the interests of the CEOs become more aligned with those of shareholders as the CEO increases her ownership in the firm she manages (Jensen and Meckling, 1976). As a consequence, we should observe better investment behavior as CEO ownership increases. However, as shown in Tables 2-6, we find gender to be associated to risk-taking even after controlling for CEO ownership.

Third, even when separation between ownership and control is present, agency conflicts should be mitigated by the presence of a large shareholder (Shleifer and Vishny, 1986, 1997). Interestingly, large shareholders are the norm in our sample of predominantly private firms. Thus, CEOs should be less able to imprint their own preferences on corporate choices, and misallocation should be less pronounced, when ownership is highly concentrated. However, in contrast with an agency story, our results hold after controlling for ownership concentration. Based on this evidence, we conclude that agency considerations are unlikely to explain our results.

V. B. Asymmetric Information

If information asymmetries are correlated with gender, the cost of accessing external financing could be different for firms run by male vs. female CEOs. Accounting research documents that the quality of earnings reported by firms with female directors, analysts, or auditors, is significantly better than that of similar companies with male directors, analysts, or auditors (Srinidhi, Gul and Tsui, 2011, Thiruvadi and Huang, 2011). Thus, the potential for informational asymmetries and for undervaluation should be greater among firms run by male CEOs. As a consequence, there will be more states of nature in which a male CEO chooses not to raise external financing even in the presence of a positive net present value investment opportunity.

This implies a greater distortion in the efficiency of capital allocation when the CEO is a male. This is because male CEOs (who act in the interest of shareholders) will choose not to raise funds to avoid diluting the undervalued equity of the firm they run. As a consequence, they will bypass some investment opportunities that have a positive net present value (Myers and Majluf, 1984), thus reducing the efficiency of capital allocation. In contrast to this argument, we find less efficient capital allocation among firms run by female CEOs. As such, informational asymmetries cannot explain our results.

V.C. Behavioral Considerations

A third alternative explanation is that women are less overconfident than men. This presumption is well documented in the social psychology literature and in experimental economics studies, as surveyed by Croson and Gneezy (2009). For example, Lundeberg, Fox and Punćochaŕ (1994) show that young boys are more overconfident (when wrong) than young girls. In a study of selection into a competitive environment, Niederle and Vesterlund (2007) document that women tend to shy away from competition, while men embrace competition. They interpret their results, at least in part, as driven by differences in overconfidence. Barber and Odean (2001) document that men trade much more than women and perform worse.

Malmendier and Tate (2005, 2008) and Malmendier, Tate, and Yan (2011) predict that overconfident managers will overestimate the returns to their investments and, as a consequence, will tend to overinvest (when they have sufficient internal resources). In our framework, a natural implication of Malmendier and Tate's work is that men are more likely to understate the riskiness of their investment opportunities and therefore more likely to take *excessive* risk. Our risk-taking results are certainly in line with such an interpretation. However, overconfidence should lead to misallocation of funds, as overconfident managers misinterpret information and, as a consequence, make poor choices. In contrast to this prediction, we do not find greater misallocation among firms run by male CEOs (rather, we document the opposite). Thus, while we do not dispute the notion that men are more overconfident than women, our results are not consistent with overconfidence being the explanation for the lesser risk-taking of female CEOs *and*, at the same time, for the better allocation efficiency documented for male CEOs.[15]

It is likely that men and women differ in levels of both overconfidence and risk-aversion. The results reported in this paper indicate that "excessive" risk-aversion (by female CEOs) is worse than overconfidence (by male CEOs) in terms of implications for the efficiency of capital allocation.

VI. Conclusions

We provide evidence that CEO gender significantly affects corporate risk-taking choices. More precisely, firms run by female CEOs tend to make less risky financing and investment choices than firms run by male CEOs. The effect of CEO gender on corporate risk-taking is both statistically and economically significant. Further, it is present across a variety of corporate choices and outcomes, and it is robust to controlling for traditional determinants of risk-taking as well as for country, industry, and time trends. The results are robust to various tests for endogeneity, including

[15] Moderate degrees of overconfidence by male CEOs could actually reduce investment distortions that arise due to CEO risk aversion (Goel and Thakor, 2008). While a "moderate overconfidence" story is possibly consistent with the better allocation efficiency of firms run by male (relative to female) CEOs, it does not explain why firms run by female CEOs fail to allocate capital according to a value maximization rule.

firm fixed effects and change specifications, the use of a propensity score matching procedure, a switching regression analysis with endogenous switching, and a treatment effects model.

We further show that the risk-avoidance of female CEOs has important implications for the efficiency of the capital allocation process. We observe a positive association between the quality of investment opportunities (e.g., the net present value) and the level of investments for firms run by male CEOs, but we fail to find such a relation for firms run by female CEOs. Thus, women do not appear to allocate capital efficiently.

Our explanation for these results builds upon previously documented gender-related differences in risk-aversion. In particular, as women are more risk-averse than men, they tend to avoid choices that are (from their perspective) "too risky." In particular, women do not appear to undertake *all* positive net present value projects. Our results, taken as a whole, cannot be explained with agency, informational asymmetries, or overconfidence considerations.

In equilibrium, why would decision-makers' preferences play a role in the capital budgeting (and capital structure) decisions? In a traditional perfect capital markets framework, managers would undertake all projects with positive net present value, so the preferences of managers would not play any role in corporate investment decisions. However, a large fraction of the firms in our sample are private firms that are managed by relatively undiversified CEOs with varying degrees of risk-aversion. Since the wealth and human capital of these risk-averse owner-managers are largely concentrated in the firms that they own, they will seek to avoid increasing firm-specific risk as this would decrease their expected utility. In other words, because CEOs are undiversified, corporate choices will reflect their personal preferences. These implications are more pronounced for female CEOs since women tend to be more risk-averse than men.

Our results have important macroeconomic implications, as the degree of efficiency of the capital allocation process is an important determinant of long-term economic growth. The results may also have direct policy implications. In the last decade, a number of countries (including Norway, Spain, Australia and France) have introduced recommendations or passed laws mandating gender quotas for boards of publicly traded companies. Our results imply that such policies may destroy value for shareholders, as women have (more of) a tendency to "leave money on the table," bypassing profitable investment opportunities that have "high" risk.

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Appendix A. Estimation of a firm's marginal Q ($\dot{q}$)

To estimate $\dot{q}$, we rewrite (4) as

$$\dot{q}_{j,t} = \frac{V_{j,t} - V_{j,t-1}(1 + \hat{r}_{j,t} - \hat{d}_{j,t})}{A_{j,t} - A_{j,t-1}(1 + \hat{g}_{j,t} - \hat{\delta}_{j,t})} \tag{6}$$

where $\dot{q}_{j,t}$ is the marginal Q of firm *j* at time *t*. $V_{j,t}$ is the market value of firm *j* at time *t*, and $A_{j,t}$ is the stock of capital of firm *j* at time *t*. $\hat{r}_{j,t}$ is the expected return from owning *j*; $\hat{d}_{j,t}$ is the expected disbursement rate to providers of capital; $\hat{g}_{j,t}$ is the expected rate of growth of the stock of capital; and $\hat{\delta}_{j,t}$ is its expected rate of depreciation. Thus, $V_{j,t} - V_{j,t-1}(1 + \hat{r}_{j,t} - \hat{d}_{j,t})$ is the change in the market value of firm and $A_{j,t} - A_{j,t-1}(1 + \hat{g}_{j,t} - \hat{\delta}_{j,t})$ is the unexpected change in the stock of capital.

Equation (6) can be rewritten as

$$\frac{V_{j,t} - V_{j,t-1}}{A_{j,t-1}} = -\dot{q}_{j,t}(\hat{g}_{j,t} - \hat{\delta}_{j,t}) + \dot{q}_{j,t}\frac{A_{j,t} - A_{j,t-1}}{A_{j,t-1}} + \hat{r}_{j,t}\frac{V_{j,t-1}}{A_{j,t-1}} - \hat{d}_{j,t}\frac{V_{j,t-1}}{A_{j,t-1}} \tag{7}$$

which we estimate separately for each 3-digit SIC *i* industry in each country *c*, using all firms with available accounting and market data in any given year, as follows:

$$\frac{\Delta V_{j,t}^{i,c}}{A_{j,t-1}^{i,c}} = \beta_0^{i,c} + \beta_1^{i,c}\frac{\Delta A_{j,t}^{i,c}}{A_{j,t-1}^{i,c}} + \beta_2^{i,c}\frac{V_{j,t-1}^{i,c}}{A_{j,t-1}^{i,c}} + \beta_3^{i,c}\frac{\hat{d}_{j,t}^{i}V_{j,t-1}^{i,c}}{A_{j,t-1}^{i,c}} + u_{j,t}^{i,c} \tag{8}$$

The coefficient $\beta_1^{i,c}$, estimated across all publicly traded firms in a given industry *i* and country *c*, represents the marginal Q for that industry in that country. We estimate the regression using ordinary least squares with rolling panels of 5 years to obtain yearly estimates of marginal Q ($\dot{\hat{q}}_t^{i,c}$).

Estimates of $\hat{q}_t^{i,c}$ are determined at the industry level, rather than firm level, for three main reasons. First, estimation at the firm-level would require many years of data, and could therefore suffer from severe survivorship bias. Second, as the production technology employed may change through time, estimates based on long-term event windows could be unreliable. Third, measuring across firms should reduce the impact of noise on our estimation.[16] Mitigating noise is important as we use marginal Q estimated across publicly traded firms to proxy for the investment opportunities faced by (mostly) private firms.

We define $V_{j,t}$ as $(CS_{j,t} + PS_{j,t} + LTD_{j,t} + STD_{j,t})/GDP\ deflator_t$. $CS_{j,t}$ is the market value of outstanding common shares of firm *j* at the end of year *t* (*Worldscope* item WC08001). $PS_{j,t}$ is the value of preferred shares of firm *j* at the end of year *t* (*Worldscope* item WC03451). $LTD_{j,t}$ and $STD_{j,t}$ are the book values of firm *j*'s long-term and short-term debt, respectively (*Worldscope* items WC03251 and WC03051). GDP deflators are taken from the World Bank, World Development Indicators and from EconStats.[17] We use them to convert values into 2000 prices.

We define $A_{j,t}$ as $(K_{j,t} + STA_{j,t})$. $K_{j,t}$ is the estimated market value of firm *j*'s property, plant and equipment (PPE). We use a perpetual inventory formula to estimate the market value of PPE, using data for the previous 10 years.[18] In particular, the estimated market value of PPE at the end of year *t* is computed as:

$$K_{j,t} = (1-\delta)K_{j,t-1} + \frac{\Delta\ \text{Gross PPE}_{j,t}}{GDP\ deflator} \quad (9)$$

[16] All variables in the regression are winsorized at the top and bottom 1% to reduce the impact of outliers.
[17] http://www.econstats.com/wdi/wdiv_758.htm.
[18] The first year of data we use in this calculation is 1983. If a company's history is shorter than 10 years, we use the first available data point for that firm.

We set $K_{j,t-10} = \frac{\text{Net PPE}_{j,t-10}}{GDP\ deflator}$. Net PPE is gross property, plant and equipment, less accumulated reserves for depreciation, depletion and amortization (*Worldscope* item WC02501). We assume a constant annual depreciation rate, δ, of 10%. The change in gross PPE (*Worldscope* item WC02301) measures the annual spending in PPE. Therefore, the estimated market value of PPE at the end of year *t* is equal to the estimated market value of PPE at the end of year *t-1* minus 10% depreciation plus (deflated) capital spending during year *t*.

$STA_{j,t}$ is the book value of firm *j*'s short term assets (*Worldscope* item WC02201), expressed in 2000 prices. We do not attempt to estimate the market value of short term assets, as *Worldscope* does not provide information on the method used to evaluate inventories (e.g., LIFO vs. FIFO). Finally, we define $\hat{d}^{i}_{j,t}V^{i}_{j,t-1}$ as dividends plus interest expense (*Worldscope* items WC04551 and WC01251).

Appendix B. Exogenous variables

As a first exogenous variable, we focus on the *local supply of educated women* in a given geographic subdivision. We gather geographic data on education from *Eurostat*. For a given geographic subdivision, *Eurostat* provides the number of students by gender and level of education. For our purposes, we focus on the first and second stages of tertiary education, which includes any degree equal to or higher than a bachelor's degree. We gather education data for the smallest geographical subdivision covered in *Eurostat* in each country.[19] We use the postal code or the name of the city in which a firm is headquartered to match the *Eurostat* education data with the *Amadeus* CEO gender and accounting data. When the available information is insufficient to match the two data sources, we exclude the firm from the analysis. Using these data, we define the *Supply of Educated Women* (in each geographic subdivision and in each year) as the ratio of female students to the total number of students in the first and second stages of tertiary education.

As a second exogenous variable, we focus on the region-specific *attitude towards women* participating to the labor force. We collect information on the attitude towards female labor force participation from the integrated *World Bank World Value Survey/European Value Survey* (WVS/EVS). These are two large-scale, cross-national, and longitudinal surveys conducted by a large network of social scientists around the world.[20]

We focus on three questions that are related to the attitude towards the participation of women in the workforce. Respondents were asked whether they (strongly) agree, (strongly) disagree or neither agree nor disagree with the following statements: (1) "When jobs are scarce, men should

[19] Examples of the smallest geographic subdivisions are "North West", "East Midlands", "London" and "Wales" in the U.K. The median population across our geographic subdivisions is 1,743,791 inhabitants. In Ireland, Luxembourg, and Switzerland, data are available only at country-level. These countries are not included in the IV regressions. In untabulated tests, we find that the results are qualitatively similar if those countries are included in the analysis.

[20] http://www.wvsevsdb.com/wvs/WVSIntegratedEVSWVS.jsp?Idioma=I

have more right to a job than women" 2) "Being a housewife is just as fulfilling as working for pay" 3) "Both the husband and wife should contribute to household income". We assign the value of 1 to reflect a more favorable attitude towards women if the answer is "Disagree" or "Strongly Disagree" in questions 1 and 2 and if the answer is "Agree" or "Strongly Agree" in question 3. We compute the proportion of respondents giving an answer coded as 1 for each question in each given region. Finally, for each region, we compute the average of the three scores to derive a measure of the *attitude towards women*, where higher values of the measure indicate more favorable attitudes towards women. As with *Eurostat,* we use the postal code or the name of the city in which a firm is headquartered to match the WVS/EVS survey data with *Amadeus*.

Table 1. Univariate statistics

Leverage is defined as the ratio of financial debt divided by the sum of financial debt plus equity. Financial debt is the sum of long term debt (excluding "other non-current liabilities") plus short term loans. *σ(ROA)* is the volatility of the firm's operating return on assets (ROA), defined as the ratio of earnings before interests and taxes to total assets. *Likelihood of survival* is an indicator variable that takes the value of 1 if the firm survives at least 5 years, and 0 otherwise. *Female CEO* is an indicator variable that takes the value of 1 if the CEO is a woman, and 0 otherwise. *CEO ownership* is the cash flow rights of the CEO on the firm's earnings. *Cash flow rights* is the ownership rights of the largest ultimate shareholder. *Sales Growth* is calculated as the annual rate of growth of sales. *Ln (Size)* is the natural log of total assets (in thousands US$), expressed in 2000 prices. Total assets is the sum of total fixed assets (tangible and intangible fixed assets and other fixed assets) and current assets (inventory, receivables, and other current assets). *Ln (1+Age)* is the natural logarithm of (1 + the number of years since incorporation). *Tangibility* is calculated as the ratio of fixed to total assets. *Private firm* is an indicator denoting firms that are not publicly traded. *Δ gross PPE/Total fixed assets* is the ratio of capital expenditure relative to the capital stock. Capital expenditures are computed as the annual change in (net) total fixed assets plus depreciation. *Marginal Q* measures the change in the market value of firm associated with an (unexpected) change in capital investment. It is estimated by industry, country, and year. *Value added growth* is the natural log of the change in the firm's value added between year t and year t-1. Value added, in constant US dollars (year 2000 prices), is defined as earnings before interest and taxes plus cost of employees. *Cash flow/Total fixed assets* is net income plus depreciation, divided by total fixed assets. With the exception of *Likelihood of survival*, all statistics are computed for the panel of observations. *Likelihood of survival* can only be computed cross-sectionally.

	Full sample					
Full sample	Mean	Median	Stnd. dev.	Female CEOs	Male CEOs	p-value of diff.
Leverage	0.374	0.329	0.326	0.324	0.379	0.000
σ(ROA)	0.048	0.030	0.057	0.027	0.050	0.000
Likelihood of survival	0.517	1	0.500	0.614	0.505	0.000
Female CEO	0.094	0	0.292			
CEO ownership	0.044	0	0.167	0.060	0.043	0.000
Cash flow rights	0.638	0.680	0.358	0.576	0.644	0.000
ROA	0.059	0.049	0.108	0.065	0.058	0.000
Sales growth	0.217	0.050	0.834	0.184	0.221	0.000
Ln (Size)	10.313	10.132	1.400	10.127	10.332	0.000
Ln (1+Age)	2.906	2.944	0.809	2.929	2.904	0.000
Tangibility	0.212	0.129	0.233	0.209	0.213	0.063
Private firm	0.954	1	0.210	0.969	0.952	0.000
Δ gross PPE/Total fixed assets	0.353	0.167	0.864	0.370	0.351	0.029
Marginal Q	1.123	0.948	1.152	0.862	1.149	0.000
Value added growth	1.129	0.273	4.012	1.113	1.131	0.135
Cash flow / Total fixed assets	0.088	0.055	0.396	0.089	0.088	0.204

Table 2. Female CEOs and corporate risk-taking

In regression (1) the dependent variable is *Leverage*, defined as the ratio of financial debt divided by the sum of financial debt plus equity; in regression (2) the dependent variable is the volatility of the firm's operating return on assets *σ(ROA)* x100, where ROA is defined as the ratio of earnings before interest and taxes to total assets; in regression (3) the dependent variable is an indicator denoting whether the firm survived over a 5-year period. Regressions (1) and (2) are run for the panel of observations. Regression (3) can only be run cross-sectionally. *Female CEO* is an indicator variable that takes the value of 1 if the CEO is a woman, and 0 otherwise. Control variables are defined in Table 1. P-values, adjusted for heteroskedasticity and clustering at the firm level (in the panel regressions), are reported in brackets below the coefficients.

	(1) Leverage	(2) σ(ROA) x100	(3) Likelihood of survival
Female CEO	-0.034***	-1.998***	0.253***
	[0.000]	[0.000]	[0.000]
CEO ownership	0.095***	-0.910***	-0.212***
	[0.000]	[0.000]	[0.000]
Cash flow rights	-0.001	0.654***	0.051***
	[0.714]	[0.000]	[0.005]
Leverage		-0.447***	-0.057***
		[0.000]	[0.001]
ROA	-0.626***	-3.525***	0.891***
	[0.000]	[0.000]	[0.000]
Sales growth	0.009***	-0.045**	-0.021***
	[0.000]	[0.029]	[0.000]
Ln (Size)	0.013***	-0.144***	0.166***
	[0.000]	[0.000]	[0.000]
Ln (1+Age)	-0.042***	-0.423***	0.102***
	[0.000]	[0.000]	[0.000]
Tangibility	0.174***	-1.116***	0.163***
	[0.000]	[0.000]	[0.000]
Private firm	0.095***	-0.858***	-0.365***
	[0.000]	[0.000]	[0.000]
Intercept	1.088***	6.898	-2.240***
	[0.000]	[0.000]	[0.003]
Country fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R-squared	0.184	0.101	0.132
No. of observations	338,397	113,614	
No. of firms	132,590	47,208	67,089

Table 3. Female CEOs and corporate risk-taking

Panel A of this table reports panel regression results with firm fixed effects. In regression (1) the dependent variable is *Leverage*, defined as the ratio of financial debt divided by the sum of financial debt plus equity. In regression (2) the dependent variable is the volatility of the firm's operating return on assets *σ(ROA)* x100, where ROA is defined as the ratio of earnings before interest and taxes to total assets. *Female CEO* is an indicator variable that takes the value of 1 if the CEO is a woman, and 0 otherwise. Control variables are defined in Table 1. Panel B reports change specifications. In the change specifications, all variables are the year-on-year changes of their corresponding level variables. P-values, adjusted for heteroskedasticity and clustering at the firm level, are reported in brackets below the coefficients.

Panel A: Firm fixed effects specifications

	(1) Leverage	(2) σ(ROA) x100
Female CEO	-0.029***	-1.647***
	[0.000]	[0.000]
CEO ownership	-0.008*	0.227
	[0.083]	[0.396]
Cash flow rights	0.014***	-0.083
	[0.000]	[0.673]
Leverage		0.050
		[0.783]
ROA	-0.427***	-3.435***
	[0.000]	[0.000]
Sales growth	0.005***	0.012
	[0.000]	[0.672]
Ln (Size)	0.044***	-0.214
	[0.000]	[0.106]
Ln (1+Age)	-0.043***	0.821**
	[0.000]	[0.047]
Tangibility	0.137***	-1.415***
	[0.000]	[0.009]
Private firm	0.009*	1.215**
	[0.068]	[0.034]
Intercept	0.004***	4.577**
	[0.000]	[0.016]
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
R-squared	0.757	0.542
No. of observations	338,397	113,614
No. of firms	132,590	47,208

Table 3. Female CEOs and corporate risk-taking (Cont'd)

Panel B: Change specifications

	(1) Leverage	(2) σ(ROA) x100
Female CEO	-0.019***	-1.065***
	[0.000]	[0.000]
CEO ownership	-0.003	0.288*
	[0.273]	[0.084]
Cash flow rights	0.015***	-0.289*
	[0.000]	[0.056]
Leverage		-0.097
		[0.398]
ROA	-0.321***	-3.237***
	[0.000]	[0.000]
Sales growth	0.003***	0.018
	[0.000]	[0.392]
Ln (Size)	0.030***	-0.426***
	[0.000]	[0.000]
Ln (1+Age)	-0.025***	0.828**
	[0.000]	[0.020]
Tangibility	0.087***	-0.205
	[0.000]	[0.494]
Private firm	-0.014***	1.215***
	[0.000]	[0.005]
Intercept	0.004**	0.233***
	[0.035]	[0.000]
Year fixed effects	Yes	Yes
R-squared	0.031	0.010
No. of observations	166,810	58,212
No. of firms	71,793	26,408

Table 4. Propensity score matching estimators

In this table, we identify a control sample of firms that are run by male CEOs by employing a propensity score matching procedure. The propensity score is estimated using all firm characteristics included in our regression analyses. We require that the difference between the propensity score of the firm run by a Female CEO and its matching peer does not exceed 0.1% in absolute value. We then compare the levels of *Leverage*, *σ(ROA)* x100 and the likelihood of survival between the two groups. *Leverage* is defined as the ratio of financial debt divided by the sum of financial debt plus equity. Financial debt is the sum of long term debt (excluding "other non-current liabilities") plus short term loans; the volatility of the firm's operating return on assets is *σ(ROA*) x100, where ROA is defined as the ratio of earnings before interest and taxes to total assets; the *Likelihood of survival* is an indicator denoting whether the firm survived over a 5-year period.

	No. of observations	Mean	Difference (Female CEOs – Male CEOs)	P-value of diff.
Leverage (Female CEOs) Leverage (Male CEOs)	32,255	0.323 0.355	-0.032	0.000
σ(ROA) x 100 (Female CEOs) σ(ROA) x 100 (Male CEOs)	11,485	2.745 4.844	-2.098	0.000
Likelihood of survival (Female CEOs) Likelihood of survival (Male CEOs)	7,319	0.612 0.516	0.096	0.000

Table 5. Counterfactual analysis

This table compares the means of the observed values for our proxies for risk-taking with their counterfactuals calculated via a two step Heckman (1979) selection model. *Leverage* is defined as the ratio of financial debt divided by the sum of financial debt plus equity. The volatility of the firm's operating return on assets is *σ(ROA*) x100, where ROA is defined as the ratio of earnings before interest and taxes to total assets. The *Likelihood of survival* is an indicator denoting whether the firm survived over a 5-year period.

	Firms with Female CEOs			
	Actual	Counterfactual	Difference	P-value of diff.
Leverage	0.315	0.384	-0.069	0.000
σ(ROA) x 100	2.745	5.476	-2.731	0.000
Likelihood of survival	0.614	0.587	0.027	0.000

	Firms with Male CEOs			
	Actual	Counterfactual	Difference	P-value of diff.
Leverage	0.379	0.272	0.107	0.000
σ(ROA) x 100	5.008	2.043	2.965	0.000
Likelihood of survival	0.504	0.999	-0.495	0.000

Table 6. Treatment effects

In the *second stage regressions*, in regression (1) the dependent variable is *Leverage*, defined as the ratio of financial debt divided by the sum of financial debt plus equity; in regression (2) the dependent variable is the volatility of the firm's operating return on assets *σ(ROA)* x100, where ROA is defined as the ratio of earnings before interests and taxes to total assets; in regression (3) the dependent variable is an indicator denoting whether the firm survived over a 5-year period. In the first stage regressions, we use the *local supply of educated women* (in each geographic subdivision and in each year) and the *attitude towards women* (in each geographic subdivision) as exogenous explanatory factors. The *local supply of educated women* is defined as the ratio of female students to the total number of students in the first and second stage of tertiary education. The *attitude towards women* is defined as the average proportion of respondents with a higher propensity towards women work to the total number of respondents in a particular region and wave. Control variables are defined in Table 1. The *Inverse Mills ratio* is calculated from the predicted values of the first stage probit regressions. P-values, adjusted for heteroskedasticity and clustering at the firm level are reported in brackets below the coefficients.

Panel A: Second stage regressions

	(1)	(2)	(3)
Dependent variable:	Leverage	σ(ROA) x100	Likelihood of survival
Female CEO	-0094***	-1.453***	0.196*
	[0.000]	[0.009]	[0.098]
CEO ownership	-0.001	0.114	-0.260***
	[0.940]	[0.608]	[0.000]
Cash flow rights	0.008**	-0.141	0.041**
	[0.018]	[0.397]	[0.038]
Leverage		-0.033	-0.074***
		[0.840]	[0.004]
ROA	-0.440***	-3.875***	0.880***
	[0.000]	[0.000]	[0.000]
Sales growth	0.002***	0.029	-0.024***
	[0.000]	[0.259]	[0.000]
Ln (Size)	0.092***	-0.155	0.167***
	[0.000]	[0.168]	[0.000]
Ln (1+Age)	-0.043***	0.931***	0.105***
	[0.000]	[0.007]	[0.000]
Tangibility	0.139***	-1.811***	0.163***
	[0.000]	[0.000]	[0.000]
Private firm	0.006	1.719***	-0.362***
	[0.142]	[0.002]	[0.000]
Inverse Mills ratio	0.031***	-0.134	0.034
	[0.001]	[0.633]	[0.591]
Intercept	-0.426***	2.658*	-2.049**
	[0.000]	[0.077]	[0.014]

Country Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
No. of observations	263,076	96,066	56,453
No. of firms	107,280	41,563	56,453

Panel B: First stage Probit model

	(1)	(2)	(3)
Dependent variable:		Female CEO	
Local supply of educated women	0.746***	1.173***	1.181***
	[0.000]	[0.000]	[0.000]
Attitude towards women	0.502***	0.153	0.315**
	[0.000]	[0.144]	[0.022]
Control variables	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
No. of observations	263,076	96,066	56,453
No. of firms	107,280	41,563	56,453

Table 7. Female CEOs and the efficiency of capital allocation

This table reports OLS regression results. In both Panels, the dependent variable is the ratio of capital expenditure relative to the capital stock. Capital expenditures are computed as the annual change in (net) total fixed assets plus depreciation. The capital stock is defined as the sum of tangible fixed assets plus intangible fixed assets plus other fixed assets. *Marginal Q* measures the change in the market value of a firm associated with an (unexpected) change in capital investment. It is estimated by industry, country, and year. *Value added growth* is the natural log of the change in the firm's value added between year t and year t-1. Value added, in constant US dollars (year 2000 prices), is defined as earnings before interest and taxes plus cost of employees. *Female CEO* is an indicator variable that takes the value of 1 if the CEO is a woman, and 0 otherwise. *Cash flow/Total fixed assets* is net income plus depreciation, divided by total fixed assets. The *Inverse Mills ratio* is calculated from the predicted values of the first stage probit regressions. *Risk-avoidance* is an index constructed by adding 1 when (1) a firm's leverage is in the bottom 20% of the distribution; (2) the volatility of firm-level profitability is in the bottom 20% of the distribution; and (3) if the firm survives at least 5 years. The index ranges from 0 to 3, with higher scores denoting greater risk-avoidance. In Panel A, bootstrapped p-values are reported in brackets below the coefficients (except for model 2). In Panel B, p-values are adjusted for heteroskedasticity and clustering at the firm level.

Panel A: *Q*-model of investment

	(1)	(2)	(3)
Marginal Q	0.013***	0.010***	0.008**
	[0.000]	[0.000]	[0.047]
Female CEO	0.015*	-0.252***	0.003
	[0.067]	[0.005]	[0.923]
Female CEO * Marginal Q	-0.020***	-0.013*	-0.006
	[0.000]	[0.083]	[0.474]
Cash flow / Total fixed assets	0.054***	0.054***	0.061***
	[0.000]	[0.000]	[0.000]
Inverse Mills ratio		0.127***	
		[0.005]	
Risk-avoidance			-0.017**
			[0.015]
Risk-avoidance * Marginal Q			-0.028*
			[0.076]
Intercept	0.045	0.225***	-0.014
	[0.212]	[0.005]	[0.780]
Country fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R-squared	0.080	0.087	0.088
No. of observations	174,111	105,686	47,376
No. of firms	77,785	49,442	22,427

Table 7. Female CEOs and the efficiency of capital allocation (Cont'd)

Panel B: Growth-model of investment

	(1)	(2)	(3)
Value added growth	0.156***	0.217***	0.153***
	[0.000]	[0.000]	[0.000]
Female CEO	0.011	-0.046	-0.025
	[0.298]	[0.580]	[0.201]
Female CEO * Value added growth	-0.073***	-0.098***	-0.072
	[0.010]	[0.004]	[0.235]
Cash flow / Total fixed assets	0.085***	0.052***	0.103***
	[0.000]	[0.000]	[0.000]
Inverse Mills ratio		0.027	
		[0.520]	
Risk-avoidance			-0.023*
			[0.051]
Risk-avoidance * Value added growth			-0.001
			[0.335]
Intercept	0.256***	-0.171***	0.268***
	[0.000]	[0.000]	[0.000]
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R-squared	0.097	0.106	0.099
No. of observations	173,111	106,337	49,645
No. of firms	75,876	48,898	22,776