THE UNIVERSITY OF CHICAGO

Female leadership and corporate ESG performance: evidence from China

By

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June 2022

A paper submitted in partial fulfillment of the requirements for the
Master of Arts degree in the
Master of Arts Program in the Social Sciences

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Acknowledgement

I gratefully acknowledge advisement from the faculty advisor of this writing, Prof. Hans B. Christensen, and my MA study advisor, Prof. Gina C. Pieters. The thesis witnessed my extremely impressive experience in the University of Chicago during the past year.

At the same time, I want to express my special gratitude to my cat Bozai and his grandparents (i.e., my parents) who take good care of him when I am studying abroad. From Bozai's eyes, I find the sea of stars, where our academic journey begins.

Abstract: This paper pursues the first systematic investigation on the implication of Chinese female leaders in connection with environmental, social and governance (ESG) performance of their businesses. With a comprehensive firm-year dataset of ESG performance and financial variables that is complemented by person-level demographics, it shows: (a) Despite alternative measures and models, no relation is detected between female directors and overall ESG performance, which appears resulting from that female directors' impact on the social and governance pillar offset each other. (b) Female managers' contribution to overall ESG performance is unambiguously positive, which results from female managers' impact on governance pillar. (c) No significant quantile heterogeneity is detected between the nomination of female leaders and overall ESG performance, though pillar-level impact of female leadership differs between the best and worst ESG performers. (d) No critical mass effect is detected under the DID framework.

1 Introduction

Though the term 'ESG' (environmental, social and governance) was coined as late as 2004 by a joint initiative of leading financial institutions invited by the United Nations[1], it has arguably become the most salient concern for all actors in the financial market with the exception of profit maximization. According to Bloomberg[2], ESG-informed investments tripled over the past eight years, reaching $38 trillion in 2020. Despite this popular term, scholarship and practice on firms' social and environmental initiatives emerged much earlier. The practice of communicating companies' social and environmental performance to outsiders can date back to the 1970s (Eccles & Stroehle, 2018), while ten years later Freeman built the fundamental justification for corporate social responsibility (see Freeman, 2010): stakeholder theory. Instead of sacrificing financial benefits to promote social good, one reason why ESG initiatives gain extensive attention from actors in financial markets is the spirit 'do well by doing good', which means that proper ESG practice is perceived to be value-adding. For example, 1) companies with high ESG profiles are less vulnerable to scandals and boycott, as if they were protected by insurance; and 2) ESG-conscious fund managers may outperform their non-ESG counterparts (Brooks & Oikonomou, 2018).

[1] https://documents1.worldbank.org/curated/en/280911488968799581/pdf/113237-WP-WhoCaresWins-2004.pdf
[2] https://www.bloomberg.com/professional/blog/opening-the-black-box-of-esg-data/

Why does ESG matter to women? At first glance, it is no wonder that gender equality is a significant component of ESG under the category 'S'. For mainstream data vendors, it is also common to take gender status under consideration when rating a company's ESG performance. As noted by Margolis and Walsh (2003), though some people are well-off and financially independent, much more are living in misery brought on by poverty, discrimination, violence, inequality and so on, posing considerable social pressure on companies do better for society. Indeed, women are more likely to fall on the spectrum of the 'much more' herein. As described by Beauvoir (2010, p.9), 'Economically, men and women almost form two castes; all things being equal, the former have better jobs, higher wages, and greater chances to succeed than their new female competitors; they occupy many more places in industry, in politics, and so forth, and they hold the most important positions.' This assertion made by a feminism theorist is also verified by scholarship in business – women need more educational achievement than men to enter boardrooms (Hillman et al., 2002).

Rather than victims of the aforementioned "misery" and thus beneficiaries of ESG initiatives, women can serve as a leading force to actively cure the miserable world. A growing body of literature starts to treat female leadership as an outstanding factor promoting a company's ESG performance and tries to establish a positive causality running from woman leadership to ESG both wholly and respectively in each dimension. A report named 'Women in Business Leadership Boost ESG Performance: Existing Body of Evidence Makes Compelling Case' by International Finance Corporation (2018) finds more than 70 peer-reviewed papers published during 2008-2017 that suggest a positive correlation between woman leadership and ESG. The report argues that "a more gender-balanced board and leadership team contributes to stronger environmental, social, and governance performance, which in turn, leads to better business performance.'

Notwithstanding the mass of positive evidence, significant ambiguity remains. Adams and Ferreira (2009) show that, by a seminal use of instrumental variables, there is a positive relation between female participation and governance performance before dealing with endogeneity. This result is robust under none of a few statistical treatments handling endogeneity, a problem that exists in many of the strand of literature.

Another ambiguity arises in ESG performance measurement. A third-party ESG data provider, such as MSCI or Bloomberg, always explicitly incorporates woman participation into the ESG rating system, which makes the uncovering of 'true' relation between woman leadership and ESG performance rather difficult. Indeed, if woman directors' contribution to ESG performance had already been correctly measured by its weight in the rating system of any data provider, there would have been few reasons to empirically investigate the relation, which is clearly not the case.

In the meantime, most of research uses data from developed economies, which may not be easily generalized to emerging economies. As Chen et al. (2016) points out, cultural and ideological factors associated with country, play a significant role in connection between woman leadership and ESG; also, governments in developed economies usually treat board gender diversity in a way different from emerging economies. In response to global concern of increasing woman participation in boardrooms, Norway, Spain, France and Italy have issued clear quota requirements; Australia, Canada, UK, and the US use a comply-or-explain approach (Ben-Amar et al., 2017); yet China adopts a rather voluntary approach, with little governmental intervention of increasing women's presence in the boardroom. This is useful to avoid the tokenism problem (Elstad & Ladegard, 2010) that may overshadow female directors' contributions and embraces the spirit of 'do well by doing good'.

The last research gap I would highlight is a too simplistic empirical strategy to test critical mass theory, which leaves considerable scope to improve. In the literature of woman leadership and ESG performance, critical mass theory is frequently cited and tested, such as Post et al. (2011), Ben-Ama et al. (2017) and Wei et al. (2017). However, the empirical technique for this purpose is nothing more than an indicator variable representing whether women on board reaches a threshold for a sampled company, which neglects the nuances of reaching/leaving a critical mass and adopt a too coarse benchmark. In part as the benefits of having a relatively large dataset, I propose another more efficient strategy to test whether a critical mass exists in the connection between woman directors and ESG performance.

Against research gaps sketched above, the main contribution of this paper are as follows:

(a) I source the data from a country with rising woman directors, arguably minimal regulatory intervention to gender diversity in boardroom, a richness of data-available companies, considerable economic volume and global impact, that is, China, which is underappreciated in existing studies and constitutes an interesting context of inquiry. Particularly, I purge the nominal effect from female leadership on contemporaneous ESG scores.

(b) Unlike prior literature focusing primarily on the impact of female leadership on the expectation of ESG performance, I additionally consider the impact on different quantile of ESG performers. This can help companies make more informed nomination of board directors and senior managers, in the sense that the optimal nomination strategy for best ESG performers and worst ESG performers may differ.

(c) In addition to adoption of the proportion of female leaders, which is the most common proxy for female leadership in prior literature, I also explore several interesting weighting schemes to adjust for potential factors playing a role in female leadership's impact.

(d) In order to test critical mass theory, I use a difference-in-difference (DID) design to investigate the effect of reaching a critical mass and leaving a critical mass respectively. Specifically, I construct the sample in a way that the absolute change of woman directors in control group for each company is exactly the same as that in treatment group. This design essentially compares one-unit increment reaching critical mass with one-unit increment not reaching critical mass, which largely eliminates the heterogeneity between the two types of companies as opposed to previous literature.

The remaining of this writing are structured as follows: Section 2 presents related literature and theories as well as how this paper adds to existing literature; Section 3 illustrates data and methods; Section 4 is empirical results and discussion; Section 5 concludes.

2 Related literature and theories

In a word, females possess attributes that are distinct from male counterparts' (Rose 2007), which is proved to be substantial in the context of female leaders and organizational performance, especially

performance of promoting non-financial well-being. According to socialization theory, females tend to be more attentive, communal and charitable than males due to the socialization process differing between genders (Skogen 1999; Zelezny et al. 2000). As board directors, females are characterized of stronger risk-aversion (Van Staveren 2014) and higher ethnic standards (Akaah 1989). Dakshina et al. (2014) analyzes 1400 questionnaires to investigate individuals' preference on trade-offs between non-financial (social and environmental) well-being and financial well-being, suggesting that females give higher priority to social and environmental good than males do. Nielsen and Huse (2010, p. 138) also suggest that women are more sensitive to organizational social responsibility and environmental politics. Particularly, Cronqvist and Yu (2017) shows that, the fact that females tend to care more about others' well-being is not only observed in female directors and senior managers with respect to ESG performance, but also in CEOs who have a daughter; since daughters care more about others' non-financial well-being than boys, and the offspring's utility is nested into the parent's utility function, then CEOs with a daughter invest more in CSR than those with a boy.

Though much less than those focusing on gender diversity and financial performance, a number of papers empirically evaluate the relation between woman leadership and ESG performance. With a sample of Canadian listed companies, Ben-Amar et al. (2017) use response/non-response to a greenhouse gas disclosure initiative as a binary response variable and test female directors' impact on the response rate through IV probit model, which suggests a positive impact of woman member proportion on response rate. Adams and Ferreira (2009) sample both director-year and company-year panel data from US companies and suggests that woman leadership can increase inputs in governance (e.g., higher attendance rate in board meetings) but not necessarily better governance outcomes. Mallin and Michelon (2011) investigate the impact of female director proportion on corporate social responsibility (CSR) by a panel of US companies listed in Business Ethics 100 Best Corporate Citizens for three consecutive years, and conclude that female directors are positively associated with corporate social performance measured by KLD ratings. Through a cross-section sample consisting of again US companies, Zhang et al. (2013) use whether a company's social performance exceeds the median within its industry as a binary response variable, and find that greater presence of female directors helps a company outperform its industry peers in CSR respect. Based on a panel of Australian listed companies, Galbreath (2011) focuses on the difference of female leadership's impact

on corporate social performance versus that on environmental performance via hierarchical regression models, suggesting that woman directors do have a positive impact on social aspect but not on environmental aspect due to their lack of technical backgrounds which is particularly useful herein. As one of the very few studies using Chinese companies, Wei et al. (2017) reveals that, only when woman leadership is measured by whether the number of woman directors exceeds three, it has a positive impact on corporate environmental motivation.

My research significantly contributes to the literature on female leadership and ESG performance in the following aspects. Firstly, China, as the second largest economy in the world, has little government intervention on females' participation in directors and senior managers, which constitutes an interesting context of enquiry. However, there is few studies focusing on China with regard to female leadership and ESG, partly due to lack of unified ESG data. I adopt a newly published ESG dataset covering all Chinese listed A-share companies, which is much more comprehensive than existing comparable research. Secondly, most existing research uses director-related measure as proxy to female leadership, whereas I investigate female leadership in terms of both female directors and female senior managers under a unified framework. Thirdly, unlike the dummy-variable setting in existing literature, I test the notion of critical mass of female leadership in a difference-in-difference framework, which can provide more reliable evidence on whether there is a critical mass. Last but not least, unlike most prior literature which only examines the impact of female leadership on the mean of ESG performance, I also consider quantile heterogeneity – it suggests that, the marginal impact of female leadership depends on the current ESG profile of a company.

Besides, this paper adds to the literature testing critical mass theory in the context of female leadership and ESG performance, or even in a broader setting, which is discussed below as an outstanding passage. Critical mass theory is attributable to Kanter's (1977a, 1977b) seminal classification of groups. Kanter suggests four types of groups from a perspective of gender diversity, namely uniform group, skewed group, tilted group and balanced group. According to critical mass theory, introduction of a few female directors to a male-dominated board will change a uniform group to a skewed group, where female members are just tokens and do not wield substantial influence; when the number of female directors exceeds a threshold, typically three, the group becomes a tilted

or balanced one and female leadership starts to make a difference. This theory is widely cited and tested in scholarship on woman leadership and ESG performance (e.g., Post et al., 2011; Ben-Amar et al., 2017; Galbreath, 2011; Wei et al., 2017), while the empirical strategy used is problematic. A common practice is adding a binary variable indicating whether the number of female directors exceeds a threshold into regression – if the coefficient is significant then they state a critical mass phenomenon, such as Ben-Amar et al. (2017). A more convincing type of results supporting critical mass theory is that derived by Wei et al. (2017) – the indicator variable of having three or more female directors deliver a statistically significant coefficient, but neither indicator variables for other numbers nor percentage of female directors deliver similar results. One could argue that, such an empirical strategy is inaccurate. Aside from reverse causality from ESG profile to nominating more woman directors, which can be handled by lagged measures of woman leadership as this paper does, there is other source of endogeneity. For example, the liberality of male directors who are the majority in most company boards, may synchronously determine corporate ESG performance and whether the board welcomes female members. On this account, I propose to narrow the sample into companies showing similar tendencies of hiring female directors and then apply a DID design. For example, among companies keeping exactly one more female director after a period, those accurately reaching (but not exceeding) a critical mass of two are compared with those still below or already above two, whereby the effect of critical mass can be pinpointed. Companies keeping exactly one less female director are examined by the same manner, to show whether the effect of leaving/reaching a critical mass is symmetric.

3 Data and variables

3.1 ESG performance

Wind Information Co., Ltd. is the largest financial data provider of China Mainland. In June 2021, it published the first unified ESG rating system that combines China's capital market, regulatory policies and ESG practice of listed companies to build a localized index system[3]. Based on this rating system, Wind ESG Score provided a numerical representation of corporate ESG performance from 2017 and covers companies in CSI 800 Index. In February 2022, the ESG dataset was tremendously

[3] https://www.wind.com.cn/en/newsdetail.html?id=693

extended, such that all A-share listed companies in China Mainland are covered and sub-scores for each dimension of ESG are released. Figure 1 provides an overview for the compilation of Wind ESG score. As is observed, this scoring system can enable consistent comparison between the three pillars, which amounts an advantage over most third-party measures used before (e.g., KLD data on corporate social performance, Hafsi and Turgut 2013) and over unidimensional measures (e.g., corporate environmental investment solely as the proxy of environmental performance, Wei et al. 2017).

[Figure 1]

At the end 2021, there are 4226 qualified companies, which constitute our initial sampling universe – this cross-sectional coverage is far more extensive than those used in prior literature where, in most cases, only hundreds of large-cap companies are considered. While the ESG scores are updated in a daily basis, to match yearly financial and demographic variables, I retain the daily observations of ESG scores at the end of each year in 2018 – 2021, whereby 4 annual observations are constructed for each company. Denote environmental performance, social performance, governance performance and overall performance as ESG_E, ESG_S, ESG_G and ESG respectively.

3.2 Female leadership

The annualized ESG dataset is complemented by demographics of board directors and senior managers. The demographic data is from CSMAR. A standard observation contains the following variables: year, person ID, name, stock ID, gender, age, education, position, start date, end date, cumulative service time, etc. When encoding person-firm-year data into firm-year data, all computations are adjusted by the persons' service time during that year. For example, in deriving the number of female directors for a company, a female director will be counted as $(12-6)/12 = 0.5$ if she joins the company in June and leaves in December. Partly due to data availability, such adjustment is absent in many existing papers and may cause measurement errors.

As mentioned, a benchmark proxy of female leadership is the ratio of female leaders to total leaders. I

consider board directors and senior managers[4] separately, abbreviated as $FemaleD$ and $FemaleM$ which are % of female board directors and % of female senior managers respectively, that is,

$$FemaleD_{i,t} = \frac{\sum_{j \in FD_{i,t}} S_{i,j,t}}{\sum_{j \in FD_{i,t} \cup MD_{i,t}} S_{i,j,t}} \times 100,$$

where i, j, t denote company, person and year respectively; $FD_{i,t}$ denotes the set of female directors for company i in year t and $MD_{i,t}$ denotes that for male directors; $S_{i,j,t} \in (0,1]$ denotes service time in years. $FemaleM$ is constructed analogously. Built on the two benchmark measures, several weighting schemes that distort female leadership toward certain factors are constructed as

$$FemaleD\_Edu_{i,t} = \frac{\sum_{j \in FD_{i,t}} S_{i,j,t} \times Edu_{i,j,t}}{\sum_{j \in FD_{i,t} \cup MD_{i,t}} S_{i,j,t} \times Edu_{i,j,t}} \times 100$$

where $Edu_{i,j,t}$ denotes education level[5];

$$FemaleD\_Imp_{i,t} = \frac{\sum_{j \in FD_{i,t}} S_{i,j,t} \times Imp_{i,j,t}}{\sum_{j \in FD_{i,t} \cup MD_{i,t}} S_{i,j,t} \times Imp_{i,j,t}} \times 100$$

where $Imp_{i,j,t}$ denote relative importance[6];

$$FemaleD\_Cum_{i,t} = \frac{\sum_{j \in FD_{i,t}} S_{i,j,t} \times Cum_{i,j,t}}{\sum_{j \in FD_{i,t} \cup MD_{i,t}} S_{i,j,t} \times Cum_{i,j,t}} \times 100$$

where $Cum_{i,j,t}$ denote cumulative service time (years). $FemaleM\_Edu$, $FemaleM\_Imp$ and $FemaleM\_Cum$ are constructed analogously.

3.3 Control variables

Following the common practice of existing literature (e.g., Adams and Ferreira 2009; Wei et al. 2017; Ben-Amar et al. 2017), set the following control variables: (1) Company size, measured by logarithm total assets (in trillion/10 CNY), abbreviated as $Asset$ (2) book-to-market ratio (%), abbreviated as BM (3) profitability, measured by return on equity (%), abbreviated as ROE (4) financial leverage, measured by asset-debt ratio (%), abbreviated as Fin (5) the size of board (senior management), measured by the number of members on board (senior management), abbreviated as $Board$ (Mgt)

[4] According to Company Law of the People's Republic of China (2013 Amendment), the scope of senior managers for listed companies are: chief executive officer, deputy chief executive officer, chief financial officer, secretary of the board, and other persons specified by articles of incorporation.

[5] PhD=5, master=4, bachelor=3, junior college=2, secondary school or unknown=1. This is merely a convenient representation of the ordinal relation on degrees.

[6] Chairman/chairwoman=2, other=1. This is merely a convenient representation of the ordinal relation on different positions held by board directors. In construction of counterparts for senior managers, CEO=2, other=1.

(6) CEO duality, abbreviated as $Dual$, if yes $Dual = 1$, otherwise $Dual = 0$. I additionally control the average education level of board (senior management), abbreviated as $Board\_Edu$ (Mgt_Edu), which are computated by

$$Board\_Edu_{i,t} = \frac{\sum_{j \in FD_{i,t} \cup MD_{i,t}} S_{i,j,t} \times Edu_{i,j,t}}{\sum_{j \in FD_{i,t} \cup MD_{i,t}} S_{i,j,t}}$$

and by the same way for Mgt_Edu.

4. Models

4.1 Female leadership's impact on ESG performance

As discussed, a comprehensive score for measuring ESG performance may outperform unidimensional counterparts; however, this causes additional confusion brought by nominal effect. To illustrate, note that the generating of ESG scores takes the form

$$ESG_{i,t} = \sum_{k} weight_{i,k,t} \times indicator_{i,k,t},$$

while female leadership explicitly appears in some indicators[7]. If we estimate, for instance,

$$ESG_{i,t} = \alpha + \underbrace{\beta}_{\beta = \beta_1 + \beta_2} FemaleD_{i,t} + \varepsilon_{i,t}$$

where β_1 and β_2 denote nominal and actual impact of $FemaleD_{i,t}$ on $ESG_{i,t}$, then we cannot identify the interested actual impact, β_2. The nominal impact is of course with no research value since it is merely an artefact. Ideally, we need ESG scores excluding female leadership in construction, but we have no such customized data. To deal with the nominal nuisance, I suggest the following benchmark model

$$ESG_{i,t} = \alpha + X'_{i,t-1}\beta + \varepsilon_{i,t}$$

where

$$X'_{i,t-1} = \left[ESG_{i,t-1}\ \ FemaleD_{i,t-1}\ \ FemaleM_{i,t-1}\ \ Controls'_{i,t-1}\ \ Year'_t\ \ Industry'_i\right],$$

where $Controls'$ is the row vector containing control variables discussed in section 3.3; $Year'_t$ and $Industry'_i$ is row vectors containing year dummies and industry dummies. As suggested by Manner (2010), the demonstration of female leadership's impact on ESG performance takes time, so it is informative to look at lagged measures of female leadership. At the same time, a company's profile at

[7] Specifically, female leadership appears in the social pillar and governance pillar for Wind ESG score.

time $t-1$ does not directly enter the construction of its ESG score at time t, as is observed from the construction process of $ESG_{i,t}$. Another channel by which nominal effect enters is, the persistence of some variables that play a role in ESG score construction. For example, the average education level of the board at time t is expected to be highly correlated with that at time $t-1$, since one year is not a timespan likely to generate substantial variation in this context. This consideration justifies the inclusion of $ESG_{i,t-1}$ – by doing so, all possible nominal effect of $X'_{i,t-1}$ on $ESG_{i,t}$ is absorbed by $ESG_{i,t-1}$. Then consider quantile regression in a setting comparable to the benchmark model, that is,

$$Q_\tau\left[ESG_{it}|X'_{i,t-1}\right] = \alpha_\tau + X'_{i,t-1}\beta_\tau + \varepsilon_{i,t,\tau}$$

where the quantile operator Q_τ is defined by $\mathbb{P}\left[X \le Q_\tau[Y]\right] = \tau$ for a random variable Y.

4.2 Critical mass of female directors

As discussed, we want to compare companies with the same trend of hiring female directors across two periods, rather than simply setting dummies variables that indicate whether the number of female directors exceeds a threshold value. Following this idea, consider the benchmark model of testing critical mass theory as

$$ESG_{it} = \alpha + \left[Controls'_{i,t-1}\ \ industry'_i\right]\tilde{\beta} + D_t\alpha_1 + G_i\alpha_2 + D_tG_i\alpha_3 + \varepsilon_{it},$$

where $D_t = 0$ for period before treatment and $D_t = 1$ for treatment period; $G_i = 0$ for companies in control group and $G_i = 1$ for those in treatment group. In order to accurately measure critical mass effect, which prior literature fails to do, careful construction of control group and treatment group is crucial. For any two consecutive periods, consider companies with the same tendency of nominating female directors, whereby the treatment effect can be isolated to an extent much better than a simple dummy variable setting (e.g., Wei et al. 2017), which will be detailed in section 5.4.

5 Empirical results and discussion

5.1 Descriptive statistics

Table 1 reports descriptive statistics of the constructed variables. As observed, female leaders are still minorities in both boardroom and senior management, with an average proportion below than 20%. The proportions of female leaders under distortions by education level, relative importance and cumulative service time are similar to the values before distortion. Adams and Ferreira's (2009)

research based on US listed companies suggests that, in order to enter boardroom, females need higher education level than males to demonstrate qualifications because of gender-related stereotype and the nature of 'old boys club'. This is, however, not the case in Chinese listed companies. The mean of $FemaleD$ is even slightly higher than $FemaleD\_Edu$, indicating that on average the education level of female directors is mildly lower than male counterparts; a similar pattern is also observed between $FemaleM$ and $FemaleM\_Edu$. In addition, the average education level of board directors is higher than that for senior managers, where the former slightly exceeds bachelor's degree and the latter is below that. Some extreme values are observed in financial variables (e.g., ROE), and they will be winsorized in due courses.

[Table 1]

5.2 OLS regression

Table 2 reports OLS regressions of overall ESG performance on female leadership; table 3 – 5 report regressions of female leadership on each pillar of ESG performance. In addition to control variables discussed in section 3.3, industry-fixed effects[8] and year-fixed effects are also included. Note that across different pillars, or between any pillar and the aggregate ESG performance, the scores and therefore the coefficients of female leadership are not numerically comparable.

Table 2 suggests a pattern very different from the majority of studies on female leadership and ESG performance, studies which feature developed economies, relatively small sample size, and large-cap listed companies (those in S&P 500 are especially popular). Female leadership related to board directors does not make a difference in overall ESG performance, but this is not the end of story. Inspecting table 4 and table 5 that stand for social and governance performance respectively, it shows that the contribution of female directors is statistically significant in both settings, but of opposing signs. Combining the results, it is plausible that the underlying fact is that the female directors'

[8] Based on level-2 Wind Industry Classification (a 'localized version' of Global Industry Classification Standard). 24 industries are included: Banks; Real Estate; Software & Service; Commercial & Professional Services; Capital Goods; Materials; Consumer Durables & Apparel; Technology Hardware & Device; Retailing; Utilities; Medical Health Care Device & Service; Media; Diversified Financials; Food, Beverage & Tobacco; Energy; Food & Staples Retailing; Consumer Services; Transport; Pharmaceuticals, Biotechnology & Life Sciences; Household & Personal Products; Automobiles & Components; Insurance; Semiconductors & Semiconductor Equipment; elecommunication Services.

contributions on social pillar and governance pillar offset each other. By contrast, Galbreath's (2011) study with Australian companies find that female directors are positively related to social but not environmental performance, which is then explained as that, females typically have less technical backgrounds, while environmental pillar is the most technical one in ESG. One probable explanation to reconcile the conflicting results is that, institutional difference matters here. While in general females are socialized to be more sensitive to non-financial well-being, this population personality may not be literally applied to the group of female leaders due to self-selection problem (Adames 2016), while the institutional context influences how self-selection happens. If the self-selected female directors in Chinese listed companies actually do not have more non-financial-well-being consciousness as what happens in the general population, then there is no wonder to work out such the contrasting results.

On the other hand, as table 2 suggests, female leadership related to senior managers has an unequivocally positive contribution on overall ESG performance; a further inspection of table 3 – 5 shows that, such a positive contribution is from the governance pillar. An interesting pattern is that, the coefficient of $FemaleM$ and that of $FemaleM\_Edu$ are almost indistinguishable, that is, their educational advantage relative to male counterparts in the same panel does not make a difference on how much they can improve the company's ESG performance. De Silva and Pownall's (2014) study based on survey data from Netherland shows that, dividing the population by gender and education level, higher educated female is the group most keen on 'going green'. This is however not observed in the comparison between the benchmark measure of female leadership and that distorted by education level.

[Table 2 – 5]

5.3 Quantile regression

The set of regressions in table 2 are replicated from a quantile perspective, which are reported in figure 2 – 9. Consistent with the OLS results, in the quantile regressions female directors have negative contribution to social but positive to governance performance; female senior managers have positive contribution on governance performance as well as the overall ESG performance. Oikonomou et al.

(2014) argue that, Conflicting ESG signals are not convincing, that is, for best ESG performers, hiring female leaders is a good signal of being socially responsible, which is consistent with their current image; for worst ESG performers, hiring female directors is a good signal of being socially responsible, but this is inconsistent with their current image and could be reminiscent of greenwashing. On this basis, one would expect that the effect of female leaders on ESG performance will depend on quantiles of ESG scores. Particularly, the coefficients of female leadership should show upward trends from lower quantiles to higher quantiles. However, the figures show that the prediction does not work well here.

Arguably, the most significant quantile heterogeneity is observed from figure 6 and figure 8. Figure 6 reports the impact of female directors on different quantile of social performance. It suggests that for relatively lower performers (around 0.25 quantile), the impact of female directors achieves the lowest value; for best performers (around 0.85 quantile), the impact approaches zero. In contrast, figure 8 shows that the marginal contribution of female leadership measured by senior managers goes downward when quantile increases, such that for the worst-governed companies the introduction of female senior managers may make a great indifference, which points to the notion that female leaders are more likely to stop unethical practice in business (Van Staveren 2014) and are better at monitoring (Adams and Ferreira 2009).

[Figure 2 – 9]

5.4 DID regression

The critical mass theory, as is discussed in section 2, is tested in a DID framework. The threshold value of the number of female directors is tested mainly at one, two and three in previous literature, with three as arguably the most plausible threshold. For the two consecutive periods, year 2019 and 2020, I narrow the sample to companies those who fulfill $FemaleM_{i,2020-1} - FemaleM_{i,2019-1} = 1$, that is, companies whose one-period-lag service-time-adjusted number of female directors increases by one from 2019 to 2020. Among the narrowed sample, companies reaching a critical mass (e.g., three) in the second period are assigned to the treatment group, and others are assigned to the control group. By this way, companies with the same trend of hiring female directors are compared, whereby the

effect of critical mass is better isolated than previous research did. Analogously, the critical mass is also tested among companies hiring one less female in the second period, and tested in year 2020 and 2021. Not surprisingly, no critical mass effect is detected through the 12 regressions in table 6 and table 7, since we have learned that the number of female directors has no statistically significant effect on ESG performance with respect to the data. Nonetheless, this provides a better framework to test critical mass effect associated with female directors.

[Table 6 – 7]

6 Conclusion and open question

The raise of female leadership and ESG concerns constitute two significant trends in the world of business, which is partly reflected in the growing body of literature on female leadership's impact with respect to corporate ESG performance. The paper pursues the first systematic investigation on ESG implications of the female leaders in Chinese listed companies. The main results are as follows: (a) Despite alternative measures and models, no relation is detected between female directors and overall ESG performance, which appears resulting from that female directors' impact on the social and governance pillar offset each other. (b) Female managers' contribution to overall ESG performance is unambiguously positive, which results from female managers' impact on governance pillar. (c) No significant quantile heterogeneity is detected between the nomination of female leaders and overall ESG performance, though pillar-level impact of female leadership differs between the best and worst ESG performers. (d) No critical mass effect is detected under the DID framework.

Aggregately, the empirical evidence differs significantly from that established through cases of developed economies with quota regulation on female leaders, and provides cautions against generalizing the theories across contexts with considerable institutional differences. Beyond the revealed patterns, the framework to test critical mass theory contributes to following enquiries from a methodological perspective.

Albeit the paper complements the current literature in the four aspects highlighted in section 1, many unsolved questions remain and I would emphasize a particularly important one. Whether female

leaders *do more ESG* is of course relevant, but not the end of story. A further question is, whether female leaders are *better at doing ESG*. Arguably, one of the most important philosophies of corporate ESG practice is 'do well by doing good', that is, proper ESG practice is critical for succeeding in one's for-profit business. In a for-profit context, whether female leaders are better at doing value-adding ESG, could be of much more relevance. A long-standing criticism on corporate ESG practice is 'companies are not efficient resource users when they do ESG', instead of 'companies should do more ESG'. Accordingly, a pertinent but underappreciated question is whether female leaders in business are efficient resource users when doing ESG.

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Tables and figures

Table 1: Summary statistics

	Mean	Min	25q	50q	75q	Max	SD	Skewness	Kurtosis	Effective Obs
ESG	6.00	1.57	5.51	5.97	6.50	9.33	0.85	-0.31	4.99	16087
ESG_E	2.52	0.06	1.23	2.10	3.42	10.00	1.66	1.02	3.67	8121
ESG_S	3.80	0.06	2.55	3.75	4.93	9.82	1.71	0.30	2.76	15380
ESG_G	7.10	1.38	6.68	7.12	7.56	9.73	0.77	-0.92	7.93	15840
FemaleD	16.35	0.00	4.17	14.29	25.00	71.43	13.71	0.74	3.27	9216
FemaleD_Edu	16.24	0.00	2.04	13.79	25.00	80.00	14.33	0.86	3.52	9216
FemaleD_Imp	15.12	0.00	4.19	12.50	22.22	76.92	13.12	0.87	3.57	9216
FemaleD_Cum	15.52	0.00	0.12	12.16	24.84	96.65	15.56	1.09	4.00	9216
FemaleM	17.70	0.00	0.00	16.67	28.57	100.00	17.63	0.99	3.96	9216
FemaleM_Edu	17.49	0.00	0.00	14.81	27.93	100.00	17.99	1.07	4.10	9216
FemaleM_Imp	18.21	0.00	0.00	14.29	28.57	100.00	18.42	0.96	3.70	9216
FemaleM_Cum	17.37	0.00	0.00	11.11	28.63	100.00	20.15	1.29	4.42	9216
Asset	3.98	-0.88	2.94	3.71	4.70	12.72	1.56	1.30	6.14	9216
BM	50.64	-104.79	25.73	42.94	67.60	314.37	34.29	1.29	5.59	9216
ROE	2.08	-15824.42	2.79	7.24	12.31	1104.10	169.30	-88.78	8289.86	9216
Fin	43.12	0.84	26.43	41.88	58.07	154.54	21.43	0.37	2.66	9216
BDsize	8.38	3.17	7.00	9.00	9.00	18.00	1.79	0.92	5.88	9216
SMsize	6.23	0.58	5.00	6.00	7.33	22.00	2.39	1.11	5.57	9216
DEdu	3.07	1.00	2.56	3.43	3.86	4.86	1.05	-0.86	2.49	9216
MEdu	2.82	1.00	2.25	3.10	3.55	5.00	0.98	-0.70	2.36	9216
Dual	0.30	0.00	0.00	0.00	1.00	1.00	0.46	0.88	1.77	9216

Table 2: Female leadership versus overall ESG performance

	Dependent variable:			
	ESG			
	(1)	(2)	(3)	(4)
ESG_L1	0.0031	0.0032	0.0030	0.0029
	(0.0089)	(0.0089)	(0.0089)	(0.0089)
	[0.0120]	[0.0121]	[0.0121]	[0.0120]
FemaleD_L1	0.0003			
	(0.0005)			
	[0.0008]			
FemaleM_L1	0.0016			
	(0.0004)***			
	[0.0008]*			
FemaleD_Edu_L1		0.0003		
		(0.0005)		
		[0.0008]		
FemaleM_Edu_L1		0.0015		
		(0.0004)***		
		[0.0008]*		
FemaleD_Imp_L1			0.0001	
			(0.0005)	
			[0.0008]	
FemaleM_Imp_L1			0.0016	
			(0.0004)***	
			[0.0007]**	
FemaleD_Cum_L1				0.0001
				(0.0005)
				[0.0006]
FemaleM_Cum_L1				0.0012
				(0.0004)***
				[0.0006]*
Controls	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	9,216	9,216	9,216	9,216
R^2	0.2745	0.2745	0.2746	0.2740
Adjusted R^2	0.2717	0.2717	0.2718	0.2713
Residual Std. Error (df = 9180)	0.6202	0.6202	0.6202	0.6204
F Statistic (df = 35; 9180)	99.2378***	99.2332***	99.2757***	99.0021***

[1] *p<0.1; **p<0.05; ***p<0.01

[2] Unadjusted standard error in round brackets; Industry-clustered heteroskedasticity-robust standard error in square brackets

[3] Continuous variables are winsorized at 0.01 and 0.99

[4] _L1 denotes one-period-lag value

Table 3: Female leadership versus environmental performance

	Dependent variable:			
	ESG_E			
	(1)	(2)	(3)	(4)
ESG_E_L1	0.0807	0.0810	0.0805	0.0812
	(0.0184)***	(0.0184)***	(0.0184)***	(0.0184)***
	[0.0302])*	[0.0306])*	[0.0301]*	[0.0309]*
FemaleD_L1	0.0005			
	(0.0024)			
	[0.0035]			
FemaleM_L1	0.0005			
	(0.0020)			
	[0.0023]			
FemaleD_Edu_L1		0.0012		
		(0.0023)		
		[0.0030]		
FemaleM_Edu_L1		0.00002		
		(0.0019)		
		[0.0025]		
FemaleD_Imp_L1			−0.0015	
			(0.0026)	
			[0.0034]	
FemaleM_Imp_L1			0.0022	
			(0.0019)	
			[0.0020]	
FemaleD_Cum_L1				−0.00002
				(0.0022)
				[0.0037]
FemaleM_Cum_L1				−0.0009
				(0.0017)
				[0.0019]
Controls	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	2,385	2,385	2,385	2,385
R^2	0.2779	0.2780	0.2783	0.2780
Adjusted R^2	0.2672	0.2672	0.2676	0.2672
Residual Std. Error (df = 2349)	1.3913	1.3913	1.3909	1.3912
F Statistic (df = 35; 2349)	25.8322***	25.8373***	25.8811***	25.8395***

[1] *p<0.1; **p<0.05; ***p<0.01

[2] Unadjusted standard error in round brackets; Industry-clustered heteroskedasticity-robust standard error in square brackets

[3] Continuous variables are winsorized at 0.01 and 0.99

[4] _L1 denotes one-period-lag value

Table 4: Female leadership versus social performance

	Dependent variable:			
	ESG_S			
	(1)	(2)	(3)	(4)
ESG_S_L1	−0.0059	−0.0058	−0.0059	−0.0065
	(0.0096)	(0.0096)	(0.0096)	(0.0096)
	[0.0150]	[0.0150]	[0.0151]	[0.0150]
FemaleD_L1	−0.0031			
	(0.0013)**			
	[0.0017]*			
FemaleM_L1	0.0011			
	(0.0010)			
	[0.0018]			
FemaleD_Edu_L1		−0.0026		
		(0.0012)**		
		[0.0016]		
FemaleM_Edu_L1		0.0010		
		(0.0010)		
		[0.0018]		
FemaleD_Imp_L1			−0.0027	
			(0.0013)**	
			[0.0018]	
FemaleM_Imp_L1			0.0012	
			(0.0010)	
			[0.0016]	
FemaleD_Cum_L1				−0.0025
				(0.0011)**
				[0.0015]
FemaleM_Cum_L1				0.0008
				(0.0009)
				[0.0015]
Controls	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	8,708	8,708	8,708	8,708
R^2	0.2068	0.2066	0.2066	0.2067
Adjusted R^2	0.2036	0.2034	0.2034	0.2035
Residual Std. Error (df = 8672)	1.4876	1.4877	1.4878	1.4877
F Statistic (df = 35; 8672)	64.5821***	64.5288***	64.5168***	64.5420***

[1] *p<0.1; **p<0.05; ***p<0.01

[2] Unadjusted standard error in round brackets; Industry-clustered heteroskedasticity-robust standard error in square brackets

[3] Continuous variables are winsorized at 0.01 and 0.99

[4] _L1 denotes one-period-lag value

Table 5: Female leadership versus governance performance

	Dependent variable:			
	ESG_G			
	(1)	(2)	(3)	(4)
ESG_G_L1	−0.0182	−0.0182	−0.0188	−0.0188
	(0.0083)**	(0.0083)**	(0.0083)**	(0.0083)**
	[0.0132]	[0.0131]	[0.0132]	[0.0128]
FemaleD_L1	0.0039			
	(0.0005)***			
	[0.0007]***			
FemaleM_L1	0.0045			
	(0.0004)***			
	[0.0004]***			
FemaleD_Edu_L1		0.0035		
		(0.0005)***		
		[0.0006]***		
FemaleM_Edu_L1		0.0043		
		(0.0004)***		
		[0.0004]***		
FemaleD_Imp_L1			0.0040	
			(0.0005)***	
			[0.0005]***	
FemaleM_Imp_L1			0.0041	
			(0.0004)***	
			[0.0004]***	
FemaleD_Cum_L1				0.0029
				(0.0004)***
				[0.0006]***
FemaleM_Cum_L1				0.0031
				(0.0003)***
				[0.0003]***
Controls	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	9,216	9,216	9,216	9,216
R^2	0.2338	0.2324	0.2325	0.2268
Adjusted R^2	0.2309	0.2295	0.2296	0.2238
Residual Std. Error (df = 9180)	0.5803	0.5808	0.5808	0.5829
F Statistic (df = 35; 9180)	80.0445***	79.4152***	79.4574***	76.9297***

[1] *p<0.1; **p<0.05; ***p<0.01

[2] Unadjusted standard error in round brackets; Industry-clustered heteroskedasticity-robust standard error in square brackets

[3] Continuous variables are winsorized at 0.01 and 0.99

[4] _L1 denotes one-period-lag value

Table 6: Critical mass test during 2018 and 2019

	Dependent variable:					
	ESG					
	(1)	(2)	(3)	(4)	(5)	(6)
D	−0.0595	−0.0555	−0.0504	0.0032	0.0164	−0.0250
	(0.0697)	(0.0848)	(0.0833)	(0.0696)	(0.0841)	(0.0887)
G	0.2456	−0.0156	−0.0664	0.1188	0.0538	−0.1570
	(0.1578)	(0.0986)	(0.1024)	(0.1582)	(0.0981)	(0.0989)
D×G	0.0772	0.0133	0.0016	0.0940	−0.0199	0.0737
	(0.2133)	(0.1349)	(0.1362)	(0.2147)	(0.1329)	(0.1294)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Threshold	Three	Two	One	Three	Two	One
Direction	Reach	Reach	Reach	Leave	Leave	Leave
Observations	402	402	402	320	320	320
R^2	0.2819	0.2702	0.2716	0.4347	0.4312	0.4361

[1] *p<0.1; **p<0.05; ***p<0.01
[2] Standard error in brackets
[3] Controls additionally include FemaleM_L1

Table 7: Critical mass test during 2019 and 2020

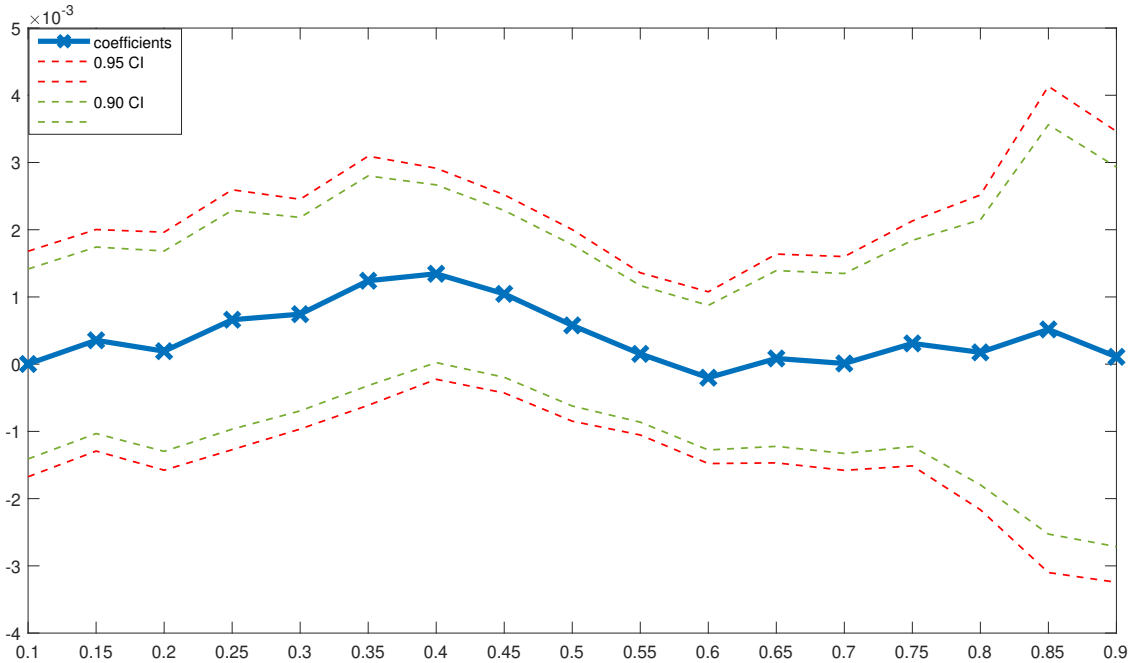
	Dependent variable:					
	ESG					
	(1)	(2)	(3)	(4)	(5)	(6)
D	0.0392	0.0108	0.0499	−0.0001	−0.0116	−0.0062
	(0.0603)	(0.0731)	(0.0735)	(0.0592)	(0.0779)	(0.0738)
G	0.1656	−0.0767	−0.0349	−0.1174	0.0003	0.0706
	(0.1287)	(0.0842)	(0.0854)	(0.1552)	(0.0828)	(0.0863)
D×G	−0.0660	0.0499	−0.0444	−0.0858	0.0079	0.0004
	(0.1786)	(0.1156)	(0.1154)	(0.2092)	(0.1135)	(0.1150)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Threshold	Three	Two	One	Three	Two	One
Direction	Reach	Reach	Reach	Leave	Leave	Leave
Observations	480	480	480	456	456	456
R^2	0.2717	0.2697	0.2698	0.4497	0.4470	0.4485

[1] *p<0.1; **p<0.05; ***p<0.01
[2] Standard error in brackets
[3] Controls additionally include FemaleM_L1

Figure 1: Wind ESG scoring System

Wind ESG Scoring System			
3 Pillars	**Environmental**	**Social**	**Governance**
27 Topics	Environment Management; biodiversity; Energy & Climate Change; Green Buildings; Water Resources; Raw Materials & Wastes; Emissions; Waste Water; Green Finance	Workplace Health & Safety; Community; Employment; Research & Innovation; Medical Service Accessibility; Training & Promotion; Product Quality; Product Sustainability; Supply Chain; Privacy Protection; Clients	ESG Governance; Staff Composition; Anti-Corruption; Capital Structure; Audit; Anti-Monopoly; Operation Continuity
300+ Indicators	• Environment management institutions; • Energy management institutions • Greenhouse gas emissions • Measures of water recycling ……	• Staff dismission rate • Average training hour per person • Protection of intellectual properties • Investment in communal well-being ……	• Connection between CEO salary with corporate ESG performance • Dismission rate of board directors and senior managers • Proportion of independent board directors • Anonymous reporting institutions ……

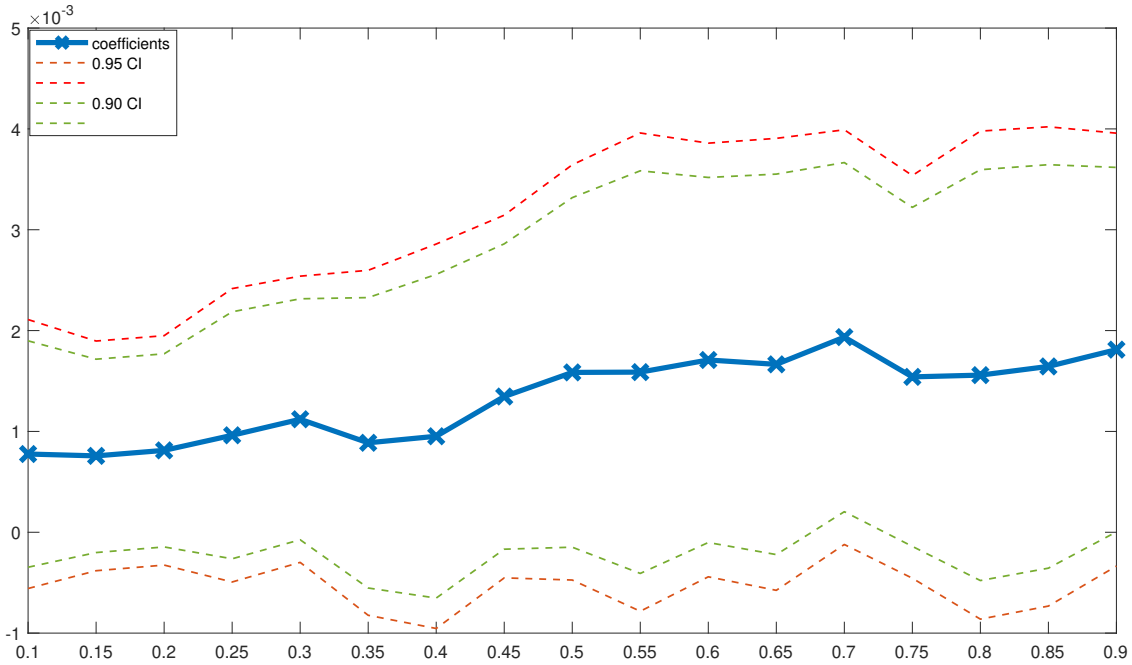
Figure 2: Quantile regression: female directors vs ESG performance



[1] 17 point estimations with respect to quantiles 0.10, 0.15,...,0.90

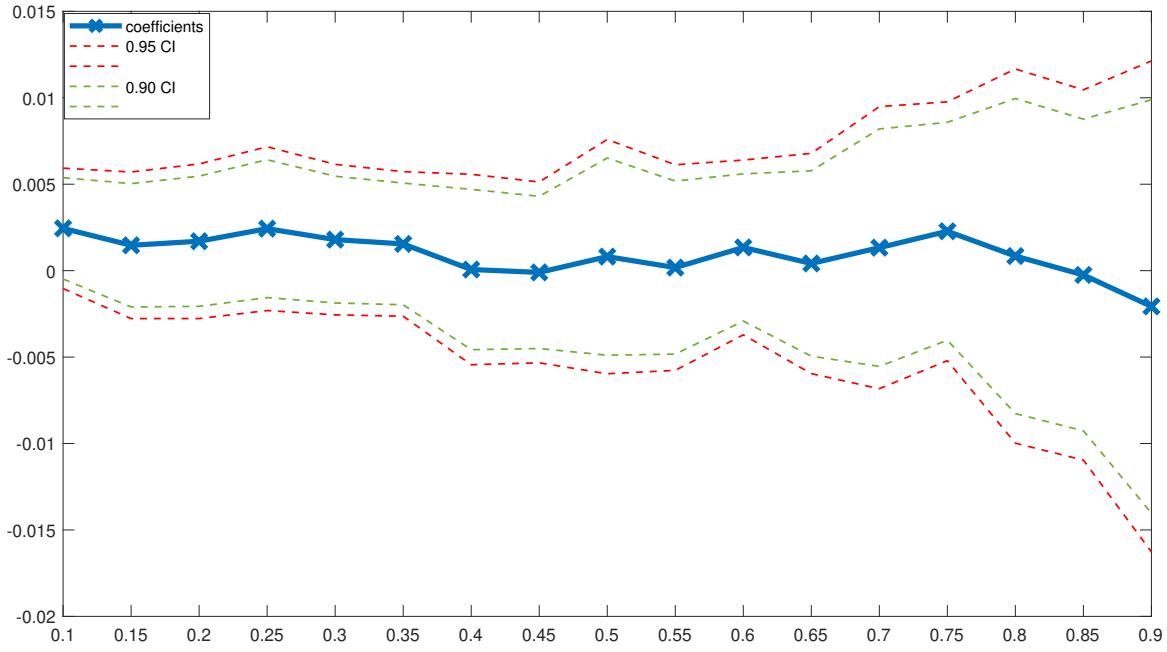
[2] Confidence intervals are computed by robust bootstrap in Hagemann (2017), clustered by industry, replication=1000

Figure 3: Quantile regression: female managers vs ESG performance



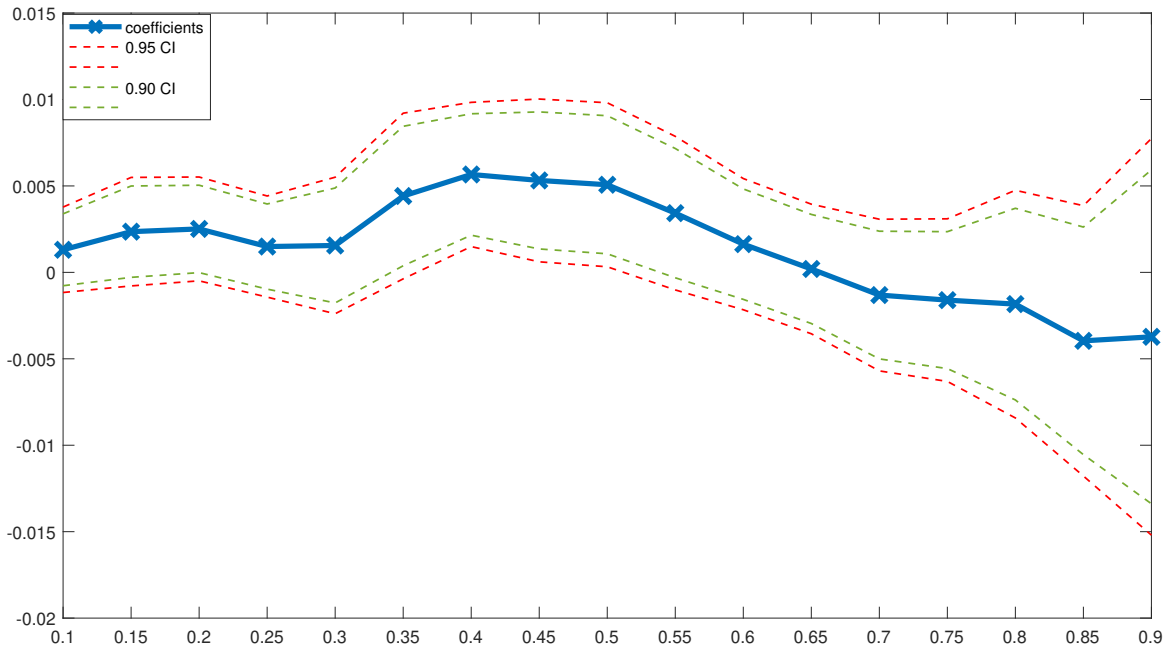
[1] 17 point estimations with respect to quantiles 0.10, 0.15,...,0.90
[2] Confidence intervals are computed by robust bootstrap in Hagemann (2017), clustered by industry, replication=1000

Figure 4: Quantile regression: female directors vs environmental performance



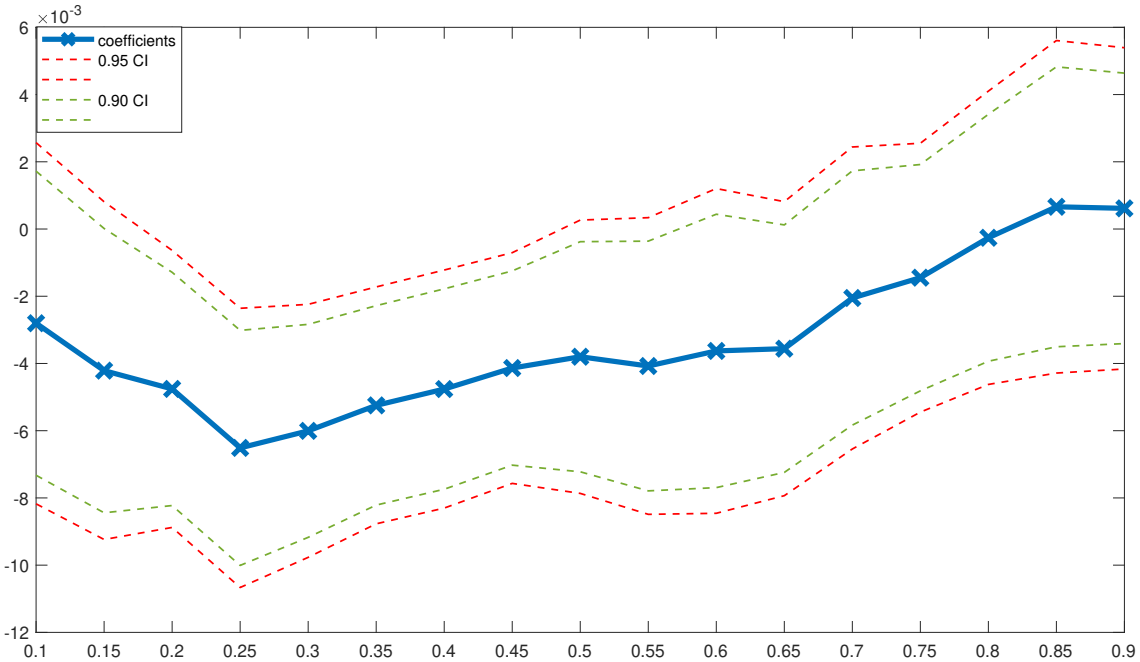
[1] 17 point estimations with respect to quantiles 0.10, 0.15,...,0.90
[2] Confidence intervals are computed by robust bootstrap in Hagemann (2017), clustered by industry, replication=1000

Figure 5: Quantile regression: female managers vs environmental performance



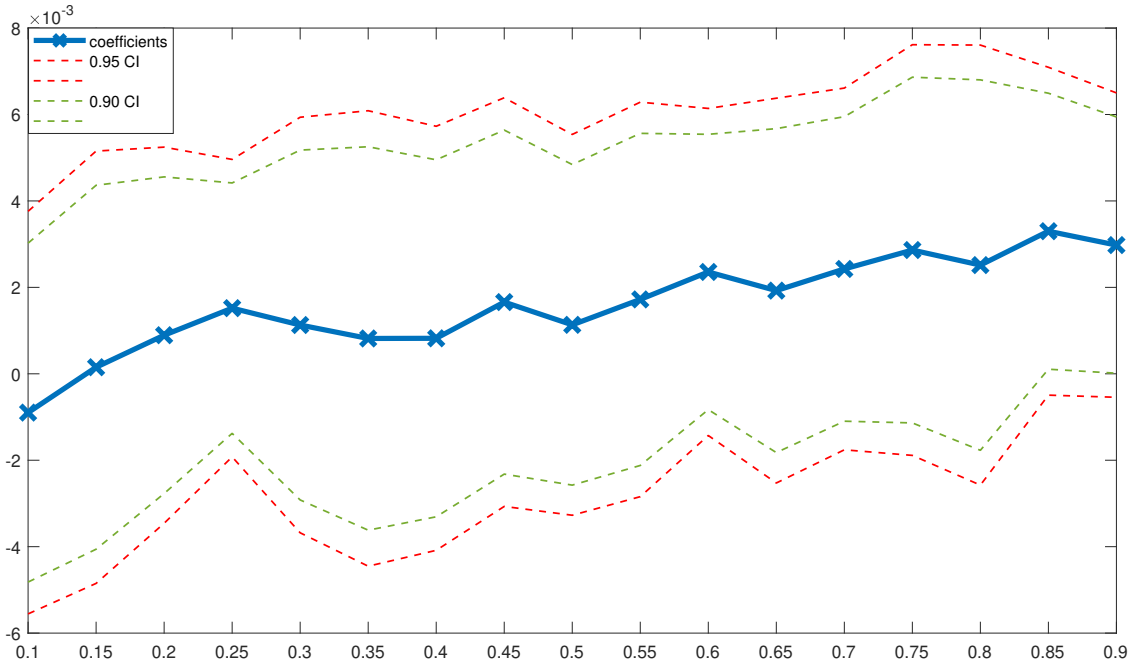
[1] 17 point estimations with respect to quantiles 0.10, 0.15,...,0.90
[2] Confidence intervals are computed by robust bootstrap in Hagemann (2017), clustered by industry, replication=1000

Figure 6: Quantile regression: female directors vs social performance



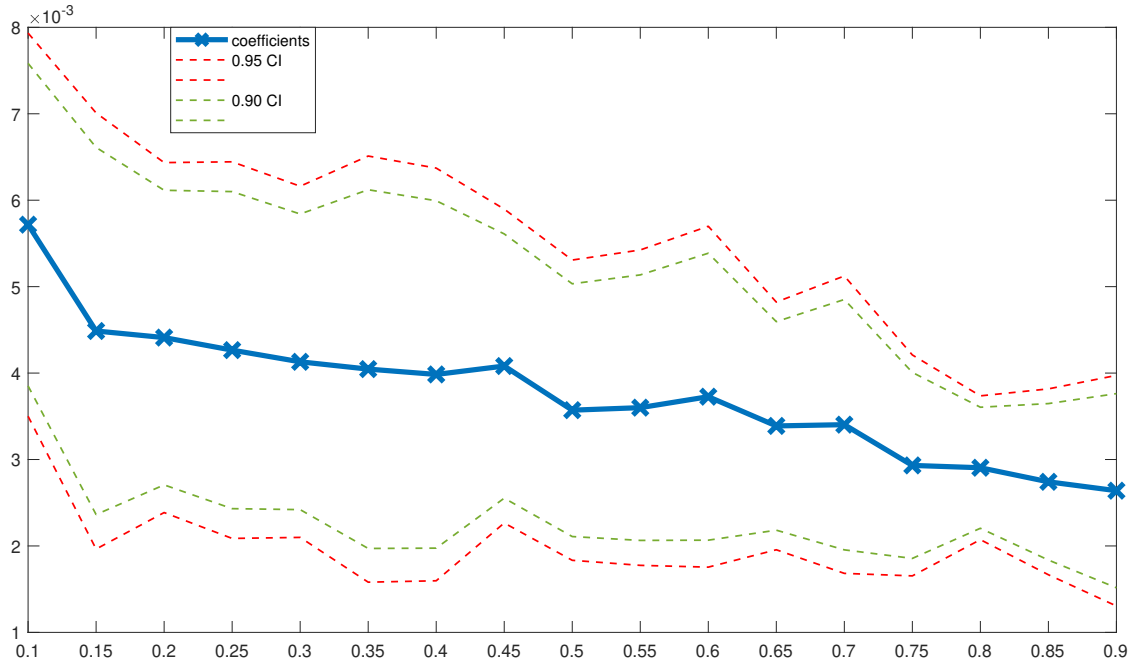
[1] 17 point estimations with respect to quantiles 0.10, 0.15,...,0.90
[2] Confidence intervals are computed by robust bootstrap in Hagemann (2017), clustered by industry, replication=1000

Figure 7: Quantile regression: female managers vs social performance



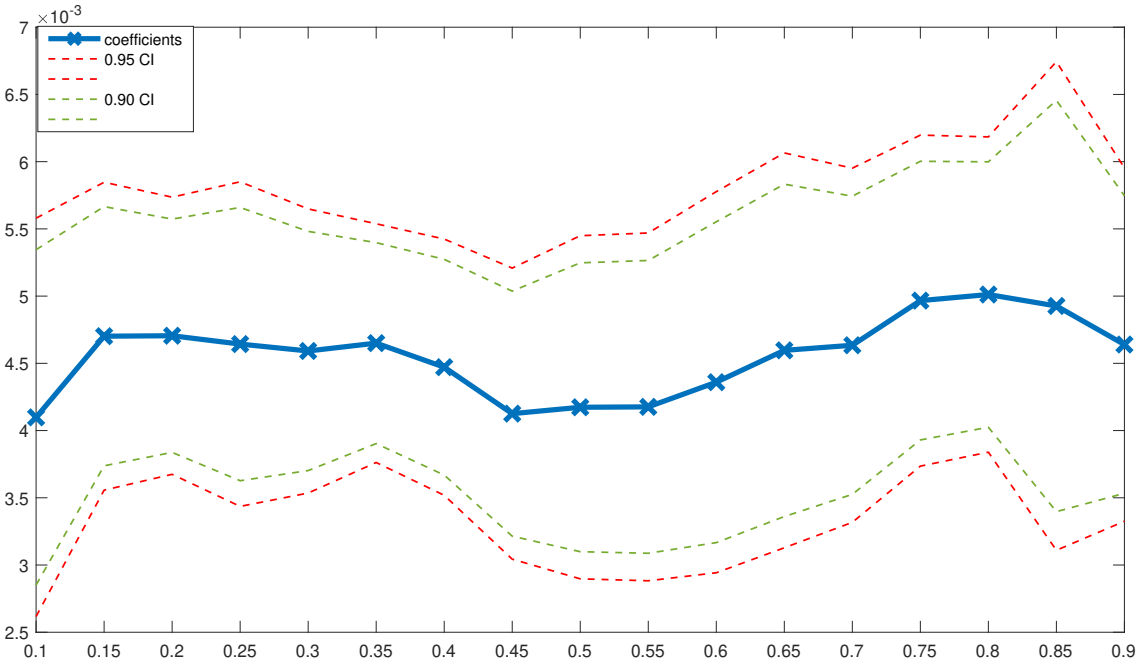
[1] 17 point estimations with respect to quantiles 0.10, 0.15,...,0.90
[2] Confidence intervals are computed by robust bootstrap in Hagemann (2017), clustered by industry, replication=1000

Figure 8: Quantile regression: female directors vs governance performance



[1] 17 point estimations with respect to quantiles 0.10, 0.15,...,0.90
[2] Confidence intervals are computed by robust bootstrap in Hagemann (2017), clustered by industry, replication=1000

Figure 9: Quantile regression: female managers vs governance performance



[1] 17 point estimations with respect to quantiles 0.10, 0.15,...,0.90

[2] Confidence intervals are computed by robust bootstrap in Hagemann (2017), clustered by industry, replication=1000