Board Gender Diversity and Firm Performance: Evidence from Chinese Firms*

Di Lu[†1] and Yangming Bao[‡2]

[1,2] *Goethe University Frankfurt*
[1] *Johannes Gutenberg University Mainz*

December 29, 2018

Abstract

This paper identifies a causal effect of board gender diversity on firm performance using Chinese listed firms. Our identification is based on the differential effect of a historical event, the education system disruption during China's *Cultural Revolution* and the subsequent resumption, as an exogenous shock to the supply of male and female directors. By building an instrument utilizing this shock for board gender diversity, we find that one standard deviation increase in board female ratio can lead to 4.78% standard deviation increase in ROA. Moreover, we find evidence that only more than two females in the board can affect corporate decision-making, supporting the critical mass theory.

Keywords: China, Gender Diversity, Firm Performance, Education System Disruption

JEL Classification: G34, J22

*We are very thankful to Ying-Lun Cheung, Martin Goetz, Byoung-Hyoun Hwang, Marie Lalanne, Thorsten Schank, and seminar participants at Johannes Gotenberg University Mainz and 1st Global Young Scholars Conference.

[†]E-mail address: dilu@uni-mainz.de

[‡]E-mail address: yangming.bao@stud.uni-frankfurt.de

1. Introduction

Individual traits of top executives could be transmitted and affect corporate financial policies (Bertrand et al., 2003). Moreover, the managerial heterogeneity, such as risk aversion and overconfidence (Malmendier et al., 2011), can lead to variations in investment and acquisition choices (Aggarwal and Samwick, 2003; Malmendier and Tate, 2005, 2008). Gender as an important demographic characteristic, could be a noteworthy source of the managerial heterogeneity. Over the past decades, women have played more and more important roles in the workplace. The proportion of women directors also increases steadily around the world. They bring more diversity into the board with their variety of education, experience and perspectives[1]. The question is, what kind of impact would gender diversity have on firm performance?

Numerous researches have looked into the relationship between the board gender diversity and firms' financial outcomes, mainly in developed countries.[2] However, only a few of them properly deal with the endogeneity issue and the empirical results are mixed. Furthermore, even fewer studies explore the causal effect of board diversity on firm performance in developing countries, which also have a growing board female ratio, and at the same time are characterized by highly concentrated ownership, weak corporate governance and shareholder protection. This paper investigates a big emerging market, China, and properly tackles the endogeneity problem by utilizing historical episodes as exogenous shocks to the higher-educated labor supply and the board structure.

In 1952, the unified college entrance examination (*Gaokao*) system of the People's Republic of China was formally established. This system was disrupted by a massive socio-political movement from 1966 to 1976, the *Cultural Revolution*. No proper higher education was provided during that period, except for certain political theories and practical working skills.

[1] Both empirical and experimental evidences have shown that women directors tend to be less overconfident (Croson and Gneezy, 2009), more diligent in monitoring (Adams and Ferreira, 2009) and they can bring different experiences and perspectives (Cox and Blake, 1991) into the board.

[2] Terjesen et al. (2009) provides a detailed literature review on this topic.

This long disruption of higher education caused a significant impact on a generation of young people who were deprived of the opportunity to access higher education (Roland and Yang, 2017). Only a very few of them had opportunities years later to go back studying after the resumption of *Gaokao*. If there were no college disruption, in general individuals would attend the colleges at 18 years old. Hence, cohorts born between 1948 and 1958 were mostly affected by the disruption of higher education. We find that the historical event affected the high-quality labor supply pool of directors for corporations, causing a long-lasting effect on corporate board structure today. More interestingly, we find a structural difference of directors between female and male cohorts. We argue that the gap is caused by different opportunity costs to attend college for male and female. At that time, female cohorts who were affected by the disruption of *Gaokao* would have fewer chances to retake the exams and get higher education compared with the contemporaneous male cohorts, especially after getting married and having children.

What's more, during 1959 to 1961, China experienced the *Great Chinese Famine* and a subsequent baby boom, which have a huge impact on population and also the supply of directors. This additional exogenous shock reinforces the effect of exam resumption on the supply of directors by gender, because families tended to invest more on sons back then, making the differential effect between male and female even bigger. The relative decrease in female director supply provides an exogenous part in gender diversity, allowing us to infer the causal effect of it on firm performance.

Based on the above historical shocks, we construct a firm-level instrument variable (IV) for board gender diversity which is the ratio of female to male directors in board[3]. We first calculate the difference in female cohort ratios born before and after the resumption of the exam. We then construct the IV employing a "difference in difference" idea by subtracting that of male cohorts to capture the extra decrease in the supply of female directors due to the exogenous shocks. The constructed instrument is significantly positive-correlated with

[3]We consider both board and supervisory board, as the latter play an important role in monitoring. Jiang and Kim (2015) give a very comprehensive and detailed modern overview of corporate governance in China.

board gender diversity.

We start from exploring the relationship between board gender diversity and firm performance (proxied by ROA, ROE and ROS) using OLS. With firm controls and fixed effect, we find a positive correlation between the two. Next, to gain a causal insight, we use the constructed IV to instrument board gender diversity and find a significantly positive effect on firm performance, consistent with the OLS findings. Moreover, the economic magnitude is large, as one standard deviation increase in female ratio can lead to a 4.78% standard deviation increase in ROA, which is about 8.6 million RMB in profit. We conduct several robustness tests for our results. First, we use alternative definitions of firm performance and gender diversity. Second, we apply a commonly used IV developed by Adams and Ferreira (2009), which is based on the social network with females of male directors, and find a consistent evidence of the positive effect.

Finally, we test the critical mass theory (Kanter, 1977). If the managerial heterogeneity by gender exists, how many women directors could form a voice? The theory indicates that the rarity of females as directors, for example, the sole female representative in the top executives could be regarded as token instead of the real leader. The theory claims that only more than two females in the board can affect corporate decision-making. We find empirical evidence supporting the view.

The contribution of this paper is mainly in the following two aspects. First, we add to a large literature exploring the effect of board gender diversity on corporate performance. The difficulties of drawing causal inferences in this literature due to omitted variables such as unobservable corporate cultures or reverse causality have long been recognized. Except the researches using gender quota in Norwegian firms (Ahern and Dittmar, 2012), many instruments have been used in the existing studies (Adams and Ferreira, 2009; Smith et al., 2006; Low et al., 2015; Liu et al., 2014). We contribute to the literature by proposing a new identification based on a unique historical episode in China, which captures an exogenous change in the relative female directors' supply and finding a positive causal effect, supporting

the view that more qualified female participation in board is effective and favorable to firm performance.

Second, we add to a strand of literature studying the consequences of historical events and political environment, in particular, the government policies in China on its citizens. Previous study provide evidence that traumatic experiences can negatively affect individual beliefs and attitudes (Li et al., 2010; Chen and Yang, 2016; Roland and Yang, 2017; Chen and Yang, 2016; Gong et al., 2014). We provide evidence that historical events can impact human capital accumulation and are likely to pass on to economic performance. In particular, we find a long-lasting effect of China's *Cultural Revolution* on corporate director labor market and firm performance.

The rest of the paper proceeds as follows. Section 2 reviews the historical background. Section 3 describes the identification strategy and the construction of IV. Section 4 describes the data and provides summary statistics. Section 5 presents and discusses the results. Section 6 concludes.

2. Institutional Background

In 1952, the unified college entrance examination (*Gaokao*) system of the People's Republic of China was formally established. Each year, the national *Gaokao* was held only once in summer, and all the colleges recruited fresh high-school graduates afterwards according to the results of *Gaokao*. This system was disrupted by a massive socio-political movement, *the Cultural Revolution*, from 1966 to 1976. For one decade, only a very few of workers, farmers and soldiers had chances to be recommended to attend colleges and get a special diploma. Meanwhile, except for some certain political theories and practical working skills, no proper higher education was provided during this period. Figure 1 shows the numbers of high school and college student enrollment from 1949 to 2000. There is a distinct break of college enrollment during *the Cultural Revolution*.

Not until December 10, 1977, the *Gaokao* system was finally resumed. Half a year later, the *Gaokao* was held again in summer. Since then it always takes place once in summer each year. As recorded in Julia Kwong (1983):

> Since 1977, poorly equipped schools have been closed, courses on agricultural and industrial skills eliminated, a new curriculum drafted, facilities for adult and technical education expanded, decision-making made more centralized, and an examination system has been introduced.

Most high school graduates (the pre-1959 cohorts, the so-called "lost generation" by Roland and Yang, 2017) and middle school graduates whose higher education was disrupted during this decade had little chances to go back to school. Cohorts born between 1948 and 1953, who graduated in 1966, 1967 and 1968 from high school or middle school, were still allowed to take the *Gaokao* from 1977 to 1979. Afterwards, only fresh high school graduates could take the *Gaokao*. However, the "lost generation" faced a lot of obstacles to go back to school. Not only it was difficult for them to pick up the high-school knowledge and review materials which were scarce at that time, but also it was very costly for them to give up their jobs and incomes which were important to support the family. Hence, the opportunity cost to attend college was rather high and many of them could not afford to take the chance.

Women during that period had even fewer opportunities to continue a college education compared with men. At that time, with the disruption of the *Gaokao* system, it was more difficult for women to take part in the college entrance exams and obtained higher education after they got married and had children. Moreover, the social attitudes at that time also preferred women to focusing more on taking care of the family. Therefore, female cohorts who were affected by the disruption of the *Gaokao* would have little chance to get higher education at that time and afterwards, together with the marriage and children, which in turn will lower the probability to become a qualified director. On the contrary, in the same period, the male cohorts could still have advancement chances by accumulating work experience or pursuing college education many years later and even after marriage. Figure 2

illustrates the numbers of board directors in Chinese listed firms in each cohort by gender. In general, the pre-1959 cohorts of female directors seem to suffer more by the disruption of the Gaokao system, consistent with the idea that women have fewer opportunities to go back and pursue education.

Another important historical event, the *Great Chinese Famine* (the Famine onwards), occurred from 1958 to 1961 and had a huge impact on population[4]. Although the cohorts born during the Famine were not affected by the disruption of *Gaokao* system, they could still be affected by the Famine. However, this additional exogenous event should not blur our identification, but instead add credit due to the following two reasons. First, the effect of Famine on higher educated population is limited. Although the Famine reduced the fertility prominently, especially among the rural population, people living in urban areas were less affected, who were the main source of the higher education. This is reflected in Figure 1, as the number of high school enrollment during 1973 to 1977, when cohorts 1958 to 1962 would attend high school, increases steadily. The famine was followed immediately by a baby boom, which peaked in 1965. The high school students also peaked in the following year resulting from the baby boom. Second, the Famine and the subsequent Baby Boom should reinforce the effect of exam resumption on the supply of directors. By that time there was no one-child policy yet, and families with many children tended to use most of the limited resource on sons back then, making the gap between the supply of male and female directors even bigger.

Therefore, the resumption of the *Gaokao* system, together with the Famine, exogenously provided more qualified directors with higher education, meanwhile these exogenous shocks affected women and men in different degrees. Moreover, these affected cohorts have grown into the mainstay of society and became board members during our sample period, together with a steady increase in female ratio in boards, which makes it very meaningful and reason-

[4]According to Chen and Yang (2016), approximately 30 million people perished unnatually during the famine, which is about 5% of China's total population in 1957. Moreover, fertility dropped by an estimated size of another 30 million.

able to investigate the effect of gender diversity on the firms by using the historical events decades ago.

3. Identification Strategy

3.1. Empirical specification

To test the effect of board gender diversity on firm performance, we test the following regression as our baseline model,

$$ROA_{i,t} = \beta_1 FemaleRatio_{i,t} + \mathbf{X}'\boldsymbol{\lambda} + \delta_i + \delta_t + \epsilon_{i,t}, \tag{1}$$

where $ROA_{i,t}$ is firm i's return of asset at time t, and $FemaleRatio$ is the ratio of female in board. $\mathbf{X}$ are firm-level controls. Standard errors are clustered at firm level.

Many empirical studies have shown different relationship, positive or negative, between board gender diversity and firm performance, but it is not easy to identify a causal effect of the former on the latter because of the omitted variables such as unobservable corporate cultures or reverse causality that better performing firms may be more likely to hire women instead of vice versa. To control for the direction of causality, we construct an instrumental variable (IV) for director female ratio based on an exogenous relative decrease in qualified female director supply in China, caused by the resumption of the *Gaokao* along with the Famine.

3.2. IV Construction

The most commonly used IV is developed by Adams and Ferreira (2009), which is the fraction of a firm's male directors who sit on other boards that have at least one female director. This instrument reflects the social network of the male director, which will in turn affect the gender diversity of the firm but has nothing to do with the firm performance.

With a similar idea, Smith et al. (2006) use the education level of the spouses of CEOs as an instrument, which will reflect the attitude of CEO towards women directors, but has no effect on firm performance. Low et al. (2015) use the proportion of female managers as an instrument to capture a corporate culture more favoring to women's career advancement. Liu et al. (2014) use the percent of women in the industry as an IV, which however, has a weak instrument problem.

In this part, instead of exploring the outside network of directors or corporate culture, we utilize the historical events and hypothesize that women were more negatively affected by the disruption of the *Gaokao* and benefited less from the subsequent resumption of the higher education system. Indeed, this inference is supported by Figure 4 that visualizes the difference between board female and male ratio in each year for each cohort.The y-axis denotes year, which ranges from year 1999 to 2016. The x-axis represents cohort with different birth years, whose interval is five years and the range is from 1944 to 1973. The value of each color block shows the difference in percentage of female and male directors in certain cohorts in year t over all male and female directors in year t. The graph shows the ratio of difference entering the board market for each cohort. One can notice a pattern of inconsistency for cohorts 1959-1963 (cohort 4 in the graph), who were benefited from the resumption of the *Gaokao* system. The difference in female and male ratio is very large comparing to the cohorts before and after, particularly for years after 2002. This implies that fewer percentage of female directors of the cohort are hired throughout the recorded years comparing to the men counterparts, although both higher educated women and men increase for the post-1959 cohorts.

Cohorts 1949-1953 (cohort 2 in the graph) are those mostly affected by the disruption of the *Gaokao* system, who were allowed to take part in the *Gaokao* in 1977, 1978 and 1979, during which time they were more than 24 years old. This is reflected in Figure 5, which shows the average bachelor graduation age of board directors. Cohorts 1949-1953 (cohort 2 in the graph) have the biggest average graduation age with more than 30 years old, which

is in accordance with the historical facts.

Based on the evidence, we build a firm-year level instrument for the board female ratio. Since no database has the information on college enrollment or graduation by cohort and gender, we build this IV based on the directors of listed Chinese firms from 1999 to 2015. We only keep directors who were enrolled in bachelor programs in the mainland China, since the resumption of education should only affect them.

First, we calculate the difference in female director ratio for two cohorts affected by the disruption (cohort 1949-1953) and the resumption (cohort 1959-1963) of the *Gaokao* system, respectively. The cohorts 1949 to 1953 were those who were mostly affected by the disruption of the higher education. While it is likely for them to retake the exams, it is much harder for the women of these cohorts, who were much older than 18 years old in 1977. Instead of continuing to pursuit for a higher education, they were more possible to get married and have children. On the contrary, the cohorts 1959 to 1963 were those who could take the college entrance exams right after the high school graduation.

Next, we take the difference of female and male directors between these two cohorts. Hence, this instrument captures the extra exogenous decrease in supply of qualified female directors over qualified male directors caused by the exogenous shocks. To attenuate the possible endogenous concern, we use the industry yearly mean of number of board directors. This "difference in difference" (DiD) IV allows us to capture the additional decrease in female board supply caused by the resumption of exams comparing to that of male. Specifically,

$$DiD\_IV_{i,t} = \frac{(\text{ female}_{59\backsim 63}\text{-female}_{49\backsim 53})_{i,j,t}}{\text{average num of directors}_{j,t}} - \frac{(\text{male}_{59\backsim 63}\text{ -male}_{49\backsim 53})_{i,j,t}}{\text{average num of directors}_{j,t}}, \tag{2}$$

where i is firm, j is the industry firm i belongs to, and t is the reporting year.

4. Data and Sample

4.1. Data source and sample construction

Our sample includes public Chinese firms listed on the Shanghai or Shenzhen stock exchanges over 1999 to 2015. The data are collected from CSMAR (China Stock Market and Accounting Research Database) database, where performance data are from its China Stock Market Financial sub-database and ownership data from its China Listed Firms' Corporate Governance Research sub-database. Following the literature, we exclude firms in financial and public utilities industries and observations with negative sales, assets or total debts.

For each firm, we collect board members' detailed personal information containing their gender, cohort, education and other personal experience from the Corporate Figure Characteristic sub-database of CSMAR. The Chinese listed firms have a two-tier board structure, which consists of a management board and a supervisory board. Only board directors can serve on the corporate strategy committee, audit committee, nomination committee, and compensation committee. We calculate the female ratio in management board and supervisory board to measure the board diversity. We include directors in supervisory board since they play a role in monitoring and are important for corporate decision. In robustness check, we also calculate the female ratio only using management board directors. Firm performance is measured by the return on assets (ROA), defined as the ratio of net income over total assets.

Other firm level control variables are defined following the literature. We control for firm assets, board size, state ratio, domestic legal ratio, firm age, sales growth, leverage and young IPO firm. The detailed definitions are in Appendix Table A. Each variable is trimmed at 0.5%th and 99.5%th percentile to reduce the effect of outliers.

4.2. Descriptive statistics

The final sample consists of 2,720 firms and 27,765 firm-year observations from 1999 to 2015. Table 1 shows the summary statistics of the variables.

On average, ROA is 3.45%. An average firm in the sample has assets of 5.73 trillion RMB and 8 years of listing history. The sale growth is 21.1% and leverage is 46.2%. The state owner and domestic legal owner account for 15.7% and 11.4% of all shares, respectively.

An average firm in the sample has a board consisting of 10 directors and a supervisory board of 4. 15.3% of board members (board and supervisory board) are female. In detail, 4.74% are executive directors, 3.12% are independent directors, and the remaining 7.10% are supervisory directors. The numbers of female directors are also quite limited, with 26.6%, 23.3%, 15.8% of firm-year have one, two and three members of female directors, respectively. Only 16.1% firm-year has more than three female directors in board. Hence, a larger female ratio can represent a board with more gender diversity.

Figure 3 plots the time trend of female ratio over the period, showing an increasing pattern, from 10% to 18% during the recent decade. One can observe a rapid increase in independent female ratio around 2003, since it is required legally that the the number of independent directors in listed firms must be no less than one-third of the total board members, while the other two components of female ratio have a flatter increase.

We use the 2017 updated industry classification and provide an overview of the firm compositions in each primary industry. Table 1 shows that the majority of firms are in manufacturing, consisting of 65.2%. The average board female ratios are reported for each industry, with limited variations across industries.

5. Empirical results

5.1. Preliminary analysis: OLS results

We start our analysis by examining whether gender diversity are correlated with better firm performance using OLS. We first add year fixed effect to remove any national variations in ROA in column (1) of Table 2. The coefficient of $FemaleRatio$ is significantly positive after controlling for corporate variables, indicating more female in board is positively associated with firm performance. From the coefficients of control variable, we can observe that firms with larger board size have worse performance, suggesting that it becomes more difficult to coordinate and make decisions with more people in control. Second, the state ratio is positively correlated with firm performance within a firm. This might be surprising at first glance, but one can think firms may have access to better resources with the relationship of government, boosting their sales and profit. Other effects of control variables are as expected.

In column (2), we add firm fixed effects to wash out firm specific characteristics, including firms' industry (secondary classification) and location (province where the headquarter locates). The estimates remain significantly positive. We find a 1% increase in female ratio is associated with 2.1% improvement of firm performance which is measured by ROA. This improvement is 4.9% and 8.6% for alternative definitions of firm performance, return on equity (ROE) and return on sales (ROS), respectively.

However, we are not able to draw any causal impact of gender diversity on firm performance yet. Unobserved variables that correlated with the firm performance and female ratio can bias the OLS estimates. For example, firms with better performance are likely to be younger and more open, and recruit more female directors. To identify any causal effect, we employ an exogenous relative decrease in female director supply caused by the resumption of national college entrance exam in 1977, which will be shown in the next part.

5.2. 2SLS Results

We estimate a two-stage-least-square regression based on Equation (1) using our IV DiD_IV. In all specifications, we add firm and year fixed effect and cluster the errors at firm level.

The 2SLS results are reported in Table 3. Panel B shows the first stage results, with a statistically strong and positive relationship between board female ratio and DiD_IV. It implies that a firm with a relatively lower decrease in female supply is positively correlated with the female ratio. The F statistics is more than 70, thus excluding the weak IV concern.

The second stage results are reported in Panel A. Consistent with the OLS results, we continue to find a statistically positive effect of female ratio on firm performance, which is measured by ROA, ROE and ROS. Regarding to the economic magnitude, we find a one standard deviation increase in female ratio can cause a 4.78% standard deviation increase in ROA, which is about 8.6 million RMB in profit. In column (2), we additionally add interactions of industry and year fixed effect to capture any time-varying factors across industry level. We also add interactions of province and year fixed effect to investigate the effect within the same geographical area in column (3), eliminating any time varying changes in each Province. The results remain robust. In column (4) and (5), we use the alternative definitions of firm performance, ROE and ROS. The results remain positive and significant.

Previous study find mixed effect, positive and negative, and suggest the effects of board gender diversity depend on the qualifications of female top managers (Matsa and Miller, 2013; **?**; Adams and Ferreira, 2009; Smith et al., 2006). One explanation of our positive results could also be due to the good quality of female board in China. The traditional social attitudes towards the role of women, tougher competitions and stricter criteria for women in workplace make the female directors to be especially outstanding and eminent to be qualified for their positions.

5.3. Robustness tests

5.3.1. Alternative definitions

We use alternative definitions for our main variables to check the robustness of the results. Table 4 shows the results. First, we use EBIDTA ratio for firm performance instead of ROA. The results are in column (1) and (2), with a positive estimates.

In column (3) and (4), we use an alternative measure for female ratio. Instead of using management and supervisory board female ratio, we calculate the female ratio only based on management board. The results are in column (3) and (4), which are also robust, showing a positive effect on firm performance.

We also check the robustness of our results using a commonly used IV developed by Adams and Ferreira (2009). They use the fraction of a firm's male directors that sit on other boards which have at least one female director. This instrument reflects the social network of the male directors, which will in turn affect the gender diversity of the firm but has nothing to do with the firm performance *per se*.

Following their procedure, we first identify the male directors that sits on other firms with females in board. We then calculate the fraction of these males in a firm as the IV. The idea is that more social network with females can improve the ability of males to work with females, hence increasing the potential gender diversity. The results are reported in column (5) and (6) of 4. The effect of female ratio on firm performance is still significantly positive using their IV.

5.3.2. Alternative IV with different cohorts

Except for cohorts 1949-1953, cohorts 1954-1958 should also be affected by the disruption of the *Gaokao* system from 1966 to 1977. Their basic education is likely to be more adversely affected due to poor quality of junior and high school, which makes them less likely to retake the exams and obtain higher education later. In this part, we use an alternative IV with the

similar method but the "diff-in-diff" between female and male ratio are those born between [1959,1964] and [1953,1958]. The results are demonstrated in 5. In most cases, the effect of female ratio is still significantly positive in the second stages.

5.4. Testing the critical mass theory

The critical mass theory (Kanter, 1977) claims that female can affect corporate decision-making only when there are more than two women in the board. To test that, we construct several dummies based on the number of females in board.

To begin with, we run an OLS regression similar as before, but replace the $FemaleRatio$ using the dummies indicating the number of female directors in board. Column (1) in shows an interesting result. The coefficient of one female director is insignificant and small, indicating one female has rarely impact on firm performance. However, the estimates for dummies of two and three female directors are significantly positive. This is consistent with the critical mass theory that more females in board can have a real impact.

In column (2), we use the dummy of more than two female directors and continue to find a significantly positive effect. Then we instrument this dummy using our DID_IV and run the 2SLS regressions. The second stage results are reported in column (3)-(4), with a relatively large F statistics. The IV estimates are also significantly positive, consistent with the critical mass theory.

6. Conclusion

We explore the effect of gender diversity on firm performance among public Chinese firms. To identify a causal relationship, we construct a novel instrumental variable based on a unique historical event in China. Access to higher education was disrupted during the *Cultural Revolution* between 1966 to 1977, and was reintroduced in 1977 with the end of the ten-year chaos. It has a significant and long-lasting impact on the supply of qualified labor,

such as board members. Moreover, we find a differentiated effect across gender. Females were more affected during that time and were less able to re-take the chances of higher education comparing to men. Utilizing this fact, we construct an instrumental variable utilizing the idea of "difference in difference" to capture the exogenous relative decreased supply of qualified female for gender diversity. We find a significant and positive effect of gender diversity on firm performance. Moreover, we find the effect exist only when there are more than two females in board, supporting the critical mass theory.

Fig. 1. **Enrollment of high schools and colleges in China, 1949-2000**

This figure plots the number of high school and college recruited students. The x-axis denotes year and y-axis counts the number of high school/college students recruited that year with the unit of ten thousands. Data source: Compilation of China Statistics Yearbooks (1949 to 2008).

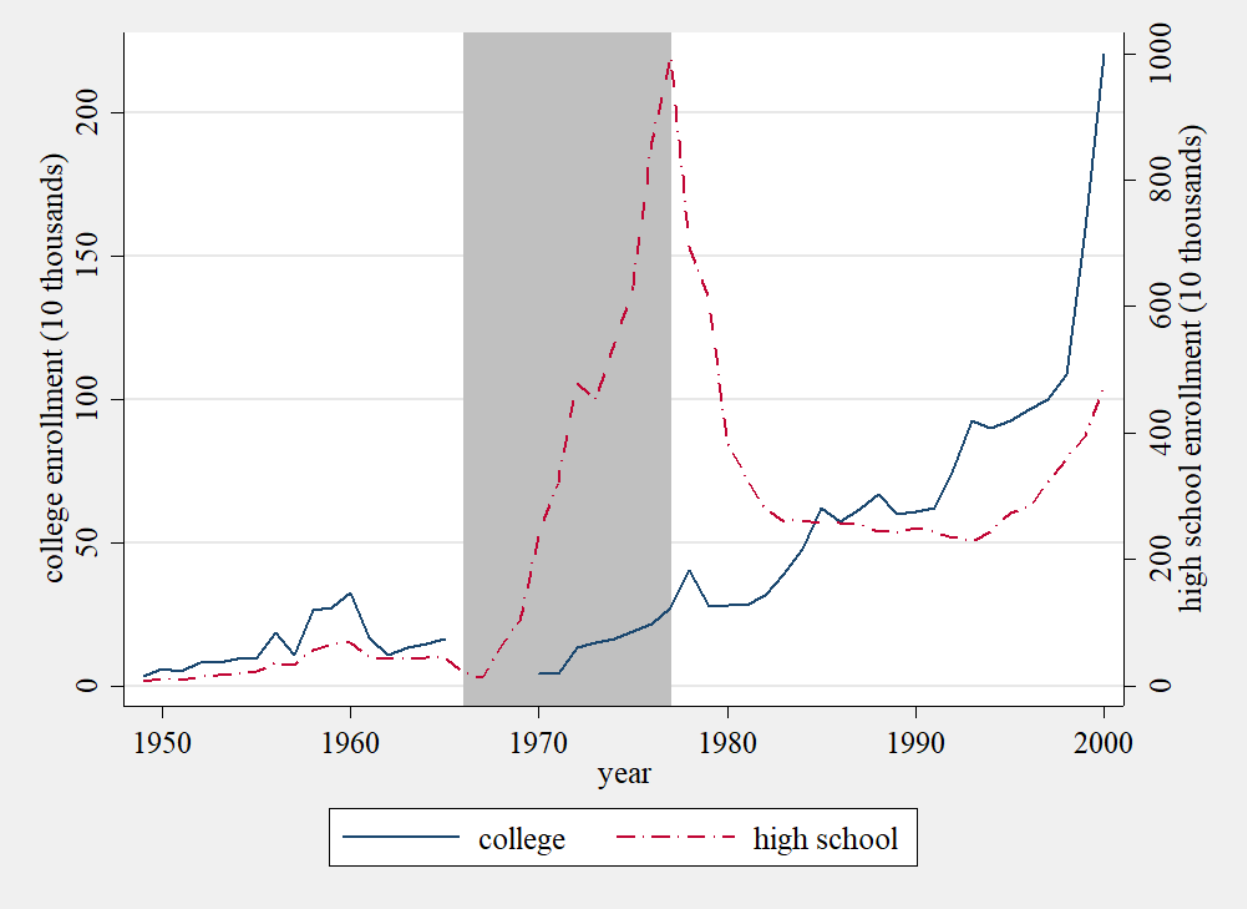

Fig. 2. **Number of directors in each cohort by gender**

This figure plots the number of board directors in Chinese listed firms in each cohort by gender. The x-axis denotes the birth year for each cohort and y-axis counts the number of directors born in that year.

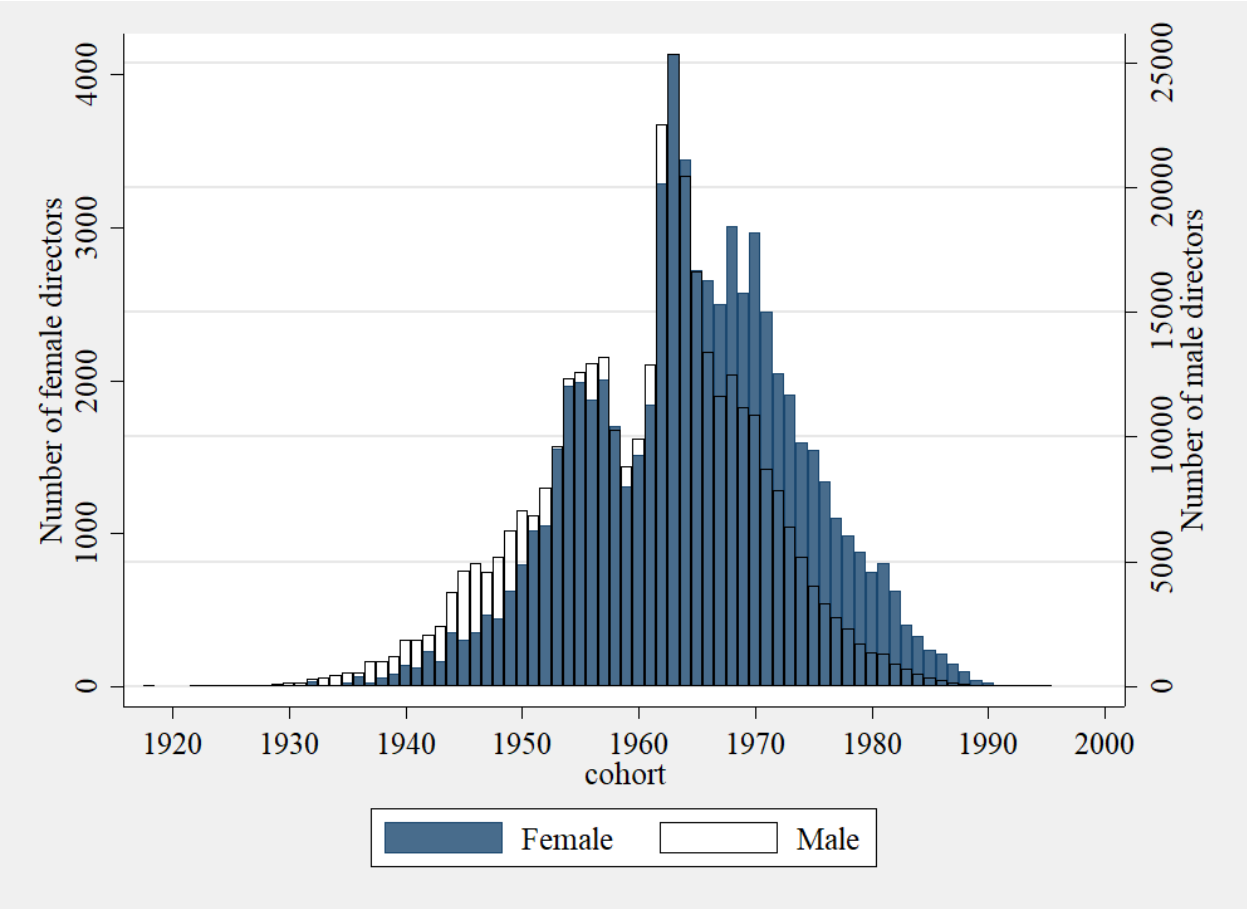

Fig. 3. **The time pattern of female ratio in board**

This figure plots the time pattern of female ratio in board from 1999 to 2015. The solid line is the female ratio, while the other dashed lines are the different components in female ratio, including executive, independent and supervisory board.

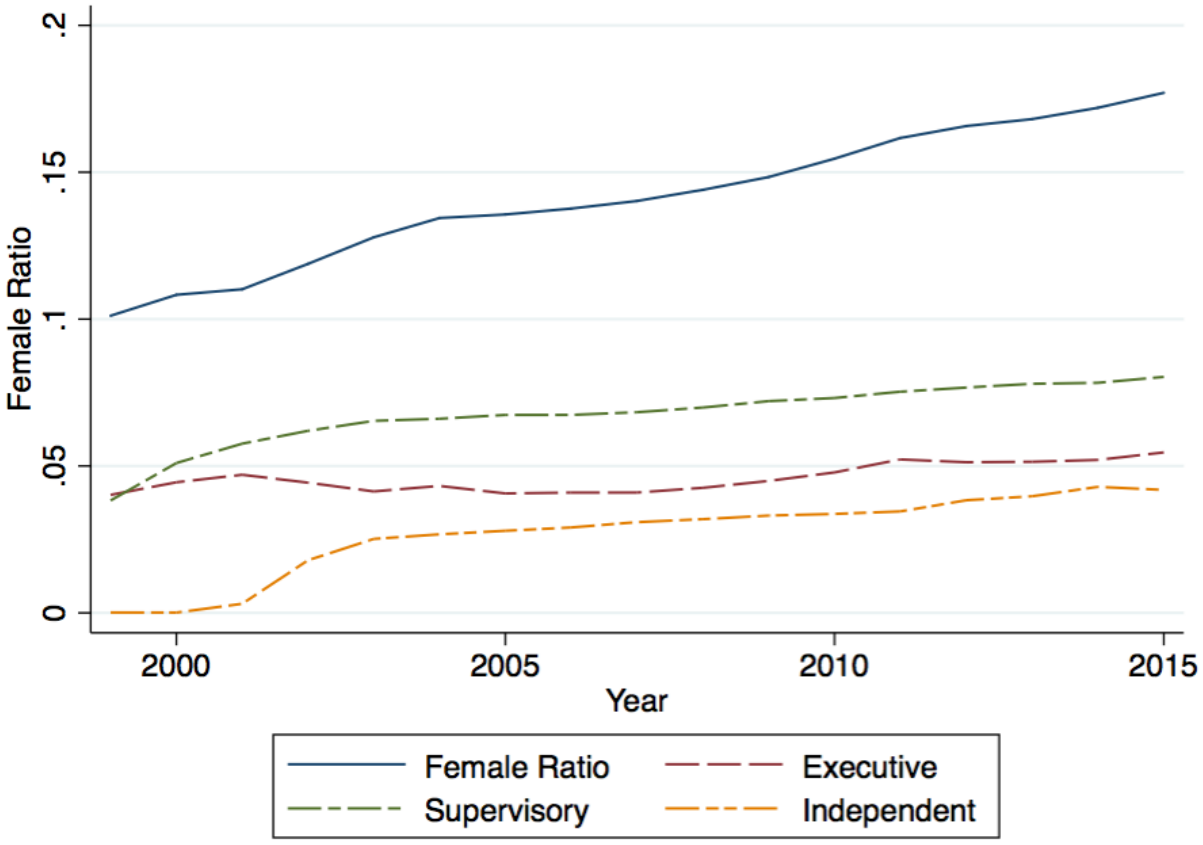

Fig. 4. **Difference between board female and male ratio**

This figure plots the difference between the board female and male ratio for each cohort and year. Y-axis denotes the time period 1999-2015, and x-axis denotes 6 cohorts of which the interval is five years and ranges from 1944 to 1973. The first cohort 1 are directors born between 1944 and 1948, and so on so forth. Hence, the cohort 4 represents those born between 1959 and 1963, who were affected by the resumption of national exams. The value of each color block represents the difference in percentage of female and male directors over all directors in year t.

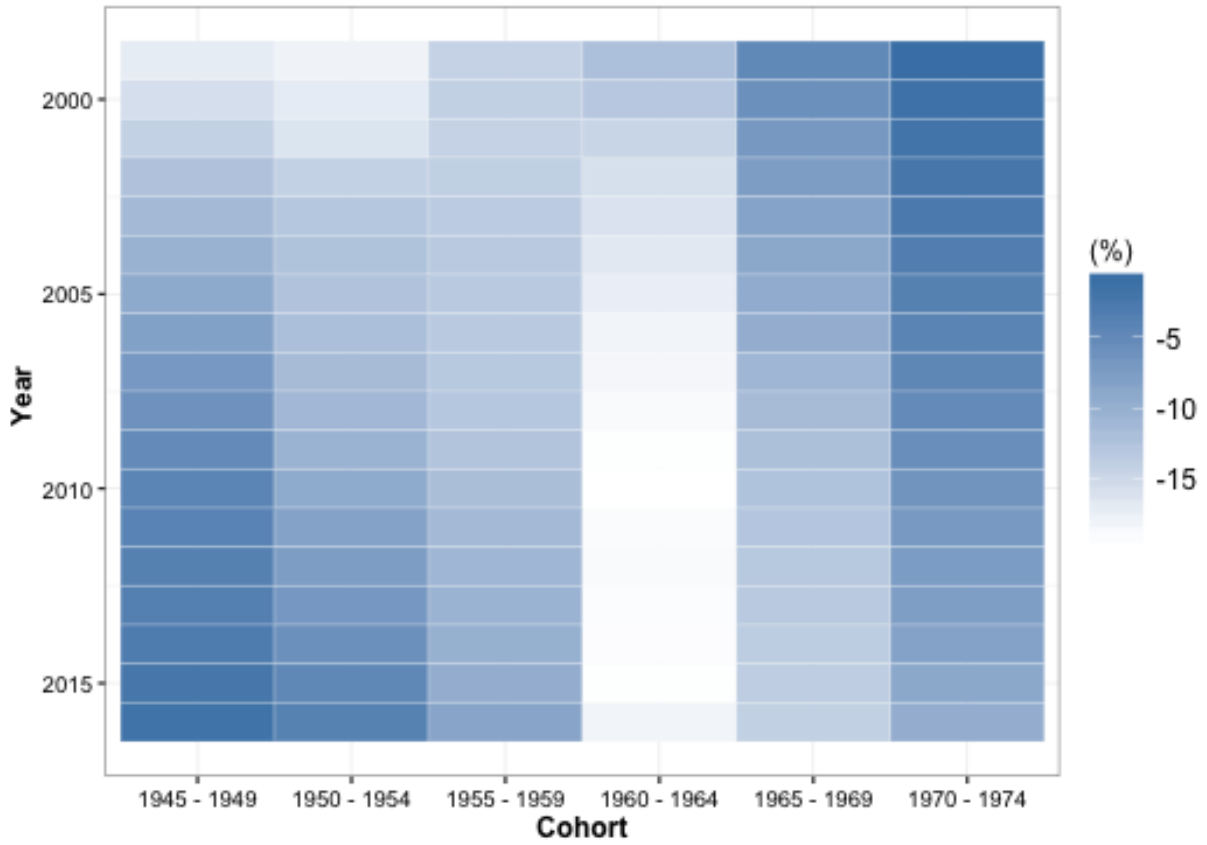

Fig. 5. **Average bachelor graduation age**

This figure plots the average bachelor graduation age by cohort groups and gender. Y-axis denotes the average bachelor graduation age, and x-axis denotes 6 cohorts of which the interval is five years and ranges from 1944 to 1973. The first cohort 1 are directors born between 1944 and 1948, and so on so forth. Hence, the cohort 2 represents those born between 1949 and 1953, whose higher education was disrupted by the *Cultural Revolution* but had chance to take the *Gaokao* in 1977, 1978 and 1979. The cohort 4 represents those born between 1959 and 1963, who were affected by the resumption of national exams. The dotted and dashed lines show the number of directors with bachelor information. In general, fewer of the older cohorts have this information in their resumes.

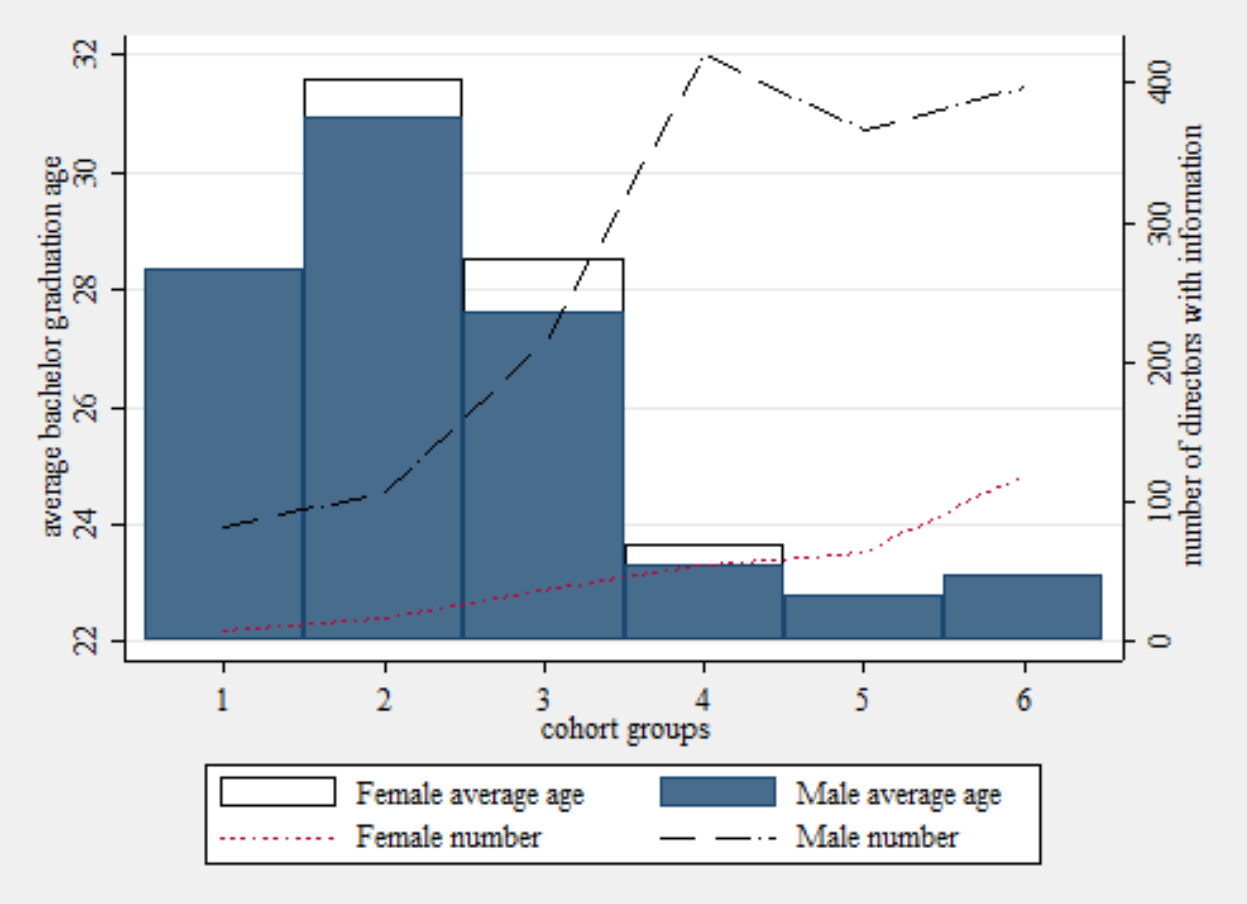

Table 1: **Summary statistics**

The sample includes public Chinese firms listed on the Shanghai or Shenzhen stock exchanges over 1999 to 2015. Panel A table reports summary statistics for the variables used in the analysis. Panel B lists the number of firms and female ratio in each industry.

Panel A:

Variables	N	Mean	Std	Min	Median	Max
ROA	26,273	0.0345	0.0641	-0.491	0.0359	0.271
ROE	25,951	0.0598	0.176	-2.143	0.0690	1.416
ROS	25,913	0.0592	0.242	-3.315	0.0623	1.323
EBIDTA Ratio	22,766	0.0793	0.0656	-0.341	0.0764	0.369
Female Ratio	26,421	0.153	0.120	0	0.143	0.600
Executive female ratio	26,412	0.0477	0.0656	0	0	0.364
Independent female ratio	26,428	0.0712	0.0748	0	0.0714	0.375
Supervisory female ratio	26,416	0.0310	0.0474	0	0	0.214
One female director	26,540	0.266	0.442	0	0	1
Two female directors	26,540	0.233	0.423	0	0	1
Three female directors	26,540	0.158	0.365	0	0	1
More than three female directors	26,540	0.161	0.368	0	0	1
Control variables						
Assets (RMB 100 millions)	26,276	57.3	140.4	1.042	19.77	1897
Board Size	26,423	12.81	4.232	1	12	30
State Ratio	26,408	0.157	0.230	0	0	0.759
Domestic Legal Ratio	26,434	0.114	0.190	0	0	0.750
Firm Age	26,540	8.096	6.129	0	7	31
Sale Growth	23,578	0.211	0.624	-0.844	0.121	10.07
Leverage	26,271	0.462	0.235	0.0341	0.455	2.685
Young IPO Firm	26,540	0.292	0.455	0	0	1
Tenure	26,087	3.768	1.822	1	3.647	9.571

Panel B:

Industry	Number of firms	Percentage (%)	Female Ratio
Agriculture, forestry and fishing	43	1.62	0.17
Mining and quarrying	70	2.64	0.09
Manufacturing	1731	65.22	0.16
Construction	78	2.94	0.14
Wholesale and retail trade	148	5.58	0.21
Transportation and storage	87	3.28	0.14
Accommodation and food service activities	9	0.34	0.21
Information and communication	190	7.16	0.18
Real estate activities	125	4.71	0.15
Renting and Commercial service	39	1.47	0.21
Professional, scientific and technical activities	24	0.90	0.17
Water resources and environment	34	1.28	0.15
Education	3	0.11	0.23
Health and social work activities	8	0.30	0.21
Arts, entertainment and recreation	41	1.54	0.17
Others	24	0.90	0.17

Table 2: **OLS results of female ratio on firm performance**

This table reports the effect of female ratio in top managers on firm performance. The sample includes public Chinese firms listed on the Shanghai or Shenzhen stock exchanges over 1999 to 2015. The dependent variable is ROA, and the independent variable is defined as the number of female in board over the number in total top managers. All other variables are defined in the appendix. Column (2) adds firm fixed effect. Standard errors are clustered at firm level and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	ROA		ROE	ROS
	(1)	(2)	(3)	(4)
Female Ratio	0.019***	0.021***	0.049**	0.086***
	(0.005)	(0.007)	(0.024)	(0.029)
ln(Board Size)	0.004*	0.006**	0.012	0.033**
	(0.002)	(0.003)	(0.008)	(0.013)
State Ratio	-0.006*	0.005	0.033***	0.016
	(0.003)	(0.004)	(0.012)	(0.013)
Domestic Legal Ratio	0.003	0.009**	0.041***	0.020
	(0.004)	(0.004)	(0.012)	(0.015)
ln(Assets)	0.013***	0.010***	0.016***	0.046***
	(0.001)	(0.001)	(0.005)	(0.007)
Sale Growth	0.018***	0.016***	0.040***	0.048***
	(0.001)	(0.001)	(0.003)	(0.004)
Leverage	-0.127***	-0.137***	-0.100***	-0.429***
	(0.004)	(0.007)	(0.026)	(0.031)
ln(Firm Age)	-0.005***	-0.005**	-0.004	-0.031***
	(0.001)	(0.002)	(0.007)	(0.010)
Young IPO Firm	0.006***	0.002	0.011***	-0.003
	(0.001)	(0.001)	(0.004)	(0.006)
Tenure	0.002***	-0.001*	-0.004**	-0.004
	(0.001)	(0.001)	(0.002)	(0.002)
Year fixed effect	✓	✓	✓	✓
Firm fixed effect		✓	✓	✓
Observations	22,282	22,172	22,101	22,188
R-squared	0.259	0.469	0.207	0.340

Table 3: **2SLS results of gender diversity on firm performance**

This table reports the first (Panel B) and second stage (Panel A) regression results from a 2SLS regression of female ratio on firm performance. The sample includes public Chinese firms listed on the Shanghai or Shenzhen stock exchanges over 1999 to 2015. The dependent variable is firm performance ROA in column (1)-(3), ROE in column (4), and ROS in column (5). The endogenous variable Female Ratio is defined as the number of female in board over the total number of top managers. The exogenous instrumental variable is the difference in difference between female and male ratio that are borned between [1959,1963] and [1949,1953]. In all specifications, control variables, firm and year fixed effects are added. Industry × year fixed effect is added in column (2) and province × year fixed effect is added in column (3). Standard errors are clustered at firm level and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

Panel A: Second stage					
	ROA			ROE	ROS
	(1)	(2)	(3)	(4)	(5)
Female Ratio	0.250***	0.151***	0.169***	0.347*	0.521***
	(0.062)	(0.054)	(0.054)	(0.179)	(0.190)
ln(Board Size)	0.002	0.004	0.002	0.002	0.022*
	(0.003)	(0.003)	(0.003)	(0.009)	(0.013)
State Ratio	0.003	0.002	0.002	0.023*	0.008
	(0.004)	(0.004)	(0.004)	(0.013)	(0.013)
Domestic Legal Ratio	0.010**	0.012***	0.012***	0.051***	0.028*
	(0.004)	(0.004)	(0.004)	(0.013)	(0.015)
ln(Assets)	0.010***	0.010***	0.010***	0.016***	0.047***
	(0.002)	(0.001)	(0.001)	(0.005)	(0.007)
Sale Growth	0.016***	0.015***	0.015***	0.037***	0.043***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.004)
Leverage	-0.138***	-0.134***	-0.136***	-0.096***	-0.420***
	(0.007)	(0.007)	(0.006)	(0.026)	(0.030)
ln(Firm Age)	-0.005**	-0.003	-0.004	-0.002	-0.029***
	(0.003)	(0.003)	(0.003)	(0.008)	(0.010)
Young IPO Firm	0.002	0.003**	0.003**	0.015***	0.001
	(0.001)	(0.001)	(0.001)	(0.004)	(0.006)
Tenure	-0.000	-0.001	-0.001	-0.003	-0.003
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Year fixed effect	✓				
Firm fixed effect	✓	✓	✓	✓	✓
Year × Industry fixed effect		✓	✓	✓	✓
Year × Province fixed effect			✓	✓	✓
Observations	22,172	22,092	22,092	22,017	22,103
Panel B: First stage					
	Female Ratio				
DiD_IV	0.005***	0.005***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
F	76.28	81.30	82.42	82.32	81.26
Observations	22,172	22,092	22,092	22,017	22,103
R-squared	0.680	0.703	0.712	0.712	0.712

Table 4: **Robustness checks**

This table reports the second stage regression results of robustness checks. The sample includes public Chinese firms listed on the Shanghai or Shenzhen stock exchanges over 1999 to 2015. In column (1)-(2), we use an alternative definition for firm performance, namely, EBIDTA ROA ratio. In column (3)-(4), we use an alternative definition for female ratio that is based only on board but exclude supervisory board. In column (5)-(6), we adopt the instrument variable suggested in Adams and Ferreira (2009) to do the analysis. The dependent variable is ROA. The instrumental variable is constructed using the share of males sit on other boards that contain female directors. In all specifications, control variables, firm and year fixed effects are added. Industry × year and province × year fixed effect is added in column (2), (4), (6). Standard errors are clustered at firm level and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	EBIDTA ratio		Board		Network	
	(1)	(2)	(3)	(4)	(5)	(6)
Female Ratio	0.231***	0.160***	0.450***	0.357***	0.063*	0.082**
	(0.064)	(0.059)	(0.146)	(0.131)	(0.033)	(0.034)
ln(Board Size)	0.004	0.004	-0.002	-0.001	0.003	0.002
	(0.003)	(0.003)	(0.005)	(0.004)	(0.003)	(0.003)
State Ratio	0.006	0.005	0.002	0.000	0.005	0.004
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Domestic Legal Ratio	0.011**	0.010**	0.012**	0.014***	0.009**	0.010**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
ln(Assets)	0.001	0.001	0.011***	0.011***	0.010***	0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Sale Growth	0.016***	0.015***	0.016***	0.015***	0.016***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Leverage	-0.101***	-0.100***	-0.137***	-0.136***	-0.137***	-0.139***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
ln(Firm Age)	0.007**	0.007**	-0.005	-0.005	-0.005**	-0.005**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
Young IPO Firm	0.000	0.001	0.003*	0.004**	0.002	0.003**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Tenure	-0.000	-0.001	0.000	-0.000	-0.001*	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Year fixed effect	✓		✓		✓	
Firm fixed effect	✓	✓	✓	✓	✓	✓
Year × Industry fixed effect		✓		✓		✓
Year × Province fixed effect		✓		✓		✓
Observations	19,554	19,429	21,964	21,884	22,147	22,141
F	79.11	81.58	21.44	20.14	219.6	210.9

Table 5: **Robustness checks with IV constructed by alternative cohorts**

This table reports the second stage regression results of robustness checks. The sample includes public Chinese firms listed on the Shanghai or Shenzhen stock exchanges over 1999 to 2015. The endogenous variable Female Ratio is defined as the number of female in board over the total number of top managers. The exogenous instrumental variable is the difference in difference between female and male ratio that are borned between [1959,1963] and [1954,1958]. In all specifications, control variables, firm and year fixed effects are added. Industry × year and province × year fixed effect is added in column (2), (4), (6) and (8). Standard errors are clustered at firm level and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	ROA		ROE		ROS		EBIDTA ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female Ratio	0.450***	0.357***	0.715*	0.387	1.321***	1.038**	0.413***	0.325**
	(0.146)	(0.131)	(0.384)	(0.346)	(0.492)	(0.454)	(0.158)	(0.140)
ln(Board Size)	-0.002	-0.001	-0.001	0.002	0.010	0.012	0.003	0.003
	(0.005)	(0.004)	(0.012)	(0.011)	(0.017)	(0.015)	(0.004)	(0.003)
State Ratio	0.002	0.000	0.027**	0.023*	0.006	0.005	0.006	0.004
	(0.005)	(0.005)	(0.013)	(0.013)	(0.017)	(0.016)	(0.006)	(0.005)
Domestic Legal Ratio	0.012**	0.014***	0.049***	0.053***	0.031*	0.033**	0.013**	0.012**
	(0.005)	(0.005)	(0.013)	(0.013)	(0.018)	(0.016)	(0.005)	(0.005)
ln(Assets)	0.011***	0.011***	0.018***	0.016***	0.049***	0.049***	0.002	0.002
	(0.002)	(0.002)	(0.005)	(0.005)	(0.007)	(0.007)	(0.002)	(0.002)
Sale Growth	0.016***	0.015***	0.040***	0.036***	0.048***	0.043***	0.016***	0.015***
	(0.001)	(0.001)	(0.003)	(0.003)	(0.004)	(0.004)	(0.001)	(0.001)
Leverage	-0.137***	-0.136***	-0.099***	-0.092***	-0.434***	-0.423***	-0.101***	-0.100***
	(0.007)	(0.007)	(0.026)	(0.026)	(0.032)	(0.031)	(0.008)	(0.008)
ln(Firm Age)	-0.005	-0.005	-0.003	-0.001	-0.032***	-0.030***	0.006*	0.006*
	(0.003)	(0.003)	(0.008)	(0.008)	(0.012)	(0.011)	(0.004)	(0.004)
Young IPO Firm	0.003*	0.004**	0.012***	0.016***	-0.001	0.002	0.001	0.001
	(0.002)	(0.002)	(0.004)	(0.004)	(0.006)	(0.006)	(0.002)	(0.002)
Tenure	0.000	-0.000	-0.002	-0.003	-0.000	-0.001	0.000	-0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)
Year fixed effect	✓		✓		✓		✓	
Firm fixed effect	✓	✓	✓	✓	✓	✓	✓	✓
Year × Industry fixed effect		✓		✓		✓		✓
Year × Province fixed effect		✓		✓		✓		✓
Observations	21,964	21,884	21,892	21,808	21,980	21,895	19,370	19,245
F	21.44	20.14	21.67	20.18	20.98	19.96	19.31	19.45

Table 6: **Testing the critical mass theory**

This table reports the OLS (column 1 and 2) and 2SLS (column 3 and 4) regression results that test the critical mass theory. The sample includes public Chinese firms listed on the Shanghai or Shenzhen stock exchanges over 1999 to 2015. The dependent variable is firm performance ROA. One (or two, three) female director(s) is a dummy taking on the value of 1 if there is only one (or two, three) female diretor(s) in board. The exogenous instrumental variable in column (3)-(4) is the difference in difference between female and male ratio that are borned between [1959,1964] and [1953,1958]. In all specifications, control variables, firm and year fixed effects are added. Industry × year and province × year fixed effect is added in column (4). Standard errors are clustered at firm level and reported in parentheses. *, **, *** mean significance at ten, five, and one percent, respectively.

	OLS		IV	
	(1)	(2)	(3)	(4)
One female director	0.002			
	(0.002)			
Two female directors	0.005**			
	(0.002)			
Three female directors	0.004*			
	(0.002)			
More than two female directors		0.003**	0.095***	0.064***
		(0.001)	(0.027)	(0.022)
Year fixed effect	✓	✓	✓	
Firm fixed effect	✓	✓	✓	✓
Year × Industry fixed effect				✓
Year × Province fixed effect				✓
Observations	22,232	22,232	22,232	22,153
R-squared	0.468	0.468		
F			29.60	30.70

Appendix A. Variable Definition

Variable	Definition
Assets	Total assets of the firm (in RMB 100 millions)
Firm age	The difference between the current year and the IPO year.
Young IPO Firm	A dummy variable equals one if firm age is less than 4
Sale growth	The growth rate of firm sales.
Leverage	The ratio of total debt over total assets.
ROA	Net income over total assets.
ROE	Equity over total assets.
ROS	Sales over total assets.
EBIDTA ratio	The ratio of EBITDA profit over total assets.
State ratio	Percent of shares owned by government or state-owned-enterprise (SOEs).
Domestic legal ratio	Percent of shares owned by domestic legal entity.
Board Size	The number of board members.
Female Ratio	The percentage of female directors in management or supervisory board.
Executive female ratio	The The percentage of female executive directors in management or supervisory board.
Independent female ratio	The percentage of female independent directors in management or supervisory board.
Supervisory female ratio	The percentage of female supervisory directors in management or supervisory board.
One female director	A dummy variable equals 1 if there is one female director in management or supervisory board.
Two female directors	A dummy variable equals 1 if there are two female directors in management or supervisory board.
Three female directors	A dummy variable equals 1 if there are three female directors in management or supervisory board.
More than three female directors	A dummy variable equals 1 if there are more than three female directors in management or supervisory board.

References

Adams, R. B., Ferreira, D., 2009. Women in the boardroom and their impact on governance and performance. Journal of Financial Economics 94, 291–309.

Aggarwal, R. K., Samwick, A. A., 2003. Performance incentives within firms: The effect of managerial responsibility. Journal of Finance 58, 1613–1649.

Ahern, K. R., Dittmar, A. K., 2012. The changing of the boards: The impact on firm valuation of mandated female board representation. Quarterly Journal of Economics 127, 137–197.

Bertrand, M., Schoar, A., Daniel, K., 2003. Managing with style : The effect of managers on firm policies. The Quarterly Journal of Economics 118, 1169–1208.

Chen, Y., Yang, D., 2016. Historical traumas and the roots of political distrust: Political inference from the Great Chinese Famine. Working Paper .

Cox, T. H., Blake, S., 1991. Managing cultural diversity: implications for organizational competitiveness. Academy of Management Executive 5, 45–56.

Croson, R., Gneezy, U., 2009. Gender differences in preferences. Journal of Economic Literature 47, 448–474.

Gong, J., Lu, Y., Xie, H., 2014. Adolescent Environment and Noncognitive Skills. Working Paper .

Jiang, F., Kim, K. A., 2015. Corporate governance in China: A modern perspective. Journal of Corporate Finance 32, 190–216.

Kanter, R. M., 1977. Some effects of proportions on group life: Skewed sex ratios and responses to token women. American Journal of Sociology 82, 965–990.

Li, H., Rosenzweig, M., Zhang, J., 2010. Altruism, favoritism, and guilt in the allocation of family resources: Sophie's choice in Mao's mass senddown movement. Journal of Political Economy .

Liu, Y., Wei, Z., Xie, F., 2014. Do women directors improve firm performance in China? Journal of Corporate Finance 28, 169–184.

Low, D. C., Roberts, H., Whiting, R. H., 2015. Board gender diversity and firm performance: Empirical evidence from Hong Kong, South Korea, Malaysia and Singapore. Pacific Basin Finance Journal 35, 381–401.

Malmendier, U., Tate, G., 2005. CEO overconfidence and corporate investment. Journal of Finance 60, 2661–2700.

Malmendier, U., Tate, G., 2008. Who makes acquisitions? CEO overconfidence and the market's reaction. Journal of Financial Economics 89, 20–43.

Malmendier, U., Tate, G., Yan, J., 2011. Overconfidence and early-life experiences : The effect of managerial traits on corporate financial policies. Journal of Finance 66, 1687–1733.

Matsa, D. A., Miller, A. R., 2013. A female style in corporate leadership? Evidence from quotas. American Economic Journal: Applied Economics 5, 136–169.

Roland, G., Yang, D. Y., 2017. China's lost generation: Changes in beliefs and their intergenerational transmission. Working Paperr .

Smith, N., Smith, V., Verner, M., 2006. Do women in top management affect firm performance?A panel study of 2,500 Danish firms. International Journal of Productivity and Performance Management 55, 569–593.

Terjesen, S., Sealy, R., Singh, V., 2009. Women directors on corporate boards: A review and research agenda. Corporate Governance: An International Review .