CEO Gender Bias in the Formation of Firm-to-Firm Transactions*

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August 23, 2023

Abstract

While female CEOs are under-represented, the barriers they face in the business environment remain poorly understood. This study investigates the influence of gender bias in forming CEOs' business networks. Using transaction data of 1 million Japanese firms, we find that CEOs of the same gender significantly trade more than those of the opposite gender, mostly driven by small- and medium-sized firms in which CEOs presumably have a strong involvement in transactions. As most CEOs are male, such same-gender bias reduces the trading opportunities for females relative to male CEOs. Regarding mechanisms, our survey reveals both the existence of barriers that impede male CEOs from becoming acquainted with female CEOs and the tendency for male CEOs to prefer interacting with male CEOs over female CEOs.

Keywords: Gender; Homophily; CEO; Firm-to-Firm Transactions; TSR data

JEL codes: J16, D22

*We are grateful to Patricia Funk, Taiji Furusawa, Takeo Hoshi, Daiji Kawaguchi, Pinchuan Ong, Jessica Pan, Giovanni Pica, Kazuhiro Teramoto, and seminar participants at AASLE 2022, Keio University, National University of Singapore, Università Cattolica del Sacro Cuore, Università della Svizzera Italiana, Waseda University, Yokohama City University, and ZEW. This research has been conducted under a joint research agreement between the Center for Research and Education in Program Evaluation (CREPE) at the University of Tokyo and Tokyo Shoko Research, LTD (TSR). Izumi acknowledges financial support from the Murata Science Foundation grant and the Research Project Grant of the Policy Research Center at GRIPS. Shigeoka acknowledges financial support from JSPS KAKENHI (23H00828, 22H00057, 22H00847, 22H05009). The authors gratefully acknowledge financial support from ESRI, the Cabinet Office, Government of Japan. The views expressed in this study are those of the authors and do not necessarily reflect the position of the ESRI, the Cabinet Office, or Government of Japan. All errors are ours.

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1 Introduction

Despite the government's efforts to promote gender equality in the labor market, women are still underrepresented in top career positions. For example, recent U.S. data show that only about 21% of all firms are female-led firms (Census Bureau, 2023).[1] The situation in Japan—our setting, is severe, where female CEOs represent, at best, approximately 14% of all firms.[2] Furthermore, female-led firms trail male-led firms in sales, growth, and firm size (Fairlie and Robb, 2009). Since CEOs have a significant influence on firm performance (Bertrand and Schoar, 2003) and female employment (Chiplunkar and Goldberg, 2021), understanding the barriers that female CEOs face in the business environment is crucial not only for to foster equity, but also for economic efficiency (Hsieh et al., 2019).

In this study, we investigate an unexplored channel of female CEOs' disadvantage in business operations: gender bias in the formation of firm-to-firm transactions.[3] While recent literature highlights the importance of business networks on firm performance (Cai and Szeidl, 2018; Asiedu et al., 2023), little is known about how such networks are formed, especially from the perspective of CEO gender. The idea comes from sociological literature suggesting that individuals with similar characteristics (e.g., gender, race, education, and income) tend to establish relationships, ranging from friendships to marriages, known as "homophily" (e.g., Currarini et al., 2009; Eika et al., 2019; Chetty et al., 2022).

We hypothesize that this tendency, in particular on gender, extends beyond individual relationships to interactions between firms, as personal networks of CEOs can lead to establishing firm-level transactions. As most CEOs are male, such gender homophily in transaction networks—if it exists—can reduce the trading opportunities for female CEOs relative to male CEOs, contributing to smaller business networks of female CEOs. Indeed, a preliminary analysis of our transaction data (Figure 1) reveals that female CEOs have smaller networks in terms of the number of suppliers and buyers compared to male CEOs. Additionally, Figure 2 demonstrates a positive relationship between network size and firm performance (measured by log sales per employment or credit score of the firms) for both CEO genders. Considered together, female CEOs' disadvantage in building business networks can be a potential determinant of their lower

[1] Source: https://www.census.gov/library/visualizations/2023/comm/women-owned-employer-businesses.html (accessed Aug 15, 2023)

[2] Authors' calculations from TSR data.

[3] The literature suggests various impediments to the business operation of female CEOs, including childcare responsibilities (Delecourt and Fitzpatrick, 2021), lack of access to funding (Ewens and Townsend, 2020), and lack of business experience (Fairlie and Robb, 2009).

firm performance.

Our study leverages unique annual-frequency panel data of roughly 1 million Japanese firms, which cover approximately 70% of all Japanese firms from 2008 to 2020. The data are obtained from a major credit reporting company in Japan, Tokyo Shoko Research, LTD. (henceforth, TSR). Two important features of the TSR data make this dataset ideal for our study. First, the data contains detailed information on supplier-buyer relationships. TSR data include as many as 38.8 million supplier-buyer links in the period 2008–2020, with roughly 3 million links per year. Second, the data report detailed information about the CEOs characteristics, including gender. Importantly, the data include other key CEO attributes such as age, education, and birth prefecture, allowing us to control other essential homophily variables that could be well correlated with the CEO's gender. To our knowledge, this is the only dataset that contains details on business networks and rich characteristics of CEOs simultaneously.

We document the presence of CEO gender homophily in firm-to-firm transactions—firms run by CEOs of the same gender are more likely to trade with each other compared with CEOs of the opposite gender. We provide such evidence in several steps. First, we consider the firm (either supplier or buyer) as the unit of analysis and compute the share of transactions with female-led firms.[4] We graphically show that the share of transactions with female-led buyers is almost always greater for female-led suppliers than for male-led suppliers *within* the markets where the set of the potential female-led buyers is identical for both female- and male-led suppliers. This so-called *relative* homophily indicates CEOs' same-gender bias in forming firm-to-firm transactions. This pattern is mostly driven by transactions by small and medium-sized enterprises (SMEs, hereafter). Given that CEOs in smaller firms are more likely to engage in transactions among themselves, this result is consistent with the hypothesis that our findings are driven by the personal interactions of CEOs.

Second, we utilize the dyad between suppliers and buyers as the unit of analysis and quantify the precise impact of CEO gender homophily on transacting probabilities, providing us with the gender homophily parameter to conduct counterfactual analysis. Importantly, applying the recent econometric technique in network data, we control supplier and buyer fixed effects (FEs) in a non-linear difference-in-differences approach using network data (Graham, 2017; Charbonneau, 2017; Jochmans, 2018). Consistent with firm-level analysis, We again find that the trading opportunities of the firms run by CEOs of the same gender are significantly higher than those of the firms run by the

[4]We use female CEO firms/suppliers/buyers and female-led firms/suppliers/buyers, interchangeably, same with male CEO firms and male-led firms.

CEOs of the opposite gender. This effect is also driven by SMEs, in particular small-sized firms. In terms of magnitude, the CEOs of small-sized firms are 12.6% more likely to trade with a CEO of the same gender than with that of the opposite gender.

One obvious concern is that the same gender bias we document captures the effect of other homophilic factors that are correlated with gender. For example, since female CEOs tend to have lower levels of education compared with male CEOs, our gender homophily may simply reflect education homophily. Here, the rich information on CEO characteristics in TSR data allows us to construct other homophily variables such as CEOs' education (i.e., both CEOs are from the same school), birthplaces (i.e., both CEOs are from the same prefecture), and ages (i.e., both CEOs are of the same age). Reassuringly, the estimate of gender homophily remains robust even after controlling for these homophily variables, suggesting that the estimate really captures something fundamental about the gender match of the CEOs.

We then conduct a counterfactual analysis to examine the impact of a policy eliminating CEO gender homophily, that is, assuming that firms led by CEOs of different genders engage in transactions at levels comparable to those between CEOs of the same gender. This policy led to an increase of 0.45% in the overall number of transactions as both female- and male-led firms engaged in more transactions with CEOs of the opposite gender. Moreover, it significantly reduced the gender gap in the number of transactions by 6.8% due to the greater impact on female-led firms. In summary, the policy eliminating CEO gender homophily is considered desirable from both *efficiency* and *equity* perspectives.

Finally, we determine the kind of policy that can effectively eliminate CEO gender homophily. While we provide evidence of CEO gender homophily in firm-to-firm transactions, our analysis of supplier-buyer relationship data does not speak to the underlying mechanisms of such observations. In particular, it is crucial to discern whether the relatively low likelihood of transactions between opposite-gender CEOs is primarily driven by either a scarcity of opportunities to become acquainted with CEOs of the opposite gender in the market (homophily in "meetings") or resistance to engage in trade with opposite-gender CEO firms, even when meetings occur (homophily in "preferences"). Distinguishing between these two mechanisms is vital due to their substantially different policy implications. If the former is the primary issue, government initiatives to foster interaction between female and male CEOs could be effective. However, if the latter is also present, the situation is more complex. Simply augmenting the opportunities for mutual encounters may not lead to actual transactions, indicating a need for strategies to address such gender biases.

To this end, we conduct our original survey of CEOs in collaboration with the Cabinet Office of the government of Japan. We distributed the survey in February of 2023 to 25,000 CEOs (12,500 of each male and female CEOs) with a response rate of 25.7% (N= 6,437). We find suggestive evidence that both homophily in "meetings" and "preferences" matter in the formation of transaction networks. As for homophily in "meetings", the estimated probability of becoming acquainted with a female CEO was 19.9% for female respondents but only 5.2% for male respondents, which is less than one-third of that of female respondents.[5] Compared to the actual proportion of female CEOs of 14.4%, female respondents are more likely to get to know other female CEOs than we would expect by random chance (19.9% >14.4%), while male respondents are more likely to get to know other male CEOs than we would expect by random chance (5.2% <14.4%). As for homophily in "preferences", we find that male respondents prefer to interact with male CEOs more than female CEOs, while female respondents have a relatively neutral preference. We further show that the gender homophily in "preferences" explains only a small fraction of gender homophily in "meetings," suggesting the existence of barriers that impede CEOs of opposite-gender from encountering, which cannot be simply explained by preferences.

Our results have several policy implications. As most CEOs are male, the same-gender bias in firm-to-firm transactions that we document leads to fewer trading opportunities for females relative to male CEOs. If gender equality is the policy goal, affirmative action to simply increase the proportion of female CEOs in the market may be supported. However, given the existence of CEO gender homophily, such a policy may reduce the trading opportunities of male CEOs. Therefore, we argue that mitigating the impact of gender homophily is a more desirable approach. Our survey suggests the existence of social barriers that impede CEOs of the opposite gender from the meeting, as well as the relatively strong same-gender preference among male CEOs. Consequently, government support in providing venues promoting female-male CEO interactions and the implementation of policies to alleviate the same-gender preference that target male CEOs are required.

The rest of the paper is organized as follows. Section 2 describes the data, Section 3 presents the analytical framework and the main findings of this study, and Section 4 reports the results of the survey. Section 5 concludes.

Related literature.— This paper is related to several strands of literature. First, it is well documented that CEOs' attributes affect management practices and firm out-

[5]Note that we use the term "respondents" to refer to the CEOs who answered the survey to distinguish from CEOs in general mentioned in the questionnaire.

comes (Bertrand and Schoar, 2003). In particular, the consequence of having female leaders in firms, including performance, are studied in, for example, Wolfers (2006), Adams and Ferreira (2009), Fairlie and Robb (2009), Bertrand et al. (2019), Flabbi et al. (2019), Chiplunkar and Goldberg (2021), and Delecourt and Fitzpatrick (2021). Our study contributes to the literature by examining the impact of CEO gender on interfirm relationships, which are closely tied to firm performance.

Second, we contribute to the growing literature on the influence of gender bias ("homophily") in economic relationships formation. Regarding choices made by non-specialists, gender homophily is documented in the patient's choices of doctors (Cabral and Dillender, 2021), and students' choices of mentors (Gallen and Wasserman, 2022). Recent literature suggests that this gender bias extends to the choices made by specialists, such as doctors' referral patterns to specialists (Zeltzer, 2020) and investors' lending decisions to entrepreneurs (Ewens and Townsend, 2020). The formation of the supplier-buyer relationship, which is examined in this study, is arguably more general as transactions occur in any business setting across the globe.

More broadly, our study is related to bias in economic transactions, in particular, the role of cultural proximity in forming economic relationships. Guiso et al. (2009) documents that commonalities in religion and ethnic origin are positively associated with trade flows between countries. Fisman et al. (2017) shows that cultural proximity between lenders and borrowers increases the quantity of credit and reduces default in India.

Finally, our study is related to the recent literature, which investigates the impact of business networks on firm performance (Cai and Szeidl, 2018; Bernard et al., 2019; Carvalho et al., 2021; Alfaro-Ureña et al., 2022; Asiedu et al., 2023). This study complements the literature by using unique transaction data to demonstrate how such a business network is endogenously formed. While some studies also examine the determinants of business networks (e.g., Bernard and Moxnes, 2018; Miyauchi, 2018; Demir et al., 2021; Panigrahi, 2021; Cevallos Fujiy et al., 2022; Arkolakis et al., 2023), to the best of our knowledge, our study is the first to specifically incorporate the role of CEO gender in transaction network formation.

2 Data

The TSR data are an annual-frequency panel of approximately 1 million Japanese firms, covering approximately 70% of all Japanese firms from 2008 to 2020.[6] In addition to the basic firm-level characteristics such as employment, sales, firm size, credit score, and geographic location, two features of the TSR data make this dataset ideal for our study.

First, the data contains detailed information on the supplier-buyer relationships. TSR's field surveyors request each firm to report up to 24 main suppliers and buyers each year. To deal with the censoring at 24, we construct a firm's transaction network by exploiting reverse reporting.[7] There are 38.8 million supplier-buyer links from 2008 to 2020, with an average of approximately 3 million links per year. Second, the data report detailed information about the characteristics of the CEOs, including gender, name, age, education, and birth prefecture, among others. This enables us to examine the existence of CEO gender homophily in firm-to-firm transactions, controlling for the homophily in other CEO characteristics. Notably, if we include transactions between firms with the same CEO in the sample, it mechanically creates an upward bias in the estimate of gender homophily. Therefore, in the following analysis, we exclude supplier-buyer links between firms with the same CEO.

However, the supplier-buyer linkage data present two significant limitations. First, no price, volume, or commodity information is included. This precludes us from examining the intensive margins of the firm-to-firm transactions. Second, the linkage data do not include firms not surveyed in the TSR data nor final consumers, implying that a firm does not have any transaction partners if all of its partners are outside of the TSR data or if its partners are final consumers. This implies that we exclusively focus on business-to-business (B-to-B) transactions, excluding business-to-consumer (B-to-C) transactions.

2.1 Descriptive statistics

Table 1 provides the summary statistics of selected characteristics for firms (Panel A) and CEOs (Panel B), separately by the CEO gender. The sample is limited to firms whose CEO gender, sales, number of employees, firm age, and credit score were non-missing in the database. We pool all data across years from 2008 to 2020. Consistent with the previous literature, Panel A shows that female-led firms (in Column (1)) lag

[6] This dataset is also used in previous studies, including Miyauchi (2018), Bernard et al. (2019), and Carvalho et al. (2021).

[7] Specifically, we consider firm A to be a supplier of firm B if either (i) A reports B as a buyer or (ii) B reports A as a supplier. Previous studies using the TSR data also construct the transaction network in this way (Miyauchi, 2018; Bernard et al., 2019; Carvalho et al., 2021).

behind male-led firms (in Column (2)) in sales, firm size measured by the number of full-time employees, firm age, a fraction of firms listed, and credit scores. Noteworthy, for our study, female-led firms have fewer trading partners for both suppliers and buyers than male-led firms. The average number of suppliers (buyers) for female-led firms is 2.5 (2.3), while that for male-led firms is 4.6 (4.6), and the differences between female-led and male-led firms, as shown in Column (3), are statistically significant at the 1% level. Moreover, recall that Figure 1 shows that the cumulative distribution function in the number of suppliers and buyers for female CEOs is first order stochastically dominated by that of male CEOs. Panel B of Table 1 reports that female CEOs are, on average, older than male CEOs.[8] We also find that female CEOs are less educated than male CEOs, consistent with the literature (Blau and Kahn, 2017).

In this study, we examine the quantity (or number) of business ties but do not delve much into the "quality" of the ties. Even if the female CEOs have smaller business networks, it is possible that the quality of the networks for female CEOs can be higher as they are more careful in choosing business partners. To shed light on the quality of the transactions, we examine the difference in the characteristics of firms that are "connected" with female- and male-led firms. Table 2 provides the summary statistics of buyers by the gender of CEO suppliers to examine this possibility.[9] Thanks to the large sample size, most of the differences in the buyer characteristics between female- and male-led suppliers are statistically significant, but the magnitude of the difference is mostly negligible, as shown in Column (3) as % change from the mean of male-led suppliers (except for a few variables that already take the log difference). In particular, the log(sales/employment), which can be viewed as a proxy for productivity, is very similar, and the difference is not statistically significant at the conventional level despite the large sample size. One obvious exception is log(distance) where the buyers are 18% closer, on average, for female-led suppliers than for male-led suppliers, possibly reflecting the type of industry that female-led suppliers enter (e.g., service industry) or lower mobility of female-led suppliers due to household chores (e.g., Le Barbanchon et al., 2021). Another clear difference is the fraction of female CEO buyers (the last row of the table), which is 3.8% for female-led suppliers and only 2.8% for male-led suppliers.

Overall, while we note that this evidence is, at best suggestive, the difference in the

[8]This may reflect that women have a longer life expectancy than men and often take over businesses after the death of their male spouses in Japan. Indeed, in our survey, we find that paths to becoming CEOs differ across CEOs gender, as shown in Figure A1. Notably, female CEOs exhibit a greater tendency to inherit the position from a previous CEO within their family compared to their male counterparts.

[9]Conversely, Appendix Table A1 presents the summary statistics of suppliers by the gender of CEO buyers. We do not find much difference in the quality of business by CEO gender either.

quality of business ties between male-led and female-led firms does not seem large, at least by the observable characteristics in our data.

As CEO gender is rarely observed in transaction data, providing more descriptive statistics of firms by the gender of CEOs is useful. Appendix Table A2 shows the distribution of female- and male-led firms across the industry at a 1-digit level. Interestingly, the composition of the industry does not markedly differ across female and male CEOs. The three leading industries are construction, wholesale and retail trade, and manufacturing for both genders. While we define the market at the finer level (2-digit industry level) than this, the marginal difference in the industry composition between female- and male-led firms mitigates some concerns that female and male CEOs enter different markets, and hence, the gender homophily we document below simply reflects the selection or sorting of female and male CEOs into different markets or selling different types of commodities.

3 Empirical analysis

3.1 Preliminary evidence

Before presenting the analysis, we provide two preliminary pieces of evidence that are consistent with gender homophily. Table 3(a) exhibits gender homophily from the supplier's perspective. Female-led suppliers trade 3.9% with female-led buyers, compared with male-led suppliers, who trade 3.0% with female-led buyers. While the difference of 0.9 percentage points may look small at a glance, this is quite large given that only 6.0% of buyers are female CEOs. Notably, this number (6.0%) is smaller than the overall share of female CEOs (14.4%) in the entire market, since as discussed earlier, we exclusively focus on B-to-B transactions.[10] Similarly, Table 3(b) presents the buyer's perspective, indicating parallel evidence of gender homophily. Female(male)-led buyers trade 3.7(2.8)% with female-led suppliers. Again, the difference of 0.9 percentage points is quite large given that only 5.4% of suppliers are female CEOs. In sum, from both perspectives, female-led firms are *relatively* more likely to trade with firms led by female CEOs than by male CEOs. Conversely, this exactly means that male-led firms are relatively more likely to trade with male-led firms than with female-led firms.

[10] Appendix Table A3 shows the fraction of female CEOs, overall and by the firm size in our working data. The table shows that female CEOs represent 5.7% of all firms, while 94.3% are male CEOs. Since the firm size of the female CEOs tends to be smaller than that of male CEOs, as shown in Table 1, the fraction of female CEOs is only 3.4% among large firms. This share increases as the firm size reduces; although for small-sized firms, female CEOs make up only 6.2%. See Appendix Table A4 for the official definition of the firm-size categories in Japan.

Figure 3 provides additional evidence of gender homophily. The figure illustrates the share of female-led buyers by the total number of buyers, separately, for female- and male-led suppliers. Keeping the number of buyers constant to account for a larger network size of male-led suppliers than female-led suppliers, the share of female-led buyers among total buyers is *uniformly* larger for female-led suppliers than for male-led suppliers. In the following, we provide more formal evidence of CEO gender homophily.

3.2 Analytical framework

Let K be the set of market segments defined by two-digit ($\approx$100) industry pairs of suppliers and buyers, and let k denote an index of an arbitrary market segment in K. Since some industry pairs have no transactions, there are approximately 5,000 markets per year. We indicate alternative definitions of markets in the Appendix B.

Define the set S^k of suppliers in market k as the set of firms trading at least once as a supplier in the market in the year. Then,

$$S^k = S^k_f \cup S^k_m,$$

where S^k_g is the set of suppliers in market k with CEO gender $g \in \{f, m\}$ where f and m represent female and male, respectively. Similarly, we define the set B^k of buyers and

$$B^k = B^k_F \cup B^k_M,$$

where we denote the buyers' gender with capital letters for distinction from the suppliers' gender.

Consider a network of suppliers and buyers in a given market k, where a link exists between supplier $i \in S^k$ and buyers $j \in B^k$ if one of the firms lists the other firm as a supplier or buyer. We model that the link formation between firms is generated by the following model:

$$Y_{ij} = \mathbb{I}\{\beta_h \times SameGender_{ij} + g(X_i, X_j)'\delta + \alpha^k_i + \gamma^k_j \geq \epsilon_{ij}\}, \tag{1}$$

where Y_{ij} is a dummy variable indicating whether a link exists between supplier i and buyer j. The model states that the link formation depends on $SameGender_{ij}$, indicating that both the CEOs of i and j are of the same gender, a vector of other pair-level observable variables $g(X_i, X_j)$, which is constructed based on firm-specific attributes X_i and X_j, supplier fixed effect α^k_i, buyer fixed effect γ^k_j, and an unobserved idiosyncratic

component ϵ_{ij}. We assume for any i and j the ϵ_{ij} are independent and have a logistic distribution. Notably, in the model, we allow firm fixed effects (α_i^k, γ_j^k) to vary from market to market, but the effects of pair-level variables are assumed to be common across markets. Note that any components additively separable in X_i and X_j will be absorbed by the terms α_i^k and γ_j^k, including any firm-related attributes (e.g., firm size, firm age, and firm culture), as well as CEO-related attributes (e.g., gender, age, education, and risk preference).

If $\beta_h > 0$ is positive, two firms are more likely to trade with each other if they have CEOs of the same gender than CEOs of the opposite gender. In this case, we say that gender homophily in CEO business networks exists.

3.3 Relative homophily in the firm-level analysis

Here, the aim is to provide suggestive evidence of the existence of homophily on CEO gender in the formation of firm-to-firm transactions: $\beta_h > 0$ in Equation (1). The analysis below is based on the following idea. If same-gender CEO bias does not exist, that is, the occurrence of transactions is determined independently of the CEO's gender (i.e., random), the share of transactions with female-led buyers (suppliers) should be the same regardless of the gender of the suppliers (buyers). The unit of analysis below is firm (either supplier or buyer), allowing each firm to enter multiple markets.

To simplify our exposition, we focus on supplier-side analysis; this is similar with the buyer side. Define, for each supplier i in market $k = 1, \cdots, K$, $i \in S^k$,

$$T_{i,F}^k \equiv \frac{\sum_{j \in B_F^k} Y_{ij}}{\sum_{j \in B^k} Y_{ij}}, \tag{2}$$

and for each supplier's gender $g \in \{f, m\}$,

$$T_{g,F}^k \equiv \frac{1}{|S_g^k|} \sum_{i \in S_g^k} T_{i,F}^k, \tag{3}$$

where $|S_g^k|$ denotes the number of suppliers in S_g^k. In other words, $T_{i,F}^k$ is the share of female-led buyers among all the buyers who transact with supplier i in market k, and

$T^k_{g,F}$ is the average of $T^k_{i,F}$ of suppliers whose CEO gender is $g \in \{f, m\}$.[11]

We denote the market proportion of female buyers by $\lambda^k_F \equiv |B^k_F|/|B^k|$. If transactions between firms are completely random, $T^k_{g,F}$ and λ^k_F should, on average, coincide with each other. Thus, in most sociological literature on homophily, such as Coleman (1958), researchers determine whether CEOs of the same gender are biased to form firm-to-firm transactions if

$$T^k_{f,F} > \lambda^k_F. \tag{4}$$

However, (4) does not properly capture the sign of β_h in Equation (1). This is because female- and male-led buyers may systematically differ regarding firm size and other characteristics that could influence the occurrence of transactions. For example, if female-led buyers are smaller in firm size and thus have less trading capacity, the share of transactions with female-led buyers in the market will be systematically lower than λ^k_F for both $T^k_{f,F}$ and $T^k_{m,F}$.

Therefore, following Zeltzer (2020), rather than examining whether (4) holds, we check whether the following inequality (called *relative* homophily) holds[12]:

$$T^k_{f,F} > T^k_{m,F}. \tag{5}$$

Intuitively, if there is no same-gender CEO bias ($\beta_h = 0$), the share of transactions with female-led buyers by female-led suppliers, $T^k_{f,F}$, should be equal to that of male-led suppliers, $T^k_{m,F}$, as long as the characteristics of the suppliers do not differ by the suppliers CEOs' gender. Importantly, we compare $T^k_{f,F}$ and $T^k_{m,F}$ *within* market k where the market proportion of female-led buyers λ^k_F is identical for both female-led and male-led suppliers. In other words, the number of female-led buyers in the market ("exposure" in Chetty et al. (2022)) that both female- and male-led suppliers can *potentially* transact with is the same. Formally, the following proposition holds.

[11] To give a complete example, suppose there are five suppliers in market k, composed of three male-led suppliers and two female-led suppliers. The first male-led supplier trades with three buyers, one of which is a female-led buyer. Then, $T^k_{i,F}$ for this male-led supplier i is 1/3. This way, $T^k_{i,F}$ is calculated for all five suppliers. Then, we sum $T^k_{i,F}$ for three male-led suppliers and divide it by the number of male suppliers in the market (i.e., $|S^k_m|$= three) to calculate the average, which is $T^k_{m,F}$. Similarly, we sum such values for the two female-led suppliers and divide it by the number of female suppliers (i.e., $|S^k_f|$= two) to calculate the average, which is $T^k_{f,F}$. For each market k, we repeat the same exercise to calculate $T^k_{g,F}$ ($g \in \{f, m\}$).

[12] The concept of relative homophily has been used in other contexts such as Anwar and Fang (2006), Antonovics and Knight (2009), and Zeltzer (2020).

Proposition 1. *Given a market $k \in K$ and suppose the market is sufficiently large, then, if $\lambda_F^k > 0$ and (X_i, α_i^k) are independently distributed among the gender of suppliers CEO, $\beta_h > 0$ if and only if $T_{f,F}^k > T_{m,F}^k$.*

Proof. See Appendix Section F.1.

We first present visual evidence that (5) indeed holds, followed by a more formal regression analysis demonstrating that (5) is valid after flexibly controlling for the supplier's characteristics.

Results.—Figure 4(a) plots the share of female-led buyers in the market, λ_F^k, on the x-axis and the share of transactions between female-led buyers and female- and male-led suppliers in the market, $T_{g,F}^k$ where $g \in \{f, m\}$, on the y-axis. Markets are defined as two-digit industry pairs and years.[13] To make the figure visually comprehensible, we present a binned scatterplot of the same data with fitted linear lines weighted by market size in Figure 4(b). Bins are defined so that the number of observations in each bin is the same.

Figure 4(b) illustrates two important findings, both of which are novel in the literature. First, both fitted lines are below 45° lines, suggesting that although the share of transactions with female-led buyers increases with the market share of female-led buyers, the share of transactions with female-led buyers is, on average, lower than the market share (i.e., the random match or 45° line) for both female- and male-led suppliers. As discussed earlier, this tendency can be interpreted as reflecting the fact that female-led buyers have less trading capacity than male-led buyers due to, for example, their smaller firm size (see Table 1).

Second and more importantly, the fitted line for female-led suppliers is above the line for male-led suppliers across almost all bins. This suggests that the share of transactions with female-led buyers is greater for female-led suppliers than for male-led suppliers ($T_{f,F}^k - T_{m,F}^k > 0$) for almost *any* values on the x-axis, that is, *within* the markets where the set of the potential female-led buyers are identical for both female- and male-led suppliers. This so-called *relative* homophily— essentially the vertical difference in two lines in the figure—indicates CEOs' same-gender bias in forming firm-to-firm transactions.

Next, we describe the regression analysis as Figure 4 does not control for the suppliers' characteristics, but the results are essentially the same after including controls. We

[13] The results are robust to alternative market definitions. See Appendix Figure B1.

estimate the following model:

$$\frac{T_{i,F}^k}{\lambda_F^k} = \beta_{rh} \times female_i + X_i'\delta_r + \alpha^k + u_i^k, \tag{6}$$

where $female_i$ is the dummy variable indicating that the CEO of supplier i is female, X_i is the vector of other observed supplier characteristics, α^k is the market fixed effects, and u_i^k is the idiosyncratic error. Note that we normalize (6) by dividing $T_{i,F}^k$ by λ_F^k. Therefore, we can interpret β_{rh} as a coefficient representing how many percentage points closer female-led suppliers are to a random match relative to male-led suppliers (Chetty et al., 2022). Standard errors are clustered at the firm level across markets.

Table 4 summarizes the results. Column (1) only includes year FE, and Column (2) further adds year × market FEs to ensure that we compare male-led and female-led suppliers *within* the same market, keeping the set of the female-led buyers that male-led and female-led suppliers can potentially transact the same. The estimate of Column (2) on the female CEO dummy indicates that female-led suppliers are 10 percentage points closer to a random match relative to male-led suppliers ($p< 0.01$). To account for the concern of sorting of particular female-led suppliers and buyers into a particular market through gendered goods, Column (3) controls for as finite as four-digit industry FEs, as well as other firm characteristics, including log(employment), firm age, a dummy for being listed, and credit score, as well as the location of the firm (prefecture FE). We are reassured that the estimate on the female CEO dummy is hardly affected. Finally, Column (4) adds a few CEO' characteristics such as age, school, and birth prefecture. This greatly reduces the sample size, but the results remain virtually unchanged.[14]

Heterogeneity by firm-size.—As a firm becomes large, one can expect that the firm's decision-making process is delegated from top management to middle- and lower-level managers. Therefore, if our results are indeed driven by personal interactions between CEOs, we anticipate that the CEO gender homophily would be more pronounced among relatively smaller firms. In fact, Figure 8(a) from our original survey of CEOs, which we describe in detail in Section 4, confirms that the CEOs of smaller firms are much more likely to attend negotiation meetings than those of larger firms. Of CEOs in small-sized (large-sized) firms 48.7% (7.2%) attend all transactions, whereas 17.3% (39.7%) rarely get involved in any transactions.

Figure 5 plots the same share of female-led buyers as Figure 4 but by (a) large-sized (27% of all transactions) and (b) SME (73% of all transactions), defined by firm size by

[14]See Appendix Figure B2, B3 and Appendix Table B1, B2 for the same analyses from buyers' perspectives. We find evidence of relative homophily that is similar in magnitude.

industry, separately.[15] On one hand, Figure 5(a) does not reveal any evidence of gender homophily among large firms. In fact, two lines of female- and male-led suppliers are almost identical to each other. On the other hand, Figure 5(b) shows a clear pattern of gender homophily among SMEs. Figure 6 further divides SMEs into medium- and small-sized firms. While both figures strongly support the evidence of relative gender homophily, it is stronger in small-sized firms than medium-sized firms, consistent with our survey observation that CEOs of smaller firms are more likely to sit at the negotiation tables, and hence CEOs gender is more crucial. Furthermore, a lack of relative gender homophily among CEOs of large firms implies that our results are not driven by a firm culture that can be well correlated with the CEO's gender.

Table 5 reports tests of the above observation in the regressions where we add the interaction of a female CEO dummy and that of large firms. Column (1) shows that the coefficient on the female CEO dummy, which captures the relative gender homophily for SMEs, is 0.126, suggesting that female-led SME suppliers are 12.6 percentage points closer to a random match with female-led buyers relative to male-led SME suppliers ($p< 0.01$). By contrast, the coefficient on the interaction term between the female CEO dummy and the large firm dummy is -0.101, which is almost the same as that of the female CEO dummy with the opposite sign. This indicates that there is no relative gender homophily among large firms. In fact, the p-value for the null hypothesis that gender homophily for large firms is zero is 0.733, indicating that we cannot reject the null hypothesis that there is no gender homophily for large firms. Columns (2)-(5) add the same sequences of covariates as Table 4 but the results are qualitatively unchanged.

3.4 Logit—Dyad Level Analysis

Here, we directly estimate β_h in the logit Equation (1) using the dyadic data of supplier-buyer linkages as the unit of analysis instead of firm-level as a unit. The advantage of this approach over the firm-level analysis in the previous section is that we can directly estimate β_h and quantify the exact impact of CEO gender homophily on transacting probabilities, allowing for counterfactual analysis. However, there are two major challenges in the estimating Equation (1) in our data. First, the estimating Equation (1) requires data on both transacting (we observe) and non-transacting pairs of firms, which we do not observe. If we consider any possible firm pairs that "might" have traded, the

[15] See Appendix Table A4 regarding the definition of large-, medium-, and small-sized firms, which is defined by the number of full-time employers and capital stock in each industry in Japan. As the information on capital stock is not complete in our data, we only use the number of full-time employers to define the firm size.

amount of calculation would explode. With 1 million firms, there are approximately 5 billion potential supplier-buyer pairs ($_{1,000,000}C_2$), which are computationally impossible to estimate.

The second challenge is possibly unobserved fixed effects for both suppliers and buyers: α_i^k and γ_j^k in the logit model (1). In our specific context, it seems essential to control for unobserved heterogeneity related to CEO's gender, as this can introduce omitted variable bias in the estimation of gender homophily. Again, as shown in Table 1, female-led firms tend to trail male-led firms regarding sales, number of employees, firm age, and credit scores. Any unobserved firm characteristics that are correlated with CEO gender might also bias the standard logit estimates.[16] Noteworthy, unobserved heterogeneity can bias logit estimates, even when omitted variables are uncorrelated with the observed variables, as emphasized by Wooldridge (2010). In fact, Graham (2017) highlights that estimates of homophily will be substantially biased if the effects of unobserved fixed effects are not accounted for when estimating the network link formation model.

To overcome these two challenges, we estimate β_h building on the insight proposed by Graham (2017) and Charbonneau (2017). Here, we exploit the unique advantage of the supplier-buyer linkage data where we have multiple observations for the same firm at the same time period, i.e., firm i trades with firm j but not with firm k, and so on.

The following exposition follows Jochmans (2018). Set a market $k \in K$. Let us denote $W_{ij} \equiv (SameGender_{ij}, g(X_i, X_j))'$, $\theta \equiv (\beta_h, \delta)$ and rewrite the model (1) as,

$$Y_{ij} = \mathbb{I}\{W_{ij}'\theta + \alpha_i^k + \gamma_j^k - \epsilon_{ij} \geq 0\},$$

Set a quadruple of distinct firms $\sigma \equiv \{i_1, i_2; j_1, j_2\}$ where $i_1, i_2 \in S^k$ and $j_1, j_2 \in B^k$, and define the random variable

$$Z_\sigma \equiv \frac{(Y_{i_1 j_1} - Y_{i_1 j_2}) - (Y_{i_2 j_1} - Y_{i_2 j_2})}{2},$$

and let $W_\sigma \equiv (W_{i_1 j_1}, W_{i_1 j_2}, W_{i_2 j_1}, W_{i_2 j_2})$. Note that Z_σ can take on values from the set $\{-1, -1/2, 0, 1/2, 1\}$. The estimation is based on the following proposition.

[16] For example, female and male CEOs may have different managing skill due to their different background experience (Kepler et al., 2007; Fairlie and Robb, 2009). Additionally, regarding the CEO characteristics associated with gender, literature in experimental economics suggests that women are less willing to take risks (Eckel and Grossman, 2002), less confident and competitive (Niederle and Vesterlund, 2007), and more reluctant to negotiate (Babcock and Laschever, 2009) than men. Women are also known to have less access to personal and professional networks (Koellinger et al., 2013) and spend less time networking due to household chores (Azmat and Ferrer, 2017).

Proposition 2. *If ϵ_{ij} are independent and identically distributed and follow the standard logistic distribution,*

$$\Pr(Z_\sigma = 1 | R_\sigma, Z_\sigma \in \{-1, 1\}) = \frac{\exp(R'_\sigma \theta)}{1 + \exp(R'_\sigma \theta)},$$

where $R_\sigma \equiv (W_{i_1 j_1} - W_{i_1 j_2}) - (W_{i_2 j_1} - W_{i_2 j_2})$.

Proof. See Charbonneau (2017), Jochmans (2018), or Appendix Section F.2.

The above proposition implies that, by pooling across all the markets, we can estimate θ based on the conditional likelihood above as

$$\arg\max_\theta \sum_{k \in K} \sum_{\sigma \in \Sigma^k} \mathbb{I}\{Z_\sigma = 1\} \log \frac{\exp(R'_\sigma \theta)}{1 + \exp(R'_\sigma \theta)} + \mathbb{I}\{Z_\sigma = -1\} \log \frac{1}{1 + \exp(R'_\sigma \theta)}, \tag{7}$$

where Σ^k is the set of all quadruples in market $k \in K$. Note that the estimation method above is a *within-year* difference-in-difference (DID) strategy that uses specific network variations of the network data (quadruples with $z_\sigma \in \{-1, 1\}$). The variation used in this method is visually shown in Figure 7.[17]

On one hand, suppose that supplier i_1 is trading with buyer j_1 and not with buyer j_2. Here, the buyer changes from j_1 to j_2, and supplier i_1's decision changes from 'trade' to 'do not trade.' There are two main reasons for this change: (i) change in pair-level covariates (i.e., $W_{i_1 j_1} - W_{i_1 j_2}$), and (ii) change in the fixed effect between buyer j_1 and buyer j_2 (i.e., $\gamma^k_{j_1} - \gamma^k_{j_2}$). On the other hand, let us assume that supplier i_2 is not trading with buyer j_1, but is trading with buyer j_2. In this case, the buyer has changed from j_1 to j_2, and supplier i_2's decision has changed from 'do not trade' to 'trade.' As aforementioned, there are two possible factors for this change in decision-making: (i) change in pair-level covariates (i.e., $W_{i_2 j_1} - W_{i_2 j_2}$), and (ii) change in the fixed effect of buyers j_1 and j_2 (i.e., $\gamma^k_{j_1} - \gamma^k_{j_2}$). However, for the latter (ii), suppliers i_1 and i_2 face the same sequence of buyers (j_1 and j_2). Therefore, the *difference* in the change in

[17] A typical DID utilizes the data structure where multiple observations are available for a single unit across multiple time periods ("panel" in time). In our context, this means observing firms over multiple time periods and utilizing *changes* in the gender of CEOs within the same firm *over time*. We are hesitant to use such a variation since paths to becoming CEOs differ across CEOs gender, making it likely to be endogenous (see Figure A1). Thus, we utilize a "panel" structure driven by the network data *within-year*. Namely, firm-to-firm transaction data have *multiple* observations for the same firm at the same time period, i.e., firm i_1 trades with firm j_1 but not with firm j_2, and so on. Utilizing these across pair variations allows us to control for all fixed effects in the same time period for a single firm.

decision-making between suppliers i_1 and i_2 is

$$Z_{\sigma\{i_1,i_2;j_1,j_2\}} = \frac{(Y_{i_1j_1} - Y_{i_1j_2}) - (Y_{i_2j_1} - Y_{i_2j_2})}{2}, \tag{8}$$

and can be attributed as being brought by the difference in the change in pair-level variables:

$$R_{\sigma\{i_1,i_2;j_1,j_2\}} = (W_{i_1j_1} - W_{i_1j_2}) - (W_{i_2j_1} - W_{i_2j_2}), \tag{9}$$

netting out supplier and buyer FEs.[18]

A practical issue for implementing the above estimation method is, again, the computation. If we consider all quadruples in our data, it would be of order 10^{28} quadruples, which is impossible to estimate. To eliminate this issue, we perform the estimation by randomly generating 5,624,536 quadruples with $z_\sigma \in \{-1, 1\}$. Specifically, given trading pairs i and j of an industry pair $Industry_i \times Industry_j$ (i.e., market) in a given year t, we randomly sampled trading pairs i' and j' from the same industry pair $Industry_i \times Industry_j$ and the year t that did not trade with either i or j. See Appendix C for details of the sampling procedure.

Results.—Table 6 shows the estimation results of Equation (1). Due to computational limitations, we report the estimates using only 2019 data here. Column (1) shows that the estimate on same-gender CEO dummy is 0.055 ($p< 0.01$), which indicates that the probability of the transactions is 5.5% higher among CEOs with the same gender relative to the transactions with the opposite gender. Columns (2)-(4) add the dummy for transactions in which large firms are involved, log(distance) between suppliers and buyers, and their interaction to allow for the effect of distance by the firm size, but the estimates on same-gender CEO dummy are robust.

Table 7 reports the heterogeneity by firm size from estimating the variant of Equation (1), which further includes the interaction of a same-gender CEO dummy with a dummy for the firm-size category. For ease of comparison, Column (1) replicates Column (4) of Table 6. Column (2) adds the interaction of a same-gender CEO dummy and a large-firm dummy. Thus, a same-gender CEO dummy represents the estimate for SMEs, which is 0.102 ($p< 0.01$) and is much larger than that for all firms in Column (1). Furthermore, the estimate of the interaction term is negative, and the magnitude is similar to the one for the same-gender CEO dummy (-0.099), suggesting that there is no gender homophily for large firms. Column (3) adds the same-gender CEO dummy and a dummy for both

[18]It should be noted that the explanation provided here is a general idea of how FEs are controlled using within-year variation in pair-level data and is not limited to the logit model.

large-sized and medium-sized firms. Thus, the same-gender CEO dummy represents the estimate for small-sized firms, which is 0.125 ($p< 0.01$) and is much larger than that for all firms in Column (1) and SMEs in Column (2). This indicates that the probability of the transactions is 12.5% higher among CEOs with the same gender relative to the transactions with the opposite gender among small-sized firms.

Thus far, we report the estimate using only 2019 data. To ensure that the estimates in 2019 are similar to those of other years, Figure 9(a) plots the estimates for all firms, and Figure 9(b) plots the estimates for large-sized and SME over the years. Here, each estimate in each year comes from a separate regression. Reassuringly, the estimates for both overall as well by firm sizes are more or less stable over time.

Controlling for other homophily.—Thus far, we only include the distance of supplier and buyers as $g(X_i, X_j)$, the pair-level covariates, other than $SameGender_{ij}$, in Equation (1). The concern is that the coefficient on the same-gender dummy captures the effect of other homophily that are correlated with gender homophily. For example, the summary statistics in Table 1 show that female CEOs are less educated than male CEOs. Thus, it is possible that gender homophily may capture the effect of homophily through education. To account for this concern, we add a number of other homophily variables—thanks to rich information on CEO characteristics in TSR data—to determine whether the estimate on gender homophily is attenuated.

To ease the comparison, Column (1) of Table 8 replicates the baseline estimate from Column (2) of Table 7. Column (2) adds the pair-level covariates constructed only by firm characteristics, namely, a dummy for both firms to be located in the same prefecture and to be listed, the absolute difference of log(employment), firm age, and credit score between firms. The estimate on the same-gender CEO dummy is hardly affected. Column (3) further adds the pair-level covariates constructed by CEO characteristics, namely, the absolute difference in CEO age, a dummy for both CEOs to be born in the same prefecture, come from the same school, and have the same family name (to capture the transactions within the family). While the homophiles in CEO's characteristics along these dimensions are clearly observed in Column (3), the estimate on the gender homophily between SMEs remains robust at 0.139, which is even larger than the baseline estimate in Column (1). Column (4) further allows other homophily variables to differ by firm size by interacting each homophily variable with a dummy for large firms; however, the main estimate is hardly affected. As the sample size in Columns (3) and (4) is largely reduced by 4/5 from the baseline sample in Column (1), due to the missing CEO attributes, Column (5) reports the baseline estimate as Column (1) with this smaller sample. The estimate on the CEO same-gender CEO dummy is 0.156, which is close

to Columns (3) and (4), suggesting that the larger estimate in Columns (3) and (4) is due to the sample selection. In any case, we are reassured that including all possible homophily variables in our data other than gender hardly attenuates the estimate on the gender homophily, suggesting that the estimate on the same-gender CEO dummy we have documented so far indeed reflects the gender match of CEOs rather than other factors correlated with gender.

3.5 Counterfactual Exercises

Our findings suggest that in the current situation where male CEOs dominate the market, the presence of gender homophily may restrict the trading opportunities for female CEOs compared to their male counterparts. Here, we consider a counterfactual scenario in which we entirely eliminate CEO gender homophily. Under this scenario, we investigate the potential impact on the gender gap in the number of trades between female and male CEOs, as well as the overall number of transactions in the economy. Essentially, our analysis here is a truly reduced form analysis, and some caution is required. For example, our analysis does not consider the impact of eliminating gender homophily on the entry and exit of firms, which could have implications for the gender composition of CEOs and the overall productivity of the economy. These are critical issues that should be addressed in future work.

Let $Q^k_{g,G}$ be the number of transacting pairs in market k with the CEO gender of the suppliers and buyers being $g \in \{f, m\}$ and $G \in \{F, M\}$ as before. Assume that market k is sufficiently large. Then note that,

$$\begin{aligned} Q^k_{g,G} =& |S^k_g||B^k_G| \frac{Q^k_{g,G}}{|S^k_g||B^k_G|} \\ \approx& |S^k_g||B^k_G| \Pr(Y_{ij} = 1 | i \in S^k_g, j \in B^k_G), \end{aligned}$$

where the last approximation follows the assumption that the market size is sufficiently large. To evaluate the impact of eliminating the effect of gender homophily on the probability of transaction occurrence, note that the logit link formation model (1) implies,

$$\begin{aligned} &\Pr(Y_{ij} = 1 | i \in S^k_g, j \in B^k_G) \\ =& E\left[\frac{\exp(\beta_h \times SameGender_{ij} + g(X_i, X_j)'\delta + \alpha^k_i + \gamma^k_j)}{1 + \exp(\beta_h \times SameGender_{ij} + g(X_i, X_j)'\delta + \alpha^k_i + \gamma^k_j)} \middle| i \in S^k_g, j \in B^k_G \right]. \end{aligned}$$

Therefore, we assess the extent to which the above probability of transactions between

CEOs of different genders would be affected when they can enjoy the same merit of β_h as transactions between CEOs of the same gender. The problem here is that in our previous analysis, although we estimated the coefficients β_h and δ for pair-level variables, the unobserved heterogeneity α_i^k and γ_j^k were differenced out during the estimation process, making it impossible to compute predicted probabilities for each pair (i, j) inside the expectation. To address this problem, we proceed by linearly specifying $\alpha_i^k = Z_i'\tilde{\alpha}^k$ and $\gamma_j^k = Z_j'\tilde{\gamma}^k$ using the observed variables Z_i and Z_j. We then estimate $\tilde{\alpha}^k$ and $\tilde{\gamma}^k$ through standard logit estimation, thereby *fixing* the previously estimated values of β_h and δ.[19] For Z_i and Z_j, we include a female CEO dummy, firm age, log of the number of employees, credit score, listed dummy, two-digit industry, and prefecture fixed effects. For more technical details on the procedures, please refer to Appendix D.

Table 9 presents the results of a counterfactual analysis regarding the number of transactions from a supplier's perspective. Firstly, Panel A displays the average number of transactions per supplier with buyers based on actual data.[20] Panel B represents the average number of transactions per supplier with buyers predicted by the estimated model. The discrepancies between the actual and predicted numbers of transactions are all below 3%, indicating that the predicted probabilities of transactions match the actual probabilities pretty well.

Panel C shows the counterfactual results for the number of transactions per supplier with buyers assuming the absence of gender homophily, meaning there was an equal likelihood of transactions occurring between different-gender CEOs and same-gender CEOs. Columns (1) and (2) display the changes in the number of transactions with buyers by each CEO's gender of suppliers. For male CEO suppliers in Column (1), the elimination of gender homophily leads to a 0.03% increase in transactions with buyers compared to the predicted values. However, female CEO suppliers in Column (2) experience a significant increase of 4.91%.

Two important conclusions can be drawn from these findings. First, policies that mitigate the influence of gender homophily increase the number of transactions regardless of the CEO's gender. Column (3) of Panel C reports that eliminating gender homophily increases the number of transactions by 0.45% in the overall economy, which can be regarded as an improvement in *efficiency*. Second, the elimination of gender homophily increases the trading opportunities between female CEOs and male CEOs, resulting in

[19] Note that the purpose here is not to *consistently* estimate the true parameters but to *fit* the model so that the predicted transaction probability approximately matches the observed data.

[20] Using notations above, we calculate $\sum_k (Q_{g,F}^k + Q_{g,M}^k)/|S_g|$ for each suppliers gender $g \in \{m, f\}$ where $|S_g| = |\cup_k S_g^k|$ in Columns (1) and (2), $\sum_k \sum_{g\in\{m,f\}} (Q_{g,F}^k + Q_{g,M}^k)/|S|$ where $|S| = |S_m| + |S_f|$ in Column (3), and $\sum_k (Q_{m,F}^k + Q_{m,M}^k)/|S_m| - \sum_k (Q_{f,F}^k + Q_{f,M}^k)/|S_f|$ in Column (4).

a more significant impact for female CEO firms (as shown in Columns (1) and (2)), especially in markets where majority of CEOs are male. Therefore, it also addresses *equity* concerns as it shrinks the gender difference in the number of transactions between male and female CEOs. Indeed, as reported in Column (4), the gender gap in transaction numbers is substantially reduced by 6.87%.

4 Survey evidence

4.1 Settings

While we provide evidence of CEO gender homophily in firm-to-firm transactions so far, our analysis of transaction data does not address the underlying mechanisms of such observations. Generally, homophily can arise from two possibilities: individuals with similar attributes are more likely to become acquainted with each other (homophily in "meetings") or individuals "prefer" those who share similar attributes for some reasons *conditional on* meeting (homophily in "preferences"). This distinction is crucial as they have substantially different policy implications. If the former is the primary issue, effective policies may include hosting business matching events or creating matching sites that make it easier for CEOs of different genders to meet with each other. However, if homophily in "preferences", such as gender discrimination, is the cause, the government needs to implement policies to mitigate such bias, which could be more challenging.

To this end, we conduct our original survey of CEOs in collaboration with the Cabinet Office of the Government of Japan. In February 2023, we randomly selected 12,500 for each female and male CEOs identified from TSR's database and sent them a physical survey by mail. To be consistent with the sample of the transaction data, the targeted population was limited to firms whose CEO gender, sales, number of employees, firm age, and credit score were non-missing in the database and were engaged in firm-to-firm transactions. Respondents were allowed to answer the survey on paper or access a link to answer it online. Ultimately, we received responses from 3,082 female CEOs and 3,355 male CEOs, with an overall response rate of 25.7% (N= 6,437), which can be regarded as exceptionally high given that the response rates of CEO surveys range between 9% and 17% in previous studies (Graham et al., 2013; Bandiera et al., 2020).

To measure homophily in "meetings," we posed the following question to respondents: *"Please think of one CEO with whom you have been acquainted with most recently. Please indicate the gender of that person."* Respondents choose either 'female,' 'male,' or 'other gender.' If the probability of meeting a female CEO differs between female and male

respondents, a gender difference should be observed in the proportion of respondents who answer 'female' to this question.[21] However, even if such a gender difference in "meetings" is observed, one cannot tell whether it is due to the *environment*—the social barriers that make it difficult for opposite-sex CEOs to meet—because such a gender difference can also arise from male CEOs not actively searching for female CEOs ("choice" part of "preference").

Therefore, our "preference" questions are designed to satisfy two objectives. The first is to control for the aspect of homophily in "meetings" that is because of respondents' willingness to meet female CEOs ("choice" part). For this purpose, we ask, *"If you could become acquainted with a new CEO, would you like to get to know a male or female CEO, or it does not matter?"* The second set of questions is designed to measure homophily in "preference" *conditional on* already meeting CEOs by asking about impressions during interactions and business meetings with CEOs. In particular, we ask whether each of the following seven incidents (both positive and negative ones) is more likely to occur with male CEO or female CEO or equally likely to occur regardless of CEO gender: *"easier to talk business-related concerns with," "easier to negotiate business deals with," "easier to interact with," "talked down to you," "did not listen to you seriously," "pressure to follow gender stereotypes,"* and *"more concerned about the other's task ability."* For these questions, respondents choose from 'female,' 'male,' or 'neutral.'

In addition to meeting- and preference-related questions, the survey asks how much the respondent CEO is involved in the business negotiation of firm-to-firm transactions (as shown in Section 3.3), pathways to becoming CEOs (as shown in Appendix Figure A1), as well as the respondent's basic attributes such as years of business experience, hours of business per week, aspiration to expand the business, networking activities, and economic preferences such as competitiveness, risk attitude, and self-confidence. Finally, to ensure that primacy bias does not influence our results, we randomly assign the order of gender ('female' or 'male') to appear first in each gender-related question.

Table E1 compares the observed characteristics of respondents and non-respondents. Note that we use the term "respondents" to refer to the CEOs who answered the survey to distinguish from CEOs in general mentioned in the questionnaire. On average, respondents manage firms with higher firm age, lower listing ratios, and higher credit scores. Further, we obtain lower responses from female CEOs. However, each magnitude of the difference is not large, and the statistical significance can be attributed mainly to our large sample size. In fact, the differences are not statistically significant for sales and

[21] We could have asked the number of male and female CEOs that the respondent has become acquainted with in the past one year, but this type of question is likely to introduce the recall bias.

employment despite the large sample size, so we view the selection issue as not severe.

4.2 Results

First, we examine homophily in "meetings" and "preferences" separately. Then, we run a regression to test whether homophily in "meetings" persists after accounting for homophily in "preference" and other potential confounders.

Descriptive analysis.—We begin by examining homophily in "meetings." Figure 10 plots the probability that the respondent became recently acquainted with a female CEO over the gender of the respondents. Strikingly, the probability is 19.9% for female respondents but only 5.2% for male respondents, which is less than one-third of the probability for female respondents. Essentially, the actual proportion of female CEOs in the raw data of the TSR in 2022 is approximately 14.4%. This comparison suggests that female respondents are more likely to get to know female CEOs than we would expect by random chance (19.9% >14.4%), while male respondents are more likely to get to know male CEOs than we would expect by random chance (5.2% <14.4%).

Next, we examine homophily in "preferences." Figure 11 summarizes responses to the preference-related questions. Here, for each question, we report the difference in the share of respondents who selected male and female, along with its 95% confidence interval, by each gender of the respondents. We note that this is equivalent in coding to one if the respondent selects male, zero if the respondent is neutral, and -1 if the respondent selects female. Thus, larger positive values indicate a bias toward males, while larger negative values indicate a bias toward females. The value of 0 means neutral.

The results collectively show that female respondents have a neutral preference for CEO gender, while male respondents tend to prefer male CEOs. The first line of Figure 11 addresses the "choice" part of homophily in "preference." The male respondents, who would prefer to become acquainted with a male CEO, were 19.5 percentage points higher than those who would like to become acquainted with a female CEO. However, female respondents, who preferred to get acquainted with a female CEO, were only slightly higher than those who preferred to become acquainted with a male CEO, with a difference of 6.9 percentage points, which is modest compared with the male respondents.

The subsequent lines in Figure 11 measure the "preferences" conditional on meeting other CEOs, by asking about the expectations in the interactions with CEOs, separately by the gender of respondents. The subsequent three lines refer to *positive*, and the subsequent four refer to *negative* expectations.

We find that male respondents expect positive interaction with male CEOs, while

female respondents' expectation is more or less neutral. For example, male respondents expect that male CEOs are 46.6 percentage points "easier to talk about business-related concerns," 35.1 percentage points "easier to negotiate business deals," and 26.9 percentage points "easier to interact with" than female CEOs. By contrast, female respondents are closer to having a neutral bias for the same questions. The notable exception is that female respondents perceive that male CEOs are 19.8 percentage points "easier to negotiate business deals" than female CEOs, which is a large magnitude.

The last four lines of Figure 11 on negative interactions suggest that both female and male respondents equally expect that interactions with male CEOs are more likely to result in uncomfortable events ("talked down to you," "did not listen to you seriously," and "pressure to follow gender stereotypes.") The only exception is "more concerned about the other's task ability" (the last row), where notably, both male and female respondents are almost neutral. This result suggests that our result on CEO gender homophily in firm-to-firm transactions documented so far is not influenced by the lack of trust in CEO's ability of the opposite gender, which is considered crucial in other contexts (Ashraf et al., 2023; Cevallos Fujiy et al., 2022).

Overall, we conclude that male respondents have a stronger same-gender preference than female respondents, and male respondents expect better interactions with male CEOs than with female CEOs. However, female respondents are relatively neutral towards the gender of CEOs, but they perceive that it is somewhat easier to conduct business deals with male CEOs than with female CEOs.

Regressions.—Concerning gender differences in the probability of becoming acquainted with female CEOs (homophily in "meetings"), this finding does not necessarily indicate the existence of a barrier for female CEOs to encounter male CEOs (or vice versa) because it is possible that female (male) CEOs simply prefer to meet with other female (male) CEOs. Thus, we investigate whether homophily in "meetings" survives after controlling for homophily in "preferences" (in particular, "choice" part of "preference.") If so, we can attribute the remaining homophily in "meetings" to social barriers that make it difficult for opposite-sex CEOs to meet, where government intervention can be practically effective.

Table 10 presents the regression results where the dependent variable is a dummy variable indicating the CEO with whom the respondent became recently acquainted with is female (our variable on homophily in "meetings"), and the main explanatory variable of interest is a dummy variable indicating that the respondent is a female CEO.

Column (1) of Table 10 only controls for a survey dummy, which controls the order of gender in gender-related questions, and the estimate shows that female respondents

are 13.7 percentage points more likely than male respondents to meet with female CEOs ($p< 0.01$). This completely matches the difference in height between female (19.9%) and male (5.2%) respondents in Figure 10. In the following columns, we sequentially add other potentially confounding variables.

Column (2) adds dummy variables for the responses to preference-related questions, displayed in Figure 11, including "choice" part of "preference". This reduces the estimate on female CEO dummy from 13.7 in Column (1) to 10.7 percentage points, or by 22%. However, the estimate on female CEO dummy remains statistically significant at the 1% level. Column (3) adds industry (four digits) and region FEs to account for potential differences in exposure to female CEOs across industries and regions. This further reduces the estimates to 8.8 percentage points, but it again remains statistically significant ($p< 0.01$). Column (4) adds firm-level characteristics, and Column (5) further controls for CEO attributes such as education, years of business experience, hours of business per week, competitiveness, risk attitude, and confidence. These variables are included to account for gender differences in the opportunities due to firm-level and CEO attributes. However, the results remain virtually unchanged from Column (3).

In sum, the estimate on female CEO dummy decreases from 13.7 in Column (1) to 8.8 percentage points in Column (5) after controlling for homophily in "preferences" and other confounding factors but remains highly statistically significant ($p< 0.01$). This remaining gender difference of 8.8 percentage points is even larger than the baseline probability of becoming acquainted with female CEOs for male respondents, which is around 5.9% as shown in Figure 10. Therefore, we conclude that most of the gender homophily in "meetings" stem from, if anything, social barriers in encountering CEOs of the opposite gender, which cannot be simply explained by preferences.

5 Conclusion

Using a novel dataset that includes both firm-to-firm transactions and CEO characteristics in Japan, this study shows that transactions are more likely to occur between firms with CEOs of the same gender than those with CEOs of the opposite gender. The result comes from SMEs, in particular small-sized firms, in which CEOs presumably have a strong involvement in transactions. We find that transactions are 12.5% more likely to occur between the small-sized firms with CEOs of the same gender than small-sized firms with CEOs of the opposite gender. Given that majority of CEOs in the current market are male, such CEO gender homophily in firm-to-firm transactions suggests a disadvantage in building business networks for female CEOs, especially among SMEs.

To investigate the underlying mechanisms of CEO gender homophily, we conduct our own survey that targets representative CEOs in Japan, obtaining a sample of over 6,000 respondents. Our survey results suggest that both gender homophily in "meetings" and "preference" are mechanisms that generate CEOs' gender homophily in transaction networks.

On one hand, our analysis reveals the existence of barriers that make it difficult for CEOs of the opposite gender to get acquainted with each other (homophily in "meetings.") For instance, Cullen and Perez-Truglia (2023) show the evidence of "old boys' club", whereby men are more promoted than women because, compared with women, men have more access to important social network tools to interact with more powerful men (e.g., chat over smoking and playing golf together).[22] TSR data indeed ask CEOs to list their hobbies (up to three), and the data reveal that (i) CEOs who play golf have larger transaction networks on average (regardless of the CEO gender), and (ii) male CEOs are much more likely to play golf than female CEOs (46.0% vs. 16.2%).

While this study cannot establish the precise social barriers that female CEOs face, it can be interpreted that such a gender ceiling for women to interact with men exists not only *within* the firm as Cullen and Perez-Truglia (2023) but also *across* the firms. Since any transactions cannot begin without encountering trading partners, policy interventions to eliminate those impediments and increase networking opportunities can be beneficial. Such policies include, for example, hosting business matching events or creating matching sites that make it easier for CEOs of different genders to meet and interact.

On the other hand, the survey also suggests that even when CEOs of the opposite gender meet with each other, male CEOs tend to have a stronger same-gender preference for interactions than female CEOs (homophily in "preference"), who have much more neutral preferences. While it is beyond the scope of this study to identify the underlying roots of such gender preferences such as discrimination, government policies to reduce male CEOs' bias, while challenging, can also be effective.[23]

There are a few limitations in this study that should be acknowledged. First, due to data constraints, we could only examine the extensive margin of a transaction (i.e., occurred or not). Access to more detailed data on the volume and price of transactions is warranted to assess the welfare consequences of CEO gender homophily accurately. Second, while we provide solid evidence of CEOs' gender homophily in firm-to-firm trans-

[22] Mayer and Puller (2008) show that social ties often operate along the gender lines.

[23] This finding indicates that male CEOs may discriminate against female CEOs in business transactions. However, our survey cannot identify whether this discrimination is based on statistical or taste-based discrimination.

actions for SMEs, as long as we can identify the individuals responsible for transactions, such gender homophily may exist even among large firms. This paper is one of the first steps toward understanding the disadvantages that female CEOs face in business operations.

References

Adams, Renée B, and Daniel Ferreira. 2009. "Women in the Boardroom and Their Impact on Governance and Performance." *Journal of Financial Economics* 94 (2): 291–309.

Alfaro-Ureña, Alonso, Isabela Manelici, and Jose P Vasquez. 2022. "The Effects of Joining Multinational Supply Chains: New Evidence from Firm-to-Firm Linkages." *Quarterly Journal of Economics* 137 (3): 1495–1552.

Antonovics, Kate, and Brian G Knight. 2009. "A New Look at Racial Profiling: Evidence from the Boston Police Department." *Review of Economics and Statistics* 91 (1): 163–177.

Anwar, Shamena, and Hanming Fang. 2006. "An Alternative Test of Racial Prejudice in Motor Vehicle Searches: Theory and Evidence." *American Economic Review* 96 (1): 127–151.

Arkolakis, Costas, Federico Huneeus, and Yuhei Miyauchi. 2023. "Spatial Production Networks." *NBER working paper No.30954.*

Ashraf, Nava, Alexia Delfino, and Edward Glaeser. 2023. "Female Entrepreneurship and Trust in the Market."

Asiedu, Edward, Monica Lambon-Quayefio, Francesca Truffa, and Ashley Wong. 2023. "Female Entrepreneurship and Professional Networks."

Azmat, Ghazala, and Rosa Ferrer. 2017. "Gender Gaps in Performance: Evidence from Young Lawyers." *Journal of Political Economy* 125 (5): 1306–1355.

Babcock, Linda, and Sara Laschever. 2009. *Women don't ask.* Princeton University Press.

Bandiera, Oriana, Andrea Prat, Stephen Hansen, and Raffaella Sadun. 2020. "CEO behavior and firm performance." *Journal of Political Economy* 128 (4): 1325–1369.

Bernard, Andrew B., and Andreas Moxnes. 2018. "Networks and Trade." *Annual Review of Economics* 10 (1): 65–85.

Bernard, Andrew B., Andreas Moxnes, and Yukiko U. Saito. 2019. "Production Networks, Geography, and Firm Performance." *Journal of Political Economy* 127 (2): 639–688.

Bertrand, Marianne, Sandra E Black, Sissel Jensen, and Adriana Lleras-Muney. 2019. "Breaking the Glass Ceiling? The Effect of Board Quotas on Female Labour Market Outcomes in Norway." *Review of Economic Studies* 86 (1): 191–239.

Bertrand, Marianne, and Antoinette Schoar. 2003. "Managing with Style: The Effect of Managers on Firm Policies." *Quarterly Journal of Economics* 118 (4): 1169–1208.

Blau, Francine D, and Lawrence M Kahn. 2017. "The Gender Wage Gap: Extent, Trends, and Explanations." *Journal of Economic Literature* 55 (3): 789–865.

Cabral, Marika, and Marcus Dillender. 2021. "Gender Differences in Medical Evaluations: Evidence from Randomly Assigned Doctors." *NBER working paper No. 29541.*

Cai, Jing, and Adam Szeidl. 2018. "Interfirm relationships and business performance." *Quarterly Journal of Economics* 133 (3): 1229–1282.

Carvalho, Vasco M, Makoto Nirei, Yukiko U Saito, and Alireza Tahbaz-Salehi. 2021. "Supply Chain Disruptions: Evidence from the Great East Japan Earthquake." *Quarterly Journal of Economics* 136 (2): 1255–1321.

Cevallos Fujiy, Brian, Gaurav Khanna, and Hiroshi Toma. 2022. "Cultural Proximity and Production Networks."

Charbonneau, Karyne B. 2017. "Multiple Fixed Effects in Binary Response Panel Data Models." *Econometrics Journal* 20 (3): S1–S13.

Chetty, Raj, Matthew O Jackson, Theresa Kuchler et al. 2022. "Social capital II: determinants of economic connectedness." *Nature* 608 (7921): 122–134.

Chiplunkar, Gaurav, and Pinelopi K Goldberg. 2021. "Aggregate Implications of Barriers to Female Entrepreneurship."

Coleman, James. 1958. "Relational analysis: The study of social organizations with survey methods." *Human organization* 17 (4): 28–36.

Cullen, Zoë, and Ricardo Perez-Truglia. 2023. "The old boys' club: Schmoozing and the gender gap." *American Economic Review* 113 (7): 1703–1740.

Currarini, Sergio, Matthew O Jackson, and Paolo Pin. 2009. "An economic model of friendship: Homophily, minorities, and segregation." *Econometrica* 77 (4): 1003–1045.

Delecourt, Solène, and Anne Fitzpatrick. 2021. "Childcare Matters: Female Business Owners and the Baby-Profit Gap." *Management Science* 67 (7): 4455–4474.

Demir, Banu, Ana Cecília Fieler, Daniel Xu, and Kelly Kaili Yang. 2021. "O-Ring Production Networks." *NBER working paper No.28433.*

Eckel, Catherine C, and Philip J Grossman. 2002. "Sex Differences and Statistical Stereotyping in Attitudes Toward Financial Risk." *Evolution and Human Behavior* 23 (4): 281–295.

Eika, Lasse, Magne Mogstad, and Basit Zafar. 2019. "Educational assortative mating and household income inequality." *Journal of Political Economy* 127 (6): 2795–2835.

Ewens, Michael, and Richard R Townsend. 2020. "Are Early Stage Investors Biased Against Women?" *Journal of Financial Economics* 135 (3): 653–677.

Fairlie, Robert W, and Alicia M Robb. 2009. "Gender differences in business performance: evidence from the Characteristics of Business Owners survey." *Small Business Economics* 33 375–395.

Fisman, Raymond, Daniel Paravisini, and Vikrant Vig. 2017. "Cultural Proximity and Loan Outcomes." *American Economic Review* 107 (2): 457–92.

Flabbi, Luca, Mario Macis, Andrea Moro, and Fabiano Schivardi. 2019. "Do Female Executives Make a Difference? The Impact of Female Leadership on Gender Gaps and Firm Performance." *Economic Journal* 129 (622): 2390–2423.

Gallen, Yana, and Melanie Wasserman. 2022. "Does Information Affect Homophily?" *IZA DP No. 15362*.

Graham, Bryan S. 2017. "An Econometric Model of Network Formation with Degree Heterogeneity." *Econometrica* 85 (4): 1033–1063.

Graham, John R, Campbell R Harvey, and Manju Puri. 2013. "Managerial attitudes and corporate actions." *Journal of financial economics* 109 (1): 103–121.

Guiso, Luigi, Paola Sapienza, and Luigi Zingales. 2009. "Cultural Biases in Economic Exchange?" *Quarterly Journal of Economics* 124 (3): 1095–1131.

Hsieh, Chang-Tai, Erik Hurst, Charles I Jones, and Peter J Klenow. 2019. "The allocation of talent and us economic growth." *Econometrica* 87 (5): 1439–1474.

Jochmans, Koen. 2018. "Semiparametric Analysis of Network Formation." *Journal of Business & Economic Statistics* 36 (4): 705–713.

Kepler, Erin, Scott Shane et al. 2007. *Are male and female entrepreneurs really that different?*. Office of Advocacy, US Small Business Administration Washington, DC.

Koellinger, Philipp, Maria Minniti, and Christian Schade. 2013. "Gender Differences in Entrepreneurial Propensity." *Oxford bulletin of economics and statistics* 75 (2): 213–234.

Le Barbanchon, Thomas, Roland Rathelot, and Alexandra Roulet. 2021. "Gender differences in job search: Trading off commute against wage." *Quarterly Journal of Economics* 136 (1): 381–426.

Manski, Charles F, and Steven R Lerman. 1977. "The Estimation of Choice Probabilities from Choice Based Samples." *Econometrica* 45 (8): 1977–1988.

Mayer, Adalbert, and Steven L. Puller. 2008. "The Old Boy (and Girl) Network: Social Network Formation on University Campuses." *Journal of Public Economics* 92 (1-2): 329–347.

Miyauchi, Yuhei. 2018. "Matching and Agglomeration: Theory and Evidence from Japanese Firm-to-Firm Trade."

Niederle, Muriel, and Lise Vesterlund. 2007. "Do Women Why Away from Competition? Do Men Compete Too Much?" *Quarterly Journal of Economics* 122 (3): 1067–1101.

Panigrahi, Piyush. 2021. "Endogenous Spatial Production Networks: Quantitative Implications for Trade and Productivity."

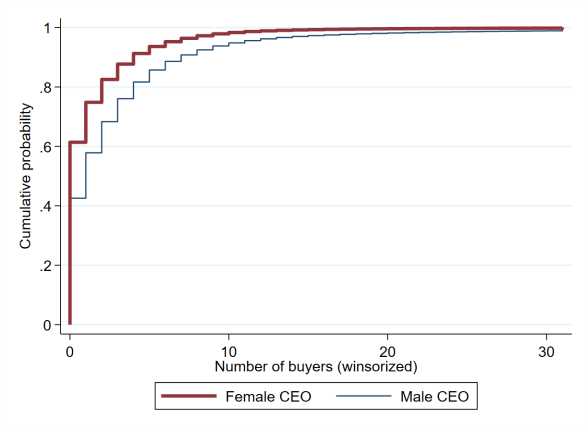
Wolfers, Justin. 2006. "Diagnosing Discrimination: Stock Returns and CEO Gender." *Journal of the European Economic Association* 4 (2-3): 531–541.

Wooldridge, Jeffrey M. 2010. *Econometric analysis of cross section and panel data*. MIT press.

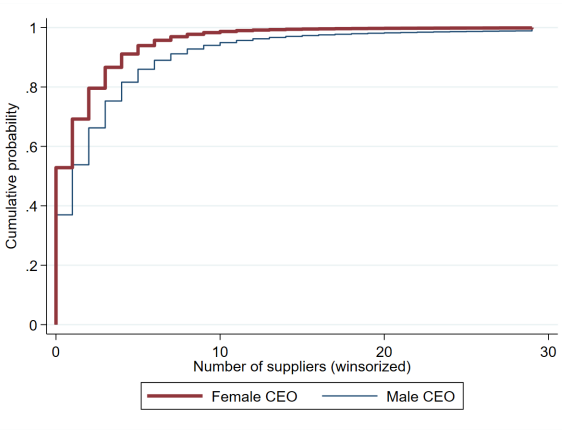
Zeltzer, Dan. 2020. "Gender Homophily in Referral Networks: Consequences for the Medicare Physician Earnings Gap." *American Economic Journal: Applied Economics* 12 (2): 169–197.

Figure 1: Network Size by CEO Gender

(a) Number of buyers



(b) Number of suppliers

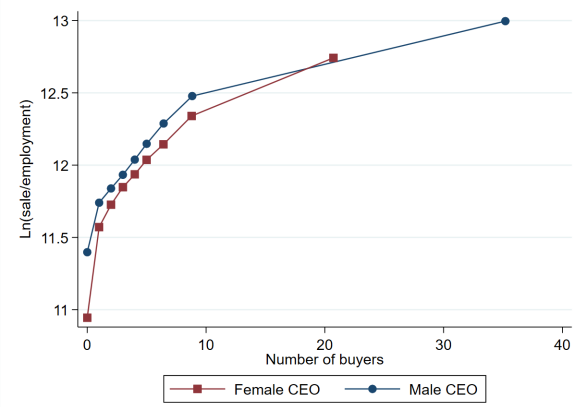


Notes: These figures show the cumulative distribution function of the number of buyers (a) and suppliers (b) by CEO gender. Both variables are winsorized at the 99th percentile. The sample is derived from the TSR data for the period 2008 to 2020.

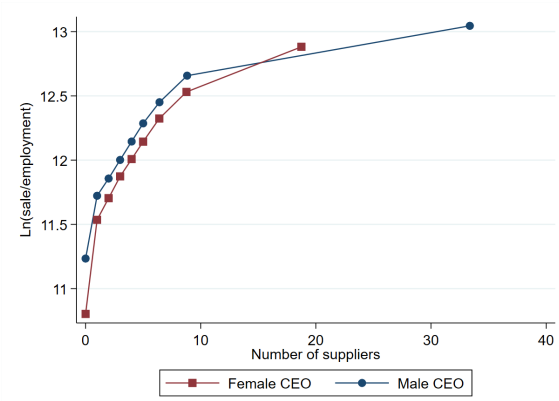
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Figure 2: Network Size and Firm Performance

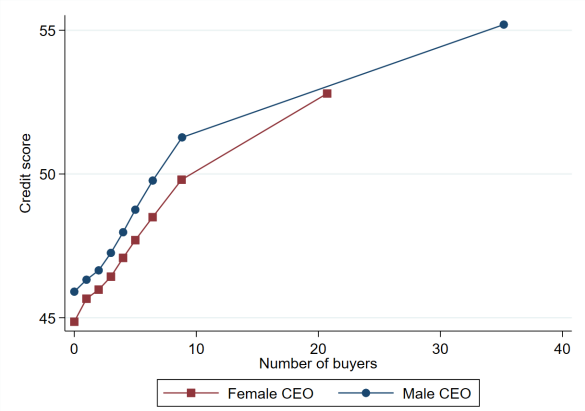
(a) Number of buyers and log sales per employment



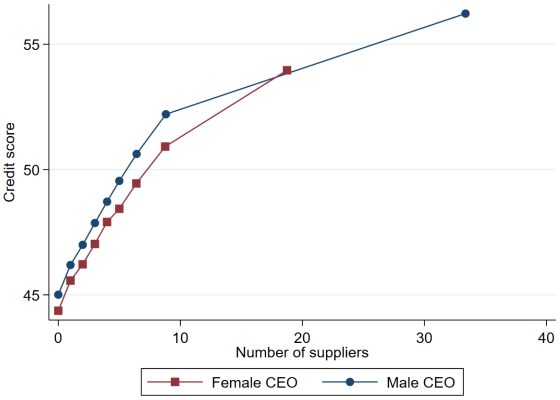
(b) Number of suppliers and log sales per employment



(c) Number of buyers and credit score

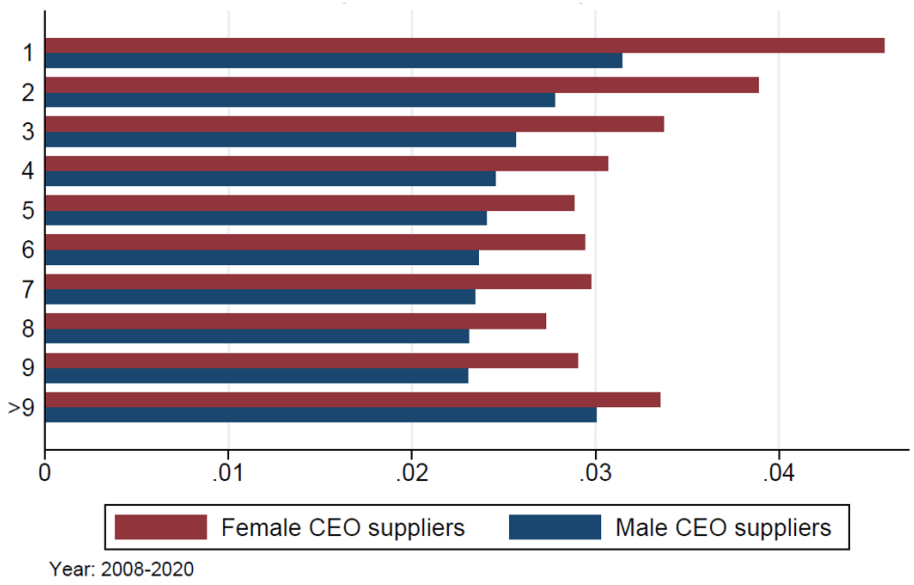


(d) Number of suppliers and credit score



Notes: These figures show the binned scatterplots of the relationship between network size (the number of suppliers and buyers) and firm performance measures, separately by the gender of the CEO. Firm performance is measured by log sales per employment in (a) and (b) and by credit scores in (c) and (d). The sample is derived from the TSR data for the period 2008 to 2020.

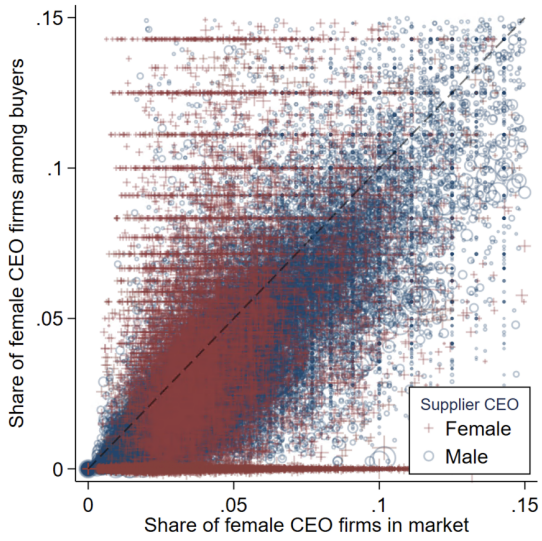
Figure 3: Share of Female CEO Buyers by Total Number of Buyers



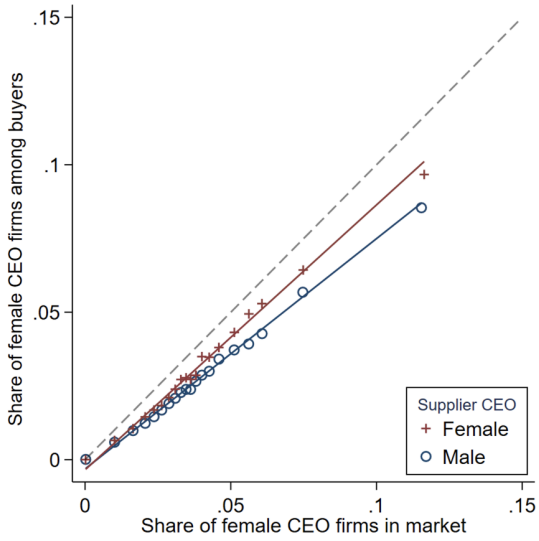
Notes: This figure shows the share of female CEO buyers by the total number of buyers, for female CEO suppliers and male CEO suppliers separately. The sample is derived from the TSR data for the period 2008 to 2020.

Figure 4: Relative Homophily

(a) Raw data



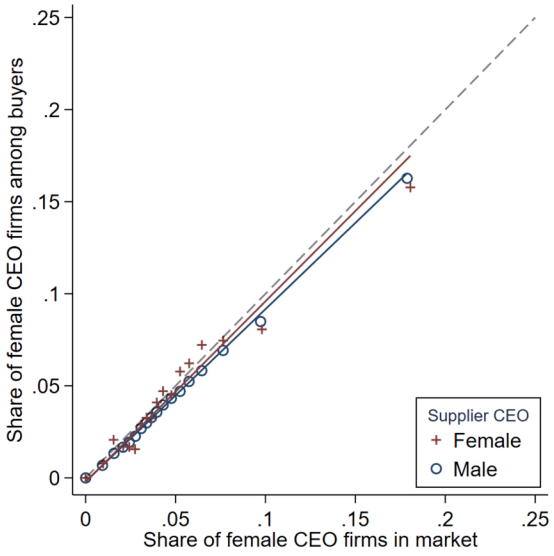
(b) Binned scatterplot



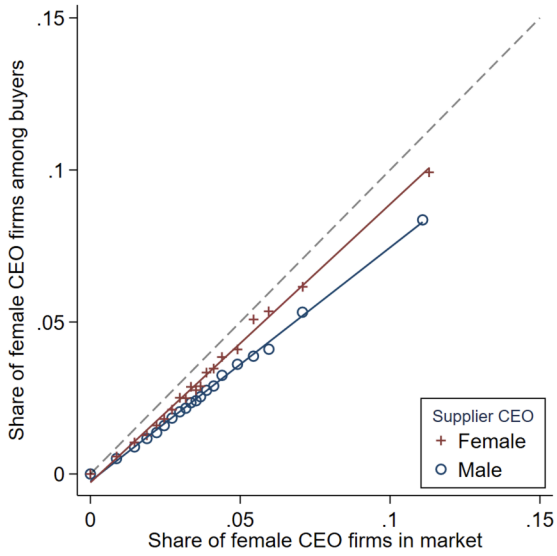
Note: This figure plots the share of female CEO buyers in the market, λ_F^k, on the horizontal axis and the share of transactions with female CEO buyers and female-CEO and male-CEO suppliers in the market, $T_{g,F}^k$ where $g \in \{f, m\}$, on the vertical axis. Markets are defined as two-digit industry pairs and years. The figure on the left presents raw data, and the figure on the right presents a binned scatterplot of the same plot with regression linear lines weighted by market size. Bins are defined such that the number of observations in each bin is the same. The 45° dotted line indicates the random match. The sample is derived from the TSR data for the period 2008 to 2020.

Figure 5: Relative Homophily by Firm Size of Suppliers

(a) Large firms



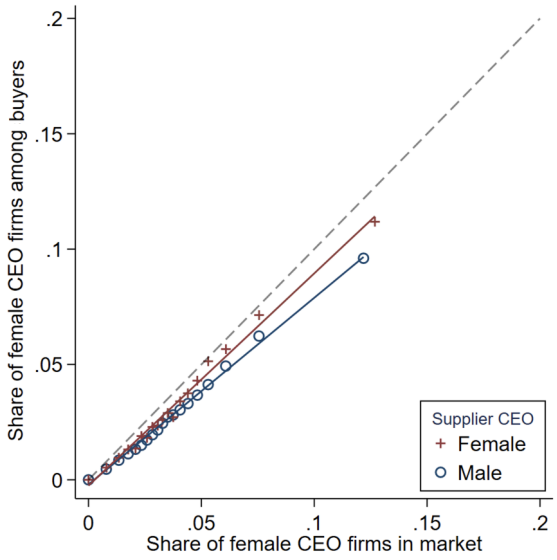
(b) SMEs



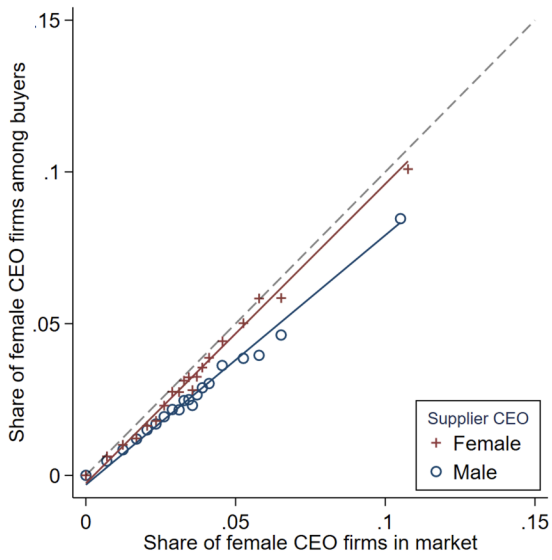
Notes: This figure displays a binned scatterplot of the share of female CEO buyers in the market, λ_F^k, on the horizontal axis and the share of transactions with female CEO buyers and female CEO and male CEO suppliers in the market, $T_{g,F}^k$ where $g \in \{f, m\}$, on the vertical axis, along with regression linear lines weighted by market size. Markets are defined as two-digit industry pairs and years. Bins are defined such that the number of observations in each bin is the same. The 45° dotted line indicates the random match. Panel (a) presents the result for large-firm, while Panel (b) presents the same plot for SMEs. See Appendix Table A4 for the definition of the firm-size categories.

Figure 6: Relative Homophily (Medium-sized vs. Small-sized Suppliers)

(a) Medium-sized firms

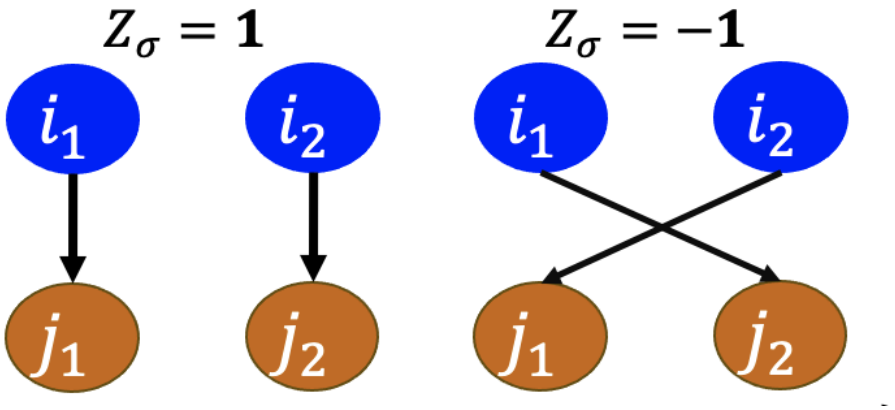


(b) Small-sized firms



Notes: This figure displays a binned scatterplot of the share of female CEO buyers in the market, λ_F^k, on the horizontal axis and the share of transactions between female CEO buyers and female CEO and male CEO suppliers in the market, $T_{g,F}^k$, where $g \in \{f, m\}$, on the vertical axis, along with regression linear lines weighted by market size. Markets are defined as two-digit industry pairs and years. Bins are defined such that the number of observations in each bin is the same. The 45° dotted line indicates the random match. Panels (a) and (b) present the results for medium-sized and small-sized firms, respectively. See Appendix Table A4 for the definition of the firm-size categories.

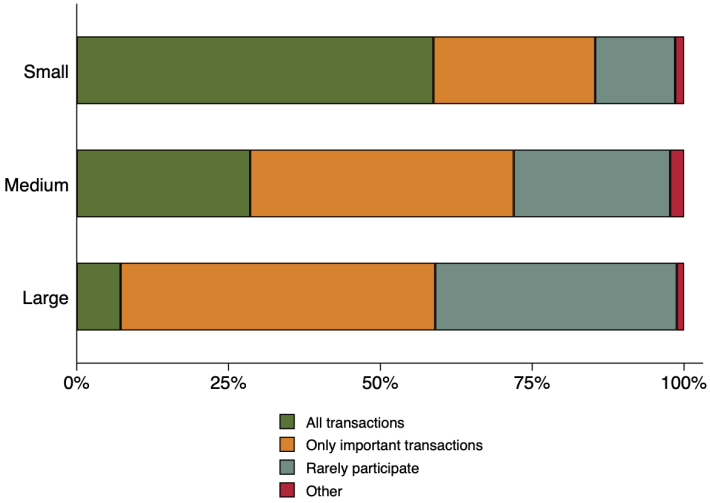
Figure 7: Sample construction



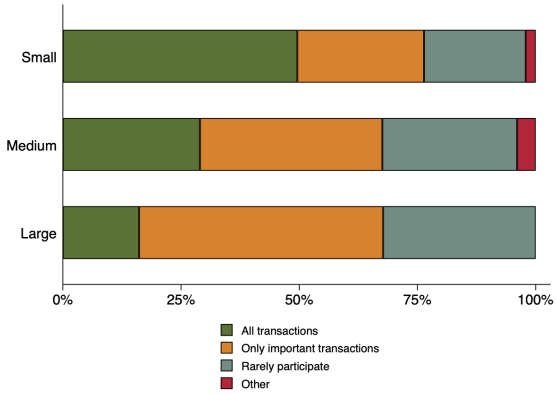
Notes: This figure shows that $\{i_1, i_2; j_1, j_2\}$ where $i_1, i_2 \in S_k$ and $j_1, j_2 \in B_k$, where Z_σ take on values from the set $\{-1, 1\}$.

Figure 8: Survey: CEO Involvement in Transactions by Firm-size

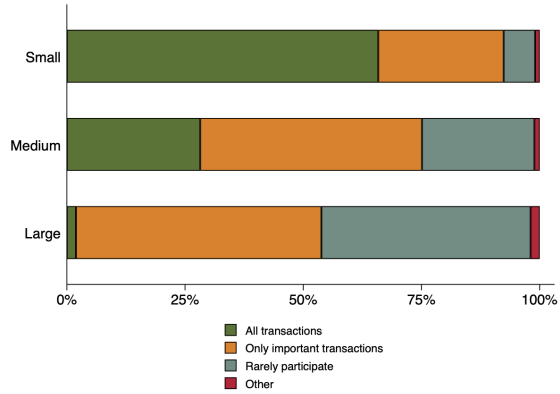
(a) All CEO



(b) Female CEO



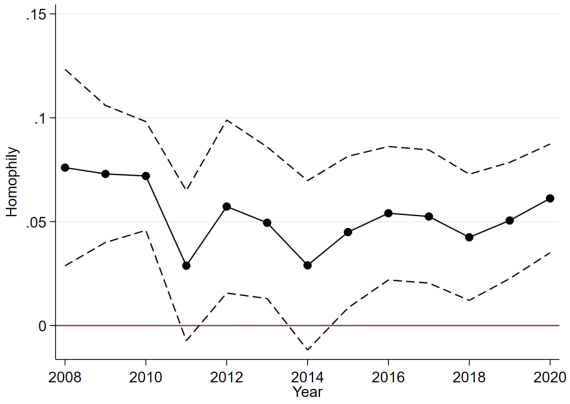
(c) Male CEO



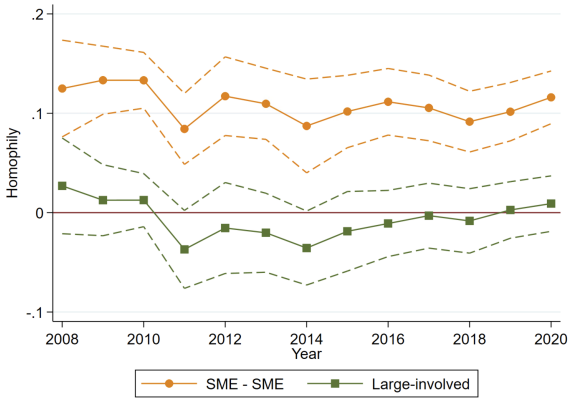
Notes: This figure shows the CEO's involvement in transactions by firm size (small vs medium vs large firms). Panel (a) includes all CEOs, while Panels (b) and (c) display the same figure by CEO gender. See Appendix Table A4 for the definition of the firm-size categories. The sample is derived from our original survey, and the level of observation is the respondent CEO of the survey.

Figure 9: Logit Estimates of Gender Homophily over Time

(a) All firms



(b) SME-SME vs. Large-involved



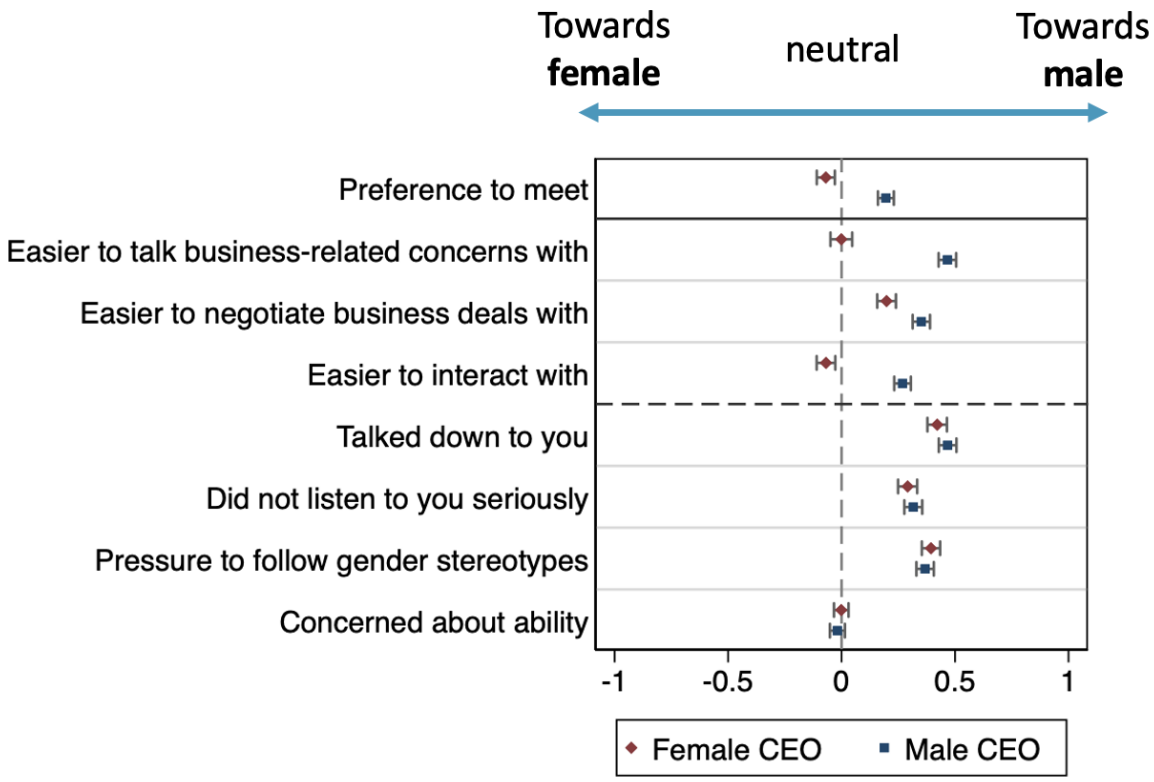
Notes: Panel (a) reports the estimates from Equation (1) for all firms, from 2008 to 2020, along with the 95% CI in dotted lines. Each estimate comes from a separate regression. Panel (b) reports the estimates from the variant of Equation (1) that further include the interaction of a CEO same-gender dummy and a dummy for firm size category, for SME and large-sized firms involved, from 2008 to 2020, along with the 95% CI in dotted lines.

Figure 10: Survey: Gender Differences in Meeting Female CEOs



Notes: The figure above shows the proportion that the CEO with whom the respondent became recently acquainted with is female by respondent gender. The sample is derived from our original survey, and the level of observation is the respondent CEO of the survey. The actual wording of the question is, "Please think of one CEO with whom you have been acquainted with most recently. Please indicate the gender of that person." The responses are 'female,' 'male,' and 'other gender.' The proportion of female CEOs who responded 'female' is 19.9%, and that of male CEOs who responded 'female' is 5.2%.

Figure 11: Survey: Responses of Preference-related Questions



Notes: The figure above shows the results of preference-related questions for CEO gender from our original survey, and the level of observation is the respondent CEO of the survey.
The actual wording of the questions are

- If you could become acquainted with a new CEO, would you like to get to know a male or female CEO, or it does not matter?: responses 'female,' 'male,' and 'neutral.'
- We would like to ask you a few questions about your impressions during interactions and business meetings with CEOs (and other business partners) of other companies. For each of the following, which of the following do you think is more likely to be true of men or women? "easier to talk business-related concerns with," "easier to negotiate business deals with," "easier to interact with," "talked down to you," "did not listen to you seriously," "pressure to follow gender stereotypes," and "more concerned about the other's task ability.": responses 'female,' 'male,' and 'neutral.'

The figure presents the difference in the share of respondents who select male and female options, where coding assigns a value of one if the respondent selects male, zero if they are neutral, and -1 if the respondent selects female and taking the means. Bars are 95% confidence intervals.

Table 1: Summary Statistics (Firm-Level)

	(1) Female CEO			(2) Male CEO			(3) Female - Male		
	N	Mean	SD	N	Mean	SD	Difference	SE	% from male
Panel A. Firm characteristics									
Ln (sale)	495,112	13.825	1.628	8,164,000	14.320	1.755	-0.495***	0.003	-
Ln(employment)	495,112	1.844	1.152	8,164,000	2.131	1.302	-0.287***	0.002	-
Ln(sale/employment)	495,112	11.764	1.190	8,164,000	12.005	1.112	-0.241***	0.002	-
Firm age	495,112	30.098	16.971	8,164,000	31.224	17.134	-1.126***	0.025	-3.607
Listed	495,112	0.001	0.028	8,164,000	0.005	0.072	-0.004***	0.000	-84.829
Credit score	495,112	46.614	5.336	8,164,000	48.006	5.940	-1.393***	0.009	-2.901
Number of suppliers	495,112	2.547	4.730	8,164,000	4.593	27.810	-2.046***	0.040	-44.539
Number of suppliers | Number of suppliers > 0	397,651	3.173	5.087	6,726,868	5.574	30.548	-2.401***	0.048	-43.078
Number of buyers	495,112	2.378	6.254	8,164,000	4.603	29.001	-2.225***	0.041	-48.344
Number of buyers | Number of buyers > 0	325,554	3.617	7.417	6,128,538	6.132	33.332	-2.515***	0.058	-41.012
Panel B. CEO characteristics									
CEO's age	355,540	62.332	12.126	6,997,292	59.810	11.181	2.522***	0.019	4.216
CEO college graduate	188,123	0.296	0.456	4,701,669	0.485	0.500	-0.189***	0.001	-38.981

Notes: The sample is derived from the TSR data for the period 2008 to 2020. The table provides the summary statistics of selected variables for firm (Panel A) and CEO (Panel B) characteristics, by the CEO gender separately. Columns (1) and (2) provide the number of observations (N), mean, and standard deviations (SD) for female CEOs and male CEOs, respectively. Column (3) shows the difference between female and male CEOs. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table 2: Summary Statistics: Characteristics of Buyers from Suppliers' Perspectives

	(1) Female CEO suppliers			(2) Male CEO suppliers			(3) Female - Male		
	N	Mean	SD	N	Mean	SD	Difference	SE	% from male
Panel A. Firm characteristics (buyesr)									
Ln(sale)	325,554	17.522	2.693	6,128,538	17.483	2.540	0.039***	0.005	-
Ln(employment)	325,554	4.556	2.124	6,128,538	4.513	2.031	0.043***	0.004	-
Ln(sale/employment)	325,554	12.901	1.032	6,128,538	12.904	0.935	-0.002	0.002	-
Large	325,554	0.381	0.404	6,128,538	0.370	0.383	0.012***	0.001	3.150
Medium	325,554	0.345	0.368	6,128,538	0.351	0.344	-0.006***	0.001	-1.843
Small	325,554	0.274	0.371	6,128,538	0.279	0.351	-0.005***	0.001	-1.855
SME	325,554	0.619	0.404	6,128,538	0.630	0.383	-0.012***	0.001	-1.848
Firm age	325,554	44.510	18.460	6,128,538	45.063	17.350	-0.553***	0.031	-1.227
Listed	325,554	0.164	0.288	6,128,538	0.171	0.279	-0.007***	0.001	-3.916
Credit score	325,554	55.640	7.287	6,128,538	55.714	6.955	-0.074***	0.013	-0.132
Ln(distance)	325,554	3.068	1.625	6,128,538	3.248	1.476	-0.180***	0.003	-
Panel B. CEO characteristics (buyers)									
CEO's age	312,013	60.103	7.447	5,935,420	60.140	6.726	-0.037**	0.012	-0.062
CEO college graduate	286,529	0.691	0.374	5,579,295	0.682	0.353	0.009***	0.001	1.312
Female CEO	325,554	0.038	0.150	6,128,538	0.028	0.116	0.010 ***	0.000	37.524

Notes: The sample is derived from the TSR data for the period 2008 to 2020. The table provides the summary statistics of buyers from suppliers' perspective for firm characteristics (Panel A) and CEO characteristics (Panel B), by the gender of CEO suppliers. Columns (1) and (2) provide the number of observations (N), mean, and standard deviations (SD) for female and male CEO suppliers, respectively. Column (3) shows the difference between female and male CEO suppliers, along with the % change from the mean of male CEO suppliers (except for a few variables that already take the log difference). Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table 3: Gender Shares in Firm-to-firm Transactions (raw data)

(a) From supplier's perspective

	Buyer gender (%)		
	Female (6.0)	Male (94.0)	All (100)
Supplier gender (%)			
Female (5.4)	3.9%	96.1%	100%
Male (94.6)	3.0%	97.0%	100%

(b) From buyers' perspective

	Buyer gender (%)	
	Female (6.0)	Male (94.0)
Supplier gender (%)		
Female (5.4)	3.7%	2.8%
Male (94.6)	96.3%	97.2%
All (100)	100%	100%

Notes: The sample is derived from the TSR data for the period 2008 to 2020. Panel (a) provides the percentage of buyer gender, by the gender of the suppliers. Panel (b) provides the percentage of supplier gender, by the gender of the buyers.

Table 4: Relative Homophily from Suppliers' Perspective

	(1)	(2)	(3)	(4)
Female CEO	0.107***	0.100***	0.092***	0.086***
	(0.012)	(0.011)	(0.011)	(0.019)
Ln(employment)			0.024***	0.030***
			(0.003)	(0.003)
Firm age/100			0.069***	0.122***
			(0.016)	(0.020)
Listed			0.069***	0.039**
			(0.018)	(0.020)
Credit score			-0.002***	-0.001**
			(0.000)	(0.001)
CEO's age/100				0.031
				(0.027)
CEO college graduate				-0.026***
				(0.006)
Year FE	X	X	X	X
Year × Market FE		X	X	X
Industry FE (4-digit)			X	X
Prefecture FE			X	X
CEO birth prefecture FE				X
Observations	16,101,318	16,100,893	16,100,889	9,886,571
R-squared	0.000	0.004	0.006	0.008

Notes: The sample is derived from the TSR data for the period 2008 to 2020, and the level of observation is firm-market-year. Markets are defined as two-digit industry pairs and years. The dependent variable is $\frac{T^k_{i,F}}{\lambda^k_F}$, where λ^k_F is the share of female-led buyers in the market, and $T^k_{i,F}$ is the share of transactions between female-led buyers and female-led suppliers in the market. The estimates from Equation (6) are reported along with the standard errors clustered at the firm level across markets in parentheses. Estimates are weighted by the size of the market. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table 5: Relative Homophily from Suppliers' Perspective: Heterogeneity by Firm Size

	(1)	(2)	(3)	(4)
Female CEO	0.126***	0.116***	0.094***	0.088***
	(0.012)	(0.012)	(0.012)	(0.019)
Female CEO × large-firm	-0.101	-0.068	-0.076	-0.001
	(0.073)	(0.072)	(0.070)	(0.092)
Large-firm	0.232***	0.211***	0.208***	0.165***
	(0.009)	(0.010)	(0.012)	(0.015)
Ln(employment)			0.002	0.012***
			(0.003)	(0.003)
Firm age/100			0.083***	0.130***
			(0.015)	(0.020)
Listed			-0.000	-0.018
			(0.019)	(0.020)
Credit score			-0.002***	-0.001**
			(0.000)	(0.001)
CEO's age/100				0.018
				(0.027)
CEO college graduate				-0.025***
				(0.006)
Year FE	X	X	X	X
Year x Market FE		X	X	X
Industry FE (4-digit)			X	X
Prefecture FE			X	X
CEO birth prefecture FE				X
P-value: Female CEO + Femal CEO × large = 0	0.733	0.500	0.800	0.334
Observations	16,101,318	16,100,893	16,100,889	9,886,571
R-squared	0.000	0.004	0.006	0.008

Notes: The sample is derived from the TSR data for the period 2008 to 2020, and the level of observation is firm-market-year. Markets are defined as two-digit industry pairs and years. The dependent variable is $\frac{T^k_{i,F}}{\lambda^k_F}$, where λ^k_F is the share of female-led buyers in the market, and $T^k_{i,F}$ is the share of transactions between female-led buyers and female-led suppliers in the market. The estimates from the variant of Equation (6) that further include the interaction of a female CEO dummy and that of large firms are reported along with the standard errors clustered at the firm level across markets in parentheses. Estimates are weighted by the size of the market. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table 6: Logit Estimates of Gender Homophily

	(1)	(2)	(3)	(4)
CEO same gender	0.055***	0.070***	0.047***	0.051***
	(0.008)	(0.007)	(0.012)	(0.014)
Large firm-involved		0.909***	1.514***	-0.888***
		(0.005)	(0.006)	(0.010)
Ln(distance)			-0.661***	-0.940***
			(0.001)	(0.001)
Ln(distance) × large firm-involved				0.478***
				(0.001)
Supplier FE	X	X	X	X
Buyer FE	X	X	X	X
Number of quadruples	5,624,536	5,624,536	5,624,536	5,624,536

Notes: The sample is derived from the TSR data in 2019, and the unit of observation is a quadruple of firms $\{i_1, i_2, j_1, j_2\}$. The estimates from Equation (1) are reported along with the standard errors in parentheses. We draw a random sample of quadruples s.t. Z_σ=1,1, and we redraw random samples 30 times and report the average of β_h, to deal with the variation in the estimates due to random sampling. The standard errors are calculated as the standard deviation of β_h a la bootstrapping. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table 7: Logit Estimates of Gender Homophily: Heterogeneity by Firm Size

	(1)	(2)	(3)
CEO same gender	0.051***	0.102***	0.125***
	(0.014)	(0.015)	(0.022)
CEO same gender		-0.099***	
× large firm-involved		(0.007)	
CEO same gender			-0.074***
× medium/large firm-involved			(0.020)
Ln(distance)	-0.940***	-0.940***	-1.240***
	(0.001)	(0.001)	(0.004)
Ln(distance)	0.478***	0.478***	0.433***
× large firm-involved	(0.001)	(0.001)	(0.001)
Ln(distance)			0.345***
× medium/large firm-involved			(0.004)
Large firm-involved	-0.888***	-0.798***	-0.736***
	(0.010)	(0.011)	(0.010)
Medium/large firm-involved			-1.109***
			(0.026)
Supplier FE	X	X	X
Buyer FE	X	X	X
Number of quadruples	5,624,536	5,624,536	5,624,536

Notes: The sample is derived from the TSR data in 2019, and the unit of observation is a quadruple of firms $\{i_1, i_2, j_1, j_2\}$. The estimates from the variant of Equation (1) that further include the interaction of a CEO same-gender dummy and a dummy for firm size category are reported along with the standard errors in parentheses. We draw a random sample of quadruples s.t. Z_σ=1,1, and we redraw random samples 30 times and report the average of β_h, to deal with the variation in the estimates due to random sampling. The standard errors are calculated as the standard deviation of β_h a la bootstrapping. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table 8: Logit Estimates of Gender Homophily: Robustness

	(1)	(2)	(3)	(4)	(5)
CEO same gender	0.102***	0.097***	0.139***	0.141***	0.156***
	(0.015)	(0.016)	(0.049)	(0.048)	(0.045)
CEO same gender	-0.099***	-0.034***	-0.050*	-0.052*	-0.107***
× large firm-involved	(0.007)	(0.008)	(0.030)	(0.030)	(0.029)
Large-involved	-0.798***	-1.718***	-1.630***	-1.273***	-0.795***
	(0.011)	(0.013)	(0.040)	(0.045)	(0.033)
Ln(distance)	-0.940***	-0.812***	-0.735***	-0.699***	-0.885***
	(0.001)	(0.001)	(0.004)	(0.004)	(0.003)
Ln(distance)	0.478***	0.469***	0.426***	0.371***	0.465***
× large firm-involved	(0.001)	(0.002)	(0.004)	(0.004)	(0.004)
Same prefecture		0.587***	0.265***	0.375***	
		(0.005)	(0.011)	(0.018)	
|Δ. in ln(employment)|		0.208***	0.223***	0.230***	
		(0.001)	(0.004)	(0.004)	
|Δ. in firm age|		-0.003***	-0.002***	-0.003***	
		(0.000)	(0.000)	(0.000)	
|Δ. in credit score|		-0.002***	-0.001**	0.002*	
		(0.000)	(0.001)	(0.001)	
Both listed		-0.324***	-0.283***	-0.235	
		(0.012)	(0.024)	(0.147)	
|Δ. in CEO age|			-0.004***	-0.005***	
			(0.000)	(0.000)	
CEO same birth prefecture			0.702***	0.852***	
			(0.009)	(0.017)	
CEO same school			0.052***	0.055	
			(0.018)	(0.038)	
CEO same family name			0.643***	0.979***	
			(0.044)	(0.052)	
Supplier FE	X	X	X	X	X
Buyer FE	X	X	X	X	X
Homophily × large firm-involved				X	
Number of quadruples	5,624,536	5,624,536	1,011,930	1,011,930	1,011,930

Notes: The sample is derived from the TSR data in 2019, and the unit of observation is a quadruple of firms $\{i_1, i_2, j_1, j_2\}$. The estimates from Equation (1) are reported along with the standard errors in parentheses. We draw a random sample of quadruples s.t. Z_σ=1,1, and we redraw random samples 30 times and report the average of β_h, to deal with the variation in the estimates due to random sampling. The standard errors are calculated as the standard deviation of β_h a la bootstrapping. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table 9: Counterfactual Analysis

	(1) Male CEO supplier		(2) Female CEO supplier		(3) All		(4) Male - Female	
(A) Actual	6.03		3.61		5.91		2.42	
(B) Predicted	6.00		3.65		5.87		2.35	
(C) Counterfactual	6.01	(+ 0.30%)	3.83	(+ 4.91%)	5.90	(+ 0.45%)	2.19	(- 6.87%)

Notes: Panel (A) presents the actual number of transactions per firm in our sample. Panel (B) presents the predicted number of transactions per firm using the estimated logit model. Panel (C) presents the predicted number of transactions per firm under a counterfactual scenario, where we assume an equal probability of transactions taking place between CEOs of different genders and CEOs of the same gender. The numbers in parentheses in Panel (C) are the percentage change in the number of transactions per firm compared to the predicted number of transactions per firm.

Table 10: Survey: Regressions of Meeting with Female CEOs

	(1)	(2)	(3)	(4)	(5)
Female CEO	0.137***	0.107***	0.089***	0.087***	0.088***
	(0.010)	(0.012)	(0.018)	(0.018)	(0.019)
Ln(employment)				-0.015***	-0.015***
				(0.005)	(0.005)
Listed				-0.104	-0.101
				(0.096)	(0.096)
Credit score				0.001	0.001
				(0.001)	(0.001)
Survey dummy	X	X	X	X	X
Responses to preference-related questions		X	X	X	X
Ind. and region FE			X	X	X
CEOs attributes					X
Observations	5,114	5,114	5,114	5,114	5,114

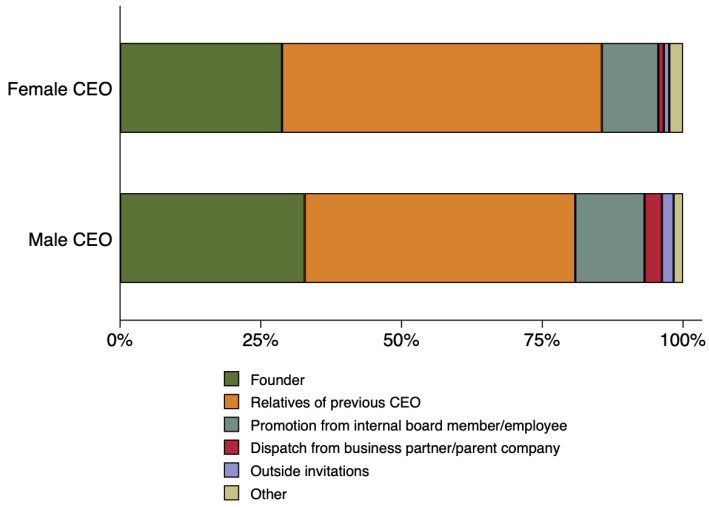
Notes: The sample is derived from our original survey, and the level of observation is the CEO respondent of the survey. The dependent variable is the dummy variable indicating the CEO with whom the respondent became recently acquainted with is female. For responses to preference-related questions, we include all the dummies of responses to questions listed in Figure 11. Industry FE is defined as the four-digit industry and region FE is defined as the prefecture level. CEOs attributes include CEOs' education categories, years of business experience, hours of working per week, and psychological attributes such as competitiveness, risk attitude, and confidence. The standard errors are clustered at the prefecture level. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Online Appendix (not for publication)

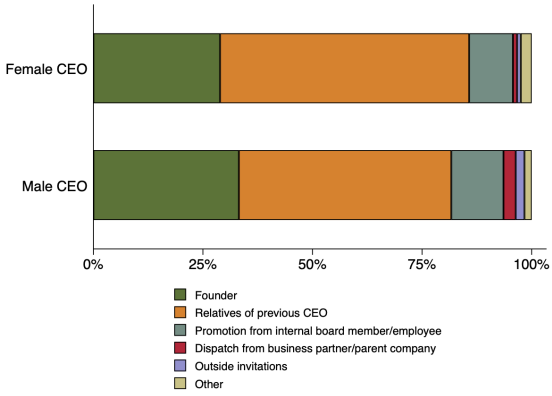
A Additional figures and tables

Figure A1: Background of CEO Appointment by Gender

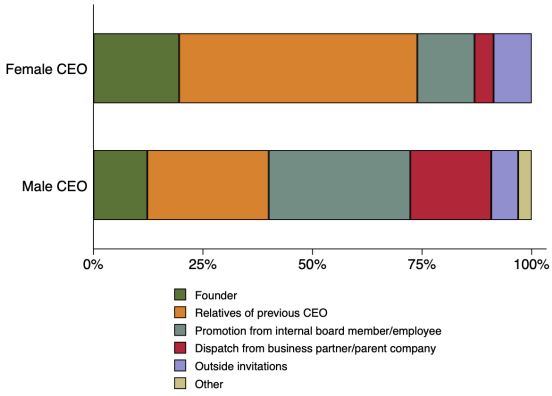
(a) All firms



(b) SMEs



(c) Large



Notes: This figure shows the background of CEO appointment by gender. Panel (a) includes all firms, while Panels (b) and (c) display the same figure for SMEs and large firms, respectively. See Appendix Table A4 for the definition of the firm-size categories. The sample is derived from our original survey, and the level of observation is the CEO respondent of the survey.

Table A1: Summary Statistics: Characteristics of Suppliers

	(1) Female CEO buyers			(2) Male CEO buyers			(3) Female - Male		
	N	Mean	SD	N	Mean	SD	Difference	SE	% from male
Panel A. Firm characteristics (suppliers)									
Ln(sale)	397,561	17.343	2.596	6,726,868	17.194	2.465	0.148***	0.004	-
Ln(employment)	397,561	4.270	2.027	6,726,868	4.154	1.906	0.116***	0.003	-
Ln(sale/employment)	397,561	12.999	0.981	6,726,868	12.963	0.928	0.036***	0.002	-
Large	397,561	0.376	0.399	6,726,868	0.357	0.375	0.019***	0.001	5.443
Medium	397,561	0.368	0.377	6,726,868	0.371	0.352	-0.003***	0.001	-0.709
Small	397,561	0.256	0.359	6,726,868	0.273	0.344	-0.017***	0.001	-6.159
SME	397,561	0.624	0.399	6,726,868	0.643	0.375	-0.019***	0.001	-3.017
Firm age	397,561	44.430	17.978	6,726,868	44.289	16.846	0.141***	0.028	0.317
Listed	397,561	0.106	0.237	6,726,868	0.107	0.225	-0.001***	0.000	-1.219
Credit score	397,561	55.287	7.342	6,726,868	55.098	6.895	0.190***	0.011	0.344
Ln(distance)	397,561	3.541	1.610	6,726,868	3.514	1.474	0.026***	0.002	-
Panel B. CEO characteristics (suppliers)									
CEO's age	380,823	59.727	7.650	6,497,967	59.666	7.025	0.061***	0.012	0.102
CEO college graduate	349,059	0.707	0.367	6,055,376	0.698	0.345	0.009***	0.001	1.308
Female CEO	397,561	0.034	0.142	6,726,868	0.026	0.113	0.008***	0.000	30.065

Notes: The sample is derived from the TSR data for the period 2008 to 2020. The table provides the summary statistics of suppliers from buyers' perspective for firm characteristics (Panel A) and CEO characteristics (Panel B), by the gender of CEO buyers'. Columns (1) and (2) provide the number of observations (N), mean, and standard deviations (SD) for female and male CEO buyers, respectively. Column (3) shows the difference between female and male CEO buyers, along with the % change from the mean of male CEO suppliers (except for a few variables which already take the log difference). Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table A2: Distribution of Female and Male CEO Firms across Industries

	Industry	Male CEO (%)	Female CEO (%)
A	Agriculture and forestry	0.8	0.7
B	Fisheries	0.1	0.1
C	Mining and quarrying of stone and gravel	0.1	0.1
D	Construction	32.1	24.8
E	Manufacturing	17.1	13.1
F	Electricity, gas, heat supply and water	0.1	0.1
G	Information and communications	2.7	2.3
H	Transport and postal services	3.9	4.0
I	Wholesale and retail trade	24.5	27.4
J	Finance and insurance	0.7	0.8
K	Real estate and goods rental and leasing	3.4	7.1
L	Scientific research, professional and technical services	3.8	3.7
M	Accomodations, eating and drinking services	1.5	3.1
N	Living-related and personal services and amusement services	1.5	3.1
O	Education, learning support	0.4	0.8
P	Medical, health care and welfare	1.8	3.2
Q	Compound services	0.8	0.2
R	Services, N.E.C.	4.6	5.5
	Total	100.0 %	100.0 %

Notes: The sample is derived from the TSR data for the period 2008 to 2020. The industry classification is based on the single-digit Japanese Standard Industry Codes.

Table A3: Share of Female-CEO Firms by Firm Size

	N	Share of female CEO firms
All	8,659,838	5.7%
Large	298,211	3.4%
Medium	2,651,354	5.0%
Small	5,710,273	6.2%

Notes: The sample is derived from the TSR data for the period 2008 to 2020.

Table A4: Official Definition of Firm Size

	SME (one of two needs to be satisfied)		Small
Industry	Capital stock (Yen)	# of employees	# of employees
Manufacturing, Construction, Transport , and other categories	≤300 million	≤300	≤20
Wholesale trade	≤100 million	≤100	≤5
Service industry	≤50 million	≤100	≤5
Retail trade	≤50 million	≤50	≤5

Note: This definition is based on the provisions of Article 2, Paragraph 1 of the Small and Medium-sized Enterprise Basic Act.

Table A5: Summary Statistics (Dyad Level)

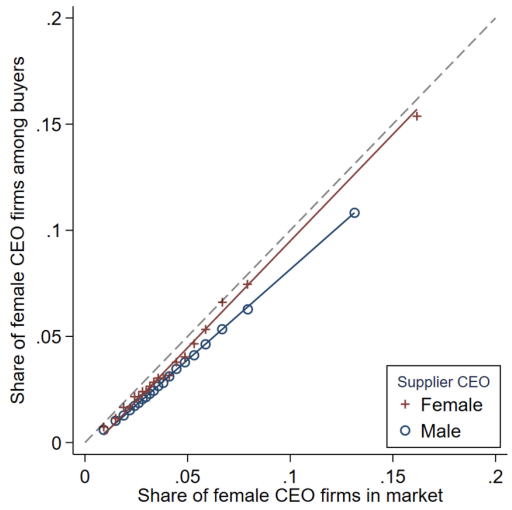
	N	Mean	SD
Panel A. CEO characteristics			
CEO same sex	11,249,072	0.934	0.249
$\|\Delta.$ in CEO age$\|$	8,552,784	11.409	8.599
CEO same birth prefecture	6,787,129	0.208	0.406
CEO same family name	11,248,780	0.005	0.071
CEO same school	5,682,659	0.011	0.102
Panel B. Firm characteristics			
Same prefecture	11,249,072	0.306	0.461
$\|\Delta.$ in ln(employment)$\|$	11,249,072	2.728	2.006
$\|\Delta.$ in firm age$\|$	11,249,072	25.627	19.203
$\|\Delta.$ in credit score$\|$	11,249,072	10.307	7.406

Notes: The sample is derived from the TSR data in 2019. The statistics in this table are based on a single draw of a random sample of quadruples s.t. $Z_\sigma = -1, 1$. The quadruples are then converted into dyad-level.

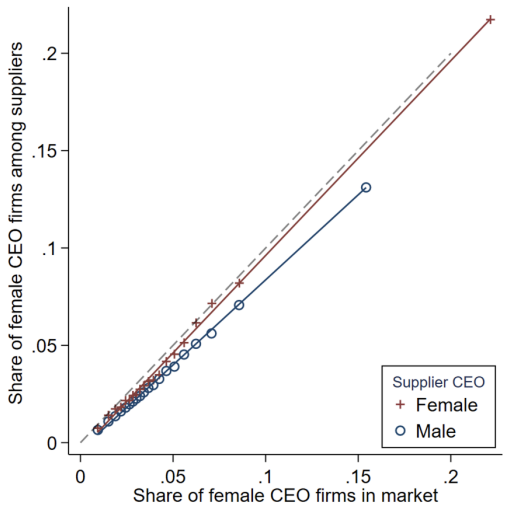
B Supplement for relative homophily

Figure B1: Relative homophily -Supplier-

(a) 3-digit industry



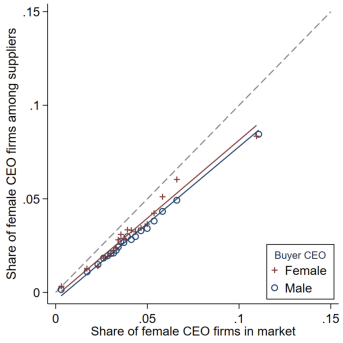
(b) 4-digit industry



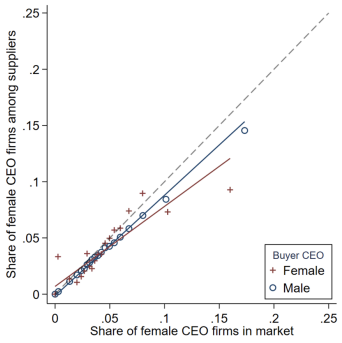
Notes: This figure displays a binned scatterplot of the share of female-led buyers in the market, λ_F^k, on the horizontal axis and the share of transactions with female-led buyers and female- and male-led suppliers in the market, $T_{g,F}^k$ where $g \in \{f, m\}$, on the vertical axis, along with regression linear lines weighted by market size. Bins are defined so that the number of observations in each bin is the same. The 45° dotted line indicates the random match. Markets are defined as three-digit industry pairs and years in Panel (a) and four-digit industry pairs and years in Panel (b). We restrict the sample to the markets with at least one female CEO firm on each side of the market.

Figure B2: Relative homophily -Buyer-

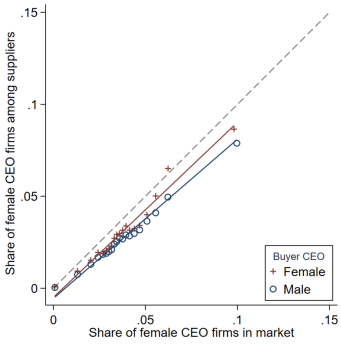
(a) All firms



(b) large firms



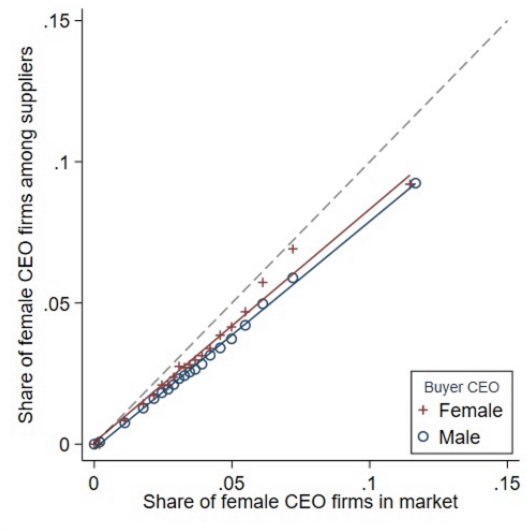
(c) SMEs



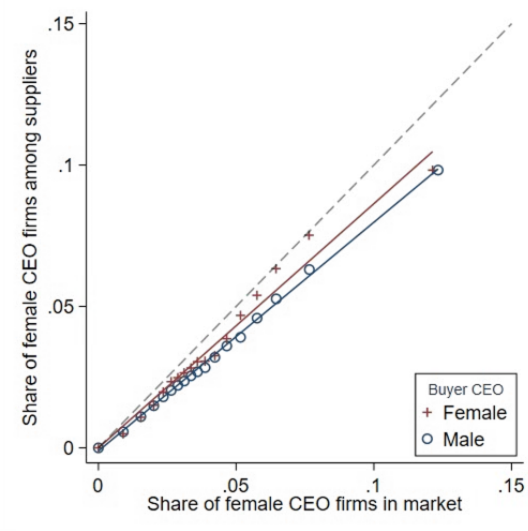
Notes: This figure displays a binned scatterplot of the share of the female CEO suppliers in the market, λ_f^k, on the horizontal axis and the share of transactions with female CEO suppliers and female CEO and male CEO buyers in the market, $T_{f,g}^k$ where $g \in \{f, m\}$, on the vertical axis, along with regression linear lines weighted by market size. Markets are defined as two-digit industry pairs and years. Markets are defined as two-digit industry pairs and years. Bins are defined so that the number of observations in each bin is the same. The 45° dotted line indicates the random match. Panels (a), (b), and (c) present the result for all firms, large-sized firms, and SMEs, respectively. See Appendix Table A4 for the definition of the firm-size categories.

Figure B3: Relative homophily -Buyer-

(a) 3-digit industry



(b) 4-digit industry



Notes: This figure displays a binned scatterplot of the share of the female CEO suppliers in the market, λ_f^k, on the horizontal axis and the share of transactions with female CEO suppliers of female CEO and male CEO buyers in the market, $T_{f,g}^k$ where $g \in \{f, m\}$, on the vertical axis, along with regression linear lines weighted by market size. Bins are defined so that the number of observations in each bin is the same. The 45° dotted line indicates the random match. Markets are defined as three-digit industry pairs and years in Panel (a) and four-digit industry pairs and years in Panel (b).

Table B1: Relative Homophily from Buyer's Perspective

	(1)	(2)	(3)	(4)
Female CEO	0.080***	0.111***	0.100***	0.066***
	(0.011)	(0.011)	(0.011)	(0.016)
Ln(employment)			0.041***	0.045***
			(0.002)	(0.002)
Firm age/100			0.012	0.042**
			(0.013)	(0.017)
Listed			-0.016	-0.025
			(0.014)	(0.016)
Credit score			-0.002***	-0.002***
			(0.000)	(0.000)
CEO's age/100				0.032
				(0.024)
CEO college graduate				-0.003
				(0.006)
Year FE	X	X	X	X
Year × Market FE		X	X	X
Industry FE (4-digit)			X	X
Prefecture FE			X	X
CEO birth prefecture FE				X
Observations	19,245,579	19,244,995	19,244,993	12,486,301
R-squared	0.000	0.007	0.009	0.011

Notes: The sample is derived from the TSR data for the period 2008 to 2020, and the level of observation is firm-market-year. Markets are defined as two-digit industry pairs and years. The dependent variable is $\frac{T^k_{i,F}}{\lambda^k_F}$, where λ^k_F is the share of female-led buyers in the market, and $T^k_{i,F}$ is the share of transactions with female-led buyers and female-led suppliers in the market. The estimates from Equation [6] are reported along with the standard errors clustered at the firm level across markets in parentheses. Estimates are weighted by the size of the market. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

Table B2: Relative Homophily from Buyer's Perspective: Heterogeneity by Firm Size

	(1)	(2)	(3)	(4)
Female CEO	0.102***	0.126***	0.103***	0.067***
	(0.011)	(0.011)	(0.011)	(0.017)
Female CEO × large firm	-0.082*	-0.032	-0.072*	-0.012
	(0.043)	(0.042)	(0.044)	(0.058)
Large firm	0.217***	0.184***	0.098***	0.089***
	(0.007)	(0.007)	(0.010)	(0.012)
Ln(employment)			0.030***	0.034***
			(0.002)	(0.003)
Firm age/100			0.019	0.047***
			(0.013)	(0.017)
Listed			-0.044***	-0.052**
			(0.015)	(0.016)
Credit score			-0.002***	-0.002***
			(0.000)	(0.000)
CEO's age/100				0.025
				(0.024)
CEO college graduate				-0.002
				(0.006)
Year FE	X	X	X	X
Year × Market FE		X	X	X
Industry FE (4-digit)			X	X
Prefecture FE			X	X
CEO birth prefecture FE				X
P-value: Female CEO + Female CEO × large = 0	0.622	0.022	0.456	0.320
Observations	19,245,579	19,244,995	19,244,993	12,486,301
R-squared	0.000	0.007	0.009	0.011

Notes: The sample is derived from the TSR data for the period 2008 to 2020, and the level of observation is firm-market-year. Markets are defined as two-digit industry pairs and years. The dependent variable is $\frac{T^k_{i,F}}{\lambda^k_F}$, where λ^k_F is the share of female-led buyers in the market, and $T^k_{i,F}$ is the share of transactions with female-led buyers and female-led suppliers in the market. The estimates from Equation [6] are reported along with the standard errors clustered at the firm level across markets in parentheses. Estimates are weighted by the size of the market. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

C Supplement for logit regressions

A practical issue in implementing the conditional maximum likelihood estimation in (7) is to overcome the computational hurdle. One approach is to randomly sample firms from each market and consider all quadruples formed by the sampled firms. However, in our data where the network is sparse, there is a possibility that the number of quadruples with $Z_\sigma = 1, -1$ is very small unless the sampling size is sufficiently large. Instead, we focus on the fact that $Z_\sigma = 1, -1$ is formed by trading pairs and sample based on trading pairs as follows:

1. From the N existing trading pairs, draw N pairs with replacement.
2. For each drawn pair (i_1, j_1), draw a counterpart (i_2, j_2) from the same market.
3. Keep the distinct quadruples $\sigma = \{i_1, i_2; j_1, j_2\}$ satisfying the following conditions:
   (a) $Z_\sigma = 1$ (i_1 trades with j_1 but not with j_2, and i_2 trades with j_2 but not with j_1).
   (b) Neither (i_1, j_2) nor (i_2, j_1) have the same CEO.
4. Repeat 1-3 until N quadruples satisfying the conditions (a) and (b) are drawn.
5. Duplicate N quadruples and swap j_1 and j_2 to construct N quadruples with $Z_\sigma = -1$. As a result, we obtain $2N$ quadruples s.t. $Z_\sigma = 1, -1$.

D Counterfactual Analysis

This section provides the technical details on the counterfactual analysis described in Section 3.5.

To evaluate the impact of reducing the same-gender CEO bias on $Pr(Y_{ij} = 1 | i \in S_g^k, j \in B_G^k)$, we proceed as follows:

Step 1. For each market k, we *fit* the logit model in (1) using the firm-pair level data by *fixing* the estimated pair-level variable coefficients in Section 3.4. To create non-trading firm-pairs, we use the choice-sampling method because the number of all possible firm-pairs in each market is prohibitively large. Note that the purpose here is to *fit* the model rather than to estimate the true underlying parameters.

Step 2. Using the fitted model in Step 1, we calculate the predicted probability of trade for each pair in the market under the counterfactual scenario. Specifically, for firm pairs with CEOs of different gender, we calculate the predicted probability of trade with the same-gender bias β_h added to it.

Step 3. We aggregate the predicted probability of trade across the gender pairs of CEOs.

For Step 1, to overcome the computational issue in this context, we follow Manski and Lerman (1977) and utilize a choice-based sampling approach as in Zeltzer (2020). Specifically, for each market k, we randomly sample non-trading pairs of suppliers and buyers within the market and construct weights using the inverse of the sampling probability. Importantly, when sampling non-trading pairs, we further stratify cells of non-trading pairs based on CEO gender pairs $(M-m, M-f, F-m, F-f)$ to ensure that rare pairs such as female-to-female are well-represented in the sample. More precisely, non-trading pairs are drawn as follows:

1. In each (market x gender pair), we randomly sample non-trading pairs so that the ratio of trading and non-trading pairs are

$$\text{trading pairs} : \text{non-trading pairs} = \begin{cases} 1:1, & M-m, \\ 1:50, & M-f, F-m, \\ 1:500, & F-f. \end{cases} \tag{D.1}$$

2. When there are insufficient potential non-trading pairs in a given (market x gender pair) to meet the above criteria, we draw all possible non-trading pairs.

3. When there are no trading pairs in a given market x gender pair, we also draw all possible non-trading pairs.

E Supplement for survey evidence

Table E1: Survey: Characteristics of Respondents and Non-respondents

	(1) Response			(2) Non-response			(3) Response - Non-response	
	N	Mean	SD	N	Mean	SD	Difference	SE
Panel A. Firm characteristics								
Ln(sale)	6,437	13.882	1.770	18,563	13.922	1.988	-0.040	0.028
Ln(employment)	6,437	1.947	1.186	18,563	1.969	1.333	-0.021	0.019
Ln(sale/employment)	6,437	11.935	1.274	18,563	11.953	1.384	-0.019	0.020
Firm age	6,437	34.411	19.032	18,563	33.397	18.819	1.015***	0.273
Listed	6,437	0.001	0.028	18,563	0.004	0.060	-0.003***	0.001
Credit score	6,437	47.229	5.594	18,563	46.824	5.883	0.404***	0.084
Panel B. CEO characteristics								
Female CEO	6,437	0.479	0.500	18,563	0.507	0.500	-0.029***	0.007

Notes: The sample is derived from our own survey. The table provides the summary statistics of firm characteristics and CEO gender, separately by respondents and non-respondents.

Table E2: Survey: Responses to Preference Related Questions

	(1) Female CEO			(2) Male CEO		
	N	Mean	SE	N	Mean	SE
Preference to meet	3,058	-0.069***	0.010	3,332	0.195***	0.009
Panel A. Positive Interactions						
Easier to talk business-releted concerns with	2,877	-0.001	0.012	3,163	0.466***	0.010
Easier to negotiate business deals with	2,893	0.198***	0.011	3,184	0.351***	0.010
Easier to interact with	2,903	-0.069***	0.011	3,189	0.269***	0.010
Panel B. Negative Interactions						
Talked down to you	2,796	0.421***	0.011	3,097	0.467***	0.010
Did not listen to you seriously	2,768	0.291***	0.011	3,086	0.316***	0.010
Pressured to follow gender stereotypes	2,768	0.394***	0.010	3,064	0.368***	0.010
More concerned about ability	2,825	-0.001	0.008	3,119	-0.019*	0.009

Notes: This table shows the results of preference-related questions for CEO gender from our original survey, and the level of observation is the respondent CEO of the survey. The actual questions are

- If you could become acquainted with a new CEO, would you like to get to know a male CEO, a female CEO, or it does not matter?": responses 'female;' 'male;' 'neutral.'
- We would like to ask you a few questions about your impressions during interactions and business meetings with CEOs (and other business partners) of other companies. For each of the following, which of the following do you think is more likely to be true of men or women? "easier to talk business-related concerns with," "easier to negotiate business deals with," "easier to interact with," "talked down to you," "did not listen to you seriously," "pressure to follow gender stereotypes," and "more concerned about the other's task ability.": responses 'female;' 'male;' 'neutral.'

The table presents the difference in the share of respondents who select male and female options, where coding assigns a value of one if the respondent selects male, zero if they are neutral, and -1 if the respondent selects female and taking the means. Significance levels: *** p< 0.01, ** p< 0.05, * p< 0.10.

F Technical appendix

F.1 Proof of the Proposition 1

Proof. Fix a market $k \in K$ and let us denote $\lambda_F^k \equiv Pr(G_j = F | j \in B^k), \tilde{\alpha}_i \equiv (X_i, \alpha_i^k), \tilde{\gamma}_j \equiv (X_j, \gamma_j^k)$, $\omega(\tilde{\alpha}_i, \tilde{\gamma}_j) \equiv g(X_i, X_j)'\delta + \alpha_i^k + \gamma_j^k$, and $\Lambda(\cdot) \equiv \frac{\exp(\cdot)}{1+\exp(\cdot)}$. Then for $g \in \{f, m\}$,

$$
\begin{aligned}
&T_{g,F}^k \to_p E[Pr(G_j = F | g_i = g, Y_{ij} = 1, j \in B^k, \tilde{\alpha}_i) | i \in S_g^k] \\
&= \int \frac{\lambda_F^k E_{\tilde{\gamma}_j|F,k}[\Lambda(\beta_h \mathbb{I}(g = f) + \omega(\tilde{\alpha}_i, \tilde{\gamma}_j))]}{\lambda_F^k E_{\tilde{\gamma}_j|F,k}[\Lambda(\beta_h \mathbb{I}(g = f) + \omega(\tilde{\alpha}_i, \tilde{\gamma}_j))] + (1 - \lambda_F^k) E_{\tilde{\gamma}_j|M,k}[\Lambda(\beta_h \mathbb{I}(g = m) + f(\tilde{\alpha}_i, \tilde{\gamma}_j))]} f(\tilde{\alpha}_i | i \in S_g^k) d\tilde{\alpha},
\end{aligned}
$$

as the market becomes large. Therefore, calculating the probability limit of $T_{f,F}^k - T_{m,F}^k$ and rewriting the expression, we have

$$
\begin{aligned}
&T_{f,F}^k - T_{m,F}^k \\
\to_p &\int \left\{ \frac{\lambda_F^k E_{\tilde{\gamma}_j|F,k}[\Lambda(\beta_h + \omega(\tilde{\alpha}_i, \tilde{\gamma}_j))]}{\lambda_F^k E_{\tilde{\gamma}_j|F,k}[\Lambda(\beta_h + \omega(\tilde{\alpha}_i, \tilde{\gamma}_j))] + (1 - \lambda_F^k) E_{\tilde{\gamma}_j|M,k}[\Lambda(\omega(\tilde{\alpha}_i, \tilde{\gamma}_j))]} \right. \\
&\qquad \left. - \frac{\lambda_F^k E_{\tilde{\gamma}_j|F,k}[\Lambda(\omega(\tilde{\alpha}_i, \tilde{\gamma}_j))]}{\lambda_F^k E_{\tilde{\gamma}_j|F,k}[\Lambda(\omega(\tilde{\alpha}_i, \tilde{\gamma}_j))] + (1 - \lambda_F^k) E_{\tilde{\gamma}_j|M,k}[\Lambda(\beta_h + \omega(\tilde{\alpha}_i, \tilde{\gamma}_j))]} \right\} f(\tilde{\alpha}_i | i \in S_f^k) d\tilde{\alpha} \\
&+ \int \frac{\lambda_F^k E_{\tilde{\gamma}_j|F,k}[\Lambda(\omega(\tilde{\alpha}_i, \tilde{\gamma}_j))]}{\lambda_F^k E_{\tilde{\gamma}_j|F,k}[\Lambda(\omega(\tilde{\alpha}_i, \tilde{\gamma}_j))] + (1 - \lambda_F^k) E_{\tilde{\gamma}_j|M,k}[\Lambda(\beta_h + \omega(\tilde{\alpha}_i, \tilde{\gamma}_j))]} \{ f(\tilde{\alpha}_i | i \in S_m^k) - f(\tilde{\alpha}_i | i \in S_f^k) \} d\tilde{\alpha}.
\end{aligned}
$$

The second term is zero when $\tilde{\alpha}_i$ is independently distributed among the gender of CEO suppliers: i.e., $f(\tilde{\alpha}_i | i \in S_m^k) = f(\tilde{\alpha}_i | i \in S_f^k)$. Further, the first term is equal to zero if and only if $\beta_h = 0$ when $\lambda_{F,k} > 0$. This completes the proof. □

F.2 Proof of the Proposition 2

Proof. Fix a market $k \in K$. Let us denote $W_{ij} \equiv (SameGender_{ij}, g(X_i, X_j))'$, $\theta \equiv (\beta_h, \delta)$ and rewrite the model (1) as

$$
Y_{ij} = \mathbb{I}\{W_{ij}'\theta + \alpha_i^k + \gamma_j^k - \epsilon_{ij} \geq 0\},
$$

where α_i^k and γ_j^k are supplier and buyer fixed effects. ϵ_{ij} is an unobserved idiosyncratic component that follows the logistic distribution independent from i and j. Fix a quadruple of distinct firms $\sigma^k \equiv \{i_1, i_2; j_1, j_2\}$, where $i_1, i_2 \in S^k$ and $j_1, j_2 \in B^k$, and define the random variable

$$
Z_\sigma \equiv \frac{(Y_{i_1 j_1} - Y_{i_1 j_2}) - (Y_{i_2 j_1} - Y_{i_2 j_2})}{2},
$$

and collect $W_\sigma \equiv (W_{i_1 j_1}, W_{i_1 j_2}, W_{i_2 j_1}, W_{i_2 j_2})$. Note that Z_σ can take on values from the set

$\{-1, -1/2, 0, 1/2, 1\}$. Conditional on W_σ and the event $Z_\sigma \in \{-1, 1\}$,

$$\Pr(Z_\sigma = 1 | W_\sigma, Z_\sigma \in \{-1, 1\}) = \frac{\Pr(Z_\sigma = 1 | W_\sigma)}{\Pr(Z_\sigma = -1 | W_\sigma) + \Pr(Z_\sigma = 1 | W_\sigma)},$$

where

$$\begin{aligned}
\Pr(Z_\sigma = 1 | W_\sigma) &= \Pr(Y_{i_1 j_1} = 1 | W_\sigma) \Pr(Y_{i_1 j_2} = 0 | W_\sigma) \Pr(Y_{i_2 j_1} = 0 | W_\sigma) \Pr(Y_{i_2 j_2} = 1 | W_\sigma) \\
&= \frac{\exp(W'_{i_1 j_1}\theta + \alpha^k_{i_1} + \gamma^k_{j_1})}{1 + \exp(W'_{i_1 j_1}\theta + \alpha^k_{i_1} + \gamma^k_{j_1})} \frac{1}{1 + \exp(W'_{i_1 j_2}\theta + \alpha^k_{i_1} + \gamma^k_{j_2})} \\
&\times \frac{1}{1 + \exp(W'_{i_2 j_1}\theta + \alpha^k_{i_2} + \gamma^k_{j_1})} \frac{\exp(W'_{i_2 j_2}\theta + \alpha^k_{i_2} + \gamma^k_{j_2})}{1 + \exp(W'_{i_2 j_2}\theta + \alpha^k_{i_2} + \gamma^k_{j_2})},
\end{aligned}$$

and

$$\begin{aligned}
\Pr(Z_\sigma = -1 | W_\sigma) &= \Pr(Y_{i_1 j_1} = 0 | W_\sigma) \Pr(Y_{i_1 j_2} = 1 | W_\sigma) \Pr(Y_{i_2 j_1} = 1 | W_\sigma) \Pr(Y_{i_2 j_2} = 0 | W_\sigma) \\
&= \frac{1}{1 + \exp(W'_{i_1 j_1}\theta + \alpha^k_{i_1} + \gamma^k_{j_1})} \frac{\exp(W'_{i_1 j_2}\theta + \alpha^k_{i_1} + \gamma^k_{j_2})}{1 + \exp(W'_{i_1 j_2}\theta + \alpha^k_{i_1} + \gamma^k_{j_2})} \\
&\times \frac{\exp(W'_{i_2 j_1}\theta + \alpha^k_{i_2} + \gamma^k_{j_1})}{1 + \exp(W'_{i_2 j_1}\theta + \alpha^k_{i_2} + \gamma^k_{j_1})} \frac{1}{1 + \exp(W'_{i_2 j_2}\theta + \alpha^k_{i_2} + \gamma^k_{j_2})}.
\end{aligned}$$

Thus,

$$\Pr(Z_\sigma = 1 | W_\sigma, Z_\sigma \in \{-1, 1\}) = \frac{\exp(((W_{i_1 j_1} - W_{i_1 j_2}) - (W_{i_2 j_1} - W_{i_2 j_2}))'\theta)}{1 + \exp(((W_{i_1 j_1} - W_{i_1 j_2}) - (W_{i_2 j_1} - W_{i_2 j_2}))'\theta)},$$

which is the desired form. □