Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Cracking the silicon ceiling: how female directors shape corporate robot adoption

Jianjun Dong
Nanjing University of Science and Technology
Yuqing Xu
Nanjing University of Science and Technology
Xuekun Suo
Sichuan University
Han Lin
Nanjing Audit University
Mingchuan Yu
Ningbo University of Finance and Economics
Ming Yuan
mingy0625@163.com
Longyan University

Article

Keywords: Female board representation, industrial robot adoption, internal control, pricing power, expectation states theory

Posted Date: February 24th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8572539/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.

Abstract

Drawing on expectation states theory, this study investigates the impact of board gender diversity on industrial robot adoption within the context of the era of industrial intelligence. Based on a sample of Chinese A-share listed manufacturing firms from 2011 to 2022, the research utilizes panel data regression analysis to empirically test this relationship, employing instrumental variables and robustness checks to address endogeneity concerns. The findings reveal that female board representation significantly promotes the adoption of industrial robots, suggesting that gender-diverse boards are more receptive to technological innovation. Furthermore, the analysis indicates that this positive effect is heterogeneous: it is enhanced by higher product pricing power but weakened by stronger internal controls. As one of the first empirical studies to connect demographic diversity with industrial robot adoption, this research contributes to the literature on corporate governance and technology management. The results suggest that manufacturing firms, particularly those with strong market positions, should consider gender diversity as a strategic asset for enhancing technological competitiveness, while providing policymakers and investors with new insights into the strategic value of diverse leadership.

I. Introduction

Combining business with artificial intelligence aims to build new pathways for enterprises to cultivate core competitiveness (Duan et al., 2023; Koch et al., 2021; Kong et al., 2023). Industrial robots, as AI-enabled generalized technology, are increasingly adopted due to their dual externality: improving productivity and generating positive environmental spillovers (Acemoglu & Restrepo, 2018; Chen et al., 2024). Amid fading demographic dividends and urgent industrial upgrading needs, they represent a strategic option for enterprises (Duan et al., 2023). Promoting environmental protection while creating economic value is an effective strategy for securing new market opportunities and competitive advantages (Li et al., 2025; Zhao et al., 2024). Therefore, exploring factors affecting industrial robot adoption holds significant theoretical and practical importance.

Given the critical importance of industrial robots, researchers have endeavored to identify the relevant antecedents of industrial robot adoption through different perspectives, which are categorized into two main areas: institutional theories and market competition. Institutional theories highlight the role of environmental institutions (Acemoglu & Restrepo, 2020; Zhu et al., 2023), with AI advancements (Goldsmith-Pinkham et al., 2020). Enabling robots to reduce industrial pollution (Rodrigue et al., 2024; Yu et al., 2023) and ensure environmental compliance (Huang et al., 2022). Market competition drives adoption through robots' productivity effects (Autor, 2015). While insightful, these views primarily frame adoption as externally driven. Crucially, adoption is a strategic decision contingent on organizational decision-makers' willingness and ability (Islam et al., 2025), influenced by factors like gender (Duan et al., 2023; Kong et al., 2023) and top management team traits (Adams & Ferreira, 2009; Zou et al., 2018). Scholars have further revealed that women tend to pursue social and economic goals through technology adoption more than men (Liu et al., 2014), suggesting board gender diversity—by increasing social diversity—may play a key role in industrial robot adoption.

Female board representation refers to the percentage of female directors on a company's board, also known as board gender diversity (Guldiken et al., 2019). Rising education and recognition of women's leadership increase female senior roles (Mao et al., 2023). This representation impacts firm competitiveness through gender-neutral hiring, meritocratic promotion (Dezsö & Ross, 2012), and diverse decision-making benefits like innovation and long-term value creation (Luo et al., 2018). Female managers' traits may facilitate technology adoption (Kong et al., 2023), accelerate technology introduction and improve decision-making efficiency (Zou et al., 2018; Adams & Ferreira, 2009). However, China presents a distinct context. Despite government gender equality advocacy, deeply ingrained traditional patriarchal norms create a persistent gap between policy and corporate reality. For instance, in companies with strong patriarchal norms, female directors' unique insights may be limited in technology adoption decisions.

Despite growing research on female board representation, its role as a motivator for industrial robot adoption remains neglected. This study addresses this gap by establishing a correlation between female board representation and industrial robotics adoption. Drawing on the expectation states theory, a gender-specific framework is developed to examine this role. The theory provides an interactive perspective on board diversity expectations, identifying gender diversity enhances the willingness and efficiency of adopting industrial robots through the differentiated ability expectation mechanism in the expected state theory and the dual-dimensional drive (vertical skill advantages and horizontal responsibility consensus) in the practical logic. In addition, internal control weakens this correlation, while pricing power strengthens it. Empirical analysis of Chinese manufacturing companies (2011–2022) supports the framework and hypotheses.

This study contributes theoretically and practically. Theoretically, it innovatively links gender diversity with industrial robot adoption in emerging tech, filling literature gaps (Adams et al., 2023; Adams & Ferreira, 2009; Chen et al., 2018; Fall et al., 2021). It empirically demonstrates female directors' unique role in promoting adoption, opening new avenues for diversity research and offering fresh perspectives on their complex technological impact from a gender equality stance. It further clarifies gender diversity's diverse manifestations across organizational contexts, laying groundwork for defining adoption boundary conditions and deepening understanding of internal mechanisms. Practically, it provides new perspectives and evidence for enterprise robot adoption, helping firms—especially high-tech enterprises—capitalize on opportunities to enhance productivity and efficiency.

II Theory, literature review and hypotheses development

Industrial robot adoption

Industrial robotics, a “high-impact” innovation boosting productivity and reducing environmental costs (Lin & Xu, 2024), faces conflicting drivers in research. While environmental regulations and competitive markets are seen by some as triggers for adoption through enhanced competitiveness (Dong et al., 2024b; Goldsmith-Pinkham et al., 2020), others argue strict regulations increase costs, inhibiting adoption. Studies have shown that firms adopt robots to optimize processes, reduce costs in response to environmental pressures, resource constraints, and market demands (Acemoglu et al., 2014; Autor, 2015).

In response to external drivers, organizations tend to acquire and develop resources for managing processes (Dong et al., 2024a) in response to industrial robot adoption, where corporate governance matters: poor governance reduces outputs (Huang et al., 2023). Another study found that internal control, a set of activities implemented by companies to monitor business processes and control risks, negatively impacts robot adoption (Islam et al., 2025), while pricing power as the ability of firms to adjust pricing strategies, facilitates adoption (Maine et al., 2015).

In summary, despite this focus on external push and governance, the role of female board representation in industrial robot adoption remains underexplored.

Socially assigned roles of gender: expectation states theory

Gender diversity in corporate boardrooms' impact on firms' strategic choices and performance has been explored through various theoretical perspectives (Ahern & Dittmar, 2012), analyzing its effects on corporate strategy and operations (Saeed et al., 2024; Triana et al., 2019). This study expands existing research by incorporating expectation states theory to explain female directors' preferences for adopting industrial robots. The theory focuses on gender diversity in team collaboration and its contribution to group goal consensus (Correll & Ridgeway, 2006).

Expectation states theory posits that inherent biases about others' capabilities influence group dynamics, evoking stereotypes in task-oriented settings (Correll, 2004; Yuan & Sun, 2024). It's pertinent in environments with low female representation, acknowledging gender disparities' impact on decision-making (Fuentes-Fuentes et al., 2023). Gender, a social construction sustaining unequal relations, shapes behavior, practice, and individual identities within organizations (Correll, 2004). The theory elucidates how gender-based status and differing competence perceptions affect social interactions in organizational contexts (Ridgeway & Correll, 2004).

Expectation states theory states that biases about group characteristics influence interactions (Correll & Ridgeway, 2006), and characteristic differences can trigger stereotypes in task-specific situations (Correll, 2004). It is applicable where women are underrepresented, as it explicitly addresses gender differences' impact on decision-making and outcomes (Fuentes-Fuentes et al., 2023). At the interaction level, it shapes organizational behavioral norms and practices; at the individual level, it shapes identities and roles (Correll, 2004). The theory describes how gender-determined status and competence beliefs affect organizational interactions (Ridgeway & Correll, 2004).

The theory also states that expectations of task completion and evaluations are influenced by vertical characteristics (specialized skills, e.g., men's competence in practical activities) and horizontal characteristics (group distinctiveness, e.g., females' team-orientation) (Fuentes-Fuentes et al., 2023; Eagly, 2009). Dominant femininity perceptions affect behavior by shaping perceived expectations (Fuentes-Fuentes et al., 2023). Thus, the framework formed by these two characteristics is pertinent in industrial robot adoption.

Female board representation and industrial robot adoption

In a context where gender diversity is increasingly valuing skills over representation, female directors are expected to provide unique insights on technology adoption, impacting firms (Saeed et al., 2024; Triana et al., 2019). Management implements industrial robotics to demonstrate its value. Based on expectation states theory, gender characteristics and task-related skills are crucial for evaluating contributions (Correll & Ridgeway, 2006; Fuentes-Fuentes et al., 2023). In industrial robot adoption, gender diversity and specialized skills interact, shaping perceptions of individual contributions.

In the vertical dimension, managers specializing in industrial robot adoption are scrutinized for critical knowledge and skills, such as those maintaining relationships with developers/suppliers or securing favorable loans. Culturally gendered competence stereotypes (e.g., Confucian expectations) often assign women group-oriented strengths: communication (Correll, 2004; Dezsö & Ross, 2012), collaboration, financing, and team cohesion (Karavitis et al., 2021; Luo et al., 2018). This skillset aligns with industrial robot adoption's demands for multi-party coordination, technology integration, and capital deployment (Duan et al., 2023; Kong et al., 2023), an area where women show higher involvement (Sang et al., 2020). Consequently, gendered competence expectations increase the likelihood that women's contributions to robotics adoption are valued (Correll & Ridgeway, 2006). Furthermore, the adoption of industrial robots may boost their credibility, standing, and acknowledgment in the company, given perceptions of their superior competency in this domain (Correll, 2001), thereby increasing their effectiveness in achieving adoption goals.

Horizontally, individual differences create heterogeneity in industrial robot adoption outcomes among female directors. Existing research shows women exhibit higher social responsibility than men (Zou et al., 2018), that is, they are more inclined to participate in decision making on strategic activities that are friendly to the environment and stakeholders (Javed et al., 2023). Female managers' stronger social responsibility may create a subgroup effect that fosters internal consensus and concerted action when adopting eco-friendly robotics that enable business transformation. This increases management's willingness to adopt industrial robots.

For the corporate strategic level, industrial robot adoption is undoubtedly a green-related technological innovation initiative (Li et al., 2025), that is, requiring integration of robotics compatible with green manufacturing across organizational processes and technological resources. To a certain extent, the corresponding investment of technological resources and conceptualization are required (Yuan & Sun, 2024). In this sense, females play a key role both in facilitating strategic decisions and accelerating adoption, advancing robots' strategic integration. Thus, even if not all possess relevant competencies, greater female representation increases the likelihood of adoption-related decisions and actions. Therefore, Hypothesis 1 is formulated as follows.

H1: Female board representation is positively associated with the adoption of industrial robots.

The moderating role of internal control

While industrial robot adoption offers benefits, it also inevitably faces high costs and necessitates process changes (Islam et al., 2025). As a core management function, internal control—ensuring operations and risk reduction—significantly impacts management teams' adoption efforts (Li et al., 2024).

Expectation states theory indicates managers' gender influences decisions (Correll, 2004). Under systemic pressures, internal control rigor critically shapes female managers' strategies for promoting adoption (Nasir et al., 2021). Moderate control enhances autonomy, fostering cross-functional cooperation and innovation, whereas high control impedes adoption and reduces flexibility.

For one thing, under relaxed internal control, female managers view industrial robot adoption challenges as inherent to innovation. This flexibility fosters collaboration and problem solving (Nakata & Im, 2010). In such an organizational climate, female managers strategically balance control with adoption to mitigate risks and enhance competitiveness through innovation, creating greater economic value (Rodríguez et al., 2008). In addition, low internal control Low control also provides motivation and autonomy, eases resource competition, and reduces internal constraints' impact on adoption, thus boosting female managers' inclination toward robotics implementation.

Conversely, overly strict internal control constrains female managers' cognitive flexibility (Li et al., 2024), reinforcing adherence to traditional practices. Industrial robot adoption entails high investment, learning costs, and risks of uneven resource allocation (Chang et al., 2023), which strict control exacerbates by prioritizing risk minimization over innovation. This limits firms to rigid processes and makes it difficult to quickly adjust strategies and business models when necessary. Expectation states theory suggests challenging environments amplify female managers' caution: while relaxed control limits diversity's impact, strict control heightens its role in adoption decisions. Therefore, Hypothesis 2 is hypothesized as follows:

H2: Internal control negatively moderates the adoption of industrial robots by female board representation.

The moderating role of pricing power

Pricing power denotes a firm’s ability to align product or service pricing with market acceptance and industry standards through market analysis, strategy adjustments, and resource optimization (Dutta et al., 2003; Maine et al., 2015). Previous studies have pointed out that pricing power critically sustains profitability and market share, thereby influencing management's decisions on corporate strategies (Maine et al., 2015). Further, the process of how female managers evaluate firms based on the level of “fit” mentioned above and thus influence decision-making is revealed in this paper. Notably, female directors associate with multi-stakeholder strategies (Meng et al., 2024). Expectation states theory posits that senior directors maintain implicit leadership through long-term strategies that align competencies with roles to enhance organizational impact (Meng et al., 2024). Thus, female board representation's impact on industrial robot adoption hinges on pricing power.

On the one hand, When firms possess high pricing power, female managers become more receptive to industrial robot adoption's uncertainties, as the firm better withstands market fluctuations (Liozu & Hinterhuber, 2013). In this case, they leverage this advantage to predict demand, adjust pricing, optimize costs, reduce risks, and actively participate in adoption decisions (Raja et al., 2020). On the other hand, high pricing power enhances perceived adoption benefits: female managers recognize such firms can precisely position offerings and respond swiftly to market, technological innovations to maximize the return on investment (Liozu, 2015). This increases their likelihood of lowering adoption thresholds, enhancing decision efficiency, and actively promoting robotics implementation.

Conversely, low pricing power heightens industrial robot adoption challenges. If female managers perceive pricing strategies cannot cover robot costs (Liozu & Hinterhuber, 2013), skepticism and resistance may weaken willingness to embrace industrial robotics. Low pricing power inefficiently converts technology investments into returns and may trigger avoidable financial risks (Liozu, 2015), motivating female managers to maintain current production models rather than explore robots' productivity gains. Based on this, the following prediction is proposed that female managers in low pricing power firms likely constrain robot adoption compared with firms with high pricing power. Therefore, Hypothesis 3 is hypothesized as follows:

H3

Pricing power positively moderates the adoption of industrial robots by female board representation.

Figure 1 illustrates the conceptual framework with explanatory, moderating, and explained variables.

< Insert Fig. 1 here >

III. Methodology

Sample and Data

To evaluate the above hypothesis, a sample of Chinese manufacturing companies listed between 2011 and 2022 was analyzed. First, companies categorized as special treatment (ST) or special transfers (PT) are excluded. This step is intended to exclude data points that could unduly influence the statistical analysis and to ensure a more representative sample. The second step excludes samples that lack variable data. Finally, a sample of this observation was obtained.

The industrial robot data used in this study is derived from the International Federation of Robotics (IFR), an authoritative global non-profit providing country-industry-year robotics statistics directly from manufacturers. Since industrial robots primarily serve manufacturing, this paper focuses on manufacturing sector data. Personnel data are obtained from the industrial enterprise database, which is widely used for research on China's economy, and financial data are derived from the CSMAR, which is known for supporting empirical research and model testing.

Variable Measuremen t

Female board representation

The percentage of women serving on the board is designated as the independent variable. According to previous studies (Adams et al., 2023), the female directors' proportion is utilized as our primary scale of female board representation (Female). For robustness, we also consider two alternatives: a binary variable assigned a value of one if there is at least one female manager on the board, and zero if there are none (Dezsö & Ross, 2012). This metric aligns with managers' pivotal roles in industrial robot adoption (Kong et al., 2023).

Industrial robot adoption

The dependent variable, industrial robot adoption (Robot), is measured using an enterprise-level penetration index. Following prior research (Acemoglu & Restrepo, 2020; Goldsmith-Pinkham et al., 2020), this paper integrates IFR industry-level robotics data with Chinese manufacturing listed firms' microdata, adopting the "Batik instrument" approach. The utilization of industrial robots in China has shown a pronounced upward trend only since 2010, and accounting for potential lagged effects of female board representation, dependent and moderating variables use one-period lagged data (2012–2022), while independent variables cover 2011–2021.

The specific measurement method is as follows:

Step 1: Calculate the industrial robot penetration rate indicator at the industry level:

$$PR_{it}^{CH} = \frac{MR_{it}^{CH}}{L_{i,t=2011}^{CH}}$$

MR_{it}^{CH} represents the stock of industrial robots in Chinese industry *i* in year *t*, $L_{i,t=2011}^{CH}$ denotes the employment level in Chinese industry *i* in the base year 2011, PR_{it}^{CH} measures the penetration rate of industrial robots in Chinese industry *i* in year *t*.

Step 2: Construct an indicator for the penetration rate of industrial robots at the enterprise level:

$$CHFexposure\ to\ robuts_{jit} = \frac{PWP_{jit=2012}}{ManuPWP_{t=2012}} * PR_{it}^{CH}$$

This indicator measures the penetration rate of industrial robots in industry *j* in year *t*. $\frac{PWP_{jit=2012}}{ManuPWP_{t=2012}}$ represents the ratio of the proportion of employees in the production sector of industry *i* and enterprise *j* in the manufacturing sector in 2012 (base period) to the median proportion of employees in the production sector of all enterprises in the manufacturing sector in 2012. For enterprises *j*, changes in the penetration rate of industrial robots mainly reflect changes in the technological characteristics of the domestic industry, and are unrelated to the characteristic factors of the enterprises themselves.

Step 3: Using US industry-level industrial robot data to construct an instrument variable for robot penetration at the Chinese enterprise level:

$$\bar{CHFexposure\ to\ robuts}_{jit} = \frac{PWP_{jit=2012}}{ManuPWP_{t=2012}} * \frac{MR_{it}^{US}}{L_{i,t=1990}^{CH}}$$

MR_{it}^{US} indicates the stock of industrial robots in the US industry *i* in year *t*. $L_{i,t=1990}^{CH}$ represents the number of people employed in the industry *i* in the US in 1990 (base period). $PR_{it}^{US} = \frac{MR_{it}^{US}}{L_{i,t=1990}^{CH}}$ indicates the penetration rate of industrial robots in the US industry *i* in year *t*.

This paper employs U.S. industrial robot data as an instrumental variable for two reasons: First (technological exogeneity): As a global leader in industrial robotics, U.S. industry robot adoption trends effectively reflect the direction of technological progress in the sector, rather than being influenced by country-specific factors. Second (exclusivity constraint): The near-perfect U.S. labor market means its robot application affects China primarily through technology spillovers, not endogenous factors like labor market distortions. Therefore, the level of industrial robot application in the United States meets the dual conditions for a tool variable: Correlation: U.S. trends align with technological characteristics in China's comparable industries; Exogeneity: Unrelated to China's domestic adoption drivers, e.g., policy subsidies, labor cost fluctuations.

Internal control

Based on previous experience, internal control index (IC) is chosen to measure the degree of internal control in firms in this study (Yuan & Sun, 2024), sourced from the DIB database and risk management database (Li et al., 2024). Data were logarithmically transformed to ensure comparability and reduce bias and extreme values. The index evaluates listed firms' internal control systems through five indicators: i.e., legitimacy of operation and management, security of company property, validity and completeness of financial reports and associated information, operational efficiency and effectiveness, and realization of the development strategy.

Pricing power

According to previous studies, pricing power (PP), measuring a firm's market position and monopoly degree (Nguyen & Nguyen, 2022), is quantified using the Lerner index (Spierdijka & Zaourasa, 2018). Lerner's index, also referred to Lerner's index of monopoly power, which gauges monopoly strength by measuring price deviation from marginal cost. When the Lerner index approaches 0, it signifies that the firm possesses negligible market power, with the price being

nearly equivalent to its marginal cost. Conversely, when the Lerner index nears 1, it indicates that the firm holds considerable market power, enabling it to set prices significantly above its marginal cost.

The formula for calculating the Lerner Index of an enterprise is $L = (P - MC)/P$. (Where *L* represents the Lerner Index, *P* represents the price, and *MC* represents marginal cost, which refers to the variation in total cost that results from producing one additional unit or reducing production by one unit at a specific level of output.)

Control variables

Various factors impact industrial robot adoption. Based on the existing literature, a set of corporate characteristics that may affect industrial robot adoption are selected (Duan et al., 2023; Kong et al., 2023) in order to minimize their potential impact (Goldsmith-Pinkham et al., 2020; Zhu et al., 2023): *firm size* (*Size*, i.e., log of annual total assets), *firm leverage* (*Lev*, i.e., total liabilities/total assets), *firm growth* (*Growth*, i.e., revenue for the current year/revenue for the previous year-1), *return on assets* (*ROA*, i.e., net profit/total assets), *cash flow ratio* (*Cashflow*, i.e., operating cash flow/current liabilities), *proportion of fixed assets* (*FIXED*, i.e., fixed assets/total assets), *firm age* (*Firm Age*, i.e., log of the number of years since the firm's founding) and *ownership concentration* (*Top1*, i.e., the number of shares held by the largest shareholder/the total number of shares).

The definitions and measurements of the variables involved in the study are described in detail in Table I.

< Insert Table I here >

IV. Results

Empirical Results

The descriptive analysis of the sample is displayed in Table□, including the mean, standard deviation, and correlation coefficients among the variables. All correlations between variables were less than 0.7, which is within acceptable limits.

< Insert Table □ here>

Table III tests Hypothesis 1 on the positive link between female board representation and industrial robot adoption. Model 1, the baseline regression, shows a significant positive correlation ($\beta = 0.717$, $p < 0.01$). Model 2, incorporating eight control variables, confirms this positive relationship ($\beta = 0.847$, $p < 0.05$), strongly validating Hypothesis 1. The coefficient of 0.847 implies that 1 percentage point increase in female representation is associated with an average increase of 0.847 units in this penetration index of industrial robots in enterprises. The rise in coefficient from Model 1 to Model 2 suggests that firm characteristics may moderate the effect. For instance, return on assets negatively correlates with adoption ($\beta = -0.041$), while the fixed asset ratio shows a strong positive correlation ($\beta = 0.661$, $p < 0.01$), indicating a substantial impact compared to other control variables.

< Insert Table III here >

The moderating effects of internal control and pricing power were tested in Models 3 and 4, respectively. Consistent with earlier findings, Model 3 showed that female board representation maintained a significant positive correlation with industrial robot adoption ($\beta = 0.839$, $p < 0.01$). However, the interaction between female board representation and internal control negatively correlated with industrial robot adoption ($\beta = -0.006$, $p < 0.05$), indicating that internal control moderates this relationship. As shown in Fig. 2, the relationship between female board representation and industrial robot adoption is positive and flat under lax internal control but significantly negative under strict internal control, highlighting its non-negligible moderating effect.

< Insert Fig. 2 here >

When considering pricing power, the interaction coefficient between female board representation and pricing power ($\beta = 4.509$, $p < 0.05$) shifts from significant at the 1% level to significant at the 5% level, compared to the coefficient for female representation alone ($\beta = 0.817$, $p < 0.01$). Pricing power is a crucial moderating factor in the relationship between female board representation and industrial robot adoption. High pricing power strengthens this positive correlation, as shown in Fig. 3.

< Insert Fig. 3 here >

Robustness Analysis

Robust test

Robust tests are conducted to ensure dependability of the research results. Table IV shows benchmark model test results using variable substitution, adding control variables, and eliminating extreme values. First, change the independent variable measurement with a 0–1 binary variable (1 for female directors in the company, 0 otherwise). Table IV shows a positive regression coefficient ($\beta = 0.430$, $p < 0.01$) in the first column, keeping core results unchanged. Next, modify the independent variable with the blindex index for female board representation and re - run regression analysis. The second column in Table IV shows a significant positive correlation ($\beta = 0.641$, $p < 0.01$) at the 1% level, strongly reinforcing the core findings.

Some literature indicates corporate governance factors impact the causality (Spierdijka & Zaourasa, 2018), so the following three control variables at the level of corporate governance are added to the sample : *ratio of independent directors* (*Indep*, the number of independent directors/the number of directors), *board size* (*Board*, log of the number of board members), and *dual positions* (*Dual*, the chairman and the general manager are the same person 1, otherwise

0). Regression on the augmented sample (third column) reveals a significant positive correlation ($\beta = 0.868$, $p < 0.01$) among main variables. Finally, to address extreme values, continuous variables are Winsorized at the 1% level. The fourth column results still show a significant positive correlation ($\beta = 0.793$, $p < 0.01$). Overall, these robust tests bolster our findings.

< Insert Table IV here >

Endogeneity Test

Female board representation positively affects industrial robot adoption, though firms may adjust executive gender ratios due to technical or managerial skill needs. In addition, economic, cultural, and policy differences between provinces also affect female board representation and industrial robot adoption. To address endogeneity, which includes reverse causality and omitted variables, this study employs an instrumental variable approach using provincial average female board representation. As an indicator of the overall level of female board representation of firms in the province, the average female board representation in the province is highly correlated with the female board representation of individual firms. In addition, Provincial averages don't directly affect individual firms' robot adoption decisions. This design controls provincial confounders while meeting instrumental variable requirements.

Table V presents the results: the Kleibergen-Paap rk LM statistic is 548.602 with p = 0, rejecting the non-identifiability hypothesis of the instrumental variable. The Kleibergen-Paap rk Wald F statistic is 629.940, rejecting the weak instrumental variable hypothesis, validating the choice of provincial average female board representation as a reasonable instrumental variable. Moreover, the regression result ($\beta = 3.150$, $p < 0.05$) shows a significant positive effect of female board representation on industrial robot adoption. Overall, these tests align with the benchmark regression, confirming result robustness considering endogeneity.

< Insert Table V here >

Heterogeneity analysis

To explore the disparities among various groups, this paper further examines the heterogeneity of female board representation's impact on industrial robot adoption across three dimensions: enterprise qualification, the property nature, and whether enterprises are high-polluting.

According to China's Measures for the Administration of the Identification of High-tech Enterprises, enterprises meeting three criteria are deemed high-tech: being in a state-supported high-tech field, having registered in China for a year, and continuously developing core independent intellectual property rights. Samples are thus split into high-tech and non-high-tech. As per Table Ⅸ, model 1 represents high-tech, model 2 non-high-tech. High-tech enterprises have a significantly positive influence coefficient on female board representation ($\beta = 1.033$, $p < 0.01$), while for non-high-tech, the coefficient ($\beta = 0.167$) is positive but insignificant. This shows high-tech enterprises have a greater demand for industrial robot adoption than non-high-tech ones.

Based on asset ownership, enterprises are grouped into state-owned and non-state-owned. Regression analysis on their samples forms Model 3 for state-owned and Model 4 for non-state-owned. In state-owned samples, the female board representation coefficient ($\beta = 0.302$) is positive but insignificant. In non-state-owned samples, it shows a highly significant positive correlation ($\beta = 0.994$, $p < 0.01$). This aligns with the baseline regression results. The findings imply non-state-owned enterprises, compared to state-owned ones, may focus more on profitability. Under "profit maximization", robot use cuts labor costs and boosts profits, so they rely more on industrial robots (Duan et al., 2023). Furthermore, state-owned enterprises are greatly affected by the national gender equality policy, so state-owned enterprises may have more "symbolic" female directors, while the gender diversity of non-state-owned enterprises is more likely to reflect the actual capacity structure, so the impact of female directors of non-state-owned enterprises on industrial robots is more significant.

A growing number of highly polluting enterprises have integrated industrial robots, but the environmental effects are uncertain. Enterprises are categorized as highly polluting or not according to state regulations. Using relevant guidance, industries like manufacturing, mining, and energy production/supply are identified as highly polluting. Table Ⅹ's columns 5 and 6 show analysis results for samples of such enterprises and non-highly polluting ones. For highly polluting enterprises, the coefficient of female board representation on robot adoption is positively correlated ($\beta = 0.641$) but insignificant; for non-highly polluting ones, it's notably positive ($\beta = 0.877$, $p < 0.01$). This indicates a smaller impact in highly polluting enterprises. Government and stakeholders should encourage them to adopt smart and clean equipment via tax incentives and subsidies to boost production and environmental responsibility (Zhu et al., 2023).

V. Discussion and Conclusion

Industrial robot adoption boosts efficiency but remains understudied (Duan et al., 2023). Accelerating its drivers is critical (Islam et al., 2025), with top executives' vision, technical expertise, decision-making style, and gender being central to implementation (Islam et al., 2025). While management diversity and technology adoption have been examined (Zou et al., 2018), few studies specifically address gender diversity's impact on industrial robotics (Kong et al., 2023).

Based on the expectation states theory, this study reveals female board representation increases industrial robot adoption, particularly under lax internal controls or high pricing power. This aligns with findings that female-led firms exhibit stronger social responsibility and robotics adoption tendencies (Kong et al., 2023; Zou et al., 2018). At this point, enhancing board gender diversity is thus crucial for industrial intelligence advancement.

The study actively invited manufacturing enterprises for authentic feedback. Many practitioners and managers emphasized that female directors enhance decision-making comprehensiveness and inclusiveness, ensuring productivity gains from technological innovation align with employee well-being and social responsibility. They balance efficiency with humanistic care in robot adoption. The sector is actively recruiting female leaders to contribute development insights.

Theoretical contributions

First, this study bridges gender diversity with industrial robotics adoption—an emerging technology gap in extant literature. While prior research examines gender diversity's impact on performance, innovation, and decision-making in traditional industries (Saeed et al., 2024), it overlooks technology adoption in industrial intelligence contexts. Our empirical analysis reveals female directors' unique role in advancing robot adoption, pioneering new theoretical directions for diversity research. Paradoxically, despite growing gender equality awareness, women's status remains restricted in certain sectors (Hong, 2024), offering fresh perspectives on diversity's complex role in technology adoption.

Second, by introducing expectation states theory, this study provides a solid theoretical foundation for explaining the impact of gender diversity on industrial robotics adoption. While the theory emphasizes sociocultural gender bias's behavioral influence, the paper extends it by revealing female directors' critical role in technology adoption. They drive adoption through unique perspectives, decision-making styles and exert a board-level "multiplier effect," significantly enhancing team decision quality. This enriches expectation states theory and provides a new framework for analyzing executive gender structures in industrial intelligence contexts.

Third, this study not only explores the direct impact of female directors on the adoption of industrial robots but further reveals the moderating role of internal control and pricing power in this relationship. It finds that tight internal control diminishes the driving role of female directors, while strong pricing power amplifies it. This finding provides a new theoretical perspective for understanding the differential role of gender diversity in different organizational contexts, as well as an important theoretical basis for examining the boundary conditions of technology adoption. These moderators deepen mechanistic understanding and open new research pathways.

Fourth, although existing literature highlights female directors' importance, feminist perspectives remain scarce. This study explores their unique role in industrial robotics adoption, showing how gender diversity drives technology uptake by disrupting traditional power structures. This perspective offers new insights for gender and management theory and supports firms in leveraging gender diversity during industrial intelligence.

Fifth, examining female directors' role in industrial robotics adoption reveals how optimizing executive team structure helps organizations adapt to technological change. Gender diversity enhances firms' technology adoption capabilities, adaptability, and competitiveness in dynamic environments. This finding provides new insights into organizational adaptation theory and provides a theoretical basis for studying decision-making in industrial intelligence.

Practical Implications

This paper offers practical guidelines for executives using empirical data. First, recognizing the value of gender diversity, firms should increase female board representation to drive industrial robot adoption, through policies promoting board diversity and stakeholder awareness. Second, relaxing rigid internal controls facilitates industrial robot diffusion (Li et al., 2024). Management should embrace flexibility and innovation to enhance efficiency (Sang et al., 2020). Furthermore, firms must strengthen pricing power via enhanced market analysis, cost optimization, and strategic pricing adjustments.

Limitations

This study also has limitations. First, due to data constraints, we used annual industrial robot adoption metrics which may not fully capture adoption dynamics. Second, some unconsidered factors like board composition, educational backgrounds, experiences, organizational longevity of both managers and board members, as well as the specific characteristics of the industrial robotics market may influence firms' robot adoption decisions. Future research should validate findings through diverse data sources and primary methods. Ultimately, the descriptive results reflect China's current manufacturing landscape. As a developing economy, China’s institutional/technological infrastructure differs from other nations. Since robot adoption and female board representation are context-specific, findings require testing elsewhere. Exploring additional institutional or regional cultural factors would be interesting in the future.

Declarations

Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

Informed Consent

This article does not contain any studies with human participants performed by any of the authors.

Author Contribution

Jianjun Dong, Yuqing Xu, and Han Lin wrote the manuscript. Xuekun Suo and Mingchuan Yu performed the data analysis and designed the tables. Yuan Ming created the figures and revised the overall manuscript. All authors reviewed the manuscript.

Acknowledgement

We gratefully acknowledge the support of this study from the National Natural Science Foundation of China (Grants No. 72271126, 72201162, 72372079).

Data Availability

The data are available from the corresponding author on reasonable request.

References

1. Acemoglu D, Autor D, Dorn D, Hanson GH, Price B (2014) Return of the solow paradox? IT, productivity, and employment in US manufacturing. Am Econ Rev 104:394–399. https://doi.org/10.1257/aer.104.5.394
2. Acemoglu D, Restrepo P (2018) The Race between man and machine: Implications of technology for growth, factor shares, and employment. Am Econ Rev 108:1488–1542. https://doi.org/10.1257/aer.20160696
3. Acemoglu D, Restrepo P (2020) Robots and jobs: Evidence from US labor markets. J Polit Econ 128:2188–2244. https://doi.org/10.1086/705716
4. Adams K, Attah-Boakye R, Yu H, Johansson J, Njoya ET (2023) Female board representation and coupled open innovation: Evidence from emerging market multinational enterprises. Technovation 124:102749. https://doi.org/10.1016/j.technovation.2023.102749
5. Adams RB, Ferreira D (2009) Women in the boardroom and their impact on governance and performance. J Financ Econ 94:291–309. https://doi.org/10.1016/j.jfineco.2008.10.007
6. Ahern KR, Dittmar Ak (2012) The changing of the boards: the impact on firm valuation of mandated female board representation. Q J Econ 127:137–197. https://doi.org/10.1093/qje/qjr049
7. Autor DH (2015) Why are there still so many jobs? The history and future of workplace automation. J Economic Perspect 29:3–30. http://doi.org/10.1257/jep.29.3.3
8. Chang Y, Gao Y, Zhu D, Safeer AA (2023) Social robots: Partner or intruder in the home? The roles of self-construal, social support, and relationship intrusion in consumer preference. Technol Forecast Soc Chang 197:122914. https://doi.org/10.1016/j.techfore.2023.122914
9. Chen J, Leung WS, Evans KP (2018) Female board representation, corporate innovation and firm performance. J Empir Finance 48:236–254. https://doi.org/10.1016/j.jempfin.2018.07.003
10. Chen R, Balasubramanian N, Forman C (2024) How does worker mobility affect business adoption of a new technology? The case of machine learning. Strateg Manag J 45:1510–1538. https://doi.org/10.1002/smj.3595
11. Correll SJ (2001) Gender and the career choice process: The role of biased self-assessments. Am J Sociol 106:1691–1730. http://doi.org/10.1086/321299
12. Correll SJ (2004) Constraints into preferences: Gender, status, and emerging career aspirations. Am Sociol Rev 69:93–113. https://doi.org/10.1177/000312240406900106
13. Correll SJ, Ridgeway CL (2006) Expectation states theory. In: Delamater J (ed) Handbook of Social Psychology. Springer US. https://doi.org/10.1007/0-387-36921-X_2
14. Fuentes-Fuentes M, Quintana-García C, Marchante-Lara M, Benavides-Chicón CG (2023) Gender diversity, inclusive innovation and firm performance. Sustain Dev 31:3622–3638. https://doi.org/10.1002/sd.2615
15. Dezsö CL, Ross DG (2012) Does female representation in top management improve firm performance? A panel data investigation. Strateg Manag J 33:1072–1089. https://doi.org/10.1002/smj.1955
16. Dong J, Tian J, Lin H, Suo X, Wu H, Zeng R (2024a) Can corporate digital innovation speed up climate change mitigation? Evidence from China. IEEE Trans Eng Manage 71:7797–7814. https://doi.org/10.1109/TEM.2024.3386181
17. Dong Q, Wu Y, Lin H, Sun Z, Liang R (2024b) Fostering green innovation for corporate competitive advantages in big data era: The role of institutional benefits. Technol Anal Strateg Manag 36:181–194. https://doi.org/10.1080/09537325.2022.2026321
18. Duan D, Chen S, Feng Z, Li J (2023) Industrial robots and firm productivity. Struct Change Econ Dyn 67:388–406. https://doi.org/10.1016/j.strueco.2023.08.002
19. Dutta S, Zbaracki MJ, Bergen M (2003) Pricing process as a capability: A resource-based perspective. Strateg Manag J 24:615–630. https://doi.org/10.1002/smj.323
20. Eagly AH (2009) The his and hers of prosocial behavior: An examination of the social psychology of gender. Am Psychol 64:644–658. https://doi.org/10.1037/0003-066X.64.8.644
21. Fall FS, Tchuigoua T, Vanhems H, A., Simar L (2021) Gender effect on microfinance social efficiency: A robust nonparametric approach. Eur J Oper Res 295:744–757. https://doi.org/10.1016/j.ejor.2021.03.020
22. Goldsmith-Pinkham P, Sorkin I, Swift H (2020) Bartik instruments: What, when, why and how. Am Econ Rev 110:2586–2624. https://doi.org/10.1257/aer.20181047
23. Guldiken O, Mallon MR, Fainshmidt S, Judge WQ, Clark CE (2019) Beyond tokenism: How strategic leaders influence more meaningful gender diversity on boards of directors. Strateg Manag J 40:2024–2046. https://doi.org/10.1002/smj.3049
24. Hong E (2024) Cracking the diversity code: Analyzing board gender diversity in the AEC sector. J Manag Eng 40:04024006. https://doi.org/10.1061/JMENEA.MEENG-5772
25. Huang G, He L-Y, Lin X (2022) Robot adoption and energy performance: Evidence from Chinese industrial firms. Energy Econ 107:105837. https://doi.org/10.1016/j.eneco.2022.105837

26. Huang H, Wang C, Wang L, Yarovaya L (2023) Corporate digital transformation and idiosyncratic risk: Based on corporate governance perspective. Emerg Markets Rev 56:101045. https://doi.org/10.1016/j.ememar.2023.101045
27. Islam N, Rakshit S, Paul T (2025) Antecedents and consequences of social robots adoption for SMEs—Reimaging emerging technologies in the context of the new normal. Technol Forecast Soc Chang 210:123887. https://doi.org/10.1016/j.techfore.2024.123887
28. Javed M, Wang F, Usman M, Gull A, A., Zaman U, Q (2023) Female CEOs and green innovation. J Bus Res 157:113515. https://doi.org/10.1016/j.jbusres.2022.113515
29. Karavitis P, Kokas S, Tsoukas S (2021) Gender board diversity and the cost of bank loans. J Corp Finance 71:101804. https://doi.org/10.1016/j.jcorpfin.2020.101804
30. Koch M, Manuylov I, Smolka M (2021) Robots and firms. Econ J 131:2553–2584. https://doi.org/10.1093/ej/ueab009
31. Kong G, Huang J, Kong D, Zhu L (2023) Female executives, industrial robots, and stock price crash risk. Finance Res Lett 57:104253. https://doi.org/10.1016/j.frl.2023.104253
32. Li H, Li X, Hu Z, Li Y (2025) Does industrial robot adoption inhibit environmental pollution in China? An empirical study on energy consumption and green technology innovation. J Environ Manage 373:123392. https://doi.org/10.1016/j.jenvman.2024.123392
33. Li W, Huang Y, Zhou H, Liu X (2024) CEO power, internal control quality, and entrepreneurial innovation spirit in family enterprises. Int Rev Financial Anal 95:103364. https://doi.org/10.1016/j.irfa.2024.103364
34. Lin B, Xu C (2024) The effects of industrial robots on firm energy intensity: From the perspective of technological innovation and electrification. Technol Forecast Soc Chang 203:123373. https://doi.org/10.1016/j.techfore.2024.123373
35. Liozu SM (2015) Pricing superheroes: How a confident sales team can influence firm performance. Ind Mark Manage 47:26–38. https://doi.org/10.1016/j.indmarman.2015.02.003
36. Liozu SM, Hinterhuber A (2013) CEO championing of pricing, pricing capabilities and firm performance in industrial firms. Ind Mark Manage 42:633–643. https://doi.org/10.1016/j.indmarman.2012.09.003
37. Liu Y, Wei Z, Xie F (2014) Do women directors improve firm performance in China? J Corp Finance 28:169–184. https://doi.org/10.1016/j.jcorpfin.2013.11.016
38. Luo J, Huang Z, Li X, Lin X (2018) Are women CEOs valuable in terms of bank loan costs? Evidence from China. J Bus Ethics 153:337–355. https://doi.org/10.1007/s10551-016-3369-2
39. Maine E, Soh P-H, Dos Santos N (2015) The role of entrepreneurial decision-making in opportunity creation and recognition. Technovation 39–40:53–72. https://doi.org/10.1016/j.technovation.2014.02.007
40. Mao J, Xu D, Yang S (2023) Female executives and corporate R&D manipulation behavior: Evidence from China. Finance Res Lett 57:104240. https://doi.org/10.1016/j.frl.2023.104240
41. Meng D, Li Y, Wang L (2024) Board's informal hierarchy: Influences on enterprise innovation quality. Manag Decis 62:1341–1374. https://doi.org/10.1108/MD-06-2023-1059
42. Nakata C, Im S (2010) Spurring cross-functional integration for higher new product performance: A group effectiveness perspective. J Prod Innov Manage 27:554–571. https://doi.org/10.1111/j.1540-5885.2010.00735.x
43. Nasir M, Simsek S, Cornelsen E, Ragothaman S, Dag A (2021) Developing a decision support system to detect material weaknesses in internal control. Decis Support Syst 151:113631. https://doi.org/10.1016/j.dss.2021.113631
44. Nguyen TVH, Nguyen TVH (2022) How do banks price liquidity? The role of market power. Glob Financ J 53:100736. https://doi.org/10.1016/j.gfj.2022.100736
45. Raja JZ, Frandsen T, Kowalkowski C, Jarmatz M (2020) Learning to discover value: Value-based pricing and selling capabilities for services and solutions. J Bus Res 114:142–159. https://doi.org/10.1016/j.jbusres.2020.03.026
46. Ridgeway CL, Correll SJ (2004) Unpacking the gender system: A theoretical perspective on gender beliefs and social relations. Gend Soc 18:510–531. http://doi.org/10.1177/0891243204265269
47. Rodrigue J, Sheng D, Tan Y (2024) Exporting, abatement, and firm-level emissions: Evidence from China's accession to the WTO. Rev Econ Stat 106:1064–1082. https://doi.org/10.1162/rest_a_01194
48. Rodríguez NG, Pérez MJS, Gutiérrez JAT (2008) Can a good organizational climate compensate for a lack of top management commitment to new product development? J Bus Res 61:118–131. https://doi.org/10.1016/j.jbusres.2007.06.011
49. Saeed A, Baloch MS, Liedong TA, Rajwani T (2024) Board gender diversity, nonmarket strategy and firm performance: Evidence from emerging markets MNCs. Res Int Bus Finance 71:102462. https://doi.org/10.1016/j.ribaf.2024.102462
50. Sang L, Yu M, Lin H, Zhang Z, Jin R (2020) Big data, technology capability and construction project quality: A cross-level investigation. Eng Constr Architectural Manage 28:706–727. https://doi.org/10.1108/ECAM-02-2020-0135
51. Spierdijka L, Zaourasa M (2018) Measuring banks' market power in the presence of economies of scale: A scale-corrected Lerner index. J Banking Finance 87:40–48. https://doi.org/10.1016/j.jbankfin.2017.09.022
52. Triana MdelC, Richard OC, Su W (2019) Gender diversity in senior management, strategic change, and firm performance: Examining the mediating nature of strategic change in high tech firms. Res Policy 48:1681–1693. https://doi.org/10.1016/j.respol.2019.03.013
53. Yu L, Wang Y, Wei X, Zeng C (2023) Towards low-carbon development: The role of industrial robots in decarbonization in Chinese cities. J Environ Manage 330:117216. https://doi.org/10.1016/j.jenvman.2023.117216

54. Yuan B, Sun P (2024) Does the high-tech foreign investment spark robot adoption in the developing world? Evidence from China. Struct Change Econ Dyn 71:302–314. https://doi.org/10.1016/j.strueco.2024.08.005
55. Zhao D, Gao Y, Wu Z, Shabaz M (2024) Harnessing robotics for environmental economics and energy strategy: Advancing global economic policies towards green growth. Energy Strategy Reviews 55:101504. https://doi.org/10.1016/j.esr.2024.101504
56. Zhu H, Sang B, Zhang C, Guo L (2023) Have industrial robots improved pollution reduction? A theoretical approach and empirical analysis. China World Econ 31:153–172. https://doi.org/10.1111/cwe.12495
57. Zou Z, Wu Y, Zhu Q, Yang S (2018) Do female executives prioritize corporate social responsibility? Emerg Markets Finance Trade 54:2965–2981. https://doi.org/10.1080/1540496X.2018.1453355

Tables

Table Definition of variables

Variables	Symbol	Measurements	Reference
Independent Variable			
Female board representation	*Female*	The number of female directors / Total number of directors	
Dependent Variable			
Industrial robot adoption	*Robot*	industrial robot penetration index	
Moderating Variables			
Internal control	*IC*	DIB internal control index	
Pricing power	*PP*	Lerner Index $L = (P - MC) / P$	
Control Variables			
Firm Size	*Size*	Natural logarithm of (annual total assets)	
Firm Leverage	*Lev*	Total liabilities at year-end / Total assets at year-end	
Firm Age	*Firm Age*	Natural logarithm of (the number of years since a firm's establishment)	
Ownership concentration	*Top1*	Number of shares held by the largest shareholder / Total number of shares	
Firm Growth	*Growth*	Revenue for the current year/ Revenue for the previous year-1	
Return on Assets	*ROA*	Net profit / Total assets	
Cashflow Ratio	*Cashflow*	Operating cash flow / Current liabilities	
Proportion of fixed assets	*FIXED*	Fixed assets / Total assets	

Note: Standard errors in parentheses, *p<0.1, **p<0.05, ***p<0.01

Source: Authors own work.

Table Correlation coefficients between variables

	Mean	SD	1	2	3	4	5	6	7	8	9	10	1
1.Robot	6.959	4.072	1										
2.Female	0.187	0.110	0.057***	1									
3.Size	22.05	1.179	0.031***	-0.081***	1								
4.Firm Age	2.877	0.332	0.094***	0.028***	0.173***	1							
5.Lev	0.394	0.191	0.009	-0.163***	0.469***	0.130***	1						
6.ROA	0.045	0.068	-0.005	0.039***	0.044***	-0.038***	-0.340***	1					
7.Cashflow	0.050	0.070	0.021***	0.030***	0.104***	0.067***	-0.159***	0.446***	1				
8.Growth	0.334	8.446	0.013***	0.016**	0.009	0.002	0.011	-0.008	-0.030***	1			
9.FIXED	0.227	0.134	-0.006	-0.127***	0.111***	0.040***	0.176***	-0.124***	0.153***	-0.010	1		
10.TOP1	33.46	14.21	-0.030***	-0.011	0.113***	-0.101***	-0.001	0.130***	0.092***	0.008	0.040***	1	
11.IC	643.5	116.9	-0.030***	-0.019***	0.128***	-0.107***	-0.076***	0.321***	0.126***	-0.010	-0.073***	0.122***	1
12.PP	0.118	0.133	0.033***	0.095***	0.040***	-0.008	0.603***	0.603***	0.367***	-0.003	-0.136***	0.045***	0

Note: Standard errors in parentheses, *p<0.1, **p<0.05, ***p<0.01

Source: Authors own work

Table Baseline and moderating effects regression results

	Model (1)	Model (2)	Model (3)	Model (4)
VARIABLES	*Robot*	*Robot*	*Robot*	*Robot*
Female	0.717***	0.847***	0.839***	0.817***
	(0.276)	(0.282)	(0.282)	(0.282)
Female×IC			-0.006**	
			(0.002)	
IC			-0.000	
			(0.000)	
Female×PP				4.509**
				(1.971)
PP				0.067
				(0.281)
Size		0.007	0.005	0.006
		(0.031)	(0.031)	(0.031)
Firm Age		0.036	0.033	0.036
		(0.099)	(0.099)	(0.099)
Lev		0.224	0.239	0.227
		(0.193)	(0.194)	(0.194)
ROA		-0.041	0.062	-0.174
		(0.542)	(0.563)	(0.619)
Cashflow		0.021	0.003	-0.001
		(0.481)	(0.481)	(0.483)
Growth		0.005	0.005	0.005
		(0.003)	(0.003)	(0.003)
FIXED		0.661***	0.681***	0.669***
		(0.256)	(0.256)	(0.256)
TOP1		-0.002	-0.002	-0.002
		(0.002)	(0.002)	(0.002)
Constant	5.461***	5.008***	5.095***	5.021***
	(0.232)	(0.720)	(0.726)	(0.720)
Observations	18,585	18,585	18,585	18,585
R-squared	0.044	0.045	0.045	0.045
Ind FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
r2_a	0.042	0.043	0.043	0.040

Note: Standard errors in parentheses, *p<0.1, **p<0.05, ***p<0.01

Source: Authors own work.

Table Robustness test results

	(1)	(2)	(3)	(3)
VARIABLES	*Robot*	*Robot*	*Robot*	*Robot*
Female	0.430***	0.641***	0.868***	0.793***
	(0.137)	(0.242)	(0.285)	(0.287)
Size	-0.005	0.004	0.007	0.003
	(0.031)	(0.031)	(0.032)	(0.032)
Firm Age	0.029	0.036	0.034	0.022
	(0.099)	(0.099)	(0.099)	(0.102)
Lev	0.214	0.224	0.224	0.279
	(0.193)	(0.193)	(0.193)	(0.202)
ROA	-0.051	-0.043	-0.052	0.331
	(0.542)	(0.542)	(0.542)	(0.674)
Cashflow	0.056	0.027	0.022	-0.173
	(0.481)	(0.481)	(0.481)	(0.537)
Growth	0.005	0.005	0.005	-0.103
	(0.003)	(0.003)	(0.003)	(0.096)
FIXED	0.624**	0.654**	0.663***	0.691***
	(0.255)	(0.256)	(0.257)	(0.261)
TOP1	-0.002	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Indep			-0.005	
			(0.006)	
Dual			-0.006	
			(0.066)	
Board			-0.008	
			(0.197)	
Constant	5.012***	5.043***	5.233***	5.121***
	(0.719)	(0.721)	(0.845)	(0.739)
Observations	18,585	18,585	18,585	18,585
R-squared	0.045	0.045	0.045	0.045
Ind FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
r2_a	0.043	0.042	0.042	0.042

Note: Standard errors in parentheses, *p<0.1, **p<0.05, ***p<0.01

Source: Authors own work.

Table Instrumental variable regression results

	(1)	(2)
VARIABLES	*Female*	*Robot*
Female		3.150**
		(1.571)
IVPRO	0.811***	
	(0.032)	
Control FE	YES	YES
Constant		3.793***
		(1.091)
Observations		18,585
R-squared		0.042
Kleibergen-Paap rk LM statistic	548.602	
	[0.000]	
Kleibergen-Paap rk Wald F statistic	629.940	
	{16.38}	
Ind FE	YES	YES
Year FE	YES	YES
r2_a	0.159	0.039

Note: *p<0.1, **p<0.05, ***p<0.01, () values are robust standard errors, [] values are P-values, and {} values are Stock-Yogo weak identification critical value at the 10% level of the test.

Source: Authors own work.

Figures

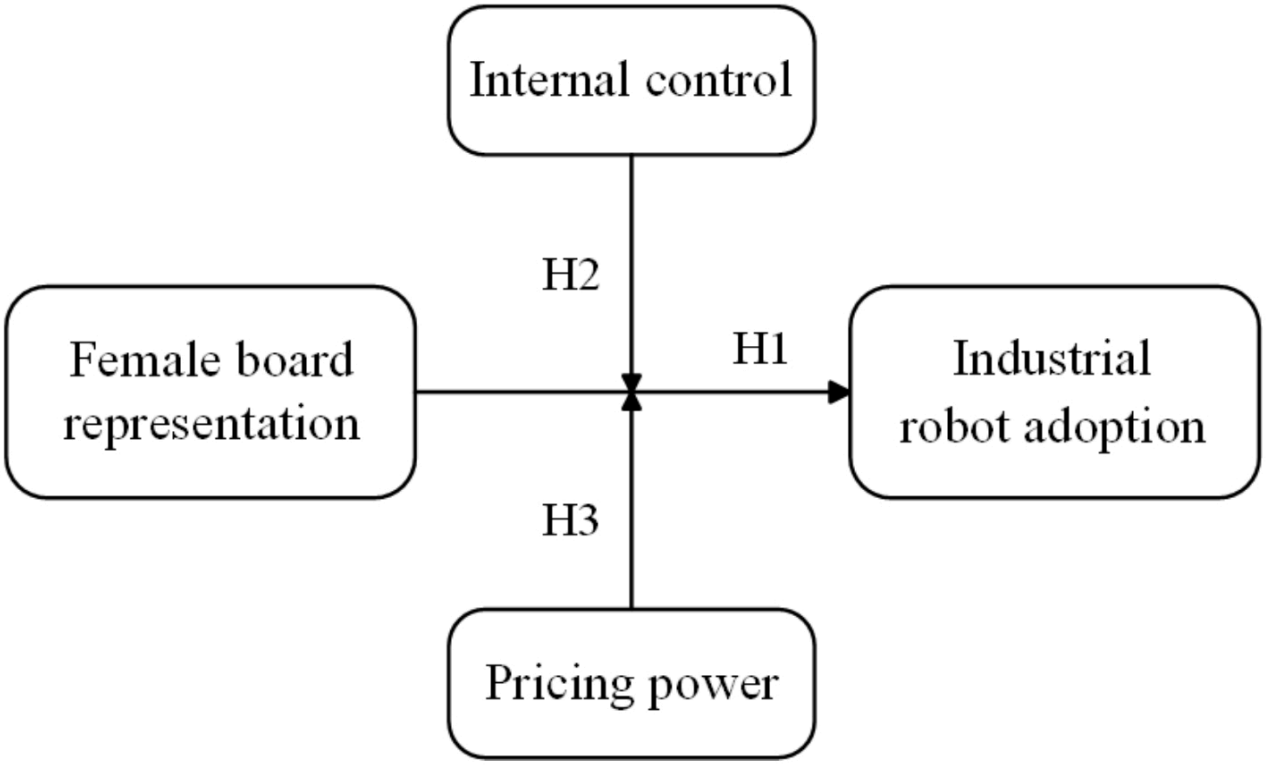


Figure 1

Theoretical framework

Source: Authors own work.

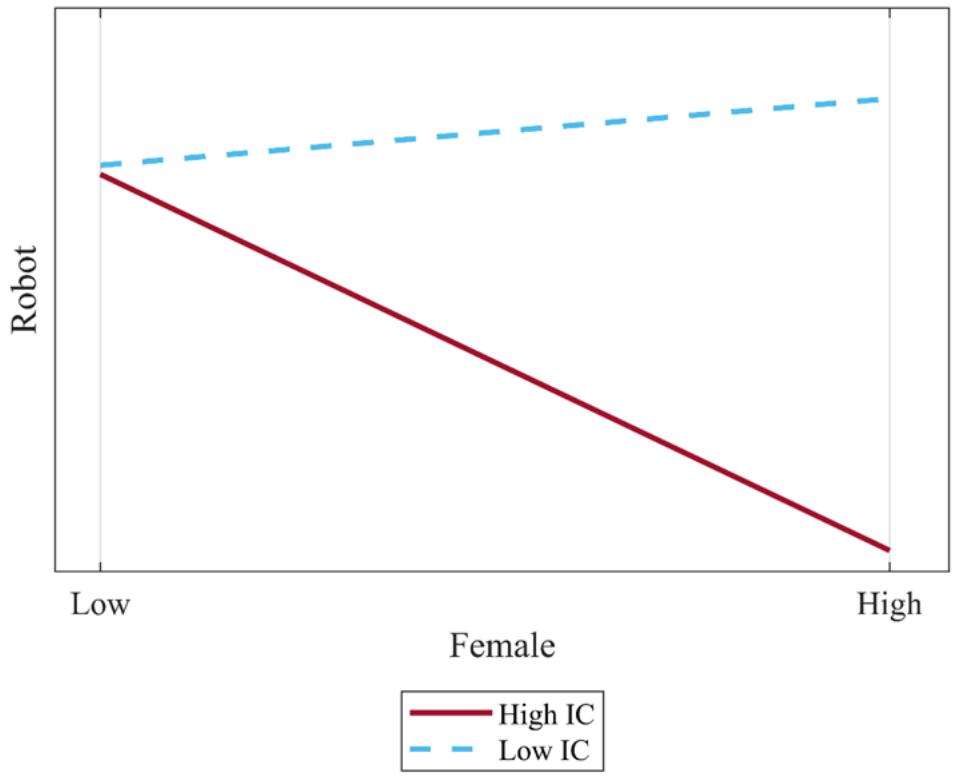


Figure 2

The moderating role of internal control

Source: Authors own work.

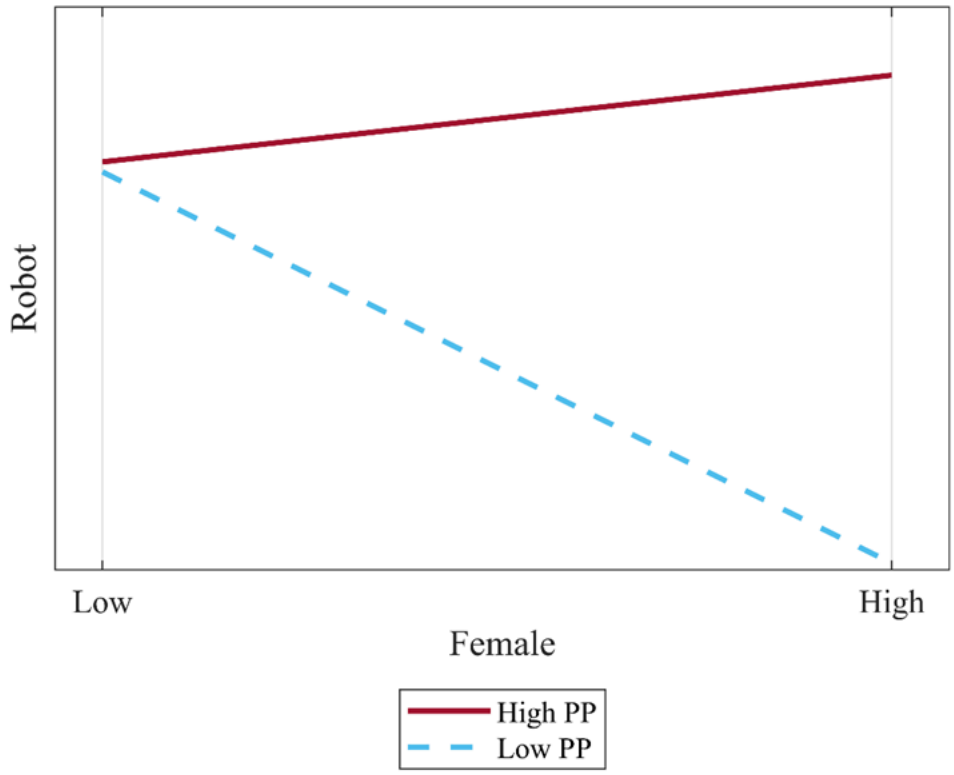


Figure 3

The moderating role of pricing power

Source: Authors own work.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- process.do
- data.dta