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# Board Gender Diversity and Investment Efficiency: evidence from UK Private Firms

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**ABSTRACT** This paper examines the relationship between private firm investment efficiency and board gender diversity in the UK from 2006 to 2019. The findings indicate that board gender diversity has a positive impact on private firm investment efficiency, with the effect primarily driven by reductions in overinvestment rather than underinvestment. Contrary to the critical mass hypothesis, even the presence of a single woman director is associated with improved investment efficiency, and this positive effect becomes more pronounced as women's representation increases. Further analysis reveals that the effect of women directors is stronger in financially constrained firms and more pronounced in non-family firms. The findings support regulations to increase the representation of women directors in private firms.

**Keywords:** investment efficiency; UK private firms; board gender diversity; critical mass; investment efficiency; UK private firms; board gender diversity; women directors; critical mass

**JEL:** codes: G30; G31; J16

## 1. Introduction

Understanding the factors that determine private firm resource allocation is crucial for the sustained success of private businesses, which constitute a significant proportion of developed and developing economies worldwide. In 2022, UK private firms made up over 99% of all businesses and contributed more than 50% to the annual gross domestic product (GDP) (Department for Business Energy and Industrial Strategy, 2022). Given the economic importance of private firms to the UK economy, this study examines the impact of board gender diversity on the investment efficiency of private firms, with a specific focus on capital investment decisions.

Prior studies offer empirical evidence concerning the influence of boardroom gender diversity on investment efficiency using publicly listed firms (Almor et al., 2022; Chen et al., 2016; Farooq

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et al., 2023). However, there is a lack of evidence on how boardroom gender diversity influences capital allocation decisions in private firms that typically operate with weaker governance, less transparency, different ownership structures, and, in some cases, token appointments of women directors (Ingram et al., 2010; Langli & Svanström, 2014; Sealy et al., 2009). These institutional and governance differences may significantly impact the investment efficiency of private firms.

Private firms also differ from public firms in several fundamental ways that directly shape investment behavior. They operate under more flexible legal and disclosure requirements (Ball & Shivakumar, 2005; Tyrowicz et al., 2020), face reduced external monitoring, adopt governance structures distinct from those of public firms (George, 2005; Ingram et al., 2010), and are typically owner-managed, illiquid, and characterized by concentrated ownership (Asker et al., 2015). UK evidence further shows that private firms always pay more for acquisitions than listed firms (Saunders & Steffen, 2011) and exhibit significantly higher leverage (Brav, 2009), underscoring the distinct financial behavior of UK private firms. International evidence suggests that private firms generally exhibit lower investment sensitivity (Gilje & Taillard, 2016; Mortal & Reisel, 2013), pay out fewer dividends (Michaely & Roberts, 2012), and face greater constraints on financing and acquisitions (Maksimovic et al., 2013). These distinctions contribute to the lack of understanding of the role of women directors in private companies. The objective is to bridge this knowledge gap by examining the impact of board gender diversity on the effectiveness of corporate investments using data from UK private firms.

Given the characteristics of private firms and the increased representation of women on boards (Ball & Shivakumar, 2005; Hampton-Alexander Review team, 2019), exploring gender diversity in private firms is both informative and timely. Diversity theory suggests that gender-diverse boards enhance investment efficiency through improved cognitive diversity, information exchange, and monitoring effectiveness (Bantel & Jackson, 1989; Chen et al., 2019; Cox & Blake, 1991; Watson et al., 1993). Women directors also tend to exercise more independently-minded characteristics (Chen et al., 2019) and bring unique communication and working styles to boardroom responsibilities (Daily & Dalton, 2003), thereby constraining managerial opportunism and contributing to more effective decision-making. These mechanisms may be especially salient in private firms, where illiquidity and concentrated ownership reduce external discipline, forcing reliance on board oversight to guide investment decisions (Asker et al., 2015). Critical mass theory (Kanter, 1977) suggests that the benefits of gender diversity may become more pronounced when at least three women are present on the board.

Analysing 50,201 firm-year observations covering 13,757 UK private firms from 2006 to 2019 reveals a robust, statistically significant positive correlation between gender diversity and the effectiveness of corporate investments, with a notable influence on mitigating overinvestment issues. Moreover, the results indicate that even one woman director can enhance investment efficiency. This effect is twice as pronounced when there are three or more women on the board. Likewise, the effect of curbing overinvestment issues is more pronounced for boards with at least three women directors. The findings are robust concerning endogeneity.

Our study provides numerous valuable contributions to the existing scholarly research. First and foremost, the research enhances the literature on corporate investment efficiency by specifically analyzing private firms, a setting that remains understudied due to data limitations and the dominance of research on public firms. Second, this paper broadens the application of diversity theory beyond public-firm settings and re-examines the relevance of critical mass theory in the context of private firms. While existing public-firm evidence emphasizes agency-based explanations (Farooq et al., 2023), our analysis draws on diversity theory to highlight how cognitive diversity, enhanced information exchange, and stronger monitoring may shape investment outcomes in private firms. Furthermore, we extend the theoretical discussion by examining whether meaningful influence may arise even when women's representation is limited, given the unique

governance characteristics of private firms. Third, the dataset encompasses all sizes of private firms, imposes no restrictions on asset size, and maintains transparency in the selection of both board characteristics and financial data, thereby effectively mitigating exclusion and selection biases. Lastly, the study offers valuable insights for regulators considering implementing board gender diversity quotas as an effective governance measure.

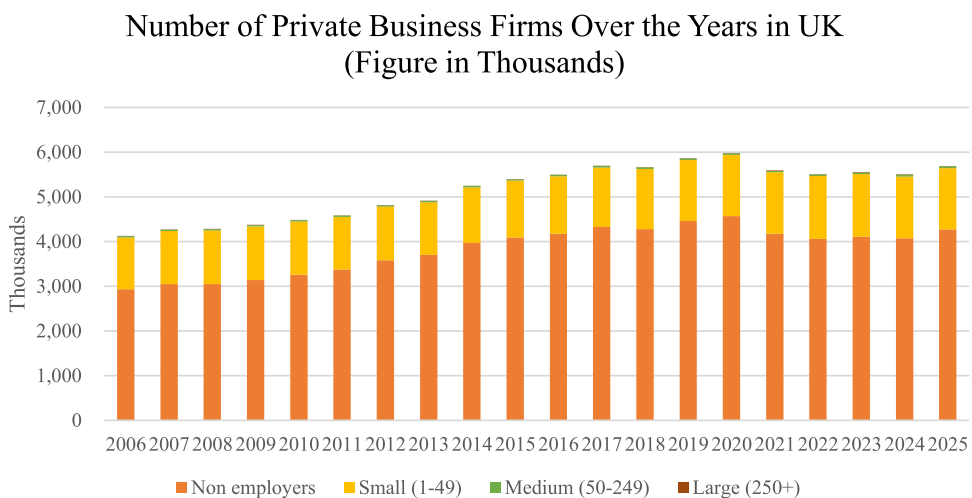
Subsequent sections of this study are structured in the following manner. Section 2 evaluates the existing literature and develops the hypotheses. Sample selection details, research design, and methodology are given in Section 3. Section 4 reports and discusses the regression results. Finally, Section 5 concludes the study, discussing theoretical insights and practical suggestions.

## 2. Background, literature review, and hypotheses development

### 2.1. Background

UK private firms play a dominant role in the UK economy (Sattar et al., 2022), making the study of investment efficiency particularly important. The number of private firms in the UK increased steadily up to 2019, followed by a temporary decline due to COVID-19 pandemic and subsequent recovery in more recent years (Department for Business & Trade, 2025; Department for Business Energy and Industrial Strategy, 2019). At the beginning of 2025, approximately 5.7 million private companies generating £5,52 trillion of revenues (Department for Business & Trade, 2025). Over the last 15 years, private firms in the UK have experienced significant growth. As of the beginning of 2019, approximately 5.9 million private companies generating £4.15 trillion of revenues (Department for Business Energy and Industrial Strategy, 2019). The sector offers a sizable, comprehensive sample of businesses of all sizes, as shown in Figure 1.

The regulatory and reporting environment for UK private firms differs markedly from that of listed firms. The UK Companies Act requires all registered companies, including private and public companies, to prepare and report annual financial statements in accordance with accounting standards. Moreover, in the UK, tax regulations are the same for private and public



**Figure 1.** Number of UK private business firms: 2006–2025. Source: Business Population Estimates, UK government (Department for Business & Trade, 2025; Department for Business Energy and Industrial Strategy, 2019).

businesses, and firms meeting a certain threshold must get their financial statements audited (Ball & Shivakumar, 2005; Brav, 2009). Thus, UK private firm data are highly available and reliable.

Although the UK does not impose mandatory gender quotas on corporate boards, regulators strongly support gender-diverse companies. A UK government-backed commission led by Lord Davies recommended that FTSE 100 boards voluntarily have at least 25% women representation by 2015 (Davies, 2011). Subsequently, the Companies Act 2006 required all UK firms to disclose the proportion of women on their boards in their annual strategic reports (UK Public General Acts, 2016). In 2016, the new Disclosure and Transparency Rules (DTRs), published by the UK Financial Conduct Authority (UK FCA), mandated all UK companies listed on European Union markets to disclose corporate diversity policies in companies' corporate governance statements or to provide justification for not doing so (UK Financial Conduct Authority, 2016). These initiatives have resulted in a level of female board representation that surpasses that of many other prosperous nations with similar non-binding regulatory frameworks. By 2019, FTSE 100 firms had 32.4% of women on their boards, and FTSE 250 firms reported 29.6% of women in corporate boardrooms (Hampton-Alexander Review team, 2019). Internationally, as of 2022, the UK was ranked seventh among European countries in terms of the representation of women on corporate boards, with a margin of only 5% less than the top-ranking country, France (Gender Statistics Database, 2022). Furthermore, the presence of women on the boards of UK-listed firms has been steadily increasing, ranking the UK eighth among European countries based on growth rates from 2006 to 2019 (Gender Statistics Database, 2019).

In contrast, gender diversity in UK private firms remains more limited and less regulated. Figure 2 illustrates the proportion of women directors on boards, using the sample data collected for this research. Notably, the representation of women directors in UK private firms peaked in 2012, which may be attributed to the implementation of the UK Corporate Governance Code in 2011. This code required listed firms to report diversity policies starting from October 2012. Although this regulation specifically targeted listed firms, the widespread promotion of gender diversity across the UK market likely increased the emphasis on women directors on boards in private firms as well. After 2012, there is a slight decline over the following seven years. The reasons for the decline could be attributed to the lack of gender diversity regulations requiring them to disclose details about their firm's gender diversity practices and policies. Overall, the

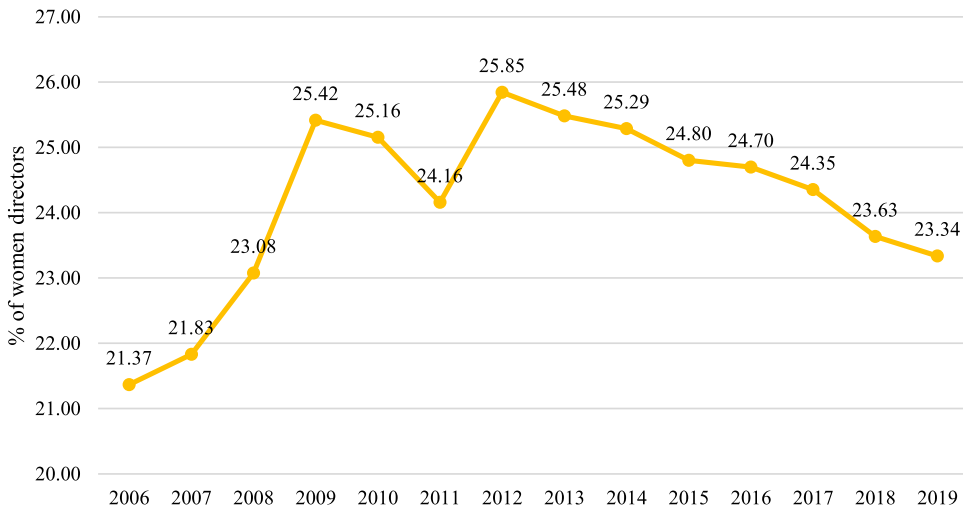


Figure 2. Annual average proportion of women directors in sampled UK private firms.

data reveal a notable upward trend in the percentage of women directors within the boardrooms of UK private firms over the 13-year study period.

## 2.2. Literature review and hypotheses development

With the growing representation of women on corporate boards, research focused on comprehending the impact of gender diversity at the board level has become increasingly popular. According to Erhardt (2003) diversity theory is generally associated with better decision-making quality. From an information and decision-making perspective, individuals possess a variety of views, experiences, knowledge, skills, and cognitive capacities. When these individuals are brought together as a group, their diverse characteristics contribute to enhancing the group's creativity, quality of thinking, and ability to make better decisions (Bantel & Jackson, 1989; Cox & Blake, 1991; Jackson, 1992; Watson et al., 1993). Gender diversity is a key dimension of this heterogeneity, as women directors bring distinct professional experiences, ethical orientations, and behavioral tendencies that help boards evaluate strategic choices and investment opportunities more comprehensively.

Gender diversity also enhances information exchange among board members. Prior research shows that women directors tend to adopt more cooperative and collaborative approaches and are more oriented toward considering others' perspectives (Eagly et al., 2003). They are also more likely to adopt democratic and participative leadership styles rather than autocratic or directive approaches (Eagly & Johnson, 1990). These behavioral tendencies promote an open communication environment in which directors are more willing to exchange information and engage in constructive discussion, encouraging the sharing of diverse viewpoints and enhancing information integration (Bantel & Jackson, 1989; Eagly et al., 2003). As a result, gender-diverse boards exhibit richer information exchange and more effective integration of information during discussions, thereby improving board effectiveness and the quality of collective decision-making.

Furthermore, gender diversity may strengthen the board's monitoring capabilities. As the body responsible for overseeing managerial behavior and safeguarding shareholder interests (Finkelstein & Hambrick, 1996), the board's monitoring effectiveness is influenced by directors' psychological traits and behavioral tendencies. Evidence from psychology indicates that women differ from men in personality traits and risk preferences, including greater risk aversion, heightened sensitivity to ethical concerns, and lower competitive and overconfident tendencies (Booth & Nolen, 2012; Costa et al., 2001; Jianakoplos & Bernasek, 1998; Levi et al., 2014). These characteristics may improve women directors' attention on risks and ethical implications and enhance their monitoring capabilities. Consistent with this view, several studies report that women respond differently to men in challenging situations and are better monitors and advisors (Charness & Gneezy, 2012; Croson & Gneezy, 2009). For example, Al-Shaer and Zaman (2016) suggest that even when accounting for corporate governance traits and company reporting conditions, a discernible association exists between board gender diversity and higher sustainability reporting quality. Therefore, these findings suggest that gender-diverse boards strengthen the monitoring process and help ensure that managers make effective strategic decisions (Liu, 2018; Shaukat et al., 2016; Sun & Zhang, 2021). Additionally, considering women's characteristics of risk-aversion and lower confidence, women directors are less likely to take unnecessary risks, which might curb overinvestment behavior (Li & Zeng, 2019).

These three mechanisms, greater cognitive diversity, improved information exchange, and stronger monitoring, are likely to be especially relevant in private firms. Prior studies show that, in private firms, financial reporting quality is generally lower (Chen et al., 2011), public disclosure requirements are minimal (Ball & Shivakumar, 2005), and external monitoring by

financial intermediaries, such as analysts and institutional investors, is limited (Badertscher et al., 2013). Additionally, ownership tends to be highly concentrated, and shareholders, often owner-managers, are directly involved in operational and strategic decisions (Van Tendeloo & Vanstraelen, 2008). Chen et al. (2017) find that private firms' ownership concentration reduces investment efficiency. These characteristics make internal governance mechanisms, especially the composition and diversity of the board, crucial for ensuring high-quality investment decisions. Gender-diverse boards may therefore play a more crucial role in enhancing investment efficiency in private firms. Therefore, we position our hypotheses within this unique context of private firms, arguing that gender-diverse boards improve the quality of strategic and investment decisions, thereby enhancing overall investment efficiency.

However, the women directors on boards may play different roles in solving overinvestment and underinvestment issues. According to behavioral finance theory, women are significantly more risk averse than men, leading to more cautious investment behavior (Charness & Gneezy, 2012; Fisher & Yao, 2017; Jianakoplos & Bernasek, 1998). Male directors also engage more frequently in acquisition activities and issue debt, reflecting higher levels of overconfidence (Huang & Kisgen, 2013). Prior research reports that gender diversity is particularly effective in improving investment efficiency in firms prone to overinvestment (Shin et al., 2020). Importantly, a significant stream of literature suggests that overinvestment often arises from managerial overconfidence or empire-building incentives (Jensen, 1986; Malmendier & Tate, 2005), which can be mitigated by the greater caution and risk aversion displayed by women directors. In contrast, underinvestment is typically driven by external financing constraints (Machokoto, 2021; Whited & Wu, 2006), rather than solely by managerial behavior, board composition has limited ability to mitigate such constraints. Consequently, women directors are more likely to exercise caution when making investment decisions, potentially mitigating overinvestment rather than underinvestment issues. Thus, we formulate the following hypotheses:

H1a: Women directors are positively associated with investment efficiency in private firms.

H1b: Women directors are negatively associated with overinvestment, but not with underinvestment in private firms.

Current studies examine the representation of women directors on corporate boards. They test the underlying hypothesis that board gender diversity is effective when women's attendance reaches a certain percentage. According to tokenism and critical mass theory, women directors who are viewed as 'tokens' or 'symbols' are more likely to be treated unfairly and have difficulty influencing group decisions unless they reach a critical mass in the firm (Kanter, 1977). In other words, boards with only a few women members would experience discriminatory behavior and struggle with decision-making. Empirical evidence generally supports that for women directors to have an impact, there must be a certain level of representation (Cook & Glass, 2018; Torchia et al., 2011). Liu et al. (2014) report that when firms have at least three women directors, their contributions become more visible and their suggestions and characteristics are considered, leading to dynamic change in the boardroom and ultimately impacting firm efficiency. In this situation, women members are not regarded as a minority group, and they can communicate their opinions boldly in the firm; thus, they are more likely to make a favorable impact on the management and administration of the firm, reducing conflicts between principals and agents (Yang et al., 2019). Likewise, Joecks et al. (2013) report that a greater representation of women in the boardroom initially has a detrimental influence on firm performance, but it begins to yield a positive impact once a critical mass of approximately 30% of women members is achieved. Recent evidence, however, shows that even when the proportion of

women falls short of a critical mass, the presence of women directors may still be beneficial (Gyapong et al., 2016; McGuinness et al., 2017; Sattar et al., 2023). Considering that private firms often have smaller boards, their decision-making processes may be more significantly influenced by a single director (Cheng, 2008). This heightened influence of individual directors on smaller boards underscores the importance of each board member's contribution. Furthermore, unlike listed firms, UK private firms are not mandated to report gender diversity-related policies, nor are they assessed on their level of diversity. This lack of regulatory pressure indicates that the presence of women directors in UK private firms is not merely a symbolic gesture or a compliance measure. Instead, these women directors are intentionally appointed to leverage their unique perspectives and expertise, thereby contributing to the board's overall effectiveness and strategy decision-making. Therefore, it seems reasonable that appointing even one woman director to the board could help firms improve their corporate investment efficiency. Considering the characteristic of board size in the sample, and consistent with most studies in the existing literature (Liu et al., 2014), we classify a board as 'skewed', 'tilted', or 'balanced' when there is only one woman director, two women directors, and at least three women directors, respectively. Nevertheless, given the mixed evidence in the literature, we empirically test whether a critical mass effect exists in the context of UK private firms. The segregation of women director representation forms the basis of the second hypothesis:

H2a: Private firm investment efficiency is greater given a critical mass of women on the board.

H2b: Private firm overinvestment is reduced given a critical mass of women on the board, whereas no such effect is expected for underinvestment.

### 3. Variable measurement and research design

#### 3.1. Variable measurement

The proxy for investment efficiency is derived from the model introduced by Biddle et al. (2009). Following prior research examining investment efficiency (Benlemlih & Bitar, 2018; Jin & Yu, 2018; Mirza et al., 2020; Rajkovic, 2020), we calculate firm investment because of growth prospects as stated in Equation (1):

$$INV_{i,t} = \beta_0 + \beta_1 \Delta SALES_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

*INV* is the proxy of investments, calculated as the net increase in tangible and intangible assets, multiplied by 100, and scaled by the lagged value of total assets; and  $\Delta SALES$  is the lagged annual percentage change in sales. More specifically, we estimate the investment value as a function of sales growth for each company using panel data for private firms. The industry classification uses the two-digit UK primary sector code based on at least 20 observations. The residual values obtained from Equation (1) reflect the deviations from the predicted investment level under given growth opportunities each year. The primary dependent variable is investment efficiency, denoted as *INV\_EFF*. It is defined as the absolute value of the residuals from Equation (1), and then multiplied by minus one, following the framework proposed by Rajkovic (2020). It then follows that a higher value of *INV\_EFF* signifies that the firm is operating with a higher degree of investment efficiency. Positive residuals proxy for overinvestment (*OVER\_INV*), and underinvestment (*UNDER\_INV*) is estimated by taking the negative residuals from Equation (1) and multiplying them by minus one. Therefore, the lower value of *OVER\_INV* (*UNDER\_INV*), the fewer overinvestment (underinvestment) issues.

### 3.2. Empirical model

The association between board gender diversity and the efficiency of corporate investments is stated in Equation (2):

$$\begin{aligned}
 Y_{i,t} = & \beta_0 + \beta_1 GENDERDIVERSITY_{i,t} + \beta_2 LNBOD_{i,t} + \beta_3 LNFIRMAGE_{i,t} \\
 & + \beta_4 FIRMSIZE_{i,t} + \beta_5 ROA_{i,t} + \beta_6 LEVERAGE_{i,t} + \beta_7 TANGASSET_{i,t} \\
 & + \sum_{i=1}^m \lambda_i INDUSTRY_i + \sum_{t=1}^n \Omega_t YEAR_t + \varepsilon_{i,t}
 \end{aligned} \tag{2}$$

where the dependent variable  $Y_{i,t}$  refers to  $INV\_EFF_{i,t}$ ,  $OVER\_INV_{i,t}$  and  $UNDER\_INV_{i,t}$  that denote the corporate investment efficiency, overinvestment, and underinvestment of firm  $i$  in year  $t$ , respectively. The independent variable,  $GENDERDIVERSITY$ , measures the representation of women on the board. Following prior studies, board gender diversity is estimated in several ways: (i) the ratio of women directors in the boardroom ( $WOMEN$ ) (Adams & Ferreira, 2009; Ahern & Dittmar, 2012; Faccio et al., 2016); (ii) a dummy variable assigned a value of one denotes the existence of at least one woman director in the boardroom and zero otherwise ( $WOMDUM$ ) (Atif et al., 2019; Joecks et al., 2013; Pandey et al., 2019; Strydom et al., 2016); (iii) a set of dummy variables is used to indicate the number of women directors, defined as one woman director ( $WOMDUM1$ ), two women directors ( $WOMDUM2$ ), and three or more women directors ( $WOMDUM3$ ), respectively.

The estimated models include control variables that are based on those used in prior studies. The variable  $LNBOD$  represents the size of the board and is estimated as a natural logarithm of the total number of directors serving on the board (Nor et al., 2017). This transformation helps us capture the nuanced relationship between board size and the effectiveness of corporate investments. The variable  $LNFIRMAGE$  denotes the natural logarithm of the number of years since the firm's incorporation date. This approach, influenced by Majumdar (1997), considers the potential impact of firm age on corporate governance, which may enhance the firm's performance but also lead to bureaucratic inefficiencies within the company. Firm size ( $FIRMSIZE$ ) is estimated as the natural logarithm of total assets and may influence cash holdings, which can affect investment decisions (Dimitropoulos & Koronios, 2021; Kadapakkam et al., 1998).  $ROA$  is calculated as net income divided by total assets. Firms possess the capacity and inclination to invest in capital assets that offer a higher  $ROA$  (Asker et al., 2015).  $LEVERAGE$  is estimated as the ratio of total liabilities to total assets. Leverage may report either a negative or a positive association with investment efficiency, depending on the specific circumstances and context of the study (Ahn et al., 2006; Aivazian et al., 2005; Ozkan & Ozkan, 2004). High leverage may increase bankruptcy risk, leading to a lower investment level; however, higher debt levels can also increase investment due to the availability of external funding. Tangible assets ( $TANGASSET$ ) are scaled by total assets. According to Almeida and Campello (2007), tangible assets can mitigate the risk of financial distress and, consequently, influence firm investment levels. In addition, firms with fewer fixed assets have to hold more cash within financial markets, which may be related to the level of investment (Dimitropoulos & Koronios, 2021). All the variables used in this study are clearly defined and detailed in the Appendix for reference.

### 3.3. Sample selection

To investigate the association between board gender diversity and investment efficiency, we use data from private enterprises registered in the UK. Table 1 outlines the sample selection process,

**Table 1.** Sample selection process.

Panel A: Identification of private firms (firm-level selection)		
Step	Sample selection criteria	Firms remaining
1	All UK private firms from FAME in 2013, subject to audit for at least one year	521,074
2	Less: Firms without a UK primary sector code or legal entity type	-67,678
3	Less: Subsidiaries	-106,035
	<b>Total eligible private firms in 2013</b>	<b>347,361</b>
4	All UK private firms from FAME in 2019, subject to audit in at least one year	222,493
5	Less: Firms without a UK primary sector code or legal entity type	-52,875
6	Less: Subsidiaries	-100,689
	<b>Total eligible private firms in 2019</b>	<b>68,929</b>
7	Less: Firms not consistently classified as private in both 2013 and 2019	-55,239
	<b>Final selected firms classified as private in both 2013 and 2019</b>	<b>136,900</b>
8	Less: Firms in the financial, real estate, and utility sectors	-47,336
9	Less: Firms with insufficient accounting data (e.g. missing tangible/intangible assets, lagged assets, or sales growth)	-58,326
10	Less: Firms with fewer than three board directors	-17,481
	<b>Final sample used in regression analyses</b>	<b>13,757 firms (50,201 observations)</b>
Panel B: Observation-level selection (firm-year observations)		
Step	Sample selection criteria	Observations remaining
1	Firm-year observations for selected private firms (2006–2019), subject to audit	763,336
2	Less: Observations in the financial, real estate, and utility sectors	-211,024
3	Less: Observations with insufficient accounting data (e.g. missing tangible/intangible assets, lagged assets, or sales growth)	-457,987
4	Less: Observations from firms with fewer than three board directors	-44,124
	<b>Final sample used in regression analyses</b>	<b>50,201 observations (13,757 firms)</b>

This table presents the step-by-step selection process of sample private firms. Panel A shows the firm-level selection criteria. Panel B presents the selection process at the firm-year level, where observations are excluded due to industry classification, missing financial data, and board size restrictions.

detailing the number of firms excluded at each stage. Panel A outlines the firm-level selection criteria, and Panel B details the observation-level selection. To ensure consistent classification of firm type, this study defines private firms as those that are recorded as ‘private’ in both 2013 and 2019. Based on this definition, the initial sample includes all private firms from 2006 to 2019 that are subject to audit in at least one of the sample years. Due to their distinctive organizational structures and industries, firms in the financial, real estate and utility sectors have been omitted from the analysis. We also eliminate observations without a UK primary sector code, entity type, and sufficient accounting data to run the baseline regression (Ball & Shivakumar, 2005). Specifically, observations are excluded if they are missing one or more of the key financial variables required to estimate the investment efficiency model, such as tangible assets, intangible assets, lagged total assets, and/or sales growth. Additionally, we exclude subsidiaries (Clatworthy & Peel, 2016) and firms with fewer than three board members. The ultimate dataset comprises 50,201 firm-year observations covering 13,757 private firms in the UK, spanning from 2006 to 2019. All continuous variables are winsorized at the 1% and 99% levels. In

alignment with prior literature (Brav, 2009; Michaely & Roberts, 2012; Shehata et al., 2017), we extract board characteristics from the ORBIS database and gather financial data from the FAME database.

## 4. Results and discussion

### 4.1. Descriptive statistics

Table 2 reports the descriptive statistics for all the variables in the sample from 2006 to 2019. Panel A reports the descriptive statistics for the continuous variables. The mean value of *WOMEN* is 24.205, indicating that the average proportion of women in the boardroom across all industries in the study sample is approximately 24.2%. On average, there is approximately one woman director for every four board members. This percentage is higher than the findings reported in earlier studies. Shehata et al. (2017) reported a rate of 17% for UK small and medium-sized enterprises (SMEs) between 2005 and 2013, while Farooq et al. (2023) reported a rate of 15% for UK listed firms between 2005 and 2018. *INV\_EFF*, *OVER\_INV*, and *UNDER\_INV* report mean values of  $-7.995$ ,  $19.080$ , and  $5.613$ , respectively. The reported standard deviations of *OVER\_INV* and *UNDER\_INV* are  $29.601$  and  $3.283$ , respectively, suggesting a reasonable difference between overinvestment and relatively concentrated underinvestment.

Panel B in Table 2 reports the descriptive statistics for several dummy variables. Around 61.86% of the sample firms have at least one woman director serving in their boardrooms. About one-half (44.39%) of firms in the sample have a board composition with one woman (*WOMDUM1*), 32.51% have two women directors on the board (*WOMDUM2*), and 25.49% have at least three women directors (*WOMDUM3*). Univariate t-test results indicate a significant difference in investment efficiency between firms with women on their boards and those with all-men boards. The reported mean investment efficiency for firms with women directors (*WOMDUM*) is 23.2% higher than for firms whose boards are composed entirely of men.<sup>1</sup> Firms with a board composition consisting of at least three women (*WOMDUM3*) report greater mean investment efficiency.

Table 3 displays the correlation matrix. According to the correlation results, all correlation coefficients are less than 0.5, except for the two dependent variables, *OVER\_INV* and *UNDER\_INV*. The low correlation coefficients suggest that multicollinearity between the main variables in the sample is not a concern. Since *OVER\_INV* and *UNDER\_INV* are not included in the same regression model, the correlation coefficient between these variables is irrelevant. The correlations between investment efficiency and the percentage of women directors are statistically significant at the 1% level. Women on the board are positively correlated with *INV\_EFF*, consistent with Farooq et al. (2023), who researched UK-listed firms. Additionally, the Variance Inflation Factors (VIFs) for each independent variable are all below 4, indicating the absence of multicollinearity.

### 4.2. Baseline regressions

Table 4, Columns (1) to (3) provide the outcomes of the baseline models using the whole sample. We use a dummy variable (*WOMDUM*) to estimate board gender diversity, which indicates whether at least one woman serves on the board. The positive *WOMDUM* coefficient is significant at the 1% level, indicating that having at least one woman director on the board is associated with a 0.891 increase in corporate investment efficiency compared to firms with all-male boards. According to the findings presented in Column (2), there is evidence to imply that a one-standard-deviation rise in the ratio of women directors (*WOMEN*) is linked to an average increase

Table 2. Descriptive statistics.

Panel A: Descriptive statistics for continuous variables									
Variable	N	Mean	SD	Min	p25	p50	p75	Max	
INV_EFF	50,201	-7.995	13.790	-170.539	-8.417	-5.339	-2.827	0.000	
OVER_INV	8,879	19.080	29.601	0.005	3.065	8.192	21.039	170.539	
UNDER_INV	41,322	5.613	3.283	0.000	2.806	5.010	7.650	61.305	
WOMEN	50,201	24.205	24.373	0.000	0.000	25.000	40.000	100.000	
BOARD	50,201	4.751	2.061	3.000	3.000	4.000	6.000	20.000	
LNBOB	50,201	1.486	0.363	1.099	1.099	1.386	1.792	2.996	
FIRMAGE	50,201	28.590	22.330	2.000	13.000	23.000	36.000	158.000	
LNFRMAGE	50,201	3.084	0.746	0.693	2.565	3.135	3.584	5.063	
FIRMSIZE	50,201	7.030	3.321	-6.908	3.909	8.300	9.503	17.848	
ROA	50,201	0.036	0.302	-3.217	0.000	0.036	0.097	4.800	
LEVERAGE	50,201	0.554	0.719	0.000	0.211	0.504	0.761	16.368	
TANGASSET	50,201	0.345	0.302	0.000	0.074	0.269	0.560	1.000	
Panel B: Descriptive statistics for dummy variables									
	N	Value	(%)	INV_EFF <sub>t</sub>	t-Stat				
WOMDUM	19,148	0	38.14	-9.333	-17.114***				
	31,053	1	61.86	-7.170					
WOMDUM1	19,148	0	55.61	-9.333	-8.454***				
	15,282	1	44.39	-7.980					
WOMDUM2	19,148	0	67.49	-9.332	-13.105***				
	9,222	1	32.51	-6.894					
WOMDUM3	19,148	0	74.51	-9.333	-17.834***				
	6,549	1	25.49	-5.670					

This table shows descriptive statistics for the sample. Panel A shows descriptive statistics for continuous variables. Panel B shows descriptive statistics for dummy variables. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed definitions of all variables.

**Table 3.** Correlation matrix showing correlations of the main variables.

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
INV_EFF	1.000									
OVER_INV	-1.000	1.000								
UNDER_INV	-1.000		1.000							
WOMEN	0.089***	-0.012	-0.210***	1.000						
LNBOD	0.019***	-0.045***	-0.027***	-0.004	1.000					
LNFRMAGE	0.092***	-0.111***	-0.102***	0.060***	0.157***	1.000				
FIRMSIZE	-0.127***	-0.105***	0.345***	-0.434***	0.144***	0.051***	1.000			
ROA	-0.012***	-0.010	0.042***	-0.015***	-0.031***	-0.004	0.073***	1.000		
LEVERAGE	-0.076***	0.051***	0.135***	-0.126***	-0.051***	-0.167***	0.092***	-0.198***	1.000	
TANGASSET	-0.095***	0.157***	-0.175***	0.114***	0.004	0.000	-0.031***	-0.042***	-0.054***	1.000

All variables are defined in the Appendix. \*\*\*, \*\*, and \* indicate statistical significance at the 1, 5, and 10% levels, respectively.

Table 4. Board gender diversity and investment efficiency.

Variables	Investment efficiency			Overinvestment			Underinvestment		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
WOMDUM	0.891*** (5.523)			-3.095*** (-4.515)			-0.009 (-0.286)		
WOMEN		0.019*** (6.270)			-0.061*** (-3.519)			0.001 (1.284)	
WOMDUM1			0.746*** (4.247)			-3.149*** (-4.192)			-0.040 (-1.162)
WOMDUM2			1.002*** (4.988)			-2.739*** (-2.715)			0.032 (0.811)
WOMDUM3			1.422*** (6.247)			-3.762*** (-2.734)			0.051 (1.103)
LNBOB	0.240 (1.243)	0.419** (2.228)	0.027 (0.131)	0.292 (0.301)	-0.438 (-0.461)	0.389 (0.381)	0.026 (0.688)	0.022 (0.596)	-0.002 (-0.041)
LNFIIMAGE	1.030*** (9.307)	1.031*** (9.314)	1.026*** (9.270)	-3.481*** (-8.086)	-3.503*** (-8.127)	-3.477*** (-8.079)	-0.039* (-1.829)	-0.041* (-1.904)	-0.040* (-1.855)
FIRMSIZE	-0.186*** (-4.305)	-0.169*** (-3.862)	-0.168*** (-3.860)	-1.058*** (-5.076)	-1.065*** (-5.048)	-1.063*** (-5.051)	-0.131*** (-15.498)	-0.129*** (-15.145)	-0.128*** (-15.083)
ROA	-0.527** (-2.187)	-0.515** (-2.138)	-0.527** (-2.186)	-0.231 (-0.169)	-0.325 (-0.238)	-0.235 (-0.172)	-0.113*** (-2.938)	-0.114*** (-2.966)	-0.113*** (-2.942)
LEVERAGE	-0.678*** (-6.330)	-0.670*** (-6.254)	-0.668*** (-6.247)	0.600 (1.402)	0.605 (1.419)	0.593 (1.379)	-0.073*** (-3.179)	-0.071*** (-3.116)	-0.071*** (-3.108)
TANGASSET	-5.134*** (-17.018)	-5.130*** (-16.992)	-5.145*** (-17.037)	18.046*** (11.935)	17.977*** (11.898)	18.057*** (11.948)	-0.960*** (-19.098)	-0.966*** (-19.224)	-0.962*** (-19.154)
CONSTANT	-9.340*** (-18.126)	-9.657*** (-18.342)	-9.185*** (-17.753)	36.368*** (12.959)	37.064*** (13.053)	36.253*** (12.931)	6.704*** (66.695)	6.676*** (65.597)	6.723*** (66.230)
WOMDUM2- WOMDUM1			1.90			0.16			
WOMDUM3- WOMDUM2			4.77**			0.50			
WOMDUM3- WOMDUM1			11.00***			0.20			
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R <sup>2</sup>	0.066	0.066	0.066	0.070	0.069	0.070	0.534	0.534	0.534
Observations	50,201	50,201	50,201	8,879	8,879	8,879	41,322	41,322	41,322
MaxVIF	2.60	2.69	2.70	2.19	2.19	2.19	3.01	3.10	3.10

This table reports the results of the baseline models with investment efficiency, overinvestment, and underinvestment as the dependent variables, respectively. The Appendix provides detailed definitions of all variables. T-statistics are reported in parentheses and are based on robust standard errors adjusted for heteroskedasticity and clustered at the firm level. \*\*\*, \*\*, and \* indicate significance at the 1%, 5% and 10% level, respectively.

of 0.058 in investment efficiency.<sup>2</sup> The result demonstrates the economic significance of the positive association between the proportion of women on the board and investment efficiency. These findings provide evidence that including women on the board has a positive association with the efficiency of firm investment, supporting the first hypothesis.<sup>3</sup>

The results for the control variables align with those of prior studies. The *LNBO*D coefficient is highly significant at the 5% level and positively associated with corporate investment efficiency. The result is consistent with prior research, which suggests that larger boards are more effective because of the greater variety of directors' knowledge and skills. A broader director skill set is beneficial for corporate decision-making, firm performance, and investment efficiency (Bzeouich et al., 2019; Kiel & Nicholson, 2003).<sup>4</sup> Similar to prior studies, a significant positive correlation exists between the efficiency of firm investments and *LN*FIRMAGE, indicating that older firms tend to have higher investment effectiveness (Rajkovic, 2020). The negative correlation between *FIRMSIZE* and the effectiveness of corporate investments implies that larger firms undertake, on average, less efficient investments, consistent with Mirza et al. (2020). *ROA* reports a significant negative relationship with investment efficiency. Gul (1999) suggests that better corporate performance leads to a discretionary allocation of the firm's earnings, potentially resulting in over- or underinvestment. Firms with better performance are more inclined to suffer reduced investment effectiveness (Bzeouich et al., 2019). Differing from Khedmati et al. (2020), *LEVERAGE* has a notable negative impact on corporate investment effectiveness, indicating that higher levels of debt are associated with lower corporate investment efficiency. In addition, firms with less *TANGASSET* have better investment efficiency.

Following Biddle et al. (2009), we further separate investment inefficiency into overinvestment and underinvestment to investigate the potential channels through which women directors influence investment efficiency. This analysis enables us to examine whether women directors improve investment efficiency by curbing overinvestment and/or mitigating underinvestment. The results are presented in Columns (4)-(9) of Table 4.

The significant negative coefficient ( $\beta = -3.095$ ,  $p < 0.01$ ) in Table 4, Column (4) is consistent with women on boards reducing overinvestment. Compared to all-men boards, firms with at least one woman director are found to reduce overinvestment. In Table 4, Column (5), it is observed that a one-standard-deviation increase in the ratio of women directors (*WOMEN*) corresponds to a decrease of 0.078 in overinvestment on average.<sup>5</sup> Differentiating women director representation in Column (5) shows that having a single woman director significantly curbs overinvestment issues. Conversely, the results in Columns (7)-(9) show no statistically significant association between board gender diversity and underinvestment, suggesting that women directors do not influence underinvestment decisions. These results are consistent with the idea that overinvestment often stems from managerial discretion, such as overconfident behavior, which can be moderated by the more conservative style of women directors. However, underinvestment is usually a consequence of limited access to external capital rather than a result of managerial decision-making. As a result, gender-diverse boards can help reduce overinvestment issues, but have limited capacity to overcome the financing constraints that drive underinvestment.

According to the second hypothesis, the presence of three or more women directors is expected to improve corporate investment efficiency. To test the hypothesis, we use three dummy variables that measure board gender diversity: firms with one woman director (*WOMDUM1*), firms with two women directors (*WOMDUM2*), and firms with at least three women directors (*WOMDUM3*). Column (3) results show positive and significant coefficients for *WOMDUM1* ( $\beta = 0.746$ ,  $p < 0.01$ ), indicating that even the presence of a single woman director can enhance investment efficiency. The larger *WOMDUM3* coefficient ( $\beta = 1.422$ ,  $p < 0.01$ ) indicate that firms with three or more women directors achieve greater investment efficiency than

one or two-woman boards. While H2a predicts a critical mass effect, these results indicate that a threshold level of women representation is not required, as even one woman on the board is sufficient to improve investment efficiency. Nevertheless, the positive effect increases as the number of women directors increases. Column (6) reports the models with *OVER\_INV* as the dependent variable. The coefficients for *WOMDUM1*, *WOMDUM2* and *WOMDUM3* are all significantly negative; Column (9) reports that there is no statistically significant correlation observed between women directors and *UNDER\_INV*. Consistent with these findings, and contrary to H2b, the results suggest that a critical mass of women directors is not required to reduce overinvestment, and that women directors do not have a significant effect on underinvestment. Overall, the results show that the presence of even a single woman in the boardroom can have a substantial positive influence on investment efficiency and reduce overinvestment, with stronger effects observed as women representation increases.

#### 4.3. Sensitivity analysis and robustness checks

The study employs multiple methods to evaluate the sensitivity and reliability of the key findings. First, following the Chen et al. (2011) In the investment model, the study adopts an alternative measure to assess investment efficiency (*INV\_EFF\_CHEN*), accounting for investment as a function of revenue growth. Thus, we differentiate between sales increases and sales decreases, employing a multi-segment linear regression model given by Equation (3):

$$INV_{i,t} = \beta_0 + \beta_1 Neg_{i,t-1} + \beta_2 \Delta SALES_{i,t-1} + \beta_3 Neg * \Delta SALES_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

where *INV* is total investments.  $\Delta SALES$  is the annual sales growth for a firm. *Neg* is an indicator variable that takes a value of '1' if  $\Delta SALES$  is negative and '0' otherwise. The absolute value of the residual values from this model, multiplied by minus one, is defined as corporate investment efficiency (*INV\_EFF\_CHEN*).

Table 5 reports the findings derived from the investment model developed by Chen et al. (2011). The association between board gender diversity and investment efficiency, as indicated by the alternative investment model, is consistent with the baseline estimation. The coefficient for *WOMDUM* in Column (1) is significantly positive, indicating the presence of women directors is linked to a 0.891 rise in investment efficiency. Additionally, a one-standard-deviation increase in the ratio of women directors (*WOMEN*) is associated with a 0.058 increase in investment efficiency (*INV\_EFF\_CHEN*).<sup>6</sup> The results in Column (3) also indicate that there is no evidence of a critical mass effect in the private firm setting. Moreover, boards with at least three women directors reveal a significantly higher corporate investment efficiency.

To further explore the influence of women directors on corporate investment efficiency, we examine the channel that impacts this relationship. Investment decisions are subject to the influence of cash flow, and therefore, financial constraints are one of the main motivations affecting investment efficiency (Carpenter & Guariglia, 2008; Franzoni, 2009). Following Hadlock and Pierce (2010), we use the *SA* index to proxy for financial constraints, noting that firm size and firm age are critical factors in assessing these constraints. The *SA* index is calculated in Equation (4) as follows:

$$SA\_INDEX_{i,t} = -0.737 * FIRM\_SIZE_{i,t} + 0.043 * FIRM\_SIZE_{i,t}^2 - 0.040 * LN\_FIRM\_AGE_{i,t}$$

A higher *SA\_INDEX* indicates more severe financial constraints. We re-examine the baseline

model by incorporating the variable *SA\_INDEX*, as defined in Equation (5) as follows:

$$\begin{aligned}
 Y_{i,t} = & \beta_0 + \beta_1 GENDERDIVERSITY_{i,t} + \beta_2 SA\_INDEX_{i,t} + \beta_3 GENDERDIVERSITY_{i,t} * SA\_INDEX_{i,t} \\
 & + \beta_4 LNBOD_{i,t} + \beta_5 LNFIRMAGE_{i,t} + \beta_6 FIRMSIZE_{i,t} + \beta_7 ROA_{i,t} \\
 & + \beta_8 LEVERAGE_{i,t} + \beta_9 TANGASSET_{i,t} + \sum_{i=1}^m \lambda_i INDUSTRY_i + \sum_{t=1}^n \Omega_t YEAR_t + \varepsilon_{i,t}
 \end{aligned}$$

Table 6 shows the estimated models for the channel analysis. The coefficient for the interaction term (*WOMDUM\*SA\_INDEX*) is both positive and statistically significant ( $\beta = 0.411$ ,  $p < 0.01$ ). This finding aligns with the theoretical framework of the study. When external financing is limited, firms rely more on internal governance to allocate capital efficiently. In these settings, gender-diverse boards with greater cognitive diversity, richer information exchange and stronger monitoring become particularly valuable. Women directors' risk aversion and cautious oversight help prevent inefficient or overly aggressive investments when financial resources are tight. Overall, these results suggest that women directors play a more influential governance role in financially constrained private firms, improving investment efficiency where internal discipline is most needed.

#### 4.4. Endogeneity corrections

Companies may tailor boards to fit certain activities and roles; hence, board features are endogenous variables (Wintoki et al., 2012). Therefore, the documented significant associations between board gender diversity and corporate investment efficiency may be potentially affected by self-selection bias and unobserved heterogeneity. Endogeneity can also arise when firms choose board structures to achieve greater investment efficiency, potentially reversing the direction of the relationship. Endogeneity may also be caused by selection bias. For example, women directors prefer to self-select to serve in better-performing enterprises (Farrell & Hersch, 2005). Firms with specific characteristics are also more inclined to boost the representation of women on their boards of directors (Xu et al., 2019). To alleviate endogeneity concerns, we re-examine the association between board gender diversity and corporate investment efficiency by employing four models: propensity score matching (PSM), Heckman two-stage self-selection (Heckman, 1979), and two-stage least squares (2SLS) estimations.

First, we employ propensity score matching (PSM) using *WOMDUM* as the treatment variable and obtain one-to-one matched pairs. After matching, differences in all covariates between treatment and control firms become statistically insignificant, confirming effective balancing of observable characteristics. Re-estimating Equation (2) using the matched sample continues to yield a positive and highly significant coefficient on *WOMEN*, indicating that the baseline relationship is not driven by observable selection bias. Second, we implement a Heckman two-stage selection model using an industry-level gender diversity instrument (*IV\_IND\_WOM*), defined as the three-year rolling industry average proportion of women directors excluding the focal firm. The first-stage probit shows that the instrument strongly predicts the likelihood of appointing women directors, and the second-stage results again produce a positive and statistically significant coefficient on *WOMEN*, reinforcing the main findings. Finally, we estimate a 2SLS model using the same instrumental variable. The first-stage coefficient on *IV\_IND\_WOM* is positive and significant, and weak-instrument diagnostics confirm instrument strength. The second-stage coefficient on *WOMEN* remains positive and statistically significant, demonstrating that our results are not attributable to reverse causality or omitted-variable bias. Together, these complementary tests provide strong evidence that the positive association between board gender diversity and

investment efficiency is unlikely to be driven by endogeneity. A detailed explanation of these tests and the empirical estimates are presented in the Online Appendix.

#### 4.5. Additional analysis: family-controlled firms versus non-family firms

Prior studies report that family firms exhibit distinct corporate governance and decision-making behaviors compared to non-family firms, primarily due to their concentrated ownership, the alignment between ownership and control, and the desire to maintain family influence and socio-emotional wealth that influence their governance structures, risk preferences, and strategic decision making (Anderson & Reeb, 2003; Gomez-Mejia et al., 2010; Randøy & Goel, 2003; Silva & Majluf, 2008). Such distinct characteristics may influence investment decision-making behavior in family firms compared to non-family firms (Anderson et al., 2012; Jin et al., 2023; Shahzad et al., 2018, 2019). These differences are relevant to diversity theory,

**Table 5.** Board gender diversity and investment efficiency (Chen et al. (2011) investment model).

Variables	INV_EFF_CHEN		
	(1)	(2)	(3)
WOMDUM	0.891*** (5.523)		
WOMEN		0.019*** (6.270)	
WOMDUM1			0.746*** (4.247)
WOMDUM2			1.002*** (4.988)
WOMDUM3			1.422*** (6.247)
LNBOB	0.240 (1.243)	0.419** (2.228)	0.027 (0.131)
LNFIRMAGE	1.030*** (9.307)	1.031*** (9.314)	1.026*** (9.270)
FIRMSIZE	-0.186*** (-4.305)	-0.169*** (-3.862)	-0.168*** (-3.860)
ROA	-0.527** (-2.187)	-0.515** (-2.138)	-0.527** (-2.186)
LEVERAGE	-0.678*** (-6.330)	-0.670*** (-6.254)	-0.668*** (-6.247)
TANGASSET	-5.134*** (-17.018)	-5.130*** (-16.992)	-5.145*** (-17.037)
CONSTANT	-9.340*** (-18.126)	-9.657*** (-18.342)	-9.185*** (-17.753)
WOMDUM2- WOMDUM1			1.90
WOMDUM3- WOMDUM2			4.77**
WOMDUM3- WOMDUM1			11.00***
Year Dummy	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes
Adj. R <sup>2</sup>	0.066	0.066	0.066
Observations	50,201	50,201	50,201

This table reports the results of the baseline model in Chen et al. (2011) investment model. All control variables from Table 4 are included. The Appendix provides detailed definitions of all variables. Based on robust standard errors adjusted for heteroskedasticity and clustered at the firm level, t-statistics are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level, respectively.

**Table 6.** Effects of gender diversity and financial constraints on investment efficiency.

Variables	Investment efficiency
WOMDUM	2.438*** (4.593)
SA_INDEX	0.449** (2.521)
WOMDUM * SA_INDEX	0.411*** (3.356)
LNBOB	0.205 (1.063)
LNFIRMAGE	1.742*** (9.094)
FIRMSIZE	-0.030 (-0.528)
ROA	-0.435* (-1.806)
LEVERAGE	-0.662*** (-6.189)
TANGASSET	-5.060*** (-16.874)
CONSTANT	-11.061*** (-17.102)
Year Dummy	Yes
Industry Dummy	Yes
Adj. R <sup>2</sup>	0.067
Observations	50,201

This table reports the results of the estimated models of the channel analysis. The channel tested is financial constraints (*SA\_INDEX*). T-statistics, based on robust standard errors adjusted for heteroskedasticity and clustered at the firm level, are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level, respectively.

which emphasizes that the benefits of diverse boards depend on an organization's ability to utilize varied perspectives, encourage information exchange, and support effective monitoring. In family-controlled settings, close relational ties within the boardroom may affect board dynamics and limit women directors' opportunities to participate in discussions and monitoring activities.

To further investigate this issue, we examine whether the impact of board gender diversity differs between family-controlled and non-family firms. Following Michaely and Roberts (2012) this study uses the number of shareholders as a proxy to distinguish between family-controlled and non-family firms. Specifically, firms with no more than twenty shareholders are classified as family-controlled, reflecting more concentrated ownership and a higher likelihood of family influence. In contrast, firms with more than twenty shareholders are considered non-family firms, as they are assumed to have more dispersed ownership and fewer family ties.

Table 7 reports the results examining the relationship between board gender diversity and investment efficiency, with the sample divided into family and non-family firms. Family firms are defined as those with twenty or fewer shareholders, while non-family firms have more than twenty shareholders. Columns (1) and (2) use a dummy variable indicating the presence of a woman director, whereas Columns (3) and (4) use the percentage of women directors on the board to measure board gender diversity. The results show that women directors are significantly and positively associated with investment efficiency in both types of firms. The positive

**Table 7.** Additional analysis: Family-controlled vs non-family firms.

Variables	INV_EFF				(5) Coefficient difference
	(1) Family firms (No of shareholders< = 20)	(2) Non-family firms (No of shareholders>20)	(3) Family firms (No of shareholders< = 20)	(4) Non-family firms (No of shareholders>20)	
WOMDUM	0.780*** (4.594)	1.950*** (3.621)			4.32**
WOMEN			0.017*** (5.294)	0.032*** (4.217)	3.30*
LNBOB	0.379* (1.852)	-0.671 (-1.079)	0.529*** (2.664)	-0.233 (-0.370)	
LNFIRMAGE	1.057*** (8.959)	0.975*** (2.869)	1.054*** (8.945)	0.970*** (2.840)	
FIRMSIZE	-0.168*** (-3.652)	-0.369** (-2.556)	-0.152*** (-3.275)	-0.346** (-2.353)	
ROA	-0.573** (-2.264)	0.132 (0.177)	-0.563** (-2.222)	0.098 (0.130)	
LEVERAGE	-0.683*** (-6.196)	-0.322 (-0.727)	-0.673*** (-6.118)	-0.365 (-0.814)	
TANGASSET	-5.360*** (-16.122)	-3.541*** (-5.050)	-5.367*** (-16.120)	-3.463*** (-4.969)	
CONSTANT	-9.417*** (-17.082)	-8.932*** (-5.361)	-9.715*** (-17.279)	-9.248*** (-5.470)	
Year Dummy	Yes	Yes	Yes		
Industry Dummy	Yes	Yes	Yes		
Adj. R <sup>2</sup>	0.066	0.058	0.066	0.057	
Observations	44,592	5,609	44,592	5,609	

This table reports the results of the additional analysis: Family-controlled vs non-family firms. All control variables from Table 4 are included. The Appendix provides detailed definitions of all variables. Based on robust standard errors adjusted for heteroskedasticity and clustered at the firm level, t-statistics are reported in parentheses. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level, respectively.

effect of women directors on corporate investment efficiency is stronger in non-family firms, with a coefficient of 1.950, compared to 0.780 in family firms. Similarly, the effect of the percentage of women directors remains more pronounced in non-family firms, with a coefficient of 0.032 compared to 0.017 in family firms. These findings support that board gender diversity contributes to better investment efficiency in non-family firms, which is consistent with the study by Jin et al. (2023). Drawing on diversity theory, firms with more dispersed ownership and weaker family ties – which are generally considered to have more transparent governance structures – provide women directors with more opportunities to voice their opinions in board discussions and to effectively exercise their monitoring roles. Therefore, gender diversity is more likely to generate positive effects, such as providing broader perspectives and enhancing board oversight in decision-making processes, which is beneficial for improved investment efficiency.

## 5. Conclusion

This study analyses a sample of 13,757 private firms (50,201 observations) in the UK from 2006 to 2019 to investigate the influence of women directors on board composition and corporate

investment efficiency. Based on diversity theory, we argue that the different perspectives of women directors, effective communication, and strong monitoring abilities reduce private firm managers' ability to pursue inefficient investments, thereby improving investment efficiency in private firms.

We adopt the Biddle et al. (2009) corporate investment model and present evidence indicating a positive association between board gender diversity and investment efficiency in UK private firms. More specifically, board gender diversity enhances corporate investment efficiency and serves as a mitigating factor in addressing overinvestment rather than underinvestment problems. Underinvestment is more strongly shaped by financing constraints, which may limit the board's ability to address it. Moreover, our evidence diverges from the critical mass theory, which argues that a minimum threshold of women's representation is necessary for women to exert influence. Instead, we find that a single-woman director can exert a meaningful influence on investment efficiency and overinvestment in private firms. This contrast may be attributed to the unique governance characteristics of private firms, such as concentrated ownership and the prevalence of owner-managed structures. In such settings, individual directors tend to have greater influence, making the contributions of a single woman director more visible and impactful. Further analysis reveals that the impact of women directors is stronger in financially constrained firms and more pronounced in non-family firms.

The research is important because private firms constitute a sizable share of the UK economy and underscore the need to better understand the role of women on boards in privately held firms. While prior studies on gender diversity and investment efficiency have predominantly focused on public firms (Almor et al., 2022; Chen et al., 2016; Farooq et al., 2023), our findings provide novel insights from the private firm setting, showing that the representation of women directors is beneficial for enhancing corporate investment efficiency, consistent with the predictions of diversity theory. Notably, unlike the findings of Farooq et al. (2023) for UK public firms, this study finds no critical mass effect in UK private firms. In other words, it is not necessary to reach a specific threshold of women board representation for a single woman director to exert a meaningful influence on corporate investment efficiency. A possible explanation for this difference is that women directors in private firms are not merely token appointees, as there is no regulatory requirement mandating their presence on corporate boards. As a result, their presence is more likely to be driven by firm-specific needs, allowing them to voice their perspectives and influence investment decisions. According to diversity theory, a more heterogeneous board composition enhances cognitive diversity, broadens the range of perspectives, and improves monitoring and decision-making processes, ultimately leading to more efficient investment strategies. Furthermore, in contrast to the conclusions of Farooq et al. (2023) regarding UK public firms, which suggest that board gender diversity mitigates both underinvestment and overinvestment, this study finds that in private firms, women directors primarily influence overinvestment rather than underinvestment. This distinction underscores the importance of considering firm ownership structure when assessing the impact of board gender diversity on investment decisions.

In addition, countries worldwide have devoted significant attention to the influence of women directors. Interestingly, the UK government has not implemented legal requirements to direct company gender quotas, despite regulator recommendations for greater board gender diversity. The study also contributes to a deeper understanding of the unique features of private firms in a less regulated environment, shedding light on the impact of women directors on the investment efficiency of these firms.

This study suggests that, from a corporate perspective, private firms should establish clear policies for diversity and promotion to ensure adequate representation of women on boards. The adoption of a more transparent gender diversity policy not only enhances the firm's image but

also brings governance benefits and improves investment efficiency. Moreover, incorporating gender diversity factors into performance evaluations and incentive mechanisms can ensure that women directors have equal opportunities for advancement. This approach helps attract and retain talented women, further improving corporate governance and investment quality. From an industry perspective, investors can leverage these findings by prioritizing firms with higher gender diversity when selecting investment targets. Such firms are likely to exhibit greater investment efficiency, offering more predictable returns. Additionally, governments and regulatory bodies can utilize these insights to develop and implement policies and regulations that promote gender diversity on boards in private firms. This not only improves corporate governance but also boosts overall investment returns. From an academic perspective, research on investment efficiency for private firms remains limited. We suggest that future scholars explore the influence of board characteristics within privately held firms to advance these firms. Further studies could explore whether other board attributes, such as director independence, educational background, age, or tenure, influence investment efficiency in private firms. Finally, we recommend that board gender diversity policies need to be more sensitive to the inclusion of women in the workforce to reduce board gender discrimination.

The research is not without limitations. In terms of data, the limited scope of private sector data constrains this study. The sample does not consider director characteristics that may influence corporate decision-making and governance effectiveness. Future research could investigate whether the characteristics of women directors, such as age, tenure, and educational background, influence investment decisions. Data on the relationship between women directors and controlling shareholders would allow a closer examination of interesting ownership features that characterize private firm ownership.

Additionally, our study focuses on UK private firms, which may limit the generalizability of our findings due to differences in cultural environments. Future studies could examine cross-country differences and assess whether institutional factors shape the relationship between board gender diversity and investment efficiency. Furthermore, this study focuses on investment efficiency, but board gender diversity may also impact other financial decisions. Further research could explore other dimensions to provide a more comprehensive view of the role of women directors in private firms.

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## Supplementary material

Supplemental data for this article can be accessed online at <https://doi.org/10.1080/17449480.2026.2622079>.

## Notes

<sup>1</sup> $(-7.170 - (-9.333)) * (-1) / (-9.333) = 0.232$ .

<sup>2</sup>The average value of *INV\_EFF* is  $-7.995$ . The coefficient for *WOMEN* is  $0.019$  and its standard deviation is  $24.373$ . Thus, a one-standard deviation increase in *WOMEN* is related to  $5.8\%$  increase in investment efficiency i.e.,  $0.019 \times 24.373 / |-7.995| = 0.058$ .

<sup>3</sup>The relationship was also verified by estimating the model using the top quartile of residuals for the *OVER* subsample and the firm-year observations in the bottom quartile for the *UNDER* subsample. We thank an anonymous reviewer for this suggestion after noting the skewed nature of the number of underinvestment and overinvestment measures. The results are available upon request from the authors.

<sup>4</sup>Note that this finding is contrary to Hermalin & Weisbach, 2003; Shin et al., 2020.

<sup>5</sup>The average value of *OVER\_INV* is  $19.080$ . The coefficient for *WOMEN* is  $-0.061$  and its standard deviation is  $24.373$ . Thus, a one-standard deviation increase in *WOMEN* is related to  $6.4\%$  increase in investment efficiency (i.e.,  $|-0.061| \times 24.373 / 19.080 = 0.078$ ).

<sup>6</sup>The average value of *INV\_EFF\_CHEN* is  $-7.995$ . The coefficient for *WOMEN* is  $0.019$  and its standard deviation is  $24.373$ . Thus, a one-standard deviation increase in *WOMEN* is related to  $4.3\%$  increase in investment efficiency (i.e.,  $0.019 \times 24.373 / |-7.995| = 0.058$ ).

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## Appendix Variable definition and firm size classification.

Abbreviation	Definition
Dependent variables	
INVESTMENT	The net increase in tangible assets and intangible assets multiplied by 100 and scaled by lagged total assets.
INV_EFF	Investment efficiency is estimated as the absolute value of the deviation from the Biddle et al. (2009) investment model multiplied by negative one.
OVER_INV	Overinvestment is estimated as the positive residuals calculated from the Biddle et al. (2009) investment model.
UNDER_INV	Underinvestment is estimated as the negative residuals calculated from the Biddle et al. (2009) investment model, multiplied by minus one.
Independent variable	
WOMEN	The percentage of women directors on the board.
WOMDUM	A dummy variable that is equal to 1 if the board includes at least one woman director and zero otherwise.

(Continued)

Continued	
Abbreviation	Definition
WOMDUM1	A dummy variable that is equal to 1 if the number of women directors on the board is 1 and zero otherwise.
WOMDUM2	A dummy variable that is equal to 1 if the number of women directors on the board is 2 and zero otherwise.
WOMDUM3	A dummy variable that is equal to 1 if the number of women directors on the board is at least 3 and zero otherwise.
Control variables	
LNBOD	Natural log of the total number of directors.
LNFIRMAGE	Natural log of the number of years since the date of incorporation.
FIRMSIZE	Natural log of total assets.
ROA	Net income divided by total assets.
LEVERAGE	Total liabilities divided by total assets.
TANGASSET	Tangible assets divided by total assets.
Robustness analysis	
INV_EFF_CHEN	The absolute value of the residual values from Chen et al. (2011) investment model, multiplied by minus one.
Instrumental variable	
IV_IND_WOM	Three-year rolling industry mean of female director percentage, excluding the focal firm.