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**Gender diversity at entrepreneurial firm IPOs:
responding
to changing societal norms** Economy

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Abstract Recently, the lack of diversity in startup leadership has been criticized by public figures and institutional investors as a signal of inadequate governance. And yet, little is known about the historical changes in gender diversity in entrepreneurial firms. Using a unique database of the gender composition in all entrepreneurial firm IPOs from 1990 to 2020 in the USA, we examine these changes. The IPO is a particularly interesting moment in an entrepreneurial firm's evolution, as governance evolves from a private firm directed by venture capitalists, with their beliefs about what a good management team is, into a public firm with owners who are institutional investors with potentially different goals and beliefs. Grounded in signaling theory, our expectation is that the changes in public investors' view of proper governance will result in changes in the gender in personnel added immediately prior to the IPO and that IPO teams

will be more diverse than Early Teams when the firm was younger and controlled by its private investors. We suggest that the private investors such as venture capitalists have different mental models of what "good" members or top management and the board of directors are. We expect these models are particularly influential in the digital technologies where a "tech bros" model is dominant, and thus there is little "space" for women leaders, particularly in contrast to the university research-based biotechnology industry, which has not experienced such direct criticism. We find support for our propositions, and also document an increase in women directors and top management team members over time.

Plain English Summary Our study shows that over the last 30 years, there has been a dramatic increase in the presence of women leadership in firms making an initial public stock offering. Using a unique longitudinal database of all entrepreneurial firms that did an initial public stock offering (IPO) on US markets from 1990 to 2020, we explore the changes in gender composition of top management teams (TMT) and board of directors (BoD). We are the first to document a dramatic increase in the participation of women in these firms' leadership. This was concentrated after the 2008 financial crisis, as institutional investors came to accept that diversity was a sign of good corporate governance. The firm leadership added immediately before the IPO Team exhibited a dramatic increase in the presence of women than those added earlier. This suggests that firms added women to signal conform-

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ance to the institutional investors' beliefs. Women are far more prevalent in entrepreneurial firm leadership than they were 30 years ago, but, when building their firms prior to the IPO, private investors appear to be less certain about the relationship between diversity and rapid entrepreneurial firm growth.

Keywords Gender · IPO · Governance · Top management teams · Boards of Directors · Diversity

JEL Classification G30 Corporate Finance and Governance—General · G34 Corporate Governance · J16 Economics of Gender · B54 Feminist Economics

1 Introduction

Over the last three decades, there have been remarkable changes in beliefs about corporate leadership. In particular, there has been mounting criticism regarding the lack of gender diversity in corporate leadership (Daily et al., 1999; Kanter, 1977; McKinsey and Co, 2021). In response to criticism, the expectations of what is considered proper corporate governance have changed resulting in an increasing number of women in corporate leadership positions (Rhode & Packel, 2014). Similar public criticisms have been directed at the absence of women in leadership positions at entrepreneurial firms (Dai et al., 2019; Hülsbeck et al., 2019) and, in part, this was attributed to an absence of diversity at venture capital partnerships (Brush et al., 2018; Calder-Wang & Gompers, 2021). Presently, gender diversity in the top management team (TMT) and independent members of the boards of directors (hereafter, BoD) of public firms is expected and increasingly required by institutional investors.

This paper offers two contributions to the entrepreneurship literature: First, we provide the first multi-decade longitudinal analysis of the gender composition of the TMT and BoD for all entrepreneurial firms that undertook an IPO from 1990 through 2020. Second, we assume that the beliefs of extremely successful private investors regarding the value of gender diversity have changed more slowly than have those of the institutional investors that are directly exposed to public opinion. To test this intuition, we compare the gender composition at the time of the IPO of those that were added to the TMT and BoD immediately before the IPO with those that had longer tenure

at the firm. Building upon Chen et al. (2008), we suggest that the IPO firm will add women to leadership positions immediately prior to the IPO as it seeks to reassure institutional investors that it conforms to their norms of good governance and thus is a legitimate investment (Fisher et al., 2016).

In the past decade, the general public, policy makers, and, in particular, institutional investors have accepted that the presence of women on the TMT and BoD is a sign of good corporate governance (Francoeur et al., 2008; Terjesen et al., 2009). This changing consensus means that gender diversity has become a signal that a firm practices good governance and thus is worthy of investment (Khoury et al., 2013). Even though this belief is now widely accepted and is even being mandated,¹ it was not always the case. Remarkably, despite enormous attention to this issue, little is known about longitudinal changes in women's representation on TMTs and BoDs.

We suggest that signaling theory explains the changes in the gender composition of TMT and BoD members in entrepreneurial firms. It suggests that in situations characterized by asymmetric information, those trying to elicit an action, in this case, investment by institutions at the public offering, will create signals about their credibility and legitimacy to this new audience (Spence, 1973). A rich literature explores signaling applications in management (Connelly et al., 2011): as firms respond to the expectations and norms of crucial audiences within which they wish to maintain legitimacy and bolster reputation (Deephouse & Carter, 2005; Huang et al., 2022). Here, we suggest that firms offering stock to investors for the first time will use the composition of their TMT and BoD

¹ The NASDAQ recently issued a requirement that all listed firms must have at least one female director on the board. California (SB 826, 2018) was the first state to mandate that all public firms headquartered in the state have at least one female board member and has mandated fines for noncompliance, followed by Washington (SB 6037, 2020). Several other states are pursuing legislation: Colorado (H J Res 17-1017, 2017), Massachusetts State Senate Resolution 1007 (2015), and Pennsylvania (H Res 273, 2017) passed non-binding resolutions encouraging board diversification; Maryland (HB 1116, 2019), Illinois (HB 3394, 2019), and New York (SB 4278, 2019) established mandatory disclosure of board gender diversity. Hawaii (SB 193, 2021), Michigan (SB 64, 2021), and Oregon (HB 3110, 2021) have gender quota statutes in the legislature. However, in a decision currently under appeal, on May 13, 2022, a California court struck down a state law mandating representation on boards of directors.

to signal their acceptance of institutional investors' beliefs that have changed over time regarding the relationship between diversity and good governance.

Our research offers several contributions to the literature on entrepreneurship and gender. First, our longitudinal dataset fills a gap in the existing entrepreneurship research, which is largely ahistorical or, if historical, largely qualitative. Almost invariably, quantitative studies of venture boards are descriptive, cross-sectional, and, at best, treat history as an afterthought rather than a powerful context within which entrepreneurial action takes place (Garg & Furr, 2017; on importance of context for entrepreneurship, see Autio et al., 2014).

Second, we answer calls for empirical research on entrepreneurial firms' corporate governance (Li et al., 2020): including before and after IPO (Burton et al., 2019; Chemmanur et al., 2022; Garg & Furr, 2017). By examining the entire population of entrepreneurial firms that undertook an IPO from 1990 through 2020, we can understand how the evolution of public/institutional investor perceptions of appropriate gender composition of leadership is reflected in TMTs and BoDs of firms undertaking an IPO.

Third, we contribute a historical perspective to current analyses of the cultural, structural, and corporate-level barriers that impede women's entrance into corporations' upper echelons (e.g., Brammer et al., 2007; Oakley, 2000) to firms prior to their IPO. Importantly, our database includes the most influential entrepreneurial firms established over the last three decades and includes Amazon, Cisco, Facebook, Google, Lyft, NVidia, Salesforce, Tesla, Uber, and Yahoo. Our analysis also highlights that there are industrial differences in the share of women in leadership roles at entrepreneurial firms (Afzali et al., 2022; Thams et al., 2018).

Overall, our study confirms the belief that entrepreneurial firms are gradually increasing the presence of women in leadership. These increases are most rapid since the 2008–2009 financial crisis as concerns about diversity became especially salient throughout the society and among institutional investors. A significant proportion of this secular increase is explained by the addition of women immediately prior to the IPO (hereafter IPO Team). We attribute this to the recognition by the firm and its investors that their tech bro mental model of a fast-growing startup may not be acceptable to public investors (Hill

& Levenhagen, 1995). Further, we show that this was most powerful among digital technology (DT) firms.

We begin by discussing signaling theory and its use in understanding how over time entrepreneurial firms have responded to changes in the public context. We follow this by introducing propositions derived from our data analysis. The third section discusses the data and study methodology. The fourth section presents our results. This is followed by a discussion and conclusion that consider how signaling theory provides insight into gender diversity among firm leadership has changed over time and the use of gender as a signal to public investors that the firm is transitioning to one that understands their governance concerns.

2 Literature review

Signaling theory concerns how one group communicates asymmetric information to another group (Spence, 1973): with a focus on “deliberate communication of positive information in an effort to convey positive organizational attributes” (Connelly et al., 2011: 44). One way of communicating these attributes is through the IPO prospectus and road show. The board and management team composition are important nonfinancial information for investors (Certo, 2003) that rely upon corporate leaders to act in their interests and according to their sensibilities.

Institutional investors, many of which represent public and private pension funds, have become ever more concerned with gender representation in all firms including those undertaking an IPO. To illustrate, in 2017, Morgan Stanley began “encouraging” analysts to consider gender scores for their investments, and in 2018 BlackRock reported “expecting” its portfolio companies to have at least two women directors (Froehlicher et al., 2021). As another example, State Street Global Advisors stated that it would vote against all-male boards, and Goldman Sachs vowed to only underwrite IPOs with at least one director from a traditionally underrepresented group (Froehlicher et al., 2021). Proxy advisory firms also joined in pressuring for increased board gender diversity. For example, in 2021, Institutional Shareholder Services adopted a policy of recommending against all-male boards, while Glass Lewis decided to recommend against voting for boards with fewer than two women directors beginning in 2022 (Breheny et al., 2020).

As a result, all actors involved in promoting an IPO have come to believe that it is necessary to show adherence to the values of their audience (Certo, 2003; Esteban-Salvador & Gargallo-Castel, 2019; Williams et al., 2010). For example, Bernardi et al. (2002) report that companies with higher percentages of women on their BoD were more likely to display pictures of the board in their annual reports, thereby intentionally signaling this fact. Additional scholarship finds that approximately 60% of Fortune 500 CEOs believe that women board members “exemplify their company’s commitment to diversity to shareholders” and “the company’s commitment to advancing women”—a result that supports the notion that women directors are used to signal firms’ compliance with gender diversity norms (Mattis, 2013:53). Taken together, this suggests that firms respond to stakeholder expectations and demands by hiring women in senior positions to send positive signals to important external audiences.

Firm performance—the “business case” for diversity—dominates US policy debates about initiatives to diversify corporate leadership, due in part to an appeal to the bottom line of corporate decision-making that avoids a zero-sum mentality associated with equal opportunity arguments (Rhode & Packel, 2014; Suk, 2012). The business case argument suggests that firms excluding women leaders miss out on their talent, and thus experience lower financial performance (Torchia et al., 2011). This suggests that increasing the proportion of women increases heterogeneity in values, beliefs, and perspectives that may stimulate creativity, independent reasoning, and critical thinking (Ramirez, 2003; Van der Walt & Ingley, 2003)—and thus increase performance. In other words, gender diversity diminishes the inclination of small homogeneous groups to experience unquestioning adherence to group norms, failure to challenge implicit or underlying assumptions, and engage in myopic decision-making (Arfken et al., 2004; Ramirez, 2003; Rhode & Packel, 2014; Selby, 2000). Moreover, it has been found that firms with greater numbers of women in leadership positions bring a greater sense of formality to company meetings leading to more task-focused and efficient discussions (Desvaux et al., 2017). Greater board gender diversity is also positively associated with uptake of good governance practices such as increased levels of attendance, compliance with internal conflict of interest guidelines, adoption of a

code of conduct, and holding the CEO accountable for poor stock price performance (Adams & Ferreira, 2009).

Evidence on the connection between gender diversity and firm performance remains mixed. Some studies report higher proportions of women in the BOD or TMT have a negative (Adams & Ferreira, 2009; Yang et al., 2019) or insignificant (Carter et al., 2010; Francoeur et al., 2008; Pletzer et al., 2015) impact on financial performance. Others find that companies with a high proportion of women in top management (Christiansen et al., 2016; Francoeur et al., 2008) and/or the BOD (Post & Byron, 2015) outperform firms with less gender diversity. This is particularly the case in knowledge-intensive and high-technology industries, which demand higher creativity and critical thinking (Christiansen et al., 2016). The inconsistency in results may reflect the wide variety of measurements utilized both to calculate firm performance and in women’s roles (Rhode & Packel, 2014). Other studies report a positive impact of gender diversity on financial performance only under certain conditions such as when firms possess a growth orientation, when the organizational culture is more nurturing and employee-focused (Dwyer et al., 2003), or when boardrooms reach a “critical mass” of 30% women (Joecks et al., 2013).

In the current business environment for public firms, gender diversity is expected. Various social actors including government bodies, institutional investors, academics, the press, and women’s advocacy groups such as Catalyst, Women Business Collaborative, Women United, and 50/50 Women on Boards pressure firms to increase the number of women senior leaders (Ramirez, 2003; Terjesen & Sealy, 2016; Terjesen et al., 2009). While women are underrepresented across all senior-level positions, most of the focus has been on the BoD (Terjesen et al., 2009). Analysis of gender quotas in Europe indicates voluntary commitments or quotas with no sanctions were ineffective at increasing gender diversity (Arndt & Wrohlich, 2019; De Cabo et al., 2019); and thus, legislative efforts may not have as great an impact as many expected. In fact, some have found that board gender quota laws may slow or halt increases (Bertrand et al., 2019; Maida & Weber, 2022).

Firms respond to stakeholder expectations by sending signals that establish or maintain legitimacy

and bolster their reputation. While legitimacy and reputation are similar in function and consequence, they serve firms in distinct ways. Legitimacy deals with a firm's adherence and conformity to the expectations, norms, values, and rules of the social system in which it is embedded (Deephouse & Carter, 2005). The continued existence of an organization depends on more than its economic or financial performance—a firm must be perceived as adhering to rules and norms to secure the approval of external stakeholders (Esteban-Salvador & Gargallo-Castel, 2019; Miller & del Carmen Triana, 2009; Hillman et al., 2007). Firms build legitimacy by responding to institutional forces, including investors, regulatory agencies, consumers, and other stakeholders (Certo, 2003; Hillman et al., 2007). What is certain is that it is increasingly accepted by both governments and institutional investors that good governance and thus legitimacy requires that women be represented in corporate leadership.

3 Proposition development

In the last three decades, beliefs regarding the representation of women in corporate leadership have changed dramatically. There are an ever-growing number of board gender composition targets and regulations including mandatory quotas with and without sanctions, codes of good governance, and “comply-or-explain” legislation. More recently institutional investors, such as CalPERS, have demanded that their investee firms have gender-diverse TMTs and BoDs. These changes have resulted in an increasing pool of women with business and advanced science degrees and significant managerial experience. Therefore, we expect a secular tendency for:

Proposition 1: The proportion of women in the TMT and the BoD to increase over time.

Attention to the lack of women's representation in public companies has concentrated upon the BOD, whose role is to represent shareholders and to represent stakeholders' interests (Terjesen et al., 2009). As diversity concerns largely concentrate on BoD gender composition, we expect women's presence to grow more rapidly and be greater on BoDs than on TMTs:

Proposition 2: The rate of increase in the proportion of women will be greater for the BOD than for TMT members.

Given the length of our time series and the major changes in US society, corporate America, and stock market behavior over the last 30 years, we divided the time series into three periods.² These three periods' markedly different dynamics trigger rapid changes which must be separately analyzed. The first period (1990 to 2000) ended with the collapse of the Dot.com Bubble and is a baseline period during which there was little concern about diversity and representation. The second period (2001 to 2008) can be seen as an interregnum with very few IPOs. This period ended with the 2008 stock market meltdown that was resolved by a massive Federal government bailout of the financial system.

The final period (2009–2020) is particularly interesting as President Obama was elected and there was an immediate and massive bailout of the entire financial system that also shifted enormous power to the Federal government. The new Obama Administration strongly pursued diversity in key legal, economic, and financial decision-making positions (Anestaki et al., 2019; Boyd, 2016). For example, in 2009 Mary Shapiro was appointed as the Chairman of the Securities Exchange Commission and Christina Romer became the head of Obama's Council of Economic Advisors. In 2013, Obama appointed Janet Yellen as president of the Federal Reserve. These appointments were accompanied by a greater pressure, particularly from institutional investors and advocacy groups, for gender diversity in corporate leadership, particularly gender diversity on the BoD (Terjesen, 2023). These changes in U.S. society and the stock market over the 30 years lead us to expect:

Proposition 3: While there will be a secular increase in the proportion of women on the TMT and independent members of the BoD, the pace of change will differ by time periods.

² Our choice of time periods; 1990–2000, 2001–2008, and 2009–2020 was based on aspects of the IPO market. Our dividing years correspond to the 2000 Internet bubble and the beginning of the Great Recession in 2008. As pointed out by an anonymous reviewer, this may not be the division that best fits the data. We explored this statistically and found that another three-time period selection does indeed fit the data somewhat more accurately. We describe this selection in the robustness checks.

We argue that private investors continued to adhere to the tech bro mental model—whose overarching goal is capital gains—that does not include gender diversity as a goal and the inclusion of women as part of this mental model changed only gradually as per Proposition One. However, with the victory of Obama, they understood that institutional investors that are far more sensitive to public beliefs were rapidly shifting in their understanding of good governance. We exploit the fact that the firm must report when each member joined the leadership. We conjecture that the firm and its investors will operate according to their tech bro mental model, but in the later period immediately prior to the IPO, appoint women to the leadership, thereby meeting institutional investors notion that good governance is signaled by gender diversity.

This captures the fact that when the firm is private, there is little need to signal conformance to public beliefs on issues such as equity and inclusion. Thus, firms and their investors concentrate on their sole priority—building the firm as rapidly as possible. We test this proposition by separating TMT and BOD members into those that have been with the firm longer (Early Team) and those that were added immediately prior to the IPO (IPO Team). We propose that there will be significantly greater proportion of women on the IPO Team, as the firm signals its conformance to public investors' beliefs about good corporate.

Proposition 4: The rate of increase in the proportion of women in the IPO Team will be greater than that of the Early Team.

The contexts and recipes for entrepreneurship differ by industries, and these may lead to different levels of women in corporate leadership (Autio et al., 2014). To explore this possibility, we investigate the changes in women's representation in two industries: digital technologies and biomedical, and a residual category, other. Previous research indicates that industries operating close to final consumers, such as retail and services, are more likely to have greater gender diversity in leadership positions (Arfken et al., 2004; Brammer et al., 2007; Goodman et al., 2003). By contrast, the manufacturing industry has been found to have significantly lower levels of women TMT members (Arfken et al., 2004; Goodman et al., 2003).

Significantly, the U.S. Equal Employment Opportunity Commission (EEOC) (2016) found the

under-representation of women was most prevalent in TMTs in the DT industry. We conjecture that the DT firms, where the tech bro model is strongest, are likely to begin with significantly lower representation of women and that they will respond to the changing context by adding women to the IPO Team. In contrast, the biomedical field that was highly linked to the more liberal university environment from its inception (Kenney, 1986) will already have higher female representation, so there will be less need to appoint them to the IPO Team, as their representation is already greater in the Early Team. This proposition builds upon the intuition that industrial contexts impact the role of diversity in entrepreneurship (Nguyen et al., 2020; Terjesen et al., 2009). This leads us to propose:

Proposition 5: The sociocultural culture trends shape industry differences such that there will be a smaller difference between in the Early and IPO Teams in the BM industry than in the DT industry.

4 Data and methodology

Our population is composed of all 4872 entrepreneurial firms that undertook an IPO on the NYSE and NASDAQ from 1990 to 2020. The population of managers and directors identified by gender listed in the prospectus of these firms consists of 53,799 individuals. Our data exclude mutual funds, real estate investment trusts, asset acquisition or blank check companies, foreign F-1 filers, spin-offs, firms assembled through a merger or acquisition for the purpose of going public, reorganizations of existing firms, and companies that were previously a division of another firm.

The database was extracted from two publicly available Securities Exchange Commission (SEC) filings submitted by each company: the registration statement (S-1) and prospectus (424B2). These documents provide firm information including financial details (shares offered, initial share price, offer size, and shares outstanding) as well as the company's headquarter location, founding year, and industry. Company industry is based on the four-digit Standard Industrial Classification (SIC) grouped into three categories: DT, BM, and other. See the [Appendix](#) for a complete list of SICs in each category.

These filings include biographies of the company’s leadership. This biographical information provides each individual’s background, current position in the firm, year of joining the firm, and age at IPO. Each individual’s gender was determined by pronoun references or honorific title and allowed us to determine the gender of all but 1289 (2.4%) individuals. The TMT is composed of all employees listed in the prospectus. Directors encompass all BoD members directors who are not employees of the firm (i.e., independent). Individuals who joined the year before or the year the company went public are considered members of the “IPO Team;” all other employees are designated as the “Early Team.”

The annual number of IPOs varies greatly; for example, when the stock market falls, the number of IPOs decreases, at times dramatically (Fig. 1). It is possible that the proportion of women is affected by differences in the yearly number of IPOs. In years with only a few IPOs, as was the case after the 2000 Internet bubble collapse and the 2008–2009 stock market collapse, the number of IPO personnel was relatively small. Figure 2 shows the proportion of women personnel from IPOs in each given year.

We utilize logistic regressions to create fitted logistic probability curves of women’s representation for each proposition. Logistic analysis is based upon

Fig. 1 Number of IPOs by year (1990–2020)

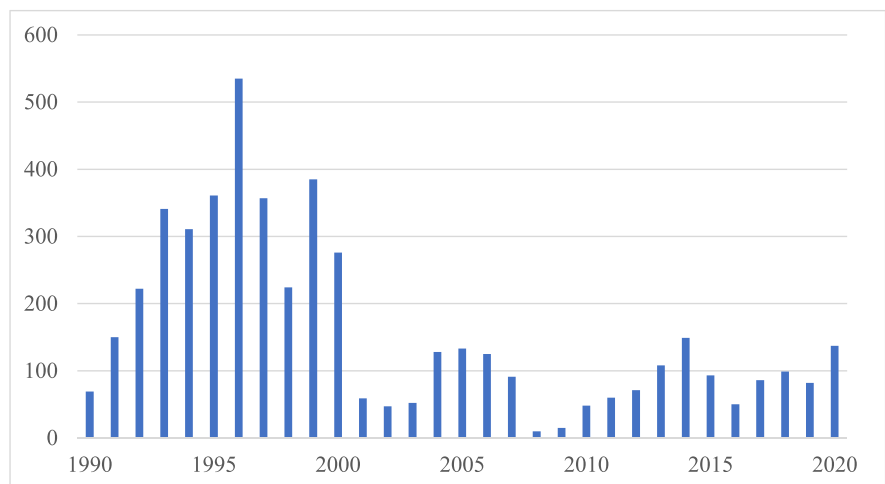


Fig. 2 Proportion of all women personnel, both BOD and TMT members (1990–2020)

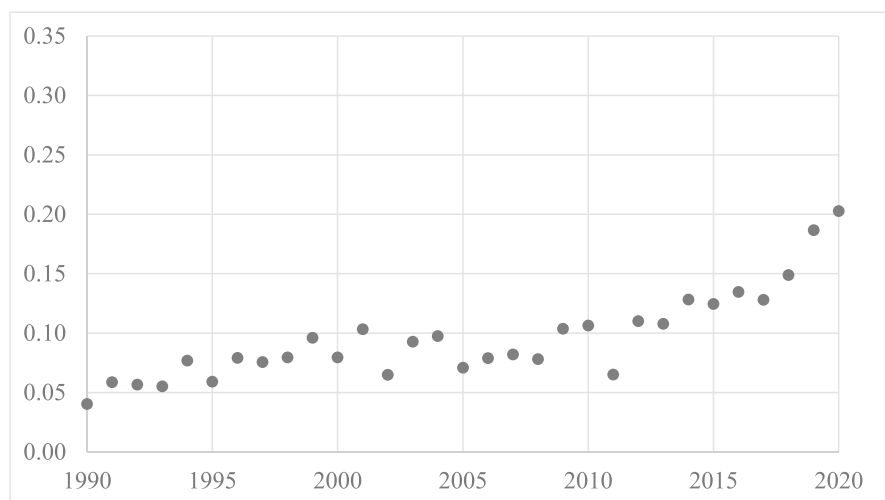


Table 1 Variable descriptions

Variable	Description
ipoyear	Year of IPO
year	Year = 0 when ipoyear = 1990; year = 30 when ipoyear = 2020
joiningyear	Year individual joined the firm
gender	Gender = 1 woman; 0 if a man
director	Director = 1 independent member of the board; 0 if a TMT member
ipoteam	ipoteam = 1 if (ipoyear – joiningyear) < 2; 0 otherwise and the individual is a member of the Early Team
indivage	Individual age at the time of IPO
firmage	Firm age at the time of IPO
marketcap	Firm market capitalization at the time of IPO
BM	BM = 1 if the firm is classified as part of the Biomedical industry
DT	DT = 1 if the firm is classified as part of the Digital Technologies group

equations where the dependent variable is a qualitative or dichotomous variable that takes a value of one or zero in any observation. In our case, the dichotomous variable gender is 1 for a woman and 0 for a man.³

The critical independent variable, year, is a continuous variable capturing the IPO year. The independent variables of ipoteam and director assume a value of 1 or 0. If ipoteam = 1, the individual joined the firm either the year of or the year before IPO and is therefore on the IPO Team; ipoteam = 0 indicates the individual is on the Early Team. The variable director bifurcates all personnel such that an individual is either an independent BOD member (director = 1) or part of the TMT (director = 0).⁴ We control for market capitalization (as a proxy for firm

size) as several studies report correlations between a firm's size and the number of women directors (Hyland & Marcellino, 2002; Singh & Vinnicombe, 2004). We include firm age at IPO as a proxy of firm resources.

The binary independent variable gender was regressed on a set of variables X to produce the estimates for the coefficients β in the equation:

$$\text{Probability}(\text{gender} = 1) = \frac{\exp(\beta X)}{1 + \exp(\beta X)} \quad (1)$$

Table 1 depicts the variables used in this analysis.

5 Results

Proposition One suggests that gender diversity will increase over our research period (Knippen et al., 2019). The observed proportions of women among all personnel in Fig. 2 clearly show an increase over the entire time period, while the rate of increase appears to be more pronounced from the year 2010 onward. The proportion of women among all IPO personnel was logistically regressed on the year of the IPO and the control variables of firm age, firm market cap, firm industry, and individual age. The regression results are shown in Table 2.

The coefficient on the variable year is highly significant for all time periods except Period 2. The control variables on firm age and size are not significant for any time periods, while individual age

³ Logistic regression is like linear regression except that instead of regressing a dependent variable y on a set of variables X , we regress the natural log of the odds ratio (or the logit) on X . We rely on the statistical package STATA to produce an estimate of the probability that an event occurs, such as a TMT member being a woman, based on the data of the variables found in set X (Johnston 1984: 419–428).

⁴ Our use of individual managers and directors as the unit of analysis rather than firms may seem an unusual approach when, as one anonymous reviewer observed, it is the representation of women in the firm that is of interest. Our use of individuals allows us to bifurcate our population into two mutually exclusive categories; Directors and TMT, and IPO Team and Early Team. If we were to rely on the proportion of women in firms that were TMT or Director, or IPO Team or Early Team, we could not readily compare these groups statistically as we do in Table 2 and Table 3.

Table 2 Logistic regression coefficient results on gender for the entire population

Variables	Period 1 1990–2000 <i>n</i> = 32,194	Period 2 2001–2008 <i>n</i> = 7135	Period 3 2009–2020 <i>n</i> = 12,115
year	0.07706***	−0.02282	0.08684***
firmage	0.00008	−0.00075	0.00085
indivage	−0.05622***	−0.04254***	−0.01754***
marketcap	1.75e−11	1.32e−12	7.64e−12
BM	0.18965**	0.29461**	0.26653***
DT	−0.31486***	0.02178	0.01728
constant	−0.41552***	−0.05420	−3.2967***

Coefficient significance levels: * = 0.05, ** = 0.01, *** = 0.001

is significant for all time periods.⁵ The coefficients on industry dummies are compared to the referent case of the industry category of Other. As will be explored in greater detail below, the proportion of women varies significantly depending on the industry of the IPO. The results for the entire time period indicate that BM had a significantly higher proportion of women than did DT. In a pattern that occurs throughout our findings, there was little change in the 2001–2008 period between the collapse of the Internet IPOs, the dot com bust, and the beginning of the great recession.

5.1 Changes in the proportion of women on the BoD and the TMT

Given the greater public attention to the representation of women on the BOD, Proposition Two suggested that there would be a greater change in women's presence among the BoD than among the TMT. We regressed gender on year for BoD and members of the TMT separately, and both together so as to assess the difference between them in their rate of change over time. These regressions were run with

⁵ The addition of the individual control variable age to the firm control variables, as suggested by an anonymous reviewer, produces equation estimates that are a better fit with the data than do firm controls alone. Not surprisingly individual age is always negatively and significantly correlated with gender indicating that an older manager or director is less likely to be a woman, although the strength of this relationship declines in later years.

Table 3 Rates of change of women independent directors and TMT members based on logistic estimates

	Period 1 1990–2000	Period 2 2001–2008	Period 3 2009–2020
Directors	<i>n</i> = 12,401	<i>n</i> = 3273	<i>n</i> = 6154
Coefficient on year	0.07771***	−0.00424	0.14909***
Change in % per year	0.24%	0.09%	1.42%
TMT	<i>n</i> = 19,793	<i>n</i> = 3862	<i>n</i> = 5961
Coefficient on year	0.07859***	−0.03080	0.03796**
Change in % per year	0.50%	−0.48%	0.60%
Directors and TMT	<i>n</i> = 32,194	<i>n</i> = 7135	<i>n</i> = 12,115
Coefficient on year	0.07943***	−0.03090	0.04178***
Coefficient on director x year	−0.00359	0.02794	0.10435***
Change in % per year	0.40%	−0.26%	1.01%

Coefficient significance levels: * = 0.05, ** = 0.01, *** = 0.001

the control variables firmage, marketcap, individual age, BM, and DT.⁶ Table 3 shows the results.

There were significant increases in women BoD and TMT members over Period 1 and Period 3, but not Period 2. By combining groups, we use director = 0 (the TMT) as the referent variable, and examine the coefficient on the interactive term director x year. This coefficient is significant at the 0.001 level indicating that the proportion of women is increasing at a faster rate among directors than among the TMT during Period 3. We separated the IPOs into three periods to capture the societal changes and stock market conditions, and as we can see from Fig. 3 and Fig. 4, the three periods had significantly different trajectories in terms of the proportion of women directors and TMT members.

In Proposition Three, we expected that there would be significant differences between the rate of increase in the proportion of women on the TMT versus BoD in each time period and, in particular, in Period Three, when the intensity of the pressure to include women was the most intense. Table 3 results support these expectations. There was no significant difference between the TMT and directors in the rate of increase in women for the first two time periods, but the difference in Period 3 was significant.

The differences between the periods are substantial. In 1990, at the beginning of Period One, the

⁶ The coefficients of these control variables were not reported in either Table 2 or Table 3 to economize on space.

Fig. 3 Proportion of women independent directors and in the TMT (1990–2020)

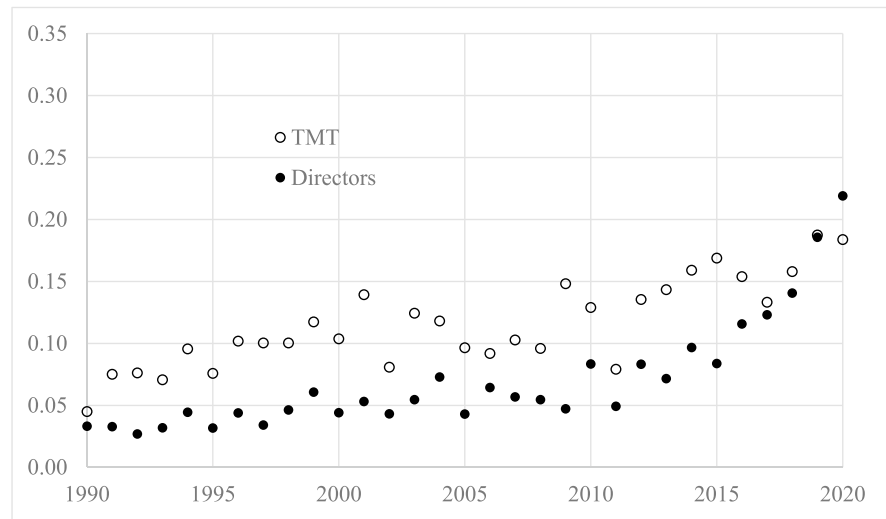
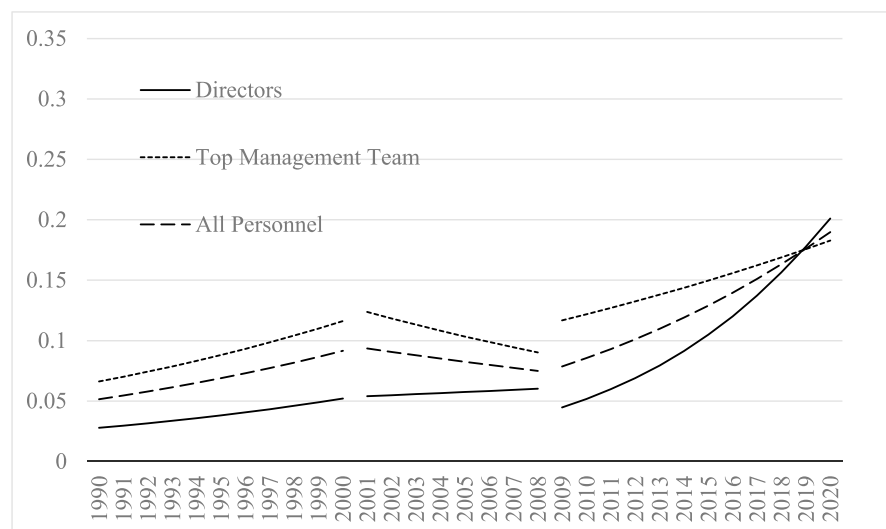


Fig. 4 Estimated proportion of women among all personnel, independent directors, and TMT by time period (1990–2020)



population was almost entirely male. In 1990, less than 5% of the TMT or BoD were women (4.49% and 3.31%, respectively): but this increased to 10.37% for TMT and 4.41% for BoD by 2000. Interestingly, while the proportion was low in both groups, there were more women in the leadership for most of these years. However, this ratio shifted and crossed over in 2020.

In the second period, the proportion of women changed little. In fact, as Table 3 shows, the proportion of women among the leadership dropped below

the earlier period. An important caveat is that there were only 10 IPOs in 2008 and 15 in 2009.

In Period Three, proportions began roughly at the same level as in 2000, but then the percentage of women increased annually by approximately 0.60% for the TMT and 1.42% for BoD. This increase began in the Obama Administration, but continued unabated during the Trump Administration. As discussed earlier, by the end of Period Three, key states such as California passed laws

requiring women’s presence on the BoDs of public firms. Given the increasingly insistent pressure to have female representation on the BoD, we expected that changes among the BoD would be significantly greater than those of the TMT, and this indeed was the case for women in Period 3.

5.2 Differences between the early and IPO leadership teams

A firm preparing for an IPO must ready itself for the new audience’s judgement regarding good

governance. Proposition Four argues that because the mental model for what private investors see as an ideal startup favors males, the Early Team will have fewer women when compared with the IPO Team. We expected that in preparation for an IPO, these firms would recruit women to the TMT and BOD to meet the expectations of public investors.

The observed proportions of women in the Early Team and IPO Team shown in Fig. 5 together with the logistic estimates of such proportions shown in Fig. 6 clearly indicate that rate of increase in the IPO Team was greater than in the Early Team, particularly in Period 3.

Fig. 5 Proportion of women in the early and IPO Teams, 1990–2020

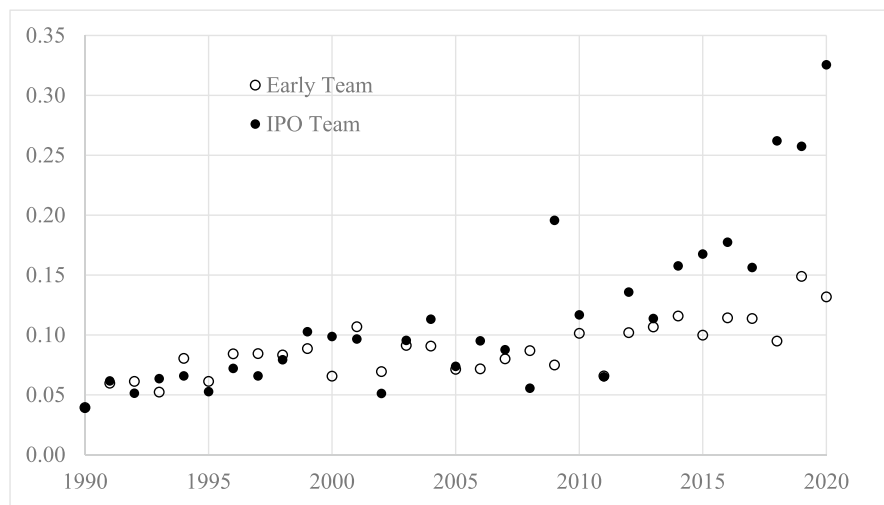


Fig. 6 Estimated proportion of women among all personnel, in the Early Team and in the IPO Team by period (1990–2020)

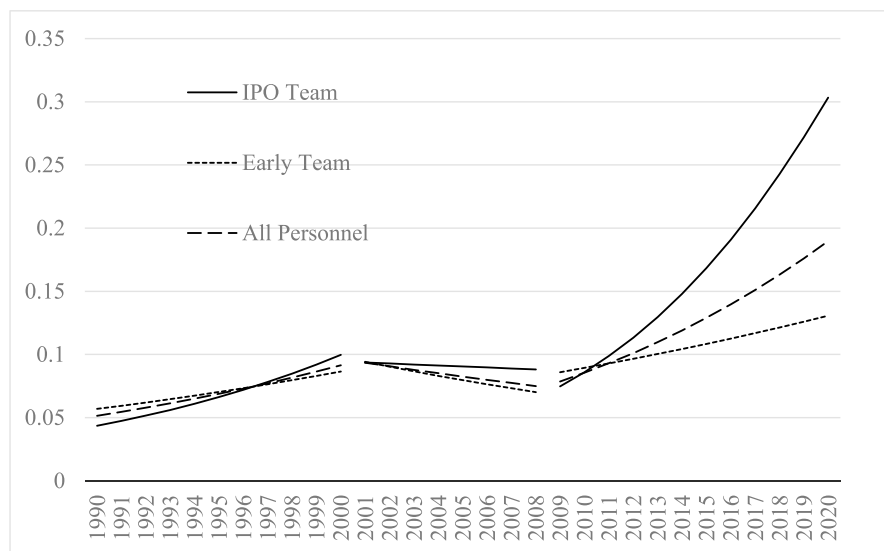


Table 4 provides further evidence of the importance of the IPO Team in increasing the proportion of women among IPO personnel. The Early Team and IPO Team both exhibit significant increases in women over the entire time period. By combining both groups, we use $ipoteam=0$ (the Early Team) as the referent case and examine the coefficient on the interactive term $ipoteam \times year$. This coefficient is significant indicating that the proportion of women is increasing at a faster rate in the IPO Team than in the Early Team for Period 1 and Period 3.

In Period Three, the overall proportion of women in both the IPO Team and the Early Team increased markedly. Importantly, the proportion of women in the IPO Team grew significantly more rapidly than in the Early Team. In fact, the dramatic increase in women's representation in Period Three is driven largely by the changes in the IPO Team, where the observed proportion of women almost tripled from 11.6% in 2010 to 32.5% in the year 2020 (see Fig. 5). This is particularly remarkable as the Early Team proportion increased only from 10.1 to 13.2%. This strongly supports Proposition Four—that firms responded to changes in the governance beliefs of public investors by appointing women to senior positions at a dramatically higher rate than previously.

The results in Period Three provide material for significant conjecture. During this period, there was a growing chorus of criticism of the tech bro culture and the exclusion of women from leadership roles in high-technology firms and, in particular, the DT (e.g., Alba,

2015). For private investors, such as venture capitalists, there is a conundrum, namely that the “tech bro” model widely denounced as “toxic” by many did result in enormous wealth creation. To abandon this mental model of success for a more welcoming model likely was hard to accept by investors. Moreover, as long as the firm was private, there was little pressure to change leadership composition. However, our results suggest that the firm and its backers understood that the lack of diversity had become unacceptable to public investors and increasingly government officials. They thus responded most visibly by adding women to both the TMT and BoD immediately prior to IPO.

5.3 Industry, firm leadership, and gender

Industries have different recipes for success and beliefs about management and governance (Spender, 1989; for university startups, see Fini et al., 2023). Proposition Five suggests that industries would differ in their acceptance of women in senior positions. The data confirms this supposition of significant industrial differences (see Table 5). Most saliently, the proportion of women is greatest in the technology-intensive biomedical industries and Internet industries, and lower in digital technologies. The most substantial increase from the first to the third period over the entire 1990–2020 period was found in the biomedical industries, while DT had a smaller increase than all industries as a whole. However, female representation increased across the board in every industry and, in particular, in Period Three.

While the representation of women increased in all industries, there were a few significant differences. By logistically regressing the proportion of all women on year of IPO and industry of IPO, and allowing each industry to assume its own intercept and year coefficient, we can test for differences in the rate of change for each time period using the Wald test (see Table 6).⁷

Table 4 Logistic estimates of the rates of change of women in the IPO Team and Early Team

	Period 1 1990–2000	Period 2 2001–2008	Period 3 2009–2020
IPO Team	$n = 11,982$	$n = 2137$	$n = 3831$
Coefficient on year	0.11027***	-0.02863	0.15675***
Change in % per year	0.56%	-0.08%	2.08%
Early Team	$n = 19,120$	$n = 4931$	$n = 8163$
Coefficient on year	0.05777***	-0.02121	0.03749***
Change in % per year	0.30%	-0.34%	0.41%
IPO Team and Early Team	$n = 31,102$	$n = 7068$	$n = 11,994$
Coefficient on year	0.05793***	-0.02679	0.04113***
Coefficient on $ipoteam \times year$	0.05601**	0.00594	0.10539***
Change in % per year	0.40%	-0.26%	1.01%

Coefficient significance levels: * = 0.05, ** = 0.01, *** = 0.001

⁷ The Wald test used in STATA is one of several tests of hypotheses regarding estimated coefficients. The Wald test compares the estimator of an unrestricted statistical model with the estimator of the model restricted by a given hypothesis. These hypotheses can be about a single coefficient ($H: \beta_4 = 0$) or a set of coefficients ($H: \beta_4 = \beta_2$). The Wald test produces a chi-square value that is a test statistic to judge the compatibility of the unrestricted and restricted model (Judge et al., 1985: 182–187).

Table 5 Percentages of women in TMT and BOD by industry for entire population and periods

	1990–2020	Period One 1990–2000	Period Two 2001–2008	Period Three 2009–2020	Increase from Period One to Three
Biomedical (<i>n</i> =9531)	12.2	8.3	9.9	15.9	7.6
DT (<i>n</i> =18,669)	8.3	7.0	8.4	12.5	5.5
All Other (<i>n</i> =25,579)	8.1	7.4	7.7	11.7	4.3
All Industries (<i>n</i> =53,779)	8.9	7.4	8.4	13.5	6.1

n = number of individuals identified by gender

In Table 6, the dummy variables DT and BM indicate how the intercept of the DT and BM industries differ from the referent industry Other. The coefficients showing how the change in women over time in these industries differ from Other are shown by DT x year and BM x year respectively. Inspection of these coefficients suggests that these industries do not differ very much in either Period 1 or Period 2. The Wald test on DT x year = BM x year indicates that indeed there are no significant differences in these time periods. Only in Period 3 is the rate of increase in women in DT significantly greater than the rate of increase in BM at the 0.01 level.

These results suggest that while industries have different recipes, they do change over time. One could speculate that the BM was more accepting of women because of its longstanding relationship with universities (Kenney, 1986) and there has always been a far

Table 6 Logistic regression results for industry rates of change in the proportion of women

Variables	Period 1 1990–2000 <i>n</i> = 32,194	Period 2 2001–2008 <i>n</i> = 7,135	Period 3 2009–2020 <i>n</i> = 12,115
year	0.06747***	−0.00601	0.06677***
firmage	0.00003	−0.00076	0.00069
age	−0.05621***	−0.04253***	−0.01764***
marketcap	1.81e−11	1.83e−12	5.29e−12
DT	−0.38014**	0.50140	−1.4741*
BM	−0.03264	0.78132	0.22800
DT x year	0.01076	−0.03227	0.05864**
BM x year	0.03933	−0.03273	0.00232
constant	−0.35954**	−0.30146	−2.7781***

Coefficient significance levels: * = 0.05, ** = 0.01, *** = 0.001

higher concentration of women studying in the biological sciences, as compared to the DTs.

In distinction with BM, DT has had a lower level of acceptance of women, and over the last decade it became apparent that this shortcoming needed to be addressed. The result was a faster rate of increase in women in DT than BM during Period 3. Our data confirms that the DT differs in terms of willingness to appoint women to senior positions. As a generalization, more traditional industries appear to have greater resistance to women in senior leadership positions. Despite this resistance, in Period Three all industries responded to the changing ethos in public markets and increased the proportion of women.

5.4 Robustness checks

It is possible that our results are sensitive to the time periods we have chosen. To see if this is the case, we derived a more statistically accurate alternative model that divides the 1990–2020 period into three distinct periods, and then compare our model, based on aspects of the IPO market, with this alternative.⁸

⁸ Because all data was gathered around just 31 separate years, it was possible to construct a database of dummy variables capturing all possible two time period periods of at least 3 years length. Gender was then logistically regressed on these dummy variables and the independent variable year, and a Wald test was applied to test the significance of the difference of slopes on each side of the break year for all possible time periods. This procedure was repeated twice to find the two most promising break year candidate. We then determined the goodness of fit all possible divisions within 1 year, plus or minus, around these candidate break years. The goodness of fit was determined by the Pearson goodness of fit measure found on STATA (estat gof – Pearson or Hosmer–Lemeshow goodness-of-fit test).

We found that the division that produced the best fit was 1990–1999, 2000–2011, and 2012–2020. Our original selection had a Pearson chi-square value of 66.28, while the alternative selection had a chi-square of 56.72. For purposes of comparison, the model without any time breaks has a chi-square of 141.71. A lower chi-square indicates a better fit.

The results from Table 2 were basically unchanged by using this alternative time period selection, while the basic results from Table 3 and Table 4 hold under this alternative time scheme. In Table 3, the increase in women among independent directors was significantly greater for the BoD than for the TMT in the final time period under both time schemes. Similarly, in Table 4, the significance in increase of women in the IPO Team compared to the Early Team in the final time period held under both time schemes.

In Table 6, where the DT and BM are compared, the use of the alternative time scheme did produce somewhat different outcomes. Under the alternative scheme, the Wald test on $DT \times year = BM \times year$ indicates that there are no significant differences in these time periods. That is, under the alternative, there was no significant difference between the slope of the digital technologies industry and the biomedical industry when the 2012–2020 period instead of the 2009–2020 period was considered.

6 Discussion

This paper has made two significant contributions. First, despite the tremendous growth in research on gender representation on boards and popular and political concern, there has been almost no research on the changes, dare we say “progress” that has been made—almost certainly due to public pressure. Second, the literature has studied the gender composition of venture capital firms and suggested this is a blockage to increased women’s representation on boards. We have shown that private investors and entrepreneurial firms have understood the perspectives of public investors and have responded, in particular, by appointing women immediately prior to the IPO. These findings are important for understanding gender and entrepreneurship.

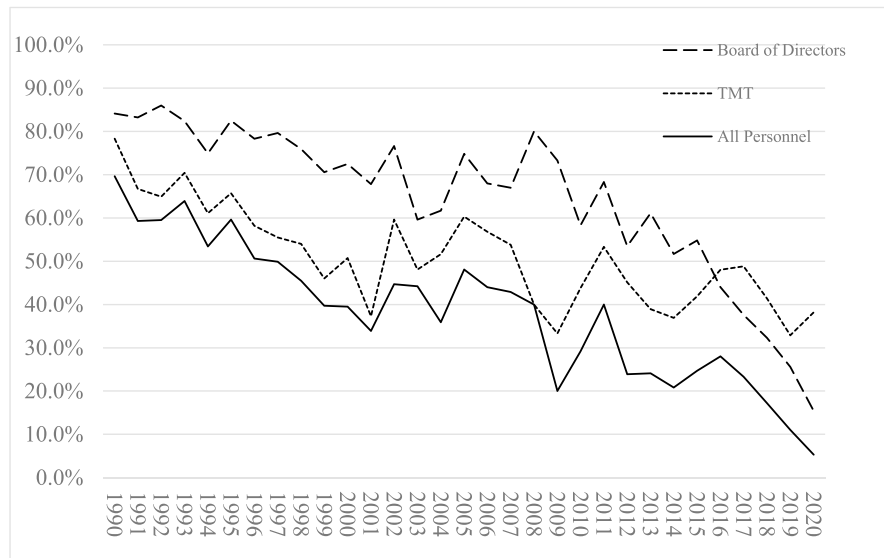
This study demonstrates that the firm audience’s judgement on what is “socially appropriate” changed over time and affected the gender composition of both the TMT and BoD. We show that the representation of women in firm leadership in the Early Team experienced a steady “organic” increase that only paused in the period between the two stock market collapses. In the first period, the increase in female representation, from a very low base, is gradual for both TMT and BoD, and Early and IPO Teams. This suggests that concerns, while existing, may not have been driven solely by public investors, but rather societal changes that impacted the context within which they made decisions (on importance of context, see Autio et al., 2014).

It is only after the Great Recession (Period 3), and particularly, in the last 3 years of the study, that there was a dramatic change in women’s representation on both the BoD and TMT—but again with the caveat this was particularly true among those individuals added immediately prior to the IPO. This dramatic change appears to be in response to the public announcements by various institutional investors, their advisors, and investment bankers and the changing legal norms. Because these announcements target BoD composition we expected there to be a significantly different response in the composition of the BoDs when compared to TMTs, and there was a significant increase in female directors compared to women in the TMT in Period 3.

California was the first state to require the boards to have at least one woman by 2017, and while the analysis here is focused on women’s representation across all firms, it would be useful to see how the composition of the board of directors has changed over time as measured by Boards having no women at all.⁹ We have examined each firm by personnel classification, BoD, TMT, and all personnel, to see how women’s representation changes for these classifications at the firm level. In particular, we have counted all firms in which no woman was present for each classification. The percentage of firms having no women by classification is shown in Fig. 7.

⁹ We recorded a dummy variable (dual) for each individual TMT member who also served as a board director. Adding these internal directors to those classified as independent directors gives us the entire BoD.

Fig. 7 Percentage of firms with no women by personnel classification



The decline of these percentages is striking. In 1990, close to 70% of all firms going public had no women at all listed in their prospectus. The proportion of firms having a Board with any women was just over 15%. By 2020, the percentage of all firms having no women in leadership positions fell to just 5.3%, and the proportion of firms having no women directors fell to 15.4%. It is clear that women’s representation on the Board has been increasing for several years prior to 2017. It seems likely that the same societal norms that were driving firms to increase the number of women were also driving legislatures to mandate quotas for women on the board of directors.

We conjectured that industries might have different recipes regarding gender participation. Our data shows

that there was a general increase in the proportion of women in leadership positions and a pronounced tendency to add women immediately prior to an IPO. This tendency is most pronounced in Period Three, as indicated in Table 7. These percentages, while quite variable, consistently indicate that the proportion of women is higher in the IPO Team than the Early Team across all industries. The final column shows the ratio of the proportion of women in the IPO Team to the proportion in the Early Team for the entire time period for each industry and all industries combined. This ratio varies between 1.5 in both BM and All Other, but increases dramatically in the DT industries to 2.4 showing that the difference was dramatically higher and thus the difference between the Early Team and IPO Team was greatest.

Table 7 Percentages of women by industry, IPO Team, and Early Team for the BM, DT, and Other industries during Period Three

	Team	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Team ratio
Biomedical	IPO	33.3	17.6	10.0	13.0	14.4	14.6	16.9	15.1	13.6	25.9	23.4	29.0	1.5
	Early	12.0	18.3	11.8	16.8	9.4	13.8	11.7	12.7	18.5	8.4	14.3	16.3	
Digital technologies	IPO	21.2	8.7	9.1	11.3	12.0	19.0	21.5	24.4	22.6	38.5	39.4	36.3	2.4
	Early	5.6	5.8	5.5	6.7	8.3	10.1	9.9	6.5	8.6	12.6	17.2	11.0	
All Other	IPO	10.0	12.2	3.4	15.8	8.8	14.7	12.6	17.9	14.2	13.9	19.7	38.1	1.5
	Early	9.1	9.9	6.0	12.1	14.1	10.2	8.4	15.2	8.3	7.3	13.3	9.7	
All industries	IPO	19.6	11.7	6.5	12.6	11.4	15.8	16.8	17.7	15.6	26.2	25.7	32.6	1.8
	Early	7.5	10.1	6.6	10.2	10.7	11.6	10.0	11.4	11.4	9.5	14.9	13.2	

Team Ratio: the ratio of the IPO Team percentage of women to the Early Team percentage of women over the entire 2009–2020 period

Our results suggest that entrepreneurs and private investors understand that public investors increasingly expect gender diversity in the corporate leadership. That this may be a response to the market rather than a philosophical change is evidenced by the fact that women's female participation in the Early Teams is increasing but more slowly than on the IPO Teams.

Our results provide confirmation for those scholars suggesting that much of the response to social pressure to increase the representation of women in firm leadership can be interpreted as tokenism. The response manifested in the IPO Team may, at least, in part be a type of "window-dressing" for the public audience. And yet, there is a gradual increase in the number of women that are members of the Early Team suggesting that such beliefs are changing more fundamentally.

7 Conclusion

The topic of diversity in entrepreneurship and the upper echelons of US firms continues among politicians, popular media, and academe. We analyze one of the longest time series ever compiled regarding the position of women leaders in entrepreneurial firms. As with any such study, there are limitations. The first limitation is that our research only covers the most successful entrepreneurial firms, i.e., those that grew sufficiently large to undertake an IPO. Therefore, we cannot easily generalize our results to all entrepreneurial firms or those that exited through a trade sale. The second limitation is that we are unable to identify who was replaced by those joining the IPO Team. It could be the case that the members of the IPO Team replaced people of the same gender. Moreover, patterns may have changed over time. We also do not examine whether the women were family members of the CEO or Board Chair (e.g., Bauweraerts et al., 2022).

Our findings suggest a number of promising directions for future research. First, given existing databases, it is possible to investigate the changes that occur as the now public firm evolves. This line of enquiry would examine the potential that strategic decisions during or prior to the IPO may imprint ventures as they evolve. Subsequent studies can explore gender patterns in membership on important board committees (i.e., nominating, compensation) as well as key TMT roles (i.e., CEO, CFO, COO). There is a literature suggesting that women are "pegged" into certain leadership roles and not others.

Future research can address these leadership issues and other changes in entrepreneurial governance at IPO, including processes for management and board teams.

This paper, while descriptive, provides insight into the changes over 30 years and how public debates affect entrepreneurial firm leadership and investor decision-making. We offer preliminary evidence regarding whether the response to public criticism regarding gender diversity is only pro forma, or signals more organic changes in the acceptance of women in entrepreneurial leadership roles that differ by industry. Future research could examine the educational backgrounds of managers to test whether previous results that show that women have better educational backgrounds, or even are older than men in similar positions, are true in entrepreneurial leadership positions. Another area of future entrepreneurship research made possible by this database is to examine the firm-level implications of gender diversity in the firm's leadership. Further research on the IPO Team members regarding their human and social capital could consider whether they are considered particularly prestigious or legitimate, e.g., Ivy League university education and blue-chip firm experience.

Our data provides unambiguous proof that women are increasingly represented in the entrepreneurial leadership. Given the social and political concern, representation seems likely to continue to increase at firms undertaking an IPO, but the true transformation of women's participation in the early days of building an entrepreneurial firm may increase more slowly, as long held and unfortunately capital gains-reinforced stereotypes change more slowly. The paucity of enormously successful IPOs that have had large female contingents may not overturn the mental models held by private investors in the DTs and who thus are likely to continue to reproduce the relative gender imbalance among the Early Team personnel in new startups. Alternatively, recent successful listing of women-led firms such as Stitch Fix, Blue Apron, and Bumble may change the mental models of early investors and thereby leading to continuing increases in women's representation on the Early Teams. However, even these successful female-led firms may not change the mental models of venture investors that believe that they can reap enormous capital gains by continuing to search for the Bill Gates, Mark Zuckers, Sergei Brins, and Travis Kalanick of this world—such gains may trump other values such as diversity, inclusion, and equity.

Appendix

Industry	SIC Name	SIC Code Range
Biomedical (BM)	Biotechnology	2830–2839
	Medical Instruments	3840–3849
Digital Technologies (DT)	Software	7372
	Semiconductors	3674
	Communications	3660–3669
	Telephone and Telegraph	4800–4829
	Computer Systems	7373
	Computers	3570–3579
	Electronic Equipment	3600–3669
	Internet	Internet firms are identified by inspection of the firm's prospectus. Internet is not a SIC category
Other		All other SIC codes

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Data availability All data is available from authors on request.

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