Mandatory Disclosure & Female Representation in Corporate Leadership: Evidence from NASDAQ

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Motivation I

▷ **Heightened scrutiny**: Diversity, Equity, and Inclusion (DEI) policies have received scrutiny by academics and policy makers across universities, the government, and the corporate sphere.

▷ **Proponents' view**: DEI broadens the candidate pool and can improve organizational outcomes by adding skills and perspectives that were previously underutilized.

- Minority candidates may have previously been overlooked because of discrimination (statistical or taste based), network-based hiring, or limited information about opportunities.

▷ **Opponents' view**: DEI can lower the bar for entry and risk worsening organizational outcomes if implementation is not aligned with job-relevant criteria.

Motivation II

▷ Background: Increasing regulatory focus on diversity in corporate boards (e.g., California's Senate Bill 826, Norway's ASA quota law, Canada's OSC "Comply or Explain").

▷ Prior research has focused on gender quotas, but not as much on mandatory disclosure.

▷ Unlike quotas, mandatory disclosure regulations do not require firms to add minority candidates onto corporate boards.

▷ **Research Questions**:
  - To what extent do firms increase female diversity in response to mandatory disclosure requirements?
  - What are the effects of mandatory disclosure on annual financial outcomes and short-term share prices?
  - Why do some firms choose not to pursue diversity initiatives?

Conceptual Framework

▷ If there are reputational consequences for disclosing no diversity, then firms would increase diversity in response to a mandatory disclosure requirement.

▷ If there are minimal reputational consequences, then firms would not increase diversity and instead provide explanations.

▷ If firms increase diversity in response to mandatory disclosures, the impact on financial outcomes depends on how diversity influences board quality.

- If the current board structure is already optimal, regulatory constraints may reduce board quality and negatively affect financial performance.
- However, if barriers prevent qualified minority candidates from joining boards, such regulations may have a neutral or positive effect on board quality and financial outcomes.

Contributions and Relevant Literatures

▷ Gender Quotas on Corporate Boards (Ahern and Dittmar, 2012; Bertrand et al, 2019; Allen and Wahid, 2024; Gopal, 2025).

▷ Mandatory Disclosure of Financial Outcomes (Hope and Thomas, 2008; Faulkender and Yang, 2013; Dye, 1990).

▷ Pay Transparency and the Gender Wage Gap (Cullen and Pakzad-Hurson, 2023; Blundell et al., 2025)

▷ Mandatory Disclosure of Board Diversity (Bakke et al, 2021)
  - To our knowledge, first to examine mandatory disclosure and corporate diversity in the US context.
  - Differences from Bakke et al: analysis window (2020s vs 2010s, textual analysis of explanations, find much smaller effects of mandatory disclosure on gender diversity.)

NASDAQ Diversity Rule

▷ Proposed by NASDAQ: Dec 01, 2020

▷ Approved by SEC: Aug 06, 2021

▷ Requirements:

- Publicly disclose board-level diversity statistics annually, starting in 2022.
- One female board member and one diverse board member (Black, Asian, Hispanic, LGBTQ+) or explain the lack of diversity.
- No financial penalties for disclosing no diversity.
- Phase-In period: One diverse director or provide explanation by Dec 31, 2023. Two diverse directors or provide explanation by Dec 31, 2025

▷ Repealed by Fifth Circuit in 9-8 decision: Dec 11, 2024

NASDAQ Diversity Rule

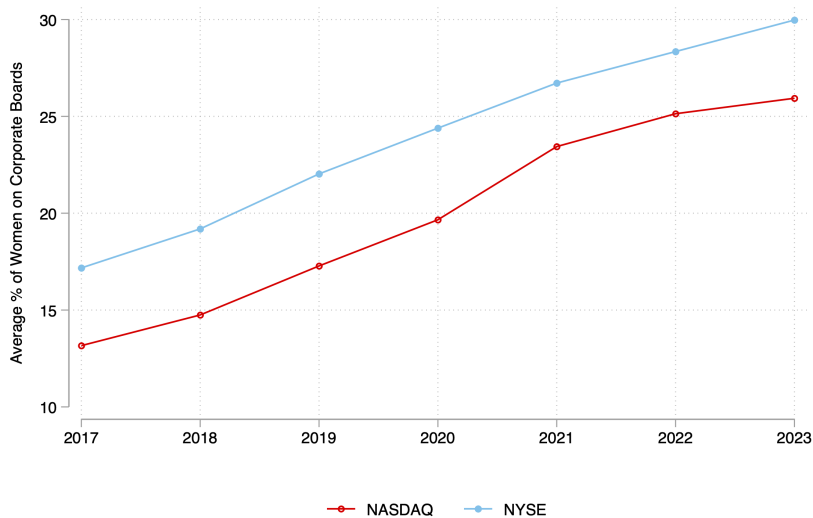| Board Diversity Matrix (As of [Date])				
Total Number of Directors	#			
	Female	Male	Non-Binary	Did Not Disclose Gender
Part I: **Gender Identity**				
Directors	#	#	#	#
Part II: **Demographic** **Background**				
African American or Black	#	#	#	#
Alaskan Native or Native American	#	#	#	#
Asian	#	#	#	#
Hispanic or Latinx	#	#	#	#
Native Hawaiian or Pacific Islander	#	#	#	#
White	#	#	#	#
Two or More Races or Ethnicities	#	#	#	#
LGBTQ+	#	#	#	#
Did Not Disclose Demographic Background	#	#	#	#

Data

▷ Sample: NASDAQ & NYSE listed firms.

- Focus on US firms present in the following three datasets from 2017 to 2023: CRSP, Compustat, and BoardEx.
- CRSP: Daily share prices.
- Compustat: Annual financial outcomes (construct winsorized return on assets, log tobin's Q, index of financial outcomes)
- BoardEx: Annual board gender diversity (consider female share, indicator for all-male male, board size, indicator for board expansion, indicator for male dropped from board)
- MSCI: Annual Environmental, Social, and Governance (ESG) scores.
- Manually collect explanations from firm proxy statements ($N = 43$)
- Exception: Use 2024 data from CRSP to evaluate share price reactions of the ban.

Summary Statistics: Female Share of Corporate Boards by Exchange

▸ Sample Size by Year

Summary Statistics

	NASDAQ	NYSE	Diff	P-Value	N:NASDAQ	N:NYSE
Board Characteristics						
Board Size	8.02	9.33	1.30***	0.000	2139	1611
1(AMB)	0.16	0.05	-0.10***	0.000	2139	1611
Employees (thous.)	5.61	20.01	14.39***	0.000	2022	1499
Firm Characteristics						
ROA	-0.05	0.00	0.05***	0.000	2075	1524
Log(Tobin's Q)	0.42	0.18	-0.24***	0.000	1993	1430
Assets (\$ mill)	5140.87	33310.06	28169.19***	0.000	2076	1524
Industry						
Energy	0.02	0.09	0.07***	0.000	2139	1611
Materials	0.02	0.09	0.07***	0.000	2139	1611
Industrials	0.09	0.17	0.08***	0.000	2139	1611
Cons. Disc.	0.08	0.11	0.03***	0.003	2139	1611
Cons. Staples	0.03	0.03	0.00	0.951	2139	1611
Health Care	0.32	0.06	-0.26***	0.000	2139	1611
Financials	0.20	0.17	-0.02*	0.062	2139	1611
Info. Tech.	0.16	0.07	-0.09***	0.000	2139	1611
Comm. Serv.	0.04	0.03	-0.01	0.214	2139	1611
Utilities	0.01	0.04	0.03***	0.000	2139	1611
Real Estate	0.02	0.10	0.08***	0.000	2139	1611

Methodology

▷ Primary Approach: Difference-in-Differences for Annual Measures of Board Composition and Financial Outcomes.

$$Y_{fti} = \beta_0 + \beta_1(\text{NASDAQ} \times \mathbb{I}(t > 2020)) + \delta_f + \gamma_{ti} + \varepsilon_{fti}$$

$$Y_{fti} = \theta_0 + \sum_{t \neq 2020} \theta^t \Big(1[\textit{Year} = t] \times \textit{NASDAQ} \Big) + \delta_f + \gamma_{ti} + \epsilon_{fti}$$

▷ Use an unbalanced panel, estimate parameters via (unweighted) ordinary least squares, cluster standard errors at firm level.

▷ Robustness Checks:
- Main specification, but restrict to set of companies with all-male boards in 2020.
- Triple-Differences: pre/post 2020, NASDAQ vs NYSE, all-male board vs gender-diverse in 2020.
- Heterogeneity by various pre-treatment characteristics including size, male-dominated industry, ESG score.

Alternative Approach: Synthetic Difference-in-Differences (Arkhangelsky et al, 2021)

▷ Estimator for the Average Treatment Effect on the Treated (ATT):

$$\left(\hat{\tau}^{sdid}, \hat{\mu}, \hat{\alpha}, \hat{\beta}\right) = \arg\min_{\tau,\mu,\alpha,\beta} \left\{ \sum_{f=1}^{N} \sum_{t=1}^{T} \left(Y_{ft} - \mu - \alpha_f - \beta_t - D_{ft}\tau\right)^2 \hat{\omega}_f^{sdid} \hat{\lambda}_t^{sdid} \right\},$$

where unit weights ($\hat{\omega}_f^{sdid}$) and time weights ($\hat{\lambda}_t^{sdid}$) are pre-estimated to balance pre-treatment trends and pre/post periods, respectively, then applied in weighted OLS.

▷ $D_{ft} \in \{0, 1\}$ indicates treatment exposure (e.g., $D_{ft} = 1$ for NASDAQ firms post-2020).

▷ Unit weights balance pre-treatment outcome trends between treated and control units; time weights make weighted pre-treatment outcomes for controls match their unweighted post-treatment average.

▷ Weights are non-negative, each set sums to 1.

Synthetic Difference-in-Differences: Coding Implementation

▷ Use stata packages *sdid* (Clarke et al, 2023) and *sdid_event* (Clarke et al, 2023).

▷ Calculate standard errors using a jackknife procedure (ATT specification) and bootstrap procedure (event study specification, resampling at the firm level, 99 draws).

▷ Sample restriction: requires a balanced panel.

Effect of Mandatory Disclosure on Board Composition (Two-Way Fixed Effects)

Dependent Variables:	Male Share of Board	1(All-Male Board)	Board Size	1(Expand Board)	1(Male Dropped)
Model:	(1)	(2)	(3)	(4)	(5)
Panel A: DiD Event Studies Estimates					
NASDAQ X Year = 2017	0.000	0.082***	0.077	0.010	-0.020
	(0.004)	(0.015)	(0.059)	(0.024)	(0.013)
NASDAQ X Year = 2018	0.004	0.066***	0.094*	0.035	-0.024*
	(0.004)	(0.013)	(0.053)	(0.025)	(0.014)
NASDAQ X Year = 2019	0.002	0.017*	0.075*	0.045*	-0.016
	(0.003)	(0.009)	(0.044)	(0.027)	(0.015)
NASDAQ X Year = 2021	-0.006**	-0.031***	-0.027	0.033	-0.015
	(0.003)	(0.008)	(0.044)	(0.026)	(0.015)
NASDAQ X Year = 2022	-0.009***	-0.056***	0.009	0.061**	-0.003
	(0.003)	(0.009)	(0.053)	(0.024)	(0.014)
NASDAQ X Year = 2023	-0.005	-0.065***	-0.027	0.037	-0.028**
	(0.004)	(0.010)	(0.058)	(0.024)	(0.014)
Panel B: DiD Estimates (ATT)					
NASDAQ $\times \mathbb{I}$(Year > 2020)	-0.008***	-0.089***	-0.074*	0.021*	-0.001
	(0.003)	(0.009)	(0.045)	(0.013)	(0.008)
Fixed-effects					
Firm	Yes	Yes	Yes	Yes	Yes
Year-SIC	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	25766	25766	25766	23958	23958
Dependent variable mean	0.783	0.133	8.63	0.266	0.066
Number of Firms	4593	4593	4593	4356	4356

Clustered (Firm) standard-errors in parentheses. Signif. Codes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Effect of Mandatory Disclosure on Board Composition (Synthetic DiD)

Dependent Variables:	Male Share of Board	1(All-Male Board)	Board Size	1(Expand Board)	1(Male Dropped)
Model:	(1)	(2)	(3)	(4)	(5)
Panel A: Synthetic DiD Event Studies Estimates					
NASDAQ $\times$ Year $=$ 2017	-0.000	0.011***	0.001	-0.004	0.000
	(0.000)	(0.003)	(0.005)	(0.004)	(0.003)
NASDAQ $\times$ Year $=$ 2018	0.002***	0.015***	0.003	0.002	-0.006**
	(0.001)	(0.003)	(0.008)	(0.004)	(0.003)
NASDAQ $\times$ Year $=$ 2019	0.002**	0.006	0.008	0.006	-0.002
	(0.001)	(0.005)	(0.008)	(0.004)	(0.003)
NASDAQ $\times$ Year $=$ 2021	-0.009***	-0.032***	-0.025	0.003	0.005
	(0.003)	(0.006)	(0.041)	(0.019)	(0.013)
NASDAQ $\times$ Year $=$ 2022	-0.009***	-0.046***	0.050	0.049***	0.008
	(0.003)	(0.008)	(0.046)	(0.018)	(0.011)
NASDAQ $\times$ Year $=$ 2023	-0.007*	-0.056***	0.045	-0.005	-0.000
	(0.004)	(0.008)	(0.058)	(0.020)	(0.011)
Panel B: Synthetic DiD Estimates (ATT)					
NASDAQ $\times \mathbb{I}$(Year $>$ 2020)	-0.008***	-0.045***	0.023	0.016	0.004
	(0.003)	(0.007)	(0.042)	(0.012)	(0.007)
Fixed-effects					
Firm	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	18410	18410	18410	17381	17381
Dependent variable mean	0.779	0.118	8.949	0.262	0.065
Number of Firms	2630	2630	2630	2428	2428

*Bootstrap (Jack-knife) standard-errors in Panel A (B). Signif. Codes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

Effect of Mandatory Disclosure on Financial Variables

Dependent Variables:	RoA	RoE	Log(Q)	Log(Market to Book)	Cash Flow to Asset	Index of Financial Outcomes
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Synthetic Difference-in-Difference						
Variables						
NASDAQ × $\mathbb{I}$(Year > 2020)	-0.004	-0.022	-0.107^{***}	-0.134^{***}	-0.007	-0.043^{***}
	(0.012)	(0.021)	(0.015)	(0.023)	(0.011)	(0.015)
Panel B: Difference-in-Difference (Balanced Panels)						
Variables						
NASDAQ × $\mathbb{I}$(Year > 2020)	0.002	-0.007	-0.043^{***}	-0.058^{**}	0.001	-0.019^{*}
	(0.005)	(0.018)	(0.015)	(0.026)	(0.005)	(0.011)
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	17850	15799	13755	13755	16660	17871
Dependent variable mean	-0.037	-0.006	0.507	0.843	-0.01	0.034
Number of Firms	2550	2257	1965	1965	2380	2553

Jackknife (firm-clustered) standard-errors in Panel A (B). Signif. Codes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

‣ Synthetic Controls Event Study Version

Heterogeneity: Effects of Mandatory Disclosure on Board Composition and Financial Outcomes

	Baseline (1)	Low ESG (2)	Size Control (3)	Small Board (4)	Male Industry (5)	Triple Diff (6)
Board Composition						
Male Share of Board	−0.008***	−0.005	−0.008***	0.011	−0.004	0.009
	(0.003)	(0.006)	(0.003)	(0.007)	(0.004)	(0.013)
I(All-Male Board)	−0.089***	−0.044***	−0.084***	−0.059**	−0.088***	0.043
	(0.009)	(0.016)	(0.009)	(0.026)	(0.013)	(0.062)
Financial Outcomes						
Index of Financial Outcomes	−0.027**	−0.018	−0.027**	−0.023	−0.035*	−0.063
	(0.012)	(0.019)	(0.011)	(0.036)	(0.019)	(0.076)
Log(Q)	−0.076***	−0.064***	−0.068***	−0.059	−0.097***	−0.091
	(0.014)	(0.023)	(0.014)	(0.036)	(0.021)	(0.085)
Log(Market to Book)	−0.103***	−0.068	−0.097***	−0.075	−0.153***	−0.24
	(0.024)	(0.042)	(0.025)	(0.061)	(0.036)	(0.138)

*Clustered (Firm) standard errors in parentheses. Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

Approaches to Measure Share Price Reactions

▷ Event Study Methodology (i.e. MacKinlay 1997):

$$AR_{f,t} = R_{f,t} - \left(\hat{\beta}_{f,0} + \hat{\beta}_{f,M} R_{M,t} + \hat{\beta}_{f,SMB} SMB_t + \hat{\beta}_{f,HML} HML_t + \hat{\beta}_{f,MOM} MOM_t \right)$$

Where:

- $R_{f,t}$ is the firm's excess returns calculated by subtracting the 1-month Treasury bill rate from the firm's daily returns.
- $R_{M,t}$ is the daily market risk premium calculated by subtracting the risk-free rate from the daily market return, where market return is the value-weighted return of all CRSP firms incorporated in the US.
- SMB_t, HML_t, MOM_t are daily size, value, and momentum factors respectively from French's website.

▷ The null hypothesis is that the mean abnormal return across firms is zero.

▷ Use a 252-day estimation window with a 30-day gap before the event, and analyze abnormal returns over a two-day window (event day and the following day).

▷ Alternative specifications include the Market Model and Fama–French 3-Factor. Model.

Alternative Methodology: Portfolio Approach

▷ Portfolio's Daily Abnormal Returns:

$$R_{pt} = \beta_0 + \beta_1 \times R_{M,t} + \beta_2 \times SMB_t + \beta_3 \times HML_t + \beta_4 \times MOM_t + AR \times D_t + \epsilon_t$$

Where:

- R_{pt} is the daily excess portfolio return calculated by subtracting the daily 1-month Treasury bill rate from the average daily return of the specified portfolio.
- D_t is a dummy equal to one on the event day and the next working day after the event day, and zero otherwise.
- The analysis covers the period from 365 calendar days prior to the event date up to one day after the event.

▷ Recent studies such as Greene et al. (2020), Eckbo et al. (2022), and Allen and Wahid (2024) have employed the portfolio method to assess share price reactions to an event.

Abnormal Returns on Aug 06, 2021 ▸ Abnormal Returns on Dec 1, 2020

Panel A: All Firms

	Day relative to event	No. of firms	Mean	Tests of mean = 0			
				Std Cross Sectional t-test	Patell's Z test	Gen. Sign test	Wilcoxon Rank test
NASDAQ							
	0	1889	0.266%	***	***	***	***
	1		0.486%	***	***	***	***
NYSE							
	0	1129	0.052%				
	1		-0.056%			***	***

Panel B: All Male Board Firms (As of 2020)

	Day relative to event	No. of firms	Mean	Tests of mean = 0			
				Std Cross Sectional t-test	Patell's Z tests	Gen. Sign test	Wilcoxon Signed test
NASDAQ							
	0	276	0.438%	**	**	***	**
	1		1.078%	*	***	***	***
NYSE							
	0	41	-0.329%	*			
	1		1.558%	*	**	**	*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Abnormal Returns on Dec 11, 2024

Panel A: All Firms

	Day relative to event	No. of firms	Mean	Tests of mean = 0			
				Std Cross Sectional t-test	Patell's Z test	Gen. Sign test	Wilcoxon Rank test
NASDAQ							
	0	2096	-0.755%	***	***	***	***
	1		-0.531%	**	***	**	***
NYSE							
	0	1185	-0.227%	***	***	***	***
	1		0.038%				

Panel B: All Male Board Firms (As of 2023)

	Day relative to event	No. of firms	Mean	Tests of mean = 0			
				Std Cross Sectional t-test	Patell's Z test	Gen. Sign test	Wilcoxon Rank test
NASDAQ							
	0	168	-1.517%	**	***	***	***
	1		-1.066%	*	*	*	***
NYSE							
	0	24	-0.003%				
	1		0.163%				

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Market Reaction Analysis Using Portfolio Approach: Evidence from August 6, 2021

	NYSE AMB	NYSE	NASDAQ AMB	NASDAQ
Intercept	0.002***	0.000	0.001	0.000
	(0.001)	(0.000)	(0.001)	(0.000)
MKT	0.885***	1.013***	0.722***	0.849***
	(0.062)	(0.016)	(0.069)	(0.032)
SMB	1.005***	0.495***	1.190***	0.952***
	(0.075)	(0.020)	(0.083)	(0.038)
HML	0.263***	0.457***	-0.141**	-0.030
	(0.063)	(0.017)	(0.070)	(0.032)
UMD	-0.089*	-0.092***	0.042	-0.055**
	(0.049)	(0.013)	(0.054)	(0.025)
AR	0.007	-0.001	0.010	0.004
	(0.006)	(0.002)	(0.007)	(0.003)
Observations	252	252	252	252
Adjusted R-squared	0.716	0.969	0.672	0.889

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
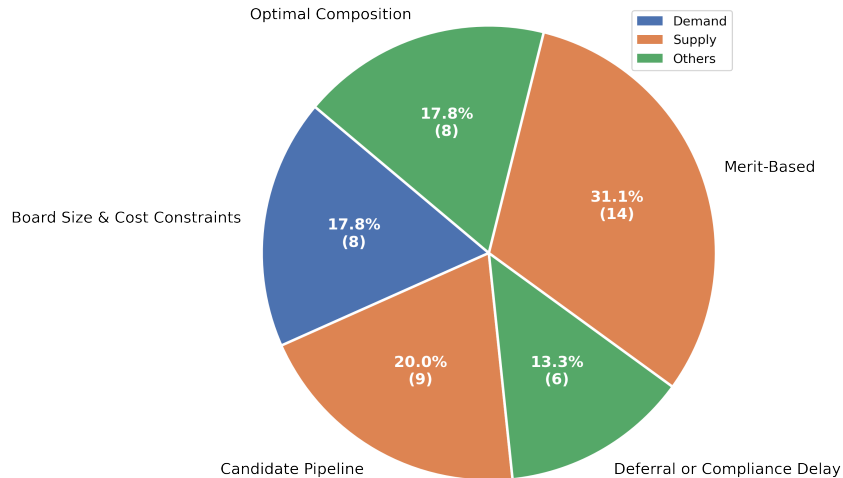
Market Reaction Analysis Using Portfolio Approach: Evidence from December 11, 2024

	NYSE AMB	NYSE	NASDAQ AMB	NASDAQ
Intercept	0.000	0.000*	-0.000	0.000
	(0.001)	(0.000)	(0.001)	(0.000)
MKT	0.851***	0.902***	0.654***	0.892***
	(0.083)	(0.021)	(0.096)	(0.035)
SMB	0.653***	0.527***	0.538***	0.916***
	(0.083)	(0.021)	(0.096)	(0.035)
HML	0.282***	0.417***	-0.069	0.118***
	(0.080)	(0.020)	(0.094)	(0.034)
UMD	-0.214**	-0.168***	-0.170*	-0.163***
	(0.085)	(0.021)	(0.099)	(0.036)
AR	0.000	-0.002	-0.014**	-0.006**
	(0.006)	(0.002)	(0.007)	(0.003)
Observations	252	252	252	252
Adjusted R-squared	0.609	0.959	0.411	0.921

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Textual Analysis of Explanations

Example Quotes

▷ Moderate increase in gender diversity in response to NASDAQ's requirement.

▷ Point estimates are much smaller relative to gender quotas (Gopal, 2025), diversity campaigns run by institutional investors (Gormley et al., 2021), and other mandatory diversity disclosure policies (Bakke et al., 2021).

▷ The relatively small increase in female diversity suggests minimal reputational consequences of disclosing no diversity.

▷ Compliance is driven by firms with larger boards and high ESG scores prior to the policy.

Conclusions II

▷ Investors are not opposed to and appear supportive of a mandatory diversity disclosure framework, from an analysis of share price reactions to both adoption and repeal.

▷ However, the policy led to a modest decline in financial outcomes (reduction in the index of financial outcomes by approx .04 standard deviation units)

▷ Supply-Side explanations pertaining to limited candidate pipelines and meritocratic hiring constitute majority of explanations.

▷ Overall, the "Comply or Explain" regulation modestly raised gender diversity while imposing relatively minimal costs on firms.

Appendix

Timeline of the NASDAQ's Board Diversity Rule

#	Event	Date	Description
1	Nasdaq Proposes Board Diversity Rule	1-Dec-2020	Nasdaq submitted a rule proposal to the SEC requiring companies listed on its exchange to have one or two diverse directors—depending on the size of their board, or to publicly explain why they do not meet this criterion. The proposal also requires disclosure of board diversity statistics.
2	SEC Approval (Final Rule Adopted)	6-Aug-2021	SEC approved the NASDAQ board diversity rule.
3	The Fifth Circuit (En Banc) Court struck down the rule	11-Dec-2024	The Fifth Circuit (en banc) issued a 9–8 decision vacating (invalidating) Nasdaq's board diversity rule.

Appendix

Share of BoardEx Companies Matched with the Following:

	BoardEx N	CRSP	Compustat	All of (2-3)
2017	4353	0.776	0.964	0.759
2018	4339	0.779	0.963	0.764
2019	4319	0.780	0.965	0.767
2020	4509	0.767	0.955	0.750
2021	5273	0.779	0.890	0.720
2022	5012	0.798	0.925	0.758
2023	4569	0.808	0.959	0.789
2024	3404	0.829	0.975	0.815

Column (2) restricts to CRSP Company Policy and BoardEx matches,

Column (3) restricts to Compustat Fundamentals and Boardex, and Column (4) restricts to both.

Appendix: Sample Size by Year

Year	All Firms	NASDAQ			NYSE		
		N	N: AMB	Pr(AMB)	N	N: AMB	Pr(AMB)
2017	3584	1940	659	0.34	1644	288	0.18
2018	3577	1961	562	0.29	1616	201	0.12
2019	3613	2018	405	0.20	1595	127	0.08
2020	3750	2139	338	0.16	1611	86	0.05
2021	4091	2399	267	0.11	1692	64	0.04
2022	4070	2423	226	0.09	1647	48	0.03
2023	3988	2370	216	0.09	1618	48	0.03

Synthetic Difference-in-Differences: Weight Estimation

▷ Unit weights ($\hat{\omega}_f^{sdid}$) minimize pre-treatment outcome differences between treated and control units:

$$\hat{\omega}_f^{sdid} = \arg\min_{\omega_f} \sum_{t:T_0} \left(\sum_{f:D_f=1} Y_{ft} - \sum_{f:D_f=0} \omega_f Y_{ft} \right)^2, \quad \omega_f \geq 0, \quad \sum_{f:D_f=0} \omega_f = 1,$$

where T_0 is pre-treatment periods, $D_f = 1$ for treated units (e.g., NASDAQ firms).

▷ Time weights ($\hat{\lambda}_t^{sdid}$) make weighted pre-treatment control outcomes match their unweighted post-treatment average:

$$\hat{\lambda}_t^{sdid} = \arg\min_{\lambda_t} \sum_{f:D_f=0} \left(\sum_{t:T_0} \lambda_t Y_{ft} - \frac{1}{T_1} \sum_{t:T_1} Y_{ft} \right)^2, \quad \lambda_t \geq 0, \quad \sum_{t:T_0} \lambda_t = 1,$$

where T_1 is post-treatment periods (e.g. 2021 to 2023)

▷ Doubly-robust: SDiD yields consistent estimates if either parallel trends (DiD) or synthetic control approximation holds.

Identifying Assumptions: TWFE vs. SDID

Potential outcomes:

$$Y_{it} = D_{it} Y_{it}(1) + (1 - D_{it}) Y_{it}(0)$$

Two-Way FE (DiD)

$$Y_{it}(0) = \alpha_i + \lambda_t + \varepsilon_{it}$$

Assumption:

$$E[Y_{it}(0) - Y_{i,t-1}(0) \mid i \in T] = E[Y_{it}(0) - Y_{i,t-1}(0) \mid i \in C]$$

(Parallel trends)

Synthetic DiD (SDID)

$$Y_{it}(0) = \alpha_i + \lambda_t + f_i' g_t + \varepsilon_{it}$$

Assumption:

$$E[\varepsilon_{it} \mid f_i, g_t] = 0, \quad D_{it} \perp \varepsilon_{it} \mid f_i, g_t$$

(Interactive fixed effects)

TWFE: homogeneous trends — **SDID:** heterogeneous trends via factors

Effect of Mandatory Disclosure on Board Composition

Dependent Variables:	Male Share of Board	1(All-Male Board)	Board Size	1(Expand Board)	1(Male Dropped)
Model:	(1)	(2)	(3)	(4)	(5)
Panel A: Synthetic Difference-in-Difference					
Variables					
NASDAQ $\times$ $\mathbb{I}$(Year > 2020)	-0.008***	-0.045***	0.023	0.016	0.004
	(0.003)	(0.007)	(0.041)	(0.012)	(0.008)
Panel B: Difference-in-Difference (Balanced Panels)					
Variables					
NASDAQ $\times$ $\mathbb{I}$(Year > 2020)	-0.009***	-0.089***	-0.064	0.031**	0.007
	(0.003)	(0.010)	(0.049)	(0.013)	(0.009)
Fixed-effects					
Firm	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	18410	18410	18410	17381	17381
Dependent variable mean	0.779	0.118	8.949	0.262	0.065
Number of Firms	2630	2630	2630	2428	2428

*Jackknife standard-errors in parentheses. Signif. Codes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

Effect of Mandatory Disclosure on Financial Variables (Synthetic DiD Event-Study)

Dependent Variables:	RoA	RoE	Log(Q)	Log(Market to Book)	Cash Flow to Asset	Index of Financial Outcomes
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Synthetic DiD Event Studies Estimates						
NASDAQ × Year = 2017	0.001	0.016*	−0.003	−0.003	0.001	0.004
	(0.003)	(0.009)	(0.006)	(0.006)	(0.003)	(0.007)
NASDAQ × Year = 2018	−0.006***	−0.010	−0.019***	−0.006	−0.007***	−0.013
	(0.002)	(0.006)	(0.007)	(0.007)	(0.002)	(0.009)
NASDAQ × Year = 2019	−0.002	−0.012	−0.020***	−0.005	−0.001	−0.002
	(0.003)	(0.009)	(0.007)	(0.006)	(0.003)	(0.005)
NASDAQ × Year = 2021	0.026***	0.047***	−0.062***	−0.087***	0.024**	0.014
	(0.009)	(0.018)	(0.013)	(0.020)	(0.010)	(0.014)
NASDAQ × Year = 2022	−0.007	−0.037	−0.134***	−0.161***	−0.014	−0.045***
	(0.012)	(0.027)	(0.017)	(0.025)	(0.012)	(0.016)
NASDAQ × Year = 2023	−0.031***	−0.075**	−0.126***	−0.154***	−0.032**	−0.097***
	(0.011)	(0.030)	(0.017)	(0.026)	(0.013)	(0.023)
Panel B: Synthetic DiD Estimates (ATT)						
NASDAQ × $\mathbb{I}$(Year > 2020)	−0.004	−0.022	−0.107***	−0.134***	−0.007	−0.043***
	(0.010)	(0.019)	(0.014)	(0.020)	(0.011)	(0.014)
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year-SIC	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	17850	15799	13755	13755	16660	17871
Dependent variable mean	−0.037	−0.006	0.507	0.843	−0.01	0.034
Number of Firms	2550	2257	1965	1965	2380	2553

*Clustered (Firm) standard-errors in parentheses. Signif. Codes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

Appendix: Test of Significance in Short-Run Abnormal Returns Calculation

▷ Concern: The main concern with evaluating the significance of an event study is that economic factors affecting stock returns often create strong positive contemporaneous return correlations among securities.

- Considered standardized cross-sectional t-test (accounts for event-induced variance and cross-sectional dependence in abnormal returns).
- Considered non-parametric tests such as Generalized Signed Tests and Wilcoxon Signed Rank Tests.
  - ⋆ These tests do not require cross-sectional symmetry of abnormal returns.
  - ⋆ Both tests are widely used in event-study studies. Cowan (1992) finds that the generalized sign test is well specified for event windows of one to eleven days.

Appendix: Example Explanations I

▷ Demand Side (Board Size and Cost Constraints): "The Board of Directors believes that the present size of the Board, consisting of five directors, is appropriate given the size and operations of the Company. The Board believes that its present members possess skills and experience that are valuable to the Company. The Board believes that the increased costs of adding additional directors outweighs any benefits. Consequently, the Board considers its present make-up to be appropriate for the Company at this time and in the best interests of shareholders." by Taylor Devices Inc

▷ Supply Side (Candidate Pipeline): "As of December 31, 2023, the Board of Directors (the "Board") of Oncocyte Corporation (the "Company") was assembled with a focus on attaining a Board comprised of people with substantial experience in bioscience, the pharmaceutical or diagnostic industry, corporate management, and finance. The Board believes that this interdisciplinary approach best suits the Company's needs as the Company works to develop and commercialize diagnostic tests. While the Board has not yet identified an appropriate candidate as of December 31, 2023, the Board intends to cause the Company to comply with the Nasdaq diversity rules and any applicable California diversity requirements by adding qualified women and qualified persons from underrepresented communities to the Board as soon as reasonably possible." by Oncocyte Corp

Appendix: Example Explanations II

▷ Supply Side (Merit-Based): "As of December 26, 2022 there have been no changes to the makeup of our board of Directors. The table above provides certain information regarding the diversity of our board of directors as of December 26, 2022, 2023 and 2024. While not diverse, the Company's board was composed based upon the skill and experience of the various members, and as a common controlled company they uphold the values and vision of our shareholders." by Dawson Geophysical Co.

▷ Optimal Composition: "Given our small size, we believe that the Board is fully and appropriately staffed with six current members who have been long-serving prior to the adoption of Rule 5605(f). Accordingly, we have no current plans to increase the size of the Board although we will continue to assess the needs of our Board in the future." by Home Federal Bancorp Inc.

Appendix: Abnormal Returns on Dec 01, 2020

Panel A: All Firms

	Day relative to event	No. of firms	Mean	Tests of mean = 0			
				Std Cross Sectional t-test	Patell's Z test	Gen. Sign test	Wilcoxon Rank test
NASDAQ							
	0	1767	-0.395%				***
	1		-0.148%			***	
NYSE							
	0	1112	-0.081%				*
	1		-0.203%	***	***	***	***

Panel B: All Male Board Firms (As of 2020)

	Day relative to event	No. of firms	Mean	Tests of mean = 0			
				Std Cross Sectional t-test	Patell's Z tests	Gen. Sign test	Wilcoxon Signed test
NASDAQ							
	0	251	-1.158%			***	***
	1		-0.414%	*	***	***	
NYSE							
	0	35	-1.099%		*	**	*
	1		-0.567%			**	***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix: Variable Definitions

Variable	Description	Source
1(AMB)	Indicator for all male board	BoardEx
1(Expand)	Indicator for increase in board size relative to previous year	BoardEx
Board Size	Board size	BoardEx
Female Directors	Number of female directors	BoardEx
Age	Time since IPO date	Compustat
Number of Employees	Number of employees at firm (thousands)	Compustat
Tobin's Q	(CSHO*PRCC + DLTT + DLC)/AT	Compustat
Total Assets	Compustat item AT	Compustat
Sales	Compustat item SALE	Compustat
ROA	Compustat item NI/AT	Compustat
Leverage	Compustat item (DLC+DLTT)/AT	Compustat
Cash to Assets	Compustat item CHE/AT	Compustat
Market Value	CRSP item shrout*prc	CRSP