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Female Directors and Firm Value: New Evidence from Directors' Deaths

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Abstract. This paper examines how female directors (FDs) affect firm value in the absence of mandatory gender quotas. Using a newly collected data set on director deaths around the globe, we find that stock prices decrease approximately 2% more when an FD passes away, compared with a male director. What explains this negative capital market reaction? We find evidence that finding successors for deceased FDs is challenging for firms: Succession delays are longer, and although firms try to replace FDs with women, two-thirds of their successors are male. Furthermore, their successors tend to be younger, less experienced, and more often externally hired. Stock prices decline less if more potential female successors exist in a country, the firm is larger, or FDs other than the deceased woman were on the board. Because observable characteristics such as age, tenure, education, and network centrality cannot explain the negative stock market reaction, unobserved differences across genders that lead to a lower fit of male successors to the existing board are the most likely explanation for the firm value loss after the death of an FD.

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Keywords: female directors • director death • firm value • board of directors • director succession

1. Introduction

Female board representation is a highly debated topic in both political and social contexts. Deloitte (2016), for instance, reports that less than 15% of board seats around the world are taken by women. Although some regulators have reacted to this female underrepresentation with mandatory quotas, firms in most jurisdictions can freely choose the gender composition of their boards. A key question in this context is whether firms' voluntary appointments of female directors (FDs), or, more generally, gender-diverse boards, create firm value. We contribute to this question by analyzing how stock markets react to the death of FDs.

Using an international sample, we identify 2,660 director death events between 1996 and 2019, of which 91 are related to FDs.[1] We find that stock prices decline more when FDs pass away, relative to their male counterparts. The cumulative announcement return (CAR) for FDs is −1.4% when using a short window of $[-1d; +1d]$ around the announcement of a director death. The capital market reaction is even stronger when we use longer windows: It increases to −2.6% for the $[-2d; +2d]$ and −2.3% for the $[-3d; +3d]$ window. We find very similar results when we control for year, industry, and country fixed effects. For male directors, the announcement return is close to zero, irrespective of the event window.

Although our empirical design is less prone to concerns about the endogenous selection of directors than are panel regressions (Hermalin and Weisbach 1998), it is far from being perfect. One potential concern with our results is that at least some of the death events might be anticipated by the stock market. To investigate this potential issue, we collect information on death causes and find that 539 death events, of which 19 are related to FDs, can be explicitly classified as sudden. Because of the substantially lower number of sudden events, we do not use them as our baseline specification, but we show that the more negative stock market reaction to the deaths of FDs is similar or even stronger when we exclude nonsudden deaths.

However, even if we consider nonsudden deaths, the number of events that represent FDs is limited to 91. This imbalance between deaths of female and male directors is likely to be related to the younger average age of FDs and, more generally, their lower share on boards. Thus, we construct an extended sample that additionally includes senior managers, departures due to illness, or both. Adding both event types increases the number of observations to 4,219, of which 159 represent FDs. The fact that the results are similar compared with our baseline specification eases concerns that our sample size harms the validity of our results.

Another potentially important concern is related to firm characteristics that might drive both the likelihood of having FDs on the board and the capital market reaction to director death announcements. However, we show that the results are similar if we control for firm characteristics in our regressions. Additionally, the results do not change substantially if we only include death events of male directors in the control group if the corresponding firm had at least one FD at the time of the director's death. Finally, tests of pretrends and posttrends show that the gender of the director has no impact on the stock returns before and after the event window.

Overall, however, an important question remains: Why does the stock market react more negatively to the deaths of FDs? Announcement returns reflect the value of the deceased director, the expected value of the replacing director, and the succession process—that is, the search cost (e.g., Jenter et al. 2018). Thus, a potential mechanism is that the stock market expects the matching quality of successors to FDs to be worse compared with the matching quality of successors to deceased male directors.[2] Generally speaking, the characteristics of a director determine how well he or she matches to a board and, as a consequence, how valuable the director is for that firm. Female and male directors can differ across multiple characteristics, which can render FDs more difficult to replace. If the stock market anticipates these replacement difficulties and matching of (female) directors to firms is important—for example, because diversity is valuable for firms—the board quality drops if a deceased FD has to be replaced by a male director, which could explain our results.

To shed light on this potential mechanism, we first investigate the succession process of deceased directors. For this purpose, we collect information on the successors of deceased directors from various sources, such as Nexis and Factiva, and are able to identify a direct successor for 885 of the 2,660 death events. Relative to their male counterparts, the probability of having a female successor is higher if an FD passes away. On average, 10.5% of all successors are female; for deceased FDs, this number increases to 32.2%, whereas it is only 9.7% for men. This finding suggests that firms try to replace deceased FDs with women, although these attempts may often be unsuccessful. Using succession delays as proxies for firms' difficulties in replacing deceased directors, we find that the announcement of a successor happens 53 days later when an FD passes away compared with the case of a male director. Furthermore, successors of FDs are, on average, younger, less experienced, and more likely externally appointed. These results indicate that firms face greater difficulties in finding successors for deceased FDs, which leads to longer delays and a broader search pool.

These findings lead to another question: Which characteristics make FDs more difficult to replace? To investigate whether we can identify observable characteristics that make FDs more difficult to replace, we check for differences in education, network centrality, industry experience, and nationality and whether the director was independent, an executive director, the chairperson, or a member of various committees. We find, among others, that deceased FDs are, on average, younger than their male counterparts and that they have shorter tenure. But do these differences render FDs more difficult to replace and explain our results? The evidence does not point in this direction: Controlling for observed characteristics, including age and tenure, has little effect on our baseline finding that the stock market reacts more negatively to the deaths of FDs. Thus, these results make it unlikely that differences between observable characteristics are the driving force behind our results.

The lack of observed director-level characteristics that explain the stock market reaction indicates that unobserved gender differences are important for the matching of FDs to firms. Those differences can stem from gender differences in the general population or from the selection processes of directors. For instance, Adams and Funk (2012) show that women who break through the glass ceiling and reach the top have different core values and risk attitudes than both their male peers and the general female population.[3] FDs may also differ from their male peers with regard to their management styles, their behavior in competitive environments, or, most generally, their skill set (Gneezy et al. 2003, Niederle and Vesterlund 2007, Croson and Gneezy 2009, Sapienza et al. 2009, Flory et al. 2015, Kim and Starks 2016). It is, however, beyond the scope of this paper to identify which of those unobserved gender differences matter most for our results, and, most likely, it is the combination of characteristics that matters.[4]

In a final step, we go beyond observable director characteristics and investigate more generally under which conditions the stock market reacts more negatively to the deaths of FDs. We consider the country-level supply of FDs, mandatory gender quotas, the legal environment of a country, firm and board characteristics, and general time patterns as potentially relevant factors. We find that announcement returns are less negative when the number of potential female successors, measured as the country-year-level share of FDs,[5] share of female successors, or female labor-force participation, is greater. This finding indicates that firms in countries with a higher number of potential female successors suffer less. We also show that the negative reaction is less pronounced for larger and more profitable firms, for which it might be easier to attract qualified successors. Board characteristics also play a role: Firms with boards that have other FDs besides the deceased woman and those with larger boards tend to suffer less from the loss of an FD, potentially because those firms are more likely able to compensate for the loss of an FD, even if they cannot appoint a female successor. We find no strong time patterns and no influence of mandatory gender quotas or a country's institutional environment on the capital market reaction to the deaths of FDs. Although the interpretation of the stand-alone results is not straightforward, taken together, they are in line with the view that firms' difficulties in adequately replacing FDs drives the more negative capital market reaction.

Our paper contributes to the literature on valuation implications of female board representation, which reports mixed results. Among the most influential papers, Adams and Ferreira (2009) find that the voluntary appointment of FDs reduces the value of U.S. firms, and Dezsö and Ross (2012) provide evidence that female representation in top management improves firm performance, especially in innovative firms. Post and Byron (2015) provide an overview on this sizeable literature and conduct a meta-analysis based on 140 studies. Their conclusion is that the empirical evidence so far is mixed. It is beyond the scope of this paper to summarize or even mention all of these papers. We complement this literature by providing novel evidence on the capital market reaction to the death of FDs.

Our research is also related to the literature on female board representation as a result of gender quotas (e.g., Ahern and Dittmar 2012, Matsa and Miller 2013, Bøhren and Staubo 2014, Bertrand et al. 2019, Rebérioux and Roudaut 2019, Ferreira et al. 2021, Greene et al. 2020, Hwang et al. 2021, Eckbo et al. 2021, and von Meyerinck et al. 2021). Gender quotas (still) reflect a relatively rare circumstance that does not pertain to the majority of firms around the world, and we complement this literature by focusing on the value effects of FDs in the absence of mandatory gender quotas. Thus, our results should be interpreted as illuminating how female board representation affects firm value if firms can freely choose the gender composition of their boards. In this regard, search frictions in the succession process are broadly in line with supply-side constraints, as documented in some of the above articles.[6]

Finally, this paper adds to the literature that exploits deaths or retirements due to poor health as exogenous shocks. For directors, this literature has shown that the loss of independent directors (Nguyen and Nielsen 2010), directors that are not connected to CEOs (Fracassi and Tate 2012), directors with high social network centrality (Fogel et al. 2021), and directors who are more connected (Bakke et al. 2021) reduce firm value. Using deaths of directors and CEOs as shocks to attention, Falato et al. (2014) find that director busyness is detrimental to firm value.[7] We complement these studies by using director deaths to systematically investigate how director gender affects stock market reactions.

2. Data

2.1. Director Death Data Set

This paper is based on a newly compiled, worldwide data set that includes director deaths between 1996 and 2019. We proceed in several steps to identify these director death events. First, we identify listed firms based on the Worldscope country lists and download their English-language annual reports from the Thomson Reuters filings database. In total, we find about 135,000 PDF files from 35,000 firms. After converting these annual reports from PDF into text format, we search for the keywords "death," "passed away," "died," "accident," "deceased," and "illness." Second, we again use the Worldscope country lists to identify listed firms and screen the biographies of their directors using the Officers & Directors database by Thomson Reuters (see Section 2.2 for details about this database). In the biographies, we check whether we can find any of the keywords that we used in the annual report search. Third, we download all announcements related to director board changes reported in the Key Developments Database by Capital IQ (event codes 101, 102, and 16) and also search these announcements for the above keywords. Fourth, we filter the Ravenpack database, which classifies all kinds of news sourced from various databases (e.g., Dow Jones) for departures of directors and perform the keyword search. Fifth, we screen the BoardEx database for death dates of directors. If we find any of the keywords in an annual report, biography, news announcement, or news report, we read the corresponding section of the document to investigate whether there is any information about the death of a director.

Next, we aggregate the events from these five data sources and drop duplicates. We then use the original data sources, such as annual reports or director biographies from the director panel data set, and additional databases such as Nexis or Factiva, as well as web searches, to obtain additional information for these events. In particular, we search for the announcement date of the death, the death date itself, the gender of the director, his or her age, tenure, education, network centrality, whether he or she was an independent or executive director, whether he or she was the chairperson, any committee memberships, and information about the successors.

Furthermore, we also obtain information on the successors of the outgoing directors by screening the above sources. We only consider replacements that take place within a year of the original announcement. In total, we are able to identify a direct successor for 885 of the 2,660 death events.[8] Notably, we determine the successor's gender and age, the time until the successor is announced and/or replaced, the successor's industry experience, the successor's nationality, and whether the successor is hired externally. Finally, we also add firm-level governance variables, such as board size or the number of other FDs on the board, and financial variables, such as firm size or leverage according to Worldscope or Capital IQ, to the data set. These firm-level variables are measured at the fiscal year ending before the stock market announcements, and they are winsorized annually at the 1% level to mitigate the effects of outliers. Detailed definitions of these variables, as well as their sources, can be found in Appendix D.

We then drop events that we cannot match to Thomson Reuters Datastream, which we use to obtain return data. We drop instances where there are multiple events in a given firm at the same time (e.g., on September 11, 2001) and cases that refer to honorary directorships. We end up with a total of 2,660 director death events from 1996 through 2019 for which we can calculate announcement returns.[9] Of these events, 91 represent FDs; we show their names, firms, and event years in Appendix A. The 2,660 events relate to 2,239 unique directors, of whom 63 are female. This is driven by the fact that some directors held multiple board positions when they passed away. An overview of the event numbers can be found in Table 1. Appendix B and Appendix C show the distribution of director death events across countries and years, respectively.

For all events, we calculate raw returns, excess returns, and cumulative abnormal returns around the announcements of the death events. The event windows that we use in our main analyses are $[-1d;1d]$, $[-2d;2d]$, and $[-3d;3d]$. Excess returns are calculated as raw returns minus the corresponding return for the Financial Times Stock Exchange (FTSE) All World index. Cumulative abnormal returns are based on a one-factor market model, again with the FTSE All World index as the benchmark index. The estimation period is set to the 250 trading days ending 30 trading days before the respective events.

Descriptive statistics for our sample are shown in Table 2. For instance, the average age at the time of the death event is 68.4 years, the average tenure of the deceased directors is 11.8 years, 36.5% served as independent directors, and 18.4% served as executive directors. The average delay before a successor is announced is 59.5 days, and the successors start their duty, on average, 68.5 days after the director death announcement. The combined announcement returns for deaths of female and male directors are mostly negative, but very close to zero. The average share of FDs in the countries where our events occur is 9%, and only 13% of the events happen in jurisdictions that announced mandatory gender quotas.

Table 1. Sample

Type	Total	Men	Women	Share of women (%)
Events	2,660	2,569	91	3.42
Directors	2,239	2,165	74	3.31

Note. This table summarizes the director death events.

2.2. Director Panel Data Set

To measure the share of FDs in a country and year, which we require for some of our mechanism tests (see Section 4), we compile an international director panel data set. This data set is obtained from the Officers and Directors database by Thomson Reuters via Thomson One Banker, which entails information on current and past firm affiliations of all directors and senior managers, their education, and some short biographies.[10] We obtain information on board members for public firms from 53 countries; to identify public firms, we rely on the Worldscope country lists.

Unfortunately, the Officers & Directors database does not explicitly distinguish directors from senior managers. Therefore, the next step is to determine which people in the database represent directors, which are the focus of our study. The distinction between directors and senior managers, however, is not always straightforward in an international context because board structures differ substantially across countries. We use role descriptions from the database to classify the affiliations of all board members in our data set as either a director position or a (nondirector) senior manager position. If a role description contains the term "director," we typically classify the affiliation as a director affiliation. An exception is, for example, the role "director of finance," which would be classified as a manager. Similarly, a role description such as "general manager" would be classified as a manager.

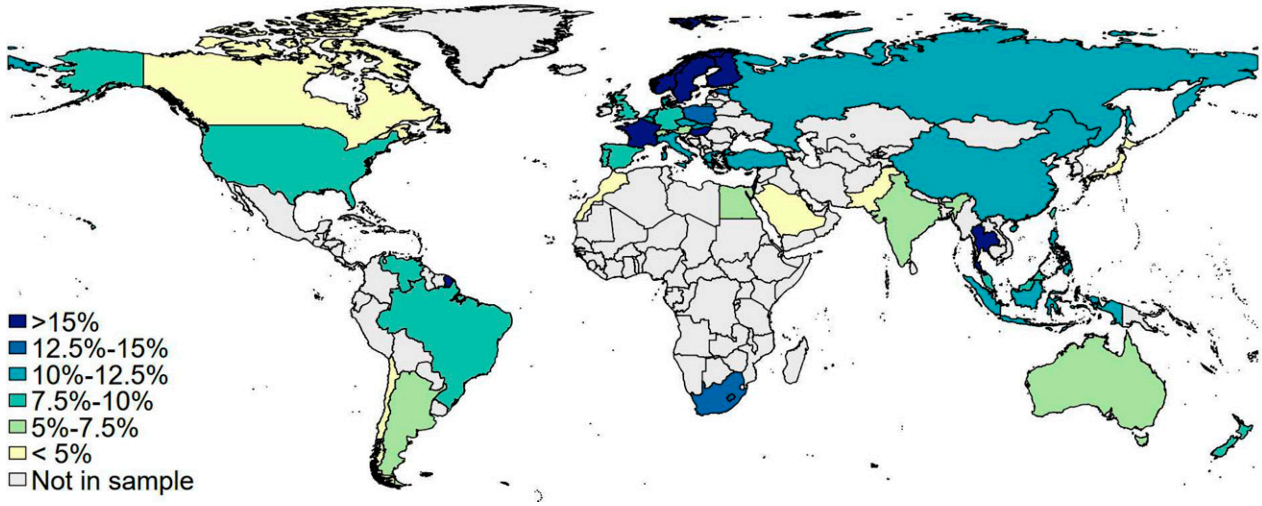
The resulting director data set covers 38,023 publicly listed firms, 447,691 firm-years, and 469,178 directors from 1998 to 2017.[11] The firms that are included in this data set cover about 89% of the worldwide market capitalization in 2010. The final step is to determine the gender of the directors in the data set. For this purpose, we follow a four-step procedure that allows us to classify 406,000 directors (86% of all directors in the data set) as either male or female.[12] Overall, we identify more than 40,500 FDs in the data set, and women constitute, on average, 8% of all directors in a firm. The fraction of FDs increased slightly from below 7% to above 13% from 1998 through 2017. Figure 1 and Appendix E present detailed information on the share of FDs for each sample country (and over time). It is interesting to see that the share of FDs

Table 2. Descriptive Statistics

Variable	*N*	Mean	First quartile	Median	Third quartile	SD
Variables related to deceased directors						
Female	2,660	0.034	0.000	0.000	0.000	0.182
Age	2,010	68.396	61.288	68.511	76.000	11.188
Ln(*Age*)	2,010	4.211	4.116	4.227	4.331	0.172
Tenure	1,884	11.763	4.227	8.800	14.147	11.288
Ln(*Tenure*)	1,884	2.201	1.654	2.282	2.718	0.860
Education	1,365	2.154	1.000	2.000	3.000	1.215
Edu_higher	1,365	0.562	0.000	1.000	1.000	0.496
Centrality	1,165	0.030	0.000	0.000	0.020	0.061
Centr_dummy	1,165	0.327	0.000	0.000	1.000	0.469
Industry experience	1,907	0.201	0.000	0.000	0.000	0.401
Foreign	760	0.137	0.000	0.000	0.000	0.344
Independent	2,658	0.365	0.000	0.000	1.000	0.481
Executive	2,658	0.184	0.000	0.000	0.000	0.388
Chairperson	2,659	0.266	0.000	0.000	1.000	0.442
Committee_any	1,699	0.604	0.000	1.000	1.000	0.489
Variables related to successors						
Announcement delay	565	59.45	0.00	24.00	94.00	77.38
Ln(*ann. delay* +1)	565	2.76	0.00	3.22	4.55	2.01
Start delay	882	68.52	1.00	36.00	107.00	82.11
Ln(*start delay* +1)	882	3.01	0.69	3.61	4.68	1.99
Female successor	885	0.11	0.00	0.00	0.00	0.31
Successor age	767	55.62	49.00	56.00	63.00	9.98
Successor industry experience	646	0.20	0.00	0.00	0.00	0.40
External successor	882	0.44	0.00	0.00	1.00	0.50
Foreign successor	422	0.14	0.00	0.00	0.00	0.35
Firm-level returns						
CAR [−1;+1]	2,660	−0.002	−0.025	−0.003	0.017	0.063
CAR [−2;+2]	2,660	−0.001	−0.032	−0.003	0.024	0.076
CAR [−3;+3]	2,660	0.000	−0.035	−0.004	0.031	0.090
CAR [−2;+2], wins. 1/99%	2,660	−0.001	−0.032	−0.003	0.024	0.071
CAR [−2;+2], wins. 5/95%	2,660	−0.002	−0.032	−0.003	0.024	0.055
Return [−2;+2]	2,660	0.001	−0.029	0.000	0.028	0.078
Excess return [−2;+2]	2,660	−0.001	−0.031	−0.004	0.026	0.076
CAR [−5;−3]	2,660	−0.001	−0.023	−0.001	0.018	0.063
CAR [+3;+5]	2,657	0.000	−0.023	−0.001	0.018	0.061
Firm-level characteristics						
# other FD	2,046	0.761	0.000	0.000	1.000	1.033
Ln(*# other FD* + 1)	2,046	0.432	0.000	0.000	0.693	0.494
Board size	2,073	8.617	6.000	8.000	10.000	3.455
Ln(*Board size*)	2,073	2.080	1.792	2.079	2.303	0.385
Ln(*Total assets*)	2,453	12.840	10.990	12.663	14.430	2.447
Leverage	2,451	0.214	0.037	0.181	0.344	0.191
Profitability	2,443	0.041	0.013	0.061	0.113	0.164
Sales growth	2,353	0.093	−0.024	0.079	0.200	0.370
Tangibility	2,415	0.295	0.068	0.234	0.466	0.258
Country-level variables						
$FD\ fraction_{c,y}$	2,608	0.09	0.06	0.08	0.12	0.05
$Female\ successors_{c,y}$	2,648	0.10	0.09	0.09	0.10	0.06
$Female\text{-}to\text{-}male\ LFP_{c,y}$	2,644	71.05	66.34	80.08	81.89	18.47
$Female\ LFP_{c,y}$	2,644	51.02	48.29	56.32	58.33	12.22
$Quota\ announcement_{c,y}$	2,660	0.13	0.00	0.00	0.00	0.33
$Quota\ introduction_{c,y}$	2,660	0.09	0.00	0.00	0.00	0.29
$Transparency_c$	2,288	24.11	18.00	28.10	31.30	8.99
$Disclosure\ rights_c$	2,565	0.90	0.83	0.92	1.00	0.13
$Anti\ self\text{-}dealing_c$	2,613	0.68	0.58	0.65	0.81	0.19
Ln($GDP\ per\ capita_{c,y}$)	2,644	9.87	8.92	10.67	10.81	1.37
$Dual\ board\ structure_c$	2,624	0.04	0.00	0.00	0.00	0.19

Notes. This table presents descriptive statistics for the director deaths sample. A description of all variables can be found in Appendix D.

Figure 1. (Color online) This Figure Shows the Countries Included in the Director Panel Data Set and the Average Share of Female Directors Across All Firms Within That Country over the 1998–2017 Period



varies considerably across countries. For instance, their share is 3% in Japan, 8% in the United States, and 19% in Sweden, with Scandinavian countries having the highest levels of female board representation.[13]

3. Stock Market Response to the Deaths of FDs

3.1. Univariate Results

To investigate how a director's gender affects the stock market response to the announcement of their deaths, we start with a univariate analysis. In Table 3, we compare announcement returns for female and male directors. For men, the announcement return is close to zero for all return definitions. For women, however, the announcement return is −1.4% when we look at the CAR during the [−1*d*;+1*d*] window. For comparison, we find that the announcement return for the subsample of male CEOs for the same window is −1.2%. The magnitude of our effect also compares well to Nguyen and Nielsen (2010), who document a 0.85% drop in stock prices around sudden deaths of independent directors. Similarly, Falato et al. (2014) observe a 0.8% decrease in stock prices in firms that share a nondeceased director with the death firm. When we use a longer event window, the magnitude of the announcement return increases to −2.6% during the [−2*d*;+2*d*] window and −2.3% during the [−3*d*;+3*d*] window. These negative returns are statistically significant, with *p*-values between 0.1% and 7.3%. For the [−2*d*;+2*d*] window, which we will use most in our empirical analysis, we also compute winsorized returns, raw returns that are not adjusted for any benchmark returns, and excess returns that assume a beta of one for all firms (details on the construction of all returns can be found in Appendix D). The patterns for these alternative return definitions are very similar to the main results.

The finding that the magnitude of the CAR is less negative for the [−1*d*;+1*d*] window and relatively similar for the [−2*d*;+2*d*] and [−3*d*;+3*d*] windows indicates that the stock price adjustment happens not

Table 3. Univariate Analysis

	Mean		Difference		Observations	
Variable	Women	Men	W-M	*p*-value	Women	Men
CAR [−1;+1]	−0.014	−0.002	−0.012	0.073*	91	2,569
CAR [−2;+2]	−0.026	0.000	−0.026	0.002***	91	2,569
CAR [−3;+3]	−0.023	0.001	−0.024	0.013**	91	2,569
CAR [−2;+2], wins. 1/99%	−0.026	0.000	−0.025	0.001***	91	2,569
CAR [−2;+2], wins. 5/95%	−0.021	−0.002	−0.019	0.001***	91	2,569
Return [−2;+2]	−0.023	0.002	−0.025	0.003***	91	2,569
Excess return [−2;+2]	−0.023	0.000	−0.023	0.005***	91	2,569
CAR [−5;−3]	0.002	−0.001	0.003	0.655	91	2,569
CAR [+3;+5]	0.002	−0.001	0.003	0.688	91	2,566

Notes. This table shows announcement returns around director retirements due to death. A description of all variables can be found in Appendix D.

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

only on the announcement day, but also during the two days before and after. Potential explanations for this time pattern are information leakage (the announcement of the director death typically happens shortly after the death itself) or short delays in the information processing of investors. Regarding the economic significance, a 1% difference in the announcement return equals a reduction in market capitalization of about 33.5 million U.S. dollars (USD) (median: 2.3 million USD). We also perform univariate tests of pretrends and posttrends by analyzing event returns in the $[-5d;-3d]$ and $[3d;5d]$ windows. Now, announcement returns for both female and male board members are virtually zero.

3.2. Regression Analysis

Regression estimates for the effect of a director's gender on the capital market reaction to their death are presented in Table 4. We show the results for our different event windows: CAR $[-1d;+1d]$ in Panel A, CAR $[-2d;+2d]$ in Panel B, and CAR $[-3d;+3d]$ in Panel C. The reported *t*-statistics are based on robust standard errors clustered by director. In each panel, we start with a simple model without any fixed effects

Table 4. Regression Analysis

Model	1	2	3	4
Panel A: *CAR* $[-1d;+1d]$				
Female	−0.012***	−0.012***	−0.012***	−0.011**
	(−2.76)	(−2.63)	(−2.63)	(−2.44)
Events total	2,660	2,659	2,659	2,651
Events women	91	91	91	91
R^2	0.0012	0.0096	0.013	0.028
Year fixed effects	No	Yes	Yes	Yes
Industry fixed effects	No	No	Yes	Yes
Country fixed effects	No	No	No	Yes
Panel B: *CAR* $[-2d;+2d]$				
Female	−0.026***	−0.024***	−0.024***	−0.024***
	(−3.88)	(−3.61)	(−3.65)	(−3.70)
Events total	2,660	2,659	2,659	2,651
Events women	91	91	91	91
R^2	0.0037	0.015	0.017	0.033
Year fixed effects	No	Yes	Yes	Yes
Industry fixed effects	No	No	Yes	Yes
Country fixed effects	No	No	No	Yes
Panel C: *CAR* $[-3d;+3d]$				
Female	−0.024***	−0.023***	−0.022***	−0.023***
	(−2.85)	(−2.73)	(−2.70)	(−2.75)
Events total	2,660	2,659	2,659	2,651
Events women	91	91	91	91
R^2	0.0023	0.016	0.020	0.036
Year fixed effects	No	Yes	Yes	Yes
Industry fixed effects	No	No	Yes	Yes
Country fixed effects	No	No	No	Yes

Notes. The dependent variable is indicated in the title of each panel. *t*-statistics based on clustered standard errors by director are presented in parentheses. A description of all variables can be found in Appendix D.
**$p < 0.05$; ***$p < 0.01$.

(model 1). In line with the univariate results, the coefficient estimates for the dummy variable *Female* range between −0.012 and −0.026, with *t*-values between −2.76 and −3.88. These estimates imply that the cumulative abnormal returns are between 1.2% and 2.6% lower around the announcement of the death of an FD, relative to the announcement of the death of a male director. We add year fixed effects in model 2, industry fixed effects based on the Fama/French 12-industries classification in model 3, and country fixed effects in model 4. The results remain similar, with a coefficient estimate for the female dummy between −0.011 and −0.024 and *t*-values between −2.44 and −3.70. Overall, these results provide strong evidence that the stock market reacts more negatively to the deaths of FDs relative to their male counterparts.

3.3. Robustness

3.3.1. Sudden Deaths. Thus far, we have not distinguished sudden from nonsudden death events. When we search for additional information about the nature of the deaths in news reports, web searches, and the original data sources that we used to identify the event, we are able to find the cause for 954 events (35.8% of the sample). Among those 954 events, 539 can be classified as sudden deaths (56.5% of the death events with an identified cause and 20.3% of all events). Of these, 19 events are related to women. The share of sudden death events for FDs is 20.9%, which is similar and not statistically different from the corresponding share for male directors, which is 20.2%. For the classification of death events, we follow Nguyen and Nielsen (2010) and Jenter et al. (2018) and classify unexpected death events without any prior news coverage on poor health as sudden. Certain types of death events, such as those related to cancer, are never classified as sudden, even if we do not find any prior news coverage of the illness.

Because of sample-size considerations, we consider all death events, irrespective of the nature of the death, for our baseline analysis. Although it is not uncommon in the literature on director deaths to include nonsudden death events (Fracassi and Tate 2012, Fee et al. 2013, Falato et al. 2014, Pan et al. 2015, Bennedsen et al. 2020), the question of how those events affect our results arises. For example, it could be that nonsudden death events are, to some extent, anticipated by the capital market and, thus, lead to smaller stock price adjustments. We investigate this possibility in Table 5. For this and the following robustness tests, we focus on the $[-2d;+2d]$ event window. In model 1, we add a control variable that indicates whether an event is sudden or not. In model 2, we interact this variable with the dummy for a deceased FD. For both specifications, we find that the baseline effect of the FD dummy is negative, highly significant, and of a similar magnitude compared

Table 5. Robustness Tests: Sudden Deaths (*CAR* [−2*d*; +2*d*])

	1	2	3	4
Variable	Full		Sudden deaths	
Female	−0.024***	−0.021***	−0.040**	−0.035*
	(−3.70)	(−3.00)	(−2.45)	(−1.79)
Sudden death	−0.0027	−0.0022		
	(−0.71)	(−0.56)		
FD × sudden death		−0.016		
		(−0.92)		
Events total	2,651	2,651	539	530
Events women	91	91	19	19
R^2	0.033	0.033	0.0099	0.11
Fixed effects	Y, I, C	Y, I, C	None	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*; +2*d*]. In this table, we investigate how the results differ if we only focus on sudden death events. *t*-statistics based on robust standard errors clustered by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table 6. Robustness Tests: Extended Sample (*CAR* [−2*d*; +2*d*])

	1	2	3
	Director deaths plus		
Variable	Managers	Illness	Both
Female	−0.024***	−0.017***	−0.018***
	(−4.06)	(−3.28)	(−3.53)
Events total	3,188	3,823	4,219
Events women	105	149	159
R^2	0.028	0.020	0.018
Fixed effects	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*; +2*d*]. In this table, we add death events from senior managers, retirements due to illness, or both to the main sample. *t*-statistics based on robust standard errors clustered by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

***$p < 0.01$.

with our baseline models. In models 3 and 4, we only focus on sudden death events. Despite only 19 of those events being related to FDs, we find a negative and statistically significant coefficient estimate for FDs. This is true whether we exclude any fixed effects (model 3) or follow our baseline specification and include year, industry, and country fixed effects (model 4).

3.3.2. Extended Sample. Our main sample includes 2,660 director death events, of which 91 are related to FDs. The lower share of deaths of FDs is likely related to the younger age of FDs. In our data set, the average age of deceased FDs is 64.9 years, whereas male directors are, on average, 68.5 at the time of their death (see Table 9 and the related discussion in Section 4.2). More generally, the low number of events related to FDs also reflects a lower share of female board representation. As we show in Appendix E, FDs account for only 8% of all directors globally between 1998 and 2017. This relatively low number of death events from FDs could bias our results, for instance, because single outliers can have a huge impact on the estimated coefficients in such a sample.

To alleviate such concerns, we also present the results when using an extended sample. In this extended sample, we either add death events of senior managers, departures of directors due to illness, or both. Table 6 presents the results for the [−2*d*; +2*d*] CAR. In model 1, we add death events of senior managers, which increases the number of events to 3,188, of which 105 represent women. In the next models, we add departures due to illness to our base sample, and the number of events increases to 3,823, of which 149 represent women. The sample in model 3 includes both additional subsets, which leads to a substantial increase in the number of events, to 4,219. Among those events, 159 are related to women. Overall, we find very similar results to those in our baseline specification in all three models. The coefficient estimate for FD ranges from −0.024 to −0.017, which is similar to our baseline estimate of −0.024, and is always significant at the 1% level.

3.3.3. Firm Characteristics. We do not include firm-level control variables in the baseline regressions because those variables are not available for all events, leading to a smaller sample size (a reduction from 91 to 73 FDs). However, it could be that firm characteristics have an impact on both the likelihood of having FDs on the board and the stock market reaction to the deaths of directors. To investigate whether differences in observable firm characteristics have an effect on our results, we control for firm size, leverage, profitability, sales growth, and tangibility, all measured at the end of the fiscal year before the death occurred. The results, which are shown in the first two columns of Table 7, remain virtually unchanged if we add these control variables. Of course, we can only control for observable firm characteristics. It could still be that unobservable differences between firms with and without FDs affect our results. To address such concerns, we remove all firms without FDs from the control group of male death events and rerun our regressions. Thus, we only consider death events of male directors if the firm has at least one FD. The results, which are reported in the last two columns of Table 7, again show that the stock market reacts more negatively to the deaths of FDs. Overall, these tests reduce concerns that omitted firm characteristics drive our results.

Table 7. Robustness Tests: Firm Characteristics (*CAR* [−2*d*; +2*d*])

	1	2	3	4
Variable	Firm controls		Firms with FDs as controls	
Female	−0.024***	−0.023***	−0.022***	−0.019***
	(−3.41)	(−3.37)	(−3.34)	(−2.69)
Ln(*total assets*)	−0.00035	−0.00061		
	(−0.57)	(−0.81)		
Leverage	−0.021***	−0.018**		
	(−2.58)	(−2.04)		
Profitability	−0.0096	−0.0031		
	(−0.60)	(−0.19)		
Sales growth	0.00060	0.0011		
	(0.14)	(0.25)		
Tangibility	0.0023	0.0039		
	(0.40)	(0.59)		
Events total	2,309	2,303	1,638	1,629
Events women	73	73	91	90
R^2	0.0084	0.041	0.0045	0.056
Fixed effects	None	Y, I, C	None	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*; +2*d*]. This table shows the results when we add control variables or restrict the sample to firms with at least one FD. *t*-statistics based on robust standard errors clustered by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

$^{**}p < 0.05$; $^{***}p < 0.01$.

3.3.4. Pretrends and Posttrends. Tests of pretrends and posttrends can also help to alleviate concerns that factors unrelated to the deaths of FDs drive the negative stock returns of impacted firms. We use the event windows [−5*d*; −3*d*] and [+3*d*; +5*d*] for tests of pretrends and posttrends and present the results in Table 8. Models 1 and 2 focus on all death events, whereas models 3 and 4 include only sudden death events. We cannot detect any statistically significant difference in the capital market reaction to death events of female and male directors for these alternative windows. In addition, the coefficient estimates are positive in three of the four models and small in economic terms. Overall, these tests show that firms in which FDs pass away do not generally have negative returns, but only around the time of the announcement of the death events.

Table 8. Robustness Tests: Pretrends and Posttrends

	1	2	3	4
	All deaths		Sudden deaths	
Variable	[−5;−3]	[3;5]	[−5;−3]	[3;5]
Female	0.0038	0.0025	0.0048	−0.013
	(0.72)	(0.47)	(0.44)	(−1.19)
Events total	2,651	2,648	530	529
Events women	91	91	19	19
R^2	0.030	0.022	0.081	0.11
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variables are *CAR* [−5*d*; +3*d*] and *CAR* [3*d*; +5*d*]. This table presents tests of pretrends and posttrends. *t*-statistics based on robust standard errors clustered by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

3.3.5. Exclusion of FD Events. We test whether outliers among the limited number of FD events drive our results. For this purpose, we re-estimate our baseline regression model from Model 4 in Panel B of

Table 9. Observable Differences Between Male and Female Directors

	Mean		Univariate difference		Regression with C, I, and Y FEs		Observations	
Variable	Women	Men	W-M	*p*-value	Female	*p*-value	Women	Men
Age	64.867	68.545	−3.678	0.004***	−4.302	0.014**	81	1,929
Ln(*age*)	4.157	4.213	−0.056	0.004***	−0.065	0.013**	81	1,929
Tenure	9.921	11.847	−1.926	0.131	−3.043	0.021**	82	1,802
Ln(*tenure*)	1.954	2.213	−0.258	0.008***	−0.316	0.005***	82	1,802
Education	2.000	2.162	−0.162	0.288	0.037	0.837	67	1,298
Edu_higher	0.567	0.562	0.006	0.929	0.080	0.338	67	1,298
Centrality	0.023	0.030	−0.007	0.504	−0.000	0.986	32	1,133
Centr_dummy	0.188	0.331	−0.143	0.088*	−0.064	0.441	32	1,133
Industry experience	0.188	0.202	−0.014	0.779	−0.023	0.733	64	1,843
Foreign	0.289	0.120	0.170	0.000***	0.029	0.546	76	684
Independent	0.393	0.364	0.030	0.567	−0.040	0.484	89	2,569
Executive	0.213	0.183	0.031	0.465	0.049	0.300	89	2,569
Chairperson	0.088	0.273	−0.185	0.000***	−0.206	0.000***	91	2,568
Committee_any	0.560	0.607	−0.047	0.388	−0.105	0.082*	84	1,615

Notes. The table shows average characteristics for female and male directors in the first two columns. The next two columns show differences in these averages, their corresponding *p*-values, and significance levels based on univariate *t*-tests. The next two columns show the coefficient estimate for the female dummy obtained from fixed effects (FEs) regressions with the characteristics in the row titles being the dependent variables. *p*-values from these regressions are based on standard errors clustered by director. The number of observations in the last two columns corresponds to the univariate analysis. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

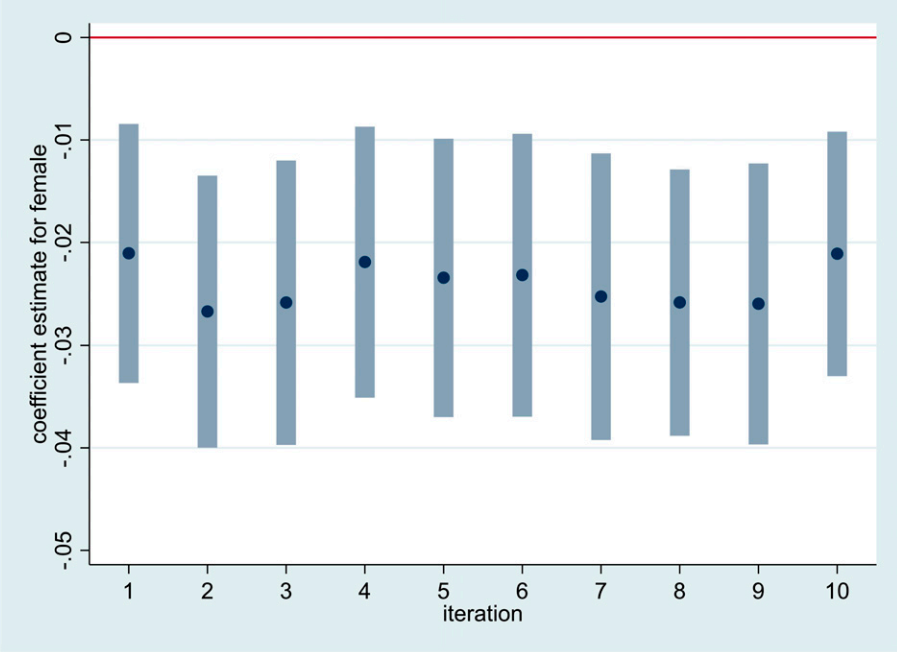
Table 4, which uses the CAR [−2*d*; +2*d*] as the dependent variable, and subsequently exclude all FD events. More specifically, we run 10 regression models, randomly pick nine or 10 events related to FDs per model, and exclude them. The exclusion is done in a way that ensures that every FD is excluded once. If a small number of outliers were driving our results, we would expect to see substantial differences in the estimated female coefficient across the 10 models, depending on whether we (randomly) exclude one of the outlier events in a particular model or not. However, the results in Figure 2 show that the estimated coefficient is very similar across all 10 models. The least negative coefficient estimate that we obtain is approximately −0.020 in the penultimate model, and the most negative coefficient estimate is approximately −0.026 in the last model. This test bolsters confidence that the negative stock market reaction to the deaths of FDs represents a general effect that is not driven by a single outlier event.

3.3.6. Additional Robustness Tests. In Panel A of the table in Appendix F, we change the measurement of the announcement returns and use winsorized versions of the CAR (at the 1%/99% level or the 5%/95% level), raw returns that are not adjusted for any benchmark returns, and excess returns that assume a beta of one for all firms. To examine the robustness with regard to the usage of different types of fixed effects, we use year times country fixed effects, year times industry fixed effects, country times year fixed effects, or year times industry times country fixed effects in Panel B. The main reason why we use these high-dimensional fixed effects is to make sure that our results are not driven by country, industry, or time-related factors. In Panel C, we apply alternative industry classification schemes. These are the Fama/French 5, 30, 38, or 49 industries classifications. In Panel D, we use an alternative clustering of standard errors and either cluster by firm and director, firm, country and director, or country. We find negative and statistically significant coefficient estimates for the FD dummy across all these models.

4. Mechanism

In the previous section, we have documented that stock prices decline more if an FD dies, compared with the case of a male director, and that this result is robust to various potential concerns. However, an important question remains: Why is there a more negative reaction to the deaths of FDs? In competitive assignment models, the matching between directors and boards would be done in a way that maximizes firm value (Gabaix and Landier 2008, Terviö 2008). The matching between directors and firms can be related to any director-specific characteristic, such as experiences or skill sets (Custodio et al. 2013, Adams et al. 2018). After a director passes away, the firm

Figure 2. (Color online) This Figure Investigates the Robustness of Our Results to Outliers in FD Events



Notes. The vertical axis shows the coefficient estimate for the *female* dummy variable and the corresponding 95% confidence interval (gray bar) from 10 regressions, in which we randomly excluded nine or, in iteration 1, 10 FD events from the regression sample. Every FD event is excluded exactly once, and the horizontal axis shows the iteration number. We use *CAR* [−2*d*; +2*d*] as the dependent variable, and the baseline regression model follows model 4 of Panel B in Table 4.

needs to hire a successor that has a similarly good matching to the existing board to minimize the deviation from the optimal board composition.[14] However, finding appropriate female successors might be challenging due to frictions in the labor market, such as search cost, and limited availability of qualified FDs, and, hence, firms might be forced to appoint a successor who is a worse fit for the board than the deceased FD. If the stock market anticipates these replacement difficulties, this mechanism could explain our results.

To test this potential mechanism, we first focus on the succession process to see whether we can find evidence that FDs are more difficult to replace. After that, we test whether observable differences between deceased male directors and FDs exist and whether those differences can explain the more negative stock price reaction to the deaths of FDs. Lastly, we go beyond directors' observable characteristics and analyze how the drop in stock prices depends on the country-level supply of potential FDs, the institutional environment of a country, firm-level characteristics, and characteristics of the board on which the deceased director served.

4.1. The Succession Process

To shed more light on the succession process for deceased directors, we collect information on the successors of deceased directors and are able to identify a direct successor for 885 of the 2,660 death events (see Section 2.1 for details about the successor data).[15] We start with delays in the succession process and focus on the characteristics of the successors in the next step.

4.1.1. Delays in the Succession Process. To measure the difficulty in replacing a deceased director—that is, the search cost for the replacing director—we first investigate the time delay between the death event and the announcement or start date of a successor. In Table 10, we find that firms need more time to announce the successor of a deceased FD. Our estimates in model 1 indicate that the announcement of a successor for an FD takes place about 50 days later relative to a deceased male director. This is considerable, given that the average delay amounts to 59 days (see Table 2). If we use the natural logarithm to account for the skewness in the delay variable (model 2), this result becomes even more statistically significant. One caveat here is that we are only able to find successor announcement dates for 559 deceased directors, of which only 14 are women. When we focus on the start dates of the successors in models 3 and 4, the results are similar, albeit somewhat weaker both in terms of the economic magnitude (31.8 versus 53.1 days) and statistical significance (t-values of 1.70 versus 2.49). Again, the statistical significance increases substantially if we use the natural logarithm of the delay. The advantage of focusing on the start date compared with the announcement date is that data coverage becomes better: Overall, we are able to find start dates for 875 deceased directors, of which 27 are women. These results, which show that replacing FDs takes longer, are consistent with a more difficult replacement process if the deceased board member is a woman.

Table 10. Succession Process: Succession Delay

	1	2	3	4
	Announcement delay		Start delay	
Variable	*Days*	ln(*days* + 1)	*Days*	ln(*days* + 1)
Female	53.1**	1.78***	31.8*	1.06***
	(2.49)	(5.46)	(1.70)	(3.01)
Events total	559	559	875	875
Events women	14	14	27	27
R^2	0.12	0.16	0.083	0.12
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variable is *Succession delay*. t-statistics based on clustered standard errors by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

4.1.2. Successor Gender. Univariate differences indicate that the probability of having a female successor is higher if an FD passes away: On average, 10.5% of all successors are female; for deceased FDs, this number increases to 32.3%, whereas it is only 9.7% for deceased men. Thus, although the majority of FDs are still replaced by men, the probability of a female successor is substantially higher if an FD passes away. Regression analysis in Table 11 confirms these differences. We find that the likelihood of a deceased FD being replaced by a women is between 23 percentage points (when we do not include fixed effects; model 1) and 16 percentage points (when we include year,

Table 11. Succession Process: Successor Gender

	1	2
Variable	*Female successor* [dummy]	
Female	0.23***	0.16**
	(2.75)	(2.08)
Events total	885	877
Events women	31	31
R^2	0.018	0.12
Fixed effects	None	Y, I, C

Notes. The dependent variable is the female successor dummy. t-statistics based on clustered standard errors by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.
**$p < 0.05$; ***$p < 0.01$.

industry, and country fixed effects; model 2) higher compared with the case of a deceased male director. This finding is in line with the view that firms try to replace deceased FDs with women.

4.1.3. Other Successor Characteristics.

We also investigate others characteristics of successors besides gender. In Table 12, we estimate two models for each characteristic: In the first model, we only consider the characteristic of the successors, and in the second model, we control for the characteristic of the deceased director. We find statistically significant differences in terms of successor age and industry experience, with successors of FDs being younger and less experienced. Both results are consistent with the idea that replacing deceased FDs is difficult for firms, and they have to broaden the pool of potential candidates. For the foreign successor variable in Table 13, we find a positive coefficient estimate that would indicate that firms are more likely to hire successors abroad, but this estimate is only statistically significant when we control for the nationality of the deceased director. Lastly, we find that FDs are more likely to have external successors, which is in line with the view that replacing FDs is difficult, and firms are unlikely to find suitable internal candidates.

4.2. Observable Differences Between Female and Male Directors

The results so far indicate that FDs are more difficult to replace than their male peers. Now, we try to identify which characteristics make FDs more difficult to replace. Generally speaking, the characteristics of a director determine how well he or she matches to a board. We first test whether differences along observed characteristics exist between deceased male directors and FDs; and, second, whether these differences can explain the more negative stock market reaction to deaths of FDs. We analyze differences along the following director-level characteristics: age; tenure; education; network centrality as measure for the connectedness of a director; industry experience; foreign nationality; whether the director was independent, an executive director, or the chairperson; and committee memberships. The results, which are presented in Table 9, show that FDs are, on average, younger, their tenure is shorter, and they are less likely to be the chairperson. These differences hold in univariate comparisons and in regression analysis. For all other characteristics, we do not detect strong evidence of differences between male and female board members. There is, however, some indication that the network centrality of FDs is lower and that they are more likely to have a foreign nationality, but these differences are not statistically significant at conventional levels after controlling for country, industry, and year fixed effects.

In Tables 14–17, we go one step further and investigate whether person-level characteristics—in particular, age and tenure—can explain the previously documented capital market reaction. If their younger age, for instance, makes them more difficult to replace, this difference could explain our results. To test this potential explanation, we add the characteristic as a control variable and interact it with the dummy variable for FD, which allows for a differential effect for the death of male directors and FDs. We find that the baseline effect for FDs is very similar to our main specification, irrespective of the person-level characteristic we add as a control variable. The characteristics themselves are all

Table 12. Succession Process: Other Successor Characteristics I/II

	1	2	3	4
Variable	*Age*		*Industry experience*	
Female	−4.56*	−3.92*	−0.16***	−0.13***
	(−1.85)	(−1.83)	(−3.36)	(−2.63)
Age		0.24***		
		(6.50)		
Industry experience				0.24***
				(4.24)
Events total	760	682	633	557
Events women	26	26	27	20
R^2	0.12	0.19	0.13	0.19
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variables are the successor characteristics provided in the column titles. *t*-statistics based on clustered standard errors by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

*$p < 0.10$; ***$p < 0.01$.

Table 13. Succession Process: Other Successor Characteristics II/II

	1	2	3
Variable	*Foreign*		*External*
Female	0.11	0.15*	0.34***
	(1.39)	(1.74)	(2.99)
Foreign		0.21*	
		(1.68)	
Events total	415	230	873
Events women	19	18	31
R^2	0.25	0.34	0.14
Fixed effects	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variables are the successor characteristics provided in the column titles. *t*-statistics based on clustered standard errors by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

*$p < 0.10$; ***$p < 0.01$.

Table 14. Director Characteristics and CARs: Age and Tenure

Variable	1 *Age*	2 Ln(*Age*)	3 *Tenure*	4 Ln(*Tenure*)
Female	−0.019***	−0.019***	−0.021***	−0.020***
	(−3.00)	(−2.96)	(−3.14)	(−2.96)
Characteristic	0.00015	0.0086	0.00017	0.00052
	(0.91)	(0.76)	(1.17)	(0.27)
FD × characteristic	0.00042	0.033	0.00078*	0.012**
	(0.85)	(1.03)	(1.80)	(2.03)
Events total	1,998	1,998	1,872	1,872
Events women	79	79	82	82
R^2	0.043	0.043	0.045	0.044
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*;+2*d*] in all models. Interacted, continuous variables are centered. *t*-statistics based on clustered standard errors by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

statistically insignificant. The same applies to nearly all interaction terms. Only for tenure and executive directorships do we find some evidence that these characteristics play a differential role for men and women: The capital market reacts less negatively when an FD with long tenure passes away and more negatively when the deceased woman was an executive director.

Overall, the evidence indicates that differences in observed director-level characteristics are unlikely to explain the more negative capital market reaction to the deaths of FDs. Thus, unobserved gender differences that are important for the matching between directors and firms are the most likely reasons why FDs are more difficult to replace, suggesting the importance of search costs in the director labor market. Potential examples for such unobserved differences include different risk attitudes, management styles, behavior in competitive environments, or skill sets (Gneezy et al. 2003, Niederle and Vesterlund 2007, Croson and Gneezy 2009, Sapienza et al. 2009, Adams and Funk 2012, Ahern et al. 2014, Flory et al. 2015, Kim and Starks 2016).

Table 15. Director Characteristics and CARs: Education and Network Centrality

	1	2	3	4
	Education		*Centrality*	
Variable	Index	Dummy	Value	Dummy
Female	−0.029***	−0.040***	−0.041***	−0.034**
	(−3.48)	(−3.00)	(−3.23)	(−2.29)
Characteristic	0.00028	−0.0041	−0.033	−0.0027
	(0.16)	(−1.00)	(−0.83)	(−0.51)
FD × characteristic	0.0071	0.019	−0.034	−0.032
	(1.08)	(1.14)	(−0.28)	(−1.14)
Events total	1,354	1,354	1,158	1,158
Events women	66	66	32	32
R^2	0.061	0.062	0.079	0.080
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*;+2*d*] in all models. Interacted, continuous variables are centered. *t*-statistics based on clustered standard errors by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

**$p < 0.05$; ***$p < 0.01$.

4.3. When Does Director Gender Matter for the Capital Market Reaction?

So far, we have investigated how director characteristics affect the stock market reaction to the deaths of FDs and found that observed characteristics have little impact. Now, we focus more generally on other factors that potentially have an influence on the stock market reaction to shed more light on the mechanism behind our results. As potentially relevant factors, we analyze the country-level supply of FDs, mandatory gender quotas, the legal environment of a country, the characteristics of the firm, characteristics of the board on which the deceased director served, and general time patterns. Please note that we do not analyze characteristics of the successors, as they are typically unknown when the death of a director is announced (the mean announcement delay is 70 days, and the median is 27 days). The results are reported in Table 18, in which we show coefficient estimates and *t*-statistics for the *female* variable, its interaction with the specific factor, and the number of total events, events from FDs, and the R^2.

4.3.1. Country-Level Supply of Potential FDs. To approximate the supply of potential FDs in a country, we use four different measures. The first is the share of FDs in a country and year according to the Thomson Reuters database (see Section 2 for more details). The second measure is the share of female successors in a country, measured based on our deaths sample; for its construction, we exclude the firm under consideration. The other measures are the ratio of the female to male labor force participation rate and the female labor force participation rate. In Panel A of Table 18, we find consistent evidence that the loss of an FD leads to a less negative capital market reaction when these variables take higher values: All the coefficient estimates for the interaction terms between the FD dummy and our supply measures are positive and statistically significant. This finding indicates that the capital market discounts firm value less if the pool of potential female successors is larger, which could make it easier for firms to replace a deceased FD with another woman.

Table 16. Director Characteristics and CARs: Industry Experience and Nationality

	1	2
Variable	*Industry experience*	*Foreign*
Female	−0.018***	−0.022**
	(−3.16)	(−2.33)
Characteristic	−0.0040	0.0076
	(−0.87)	(0.80)
FD × characteristic	−0.00040	−0.0063
	(−0.017)	(−0.35)
Events total	1,898	750
Events women	64	74
R^2	0.045	0.098
Fixed effects	Y, I, C	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*;+2*d*] in all models. *t*-statistics based on clustered standard errors by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

** $p < 0.05$; *** $p < 0.01$.

4.3.2. Mandatory Gender Quotas. The negative capital market reaction to the deaths of FDs might also be related to gender quotas that turn female board representation mandatory for firms. If firms have to maintain a certain share of FDs, the death of a woman forces them to appoint another woman to the board. If the availability of qualified FDs is limited, firms may be forced to appoint a woman who is not a good fit for the board, which could explain the negative stock price reaction (for a more thorough discussion on mandatory gender quotas and their impact on firms, see Ahern and Dittmar 2012, Matsa and Miller 2013, Bøhren and Staubo 2014, Bertrand et al. 2019, Rebérioux and Roudaut 2019, Ferreira et al. 2021, Greene et al. 2020, Hwang et al. 2021, Eckbo et al. 2021, and von Meyerinck et al. 2021). Alternatively, it could be that our results are less pronounced in countries with binding quotas because all deceased FDs have to be replaced by women. Thus, the capital market would anticipate, at the time of the death announcement, that the successor will be a woman (even though the match quality between the firm and the successor would still be unknown).

Table 17. Director Characteristics and CARs: Director Position and Committee Membership

	1	2	3	4
Variable	*Independent*	*Executive*	*Chairperson*	*Committee_any*
Female	−0.028***	−0.016**	−0.023***	−0.018**
	(−2.87)	(−2.54)	(−3.34)	(−2.27)
Characteristic	−0.0020	−0.0021	0.00065	−0.00084
	(−0.59)	(−0.52)	(0.17)	(−0.22)
FD × characteristic	0.012	−0.032*	−0.0077	−0.0049
	(1.03)	(−1.69)	(−0.46)	(−0.40)
Events total	2,649	2,649	2,650	1,690
Events women	89	89	91	84
R^2	0.033	0.033	0.033	0.051
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*;+2*d*] in all models. *t*-statistics based on clustered standard errors by director are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

To investigate the impact of mandatory gender quotas on our results, we collect their announcement and introduction dates from appendix A of Terjesen and Sealy (2016).[16] We find that 12 events from FDs occur in jurisdictions that have announced gender quotas and six in jurisdictions that have actually introduced such quotas. Regarding the impact of gender quotas on our results, we fail to detect a difference in the baseline effect between countries with and without an announced quota (Panel B of Table 18). The same results holds true for the actual introduction of gender quotas. Taken together, these results indicate that mandatory gender quotas are unlikely to play a major role in explaining our baseline effect.

4.3.3. Institutional Environment of a Country. Next, we investigate whether our results stem from regions with particular institutional environments. We consider five measures for the institutional environment of a country, described in Appendix D. Specifically, we look at measures for firm transparency, disclosure quality, the protection of minority shareholders, GDP per capita, and the presence of dual board structures. Despite consistent evidence that, relative to men, the deaths of FDs reduce firm value more, neither of these factors seems to have a material impact on the more severe drop in stock prices for FDs (see Panel C of Table 18).[17] We conclude that the documented effect does not depend on any of the above institutional factors, which makes it unlikely that the institutional environment plays a major role for the mechanism behind our findings.

4.3.4. Firm Characteristics. We consider the same firm characteristics that we used as controls in the robustness test in Section 3.3.3. These are firm size, measured as the natural logarithm of total assets in millions of USD; leverage; profitability; sales growth; and the tangibility ratio. When we interact these variables with the dummy for FDs in Panel D of Table 18, we find that the coefficient estimates for the interaction terms of leverage, sales growth, and tangibility are not statistically significant at conventional levels. However, we find evidence that the death of women leads to less negative stock price reactions for firms that are larger and more profitable, although the latter effect is only marginally significant at the 10% level. One interpretation of these results is that larger and

Table 18. Heterogeneous Capital Market Reaction

Variable	*Female*		*Female × factor*		Events total	Women	R^2	Fixed effects
Panel A: Country-level supply of potential FDs								
FD fraction$_{c,y}$	−0.031***	(−4.08)	0.33***	(3.33)	2,605	89	0.033	Y, I, C
Female successors$_{c,y}$	−0.026***	(−3.66)	0.23**	(2.69)	2,642	90	0.032	Y, I, C
Female-to-male LFP$_{c,y}$	−0.030***	(−4.44)	0.0013**	(2.08)	2,636	90	0.034	Y, I, C
Female LFP$_{c,y}$	−0.028***	(−4.75)	0.0020**	(2.17)	2,636	90	0.034	Y, I, C
Panel B: Mandatory gender quotas in a country								
Quota announcement$_{c,y}$	−0.021***	(−4.78)	−0.020	(−1.01)	2,651	91	0.033	Y, I, C
Quota introduction$_{c,y}$	−0.021***	(−5.06)	−0.048	(−1.59)	2,651	91	0.034	Y, I, C
Panel C: Institutional environment of a country								
Transparency$_c$ (Francis et al. 2009)	−0.028***	(−3.19)	0.0018	(1.09)	2,287	70	0.029	Y, I, C
Disclosure rights$_c$ (La Porta et al. 2006)	−0.023***	(−3.72)	0.0093	(0.28)	2,564	88	0.027	Y, I, C
Anti self-dealing$_c$ (Djankov et al. 2008)	−0.024***	(−3.57)	0.011	(0.49)	2,610	89	0.031	Y, I, C
ln(*GDP per capita*$_{c,y}$) (World Bank)	−0.027***	(−3.55)	0.0098	(0.99)	2,636	90	0.033	Y, I, C
Dual board structure$_c$ (Adams and Ferreira 2007)	−0.024***	(−3.67)	−0.0033	(−0.14)	2,620	89	0.031	Y, I, C
Panel D: Firm-level factors								
Ln(*total assets*)	−0.028***	(−3.74)	0.0066***	(2.91)	2,444	75	0.038	Y, I, C
Leverage	−0.023***	(−3.45)	−0.012	(−0.24)	2,442	75	0.037	Y, I, C
Profitability	−0.022***	(−3.47)	0.081*	(1.85)	2,434	75	0.038	Y, I, C
Sales growth	−0.022***	(−3.27)	0.027	(1.23)	2,347	73	0.038	Y, I, C
Tangibility	−0.022***	(−2.98)	0.024	(0.81)	2,406	74	0.037	Y, I, C
Panel E: Board-level factors								
# other FD	−0.028***	(−3.83)	0.0075**	(2.49)	2,034	86	0.046	Y, I, C
Ln(*# other FD* + 1)	−0.027***	(−3.83)	0.018*	(1.88)	2,034	86	0.046	Y, I, C
Board size	−0.028***	(−3.44)	0.0033*	(1.66)	2,060	87	0.046	Y, I, C
Ln(*board size*)	−0.028***	(−3.17)	0.026	(1.09)	2,060	87	0.046	Y, I, C
Panel F: Time patterns								
Event in second half of sample (dummy)	−0.026***	(−2.58)	0.0027	(0.21)	2,651	91	0.033	Y, I, C
Year of the event	−0.027***	(−4.15)	0.0011	(1.02)	2,651	91	0.033	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*;+2*d*] in all models. Interacted, continuous variables are centered. In Panel D, firm-level variables are observed at the end of the fiscal year before the death event. The first half in Panel F refers to the period from 1996 through 2007. The second half refers to the period from 2008 through 2019. *t*-statistics based on robust standard errors clustered by director, or by director and country if country-level variables are interacted, are presented in parentheses. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

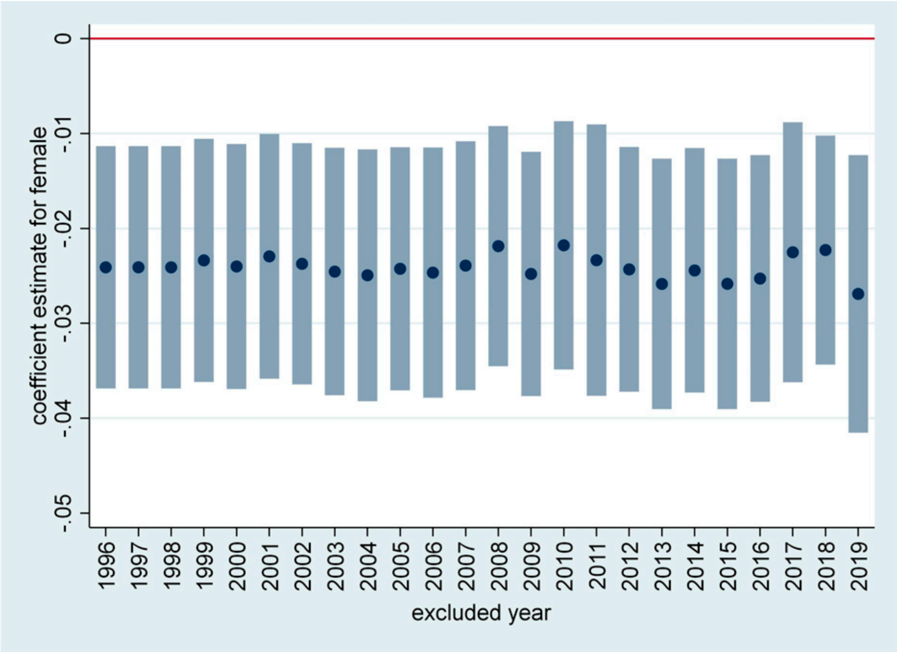
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

more profitable firms are more attractive for directors, making it easier for them to attract successors for deceased FDs that have a good fit to the firms' boards. Although this interpretation is in line with the idea that the negative stock price reaction reflects firms' difficulties in adequately replacing FDs, this is, of course, not the only interpretation, as both firm size and profitability can be correlated with many different factors.

4.3.5. Board Characteristics. We now investigate board-level characteristics and focus on how the number of other FDs on the board and the size of the board affect the capital market reaction. If there are (multiple) other FDs on the board or if the board is large, the death of one FD is likely to have a lower impact on the functioning of the board because other directors can, at least to some degree, fill the role of the deceased director. Thus, assuming that firms cannot perfectly replace the deceased FDs, their ability to compensate for this loss might also play a role in the capital market reaction. The results in Panel E of Table 18 support this prediction. We find that the CAR is less negative when there are other FDs on the board or if the board is larger in general. These results indicate that the capital market reaction also depends on the gender of the other board members and the size of the board.

4.3.6. Time Patterns. Next, we focus on the time patterns of our baseline effect. To understand whether the effect is concentrated during a particular time period, we split the sample, which spans more than two decades, into the first (1996–2007) and the second (2008–2019) half, according to the year of an event. The results, which are shown in Panel F of Table 18, do not indicate that the baseline effect is different in the first and second half. We also find no significant time trend when we interact the dummy for FD with the event year.[18]

Figure 3. (Color online) This Figure Investigates the Robustness of Our Results to the Exclusion of Single Event Years



Notes. The vertical axis shows the coefficient estimate for the *female* dummy variable and the corresponding 95% confidence interval (gray bar). The horizontal axis shows the excluded sample year. We use *CAR* [−2*d*; +2*d*] as the dependent variable, and the baseline regression model follows model 4 of Panel B in Table 4.

5. Conclusion

Despite the political and social relevance of female board representation, the literature has not yet reached consensus on the value implications of FDs in the absence of legally binding gender quotas. In this paper, we shed new light on this topic by investigating how the stock market reacts to the deaths of FDs relative to their male counterparts. For this purpose, we compile a novel worldwide data set of director deaths that covers 2,660 death events, of which 91 represent FDs.

We find strong evidence that the stock market reacts more negatively to the deaths of FDs. Depending on the event window, the announcement return for FDs is between −1.4% and −2.6%. For male directors, the corresponding announcement returns are very close to zero. After documenting that the stock market reacts more negatively to the deaths of FDs, we investigate a potential mechanism for this result. Female and male directors can differ along multiple dimensions, which can render FDs more difficult to replace. If the stock market anticipates these replacement difficulties, this mechanism could explain our results. We find evidence in favor of this mechanism: Although firms try to replace FDs with women, two-thirds of their successors are male, succession delays are longer for FDs, and their successors tend to be younger and less experienced. Unobserved gender differences seem to play an important role in the matching of directors to firms because we find no evidence that observable characteristics, such as age or tenure, explain the more negative stock market reaction. We also find that firms in countries with more potential FDs, larger or more profitable firms, firms with boards that have other FDs besides the deceased woman, and those with larger boards suffer less from the loss of an FD. Taken together, the most likely explanation for our results is that unobserved gender differences make FDs harder to replace.

We do not examine the long-term consequences of the deaths of FDs, as endogeneity concerns are more severe in such specifications. But does a negative stock market reaction to the death of an FD also have implications for the long-term performance of gender-diverse boards? Under some assumptions, such as rational decision making, our results seem to imply that the loss of an FD and the associated replacement difficulties have negative long-term consequences for firms. However, behavioral biases, such as overreaction, could also play a role, which renders the interpretation of our results regarding potential long-term effects somewhat speculative.

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Appendix A. Director Death Events Involving FDs

Name (partly shortened)	Firm	Year
Ann Rector	Owens & Minor, Inc.	1999
Chen Wenzhen	Cosco Pacific Limited	2000
Beate Rotermund	Beate Uhse AG	2001
Henrietta Milstein	Burlington Coat Factory	2001
Jane Evans	Altria Group	2003
Jane Evans	Hypercom	2003
Susan Buffett	Berkshire Hathaway	2004
Melody Teppola	Northwest Natural Gas Company	2004
Hilary Cropper	Barclays	2004
Helen Petrauskas	La-Z-Boy	2006
Jeane Kirkpatrick	IDT Corp.	2006
Loyola de Palacio	Sonae	2006
Roxy Baas	Integra Bank	2007
Sue Desborough	Rathbone Brothers	2007
Alison Richards	Beale	2007
Beatrice Yormark	ID Systems	2008
Geok Eng Loo	Kim Loong Resources	2008
Blanche Maier	Frisch's Restaurants	2009
Vilina Sheth	Fiberweb (India)	2010
Leena Palotie	Orion Corp.	2010
Germaine Gibara	Agrium	2010
Germaine Gibara	Sun Life Financia	2010
Germaine Gibara	Technip	2010
Peik Joo Ong	SLP Resources	2010
E. Gail de Planque	EnergySolutions	2010
Maureen Muggeridge	Paramount Mining Corporation	2010
Thitima Santikongka	Far East DDB	2010
Ntombekaya September	Basil Read Holdings	2011
Tan Sri Datuk Paduka	Leong Hup Holdings	2011
Tan Sri Datuk Paduka	Hirotako Holdings	2011
Tan Sri Datuk Paduka	Fitters Diversified	2011
Tan Sri Datuk Paduka	Help International Corp.	2011
Kwok Kwan Yuk Cheng	G-Vision International Holdings	2011
Ilse Schneider	Alucon	2011
Lien Fung Ho	Thai Wah Food Products	2011
Vera Kallmeyer	Qiagen	2011
Vera Kallmeyer	Elekta AB	2011
Tamilla Polezhaeva	Oriflame Cosmetics	2011
Kai Ding	Skyworth Digital Holdings	2012
Pastora San Juan Cafferty	Waste Management Inc.	2013
Theresa Jordis	Wolford	2013
Peijuan Zhuang	Chongherr Investments	2013
Betty Quadracci	Quad/Graphics	2013
Hendrika C. J. van den Burg	ASML Holding	2014
Virginia Mary Engel	Hosken Consolidated Investments	2015

Appendix A. (Continued)

Name (partly shortened)	Firm	Year
Linda Morgan	Canadian Pacific Railway	2015
Fang Jing	Sunway International Holdings	2015
Kathleen Smythe	First Financial Northwest	2015
Sindiswa Nhlumayo	Cullinan Holdings	2016
Susan Wang	Premier, Inc.	2016
Zubeda Bai	Fecto Cement	2016
Kiran Anuj	Bajaj Hindusthan	2016
Sharon Hunt	Transcontinental Realty Investors	2016
Sharon Hunt	Income Opportunity Realty Investors	2016
Sharon Hunt	American Realty Investors, Inc.	2016
Yam Tunku Yan Nazihah	PNE PCB	2016
Uma Nevatia	Hind Rectifiers	2016
Nevine Lotfy	Abu Dhabi Islamic Bank - Egypt	2016
Lam Kit Woo	Golden Resources Development International	2016
Margaret M. Cannella	The Swiss Helvetia Fund	2016
Mok Ho Yuen Wing	Shun Tak Holdings	2016
Zhong Hong	China Zhongwang Holdings	2017
Melanie Dressel	Columbia Banking System	2017
Alice M. Connell	RPT Realty	2017
Rebecca Hawk Roess	LCNB Corp.	2017
Cynthia A. Rask	Zynerba Pharmaceuticals	2017
Anna Stewart	Babcock International Group	2017
Manjit Wolstenholme	Future plc	2017
Manjit Wolstenholme	Provident Financial	2017
Manjit Wolstenholme	The Unite Group	2017
Baroness Dean of Thornton-le-Fylde	Residential Secure Income	2018
Kathy J. Bobbs	Home Bancorp, Inc.	2018
Alice C. Gohoc	Cityland Development Corporation	2018
Alice C. Gohoc	City & Land Developers	2018
Judith Harder	Cascadero Copper Corporation	2018
Shu-Chau Ho Wang	Tung Ho Steel Enterprise Corporation	2019
Lilian S. Linsangan	SBS Philippines Corporation	2019
Nashima Akhter	Central Pharmaceuticals Ltd.	2019
Ellen Tauscher	Edison International	2019
Kathleen M. Eisbrenner	NextDecade Corporation	2019
Thandi Ndlovu	Truworths International Limited	2019
Mary Ma	Lenovo Group Limited	2019
Mary Ma	Hong Kong Exchanges and Clearing	2019
Mary Ma	Swire Pacific Limited	2019
Mary Ma	The Unilever Group	2019
Mary Ma	Unilever N.V.	2019
Qi Xiaohong	Beijing Enterprises Water Group	2019
Hung Siu Woon Pauline	Wealthy Way Group	2019
Hung Siu Woon Pauline	WT Group Holdings	2019
Varindr Leelanuwatana	Thanulux Public Company	2019
Mary Carney	Creightons Plc	2019

Appendix B. Overview of Event Countries

Country	Events	Events male	Events female
Argentina	2	2	0
Australia	57	55	2
Austria	5	4	1
Belgium	2	2	0
Brazil	11	11	0
Canada	162	158	4
Chile	12	12	0
China	37	37	0
Cyprus	8	8	0
Denmark	9	9	0

Appendix B. (Continued)

Country	Events	Events male	Events female
Egypt	2	1	1
Finland	8	7	1
France	29	28	1
Germany	26	25	1
Greece	2	2	0
Hong Kong	168	155	13
Hungary	2	2	0
Iceland	1	1	0
India	395	392	3
Ireland	8	8	0
Israel	10	10	0
Italy	18	18	0
Japan	36	36	0
Korea	6	6	0
Luxembourg	3	2	1
Malaysia	115	108	7
Mexico	7	7	0
Morocco	1	1	0
Netherlands	15	11	4
New Zealand	5	5	0
Nigeria	1	1	0
Norway	5	5	0
Pakistan	16	14	2
Peru	2	2	0
Philippines	73	70	3
Poland	1	1	0
Portugal	4	3	1
Qatar	1	1	0
Russian Federation	6	6	0
Saudi Arabia	2	2	0
Senegal	1	1	0
Singapore	68	68	0
South Africa	40	36	4
Spain	7	7	0
Sri Lanka	3	3	0
Sweden	19	18	1
Switzerland	13	13	0
Taiwan	15	14	1
Thailand	92	88	4
Turkey	5	5	0
United Kingdom	207	198	9
United States	913	886	27
Vietnam	2	2	0
Virgin Islands	1	1	0
Zambia	1	1	0

Note. This table provides the distribution of director death events across countries.

Appendix C. Overview of Event Years

Year	Events	Events male	Events female
1996	1	1	0
1997	5	5	0
1998	10	10	0
1999	26	25	1
2000	37	36	1
2001	39	37	2
2002	50	50	0
2003	58	56	2
2004	71	68	3
2005	160	160	0

Appendix C. (Continued)

Year	Events	Events male	Events female
2006	168	165	3
2007	186	183	3
2008	227	225	2
2009	207	206	1
2010	217	208	9
2011	194	183	11
2012	60	59	1
2013	55	51	4
2014	53	52	1
2015	75	71	4
2016	218	205	13
2017	162	153	9
2018	183	178	5
2019	198	182	16

Note. This table provides the distribution of director death events across years.

Appendix D. Definition of Variables

Variable	Description
Variables related to deceased directors	
Female	Dummy variable that equals one for female directors and zero for male directors (sources: hc, BX, TR)
Age	Age of a director when he or she passed away (sources: hc, BX, TR)
Tenure	Tenure is the number of years a director had served on the board of a given firm when he or she passed away (sources: hc, BX, TR)
Education	Board-member-specific index that equals one for a bachelor's degree, two for a master's degree, three for an MBA, and four for a PhD (sources: hc, BX, TR)
Edu_higher	Dummy variable that equals one if a board member has at least a master's degree, MBA, or PhD (sources: hc, BX, TR)
Centrality	Centrality captures network betweenness, defined as the proportion of shortest paths between two board members in the network that pass through a certain board member. A high betweenness centrality indicates that a large flux of information may pass through a board member and that he or she may act as a broker connecting board members. When we show summary statistics, the variable is multiplied by 1,000 (source: authors' own calculations based on data by TR).
Centr_dummy	Dummy variable that equals one if Centrality is greater than zero (source: authors' own calculations based on data by TR)
Industry experience	Dummy variable that equals one if the deceased director has garnered board industry experience in the same Fama/French 12-industry prior to the current appointment (sources: hc, BX, TR)
Foreign	Dummy variable that equals one if the deceased director is of foreign nationality (sources: hc, BX)
Independent	Dummy variable that equals one if a director was an independent director and zero otherwise (sources: hc, BX, TR)
Executive	Dummy variable that equals one if a director was an executive director and zero otherwise (sources: hc, BX, TR)
Chairperson	Dummy variable that equals one if a director was the chairperson and zero otherwise (sources: hc, BX, TR)
Committee_any	Dummy variable that equals one if a director was sitting on at least one board committee when he or she passed away and zero otherwise (sources: hc, BX, TR)
Variables related to successors	
Announcement delay	Days between the announcement of the retirement and the successor announcement (source: hc)
Start delay	Days between the announcement of the retirement and the start date of the successor (source: hc).
Female successor	Dummy variable that equals one if the successor is female and zero otherwise (source: hc)
Successor age	Age of the successor in years (sources: hc, BX, TR)
Successor industry exp.	Dummy variable that equals one if the successor has garnered board industry experience in the same Fama/French 12-industry prior to the current appointment (sources: hc, BX, TR)

Appendix D. (Continued)

Variable	Description
External successor	Dummy variable that equals one if the successor is appointed externally (source: hc)
Foreign successor	Dummy variable that equals one if the successor is of foreign nationality (sources: hc, BX)
Firm-level returns	
CAR	Cumulative abnormal returns around the announcement of a director death. Abnormal returns are estimated based on a 250-day market model using the FTSE All World index as the benchmark index (source: DS).
Raw return	Raw returns are cumulative returns around the announcement of a director death without any adjustments (source: DS).
Excess return	Excess returns are cumulative returns around the event date minus the return on the FTSE All World index (source: DS)
Firm-level characteristics	
# other FD	Number of additional female directors when the director passed away (sources: hc, BX, TR)
Board size	Number of directors on the firm's board when the director passed away (sources: hc, BX, TR)
Ln(*total assets*)	Natural logarithm of total assets (WC02999) in millions of $US (sources: WS, CIQ)
Leverage	Book leverage defined as total debt (WC03255) deflated by total assets (sources: WS, CIQ)
Profitability	Earnings before interest and taxes (WC18191) to total assets (sources: WS, CIQ)
Sales growth	One-year logarithmic sales (WC01001) growth (sources: WS, CIQ)
Tangibility	Net property, plant, and equipment (WC02501) deflated by total assets (sources: WS, CIQ)
Country-level variables	
FD fraction$_{c,y}$	Share of female directors in a country and year according to our director panel data set. Because our director panel data ends in 2018, we use the share of female directors as of the end of 2017 for death events in 2018 and 2019 (source: TR).
Female successors$_{c,y}$	Share of female successors among all successors according to our successor data in a country and year. The firm under consideration is not considered for the calculation of this variable. (sources: hc, BX, TR)
Female-to-male LFP$_{c,y}$	Ratio of female to male labor force participation, calculated by dividing the female labor force participation rate by the male labor force participation rate (source: World Bank)
Female LFP$_{c,y}$	Female labor force participation rate (source: World Bank)
Quota announcement$_{c,y}$	Dummy variable that equals one if a country has announced a gender quota in a given year and zero otherwise (source: Terjesen and Sealy 2016)
Quota introduction$_{c,y}$	Dummy variable that equals one if a country has enacted a gender quota in a given year and zero otherwise (source: Terjesen and Sealy 2016)
Transparency$_c$	Country-level transparency measure, obtained from Francis et al. (2009)
Disclosure rights$_c$	Aggregated index of disclosure quality, taken from La Porta et al. (2006)
Anti self-dealing$_c$	Average of ex ante and ex post private control of self-dealing, taken from Djankov et al. (2008)
GDP per capita$_{c,y}$	GPD per capita in constant 2010 $US (source: World Bank)
Dual board structure$_c$	Dummy variable that equals one if a country has a dual board structure, taken from Adams and Ferreira (2007)

Note. DS refers to Datastream, WS to Worldscope, TR to Thomson Reuters, BX to BoardEx, CIQ to Capital IQ, and hc to hand-collected.

Appendix E. Average Share of Female Board Members

Country	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2017	Total	*N*
Argentina	0.04	0.06	0.06	0.06	0.06	0.07	0.07	0.03	0.07	0.04	0.04	0.05	1,167
Australia	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.07	0.08	0.10	0.11	0.06	21,081
Austria	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.09	0.11	0.12	0.12	0.07	1,286
Belgium	0.08	0.07	0.08	0.09	0.08	0.08	0.08	0.13	0.16	0.17	0.18	0.11	1,857
Brazil	0.06	0.09	0.09	0.08	0.07	0.06	0.06	0.09	0.08	0.08	0.08	0.08	2,400
Canada	0.04	0.03	0.04	0.03	0.04	0.04	0.04	0.05	0.06	0.07	0.08	0.05	20,786
Chile	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.05	0.06	0.06	0.04	2,714
China	0.12	0.10	0.10	0.10	0.10	0.11	0.11	0.13	0.14	0.14	0.13	0.12	32,600
Czech Republic	0.14	0.11	0.10	0.11	0.09	0.13	0.20	0.12	0.09	0.13	0.17	0.11	301
Denmark	0.08	0.08	0.09	0.08	0.08	0.07	0.09	0.15	0.18	0.19	0.19	0.11	2,069

Appendix E. (Continued)

Country	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2017	Total	*N*
Egypt	0.03	0.04	0.02	0.03	0.05	0.05	0.05	0.07	0.07	0.06	0.08	0.05	1,371
Estonia			0.33	0.14	0.16	0.16	0.12	0.08	0.14	0.10	0.14	0.13	140
Finland	0.09	0.08	0.08	0.10	0.11	0.11	0.16	0.22	0.27	0.28	0.30	0.16	2,058
France	0.14	0.14	0.14	0.14	0.12	0.12	0.13	0.19	0.22	0.24	0.25	0.16	10,536
Germany	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.09	0.11	0.13	0.13	0.08	11,055
Greece	0.11	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.12	4,486
Hong Kong	0.09	0.11	0.11	0.11	0.11	0.10	0.11	0.10	0.10	0.12	0.12	0.11	15,132
Hungary	0.15	0.21	0.20	0.16	0.18	0.17	0.18	0.17	0.18	0.30	0.31	0.19	496
Iceland			0.08	0.06	0.03	0.10	0.22	0.19	0.24	0.31	0.23	0.13	86
India	0.06	0.06	0.06	0.06	0.07	0.06	0.06	0.05	0.07	0.09	0.09	0.06	24,350
Indonesia	0.11	0.11	0.13	0.10	0.10	0.12	0.11	0.12	0.12	0.14	0.13	0.12	5,166
Ireland	0.03	0.03	0.04	0.04	0.03	0.04	0.05	0.08	0.11	0.13	0.15	0.06	934
Israel	0.06	0.11	0.12	0.15	0.15	0.16	0.16	0.27	0.26	0.25	0.27	0.21	3,689
Italy	0.07	0.07	0.07	0.07	0.06	0.07	0.08	0.14	0.21	0.31	0.33	0.12	3,828
Japan	0.04	0.04	0.03	0.03	0.02	0.01	0.02	0.02	0.03	0.04	0.04	0.03	56,944
Luxembourg	0.01	0.01	0.02	0.06	0.06	0.08	0.08	0.07	0.11	0.09	0.09	0.06	426
Malaysia	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.10	0.11	0.13	0.08	14,207
Mexico	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	1,867
Morocco	0.00	0.02	0.03	0.03	0.04	0.03	0.02	0.02	0.04	0.04	0.04	0.03	321
Netherlands	0.09	0.08	0.11	0.09	0.06	0.08	0.09	0.12	0.16	0.18	0.18	0.11	1,875
New Zealand	0.04	0.04	0.05	0.05	0.06	0.07	0.08	0.12	0.19	0.22	0.24	0.10	1,769
Norway	0.12	0.15	0.17	0.20	0.27	0.37	0.38	0.35	0.35	0.30	0.35	0.28	2,331
Pakistan	0.04	0.03	0.03	0.03	0.04	0.05	0.04	0.06	0.06	0.06	0.06	0.05	2,117
Philippines	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.10	0.10	0.10	0.08	0.11	2,867
Poland	0.08	0.09	0.09	0.12	0.15	0.15	0.14	0.15	0.15	0.15	0.15	0.14	4,455
Portugal	0.12	0.12	0.08	0.08	0.06	0.06	0.06	0.09	0.07	0.10	0.10	0.09	921
Qatar				0.00	0.02	0.01	0.00	0.02	0.03	0.02	0.03	0.02	329
Russia	0.07	0.07	0.06	0.08	0.13	0.12	0.13	0.09	0.12	0.14	0.15	0.11	4,122
Saudi Arabia			0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	1,408
Singapore	0.08	0.08	0.09	0.08	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.08	8,904
Slovakia	0.08	0.08	0.10	0.13	0.14	0.17	0.14	0.10	0.08	0.05	0.05	0.11	181
Slovenia		0.46	0.23	0.20	0.22	0.19	0.20	0.28	0.33	0.33	0.33	0.26	340
South Africa	0.07	0.07	0.08	0.08	0.10	0.12	0.15	0.20	0.21	0.24	0.25	0.13	4,520
Spain	0.05	0.06	0.06	0.06	0.06	0.08	0.10	0.11	0.14	0.19	0.20	0.10	2,070
Sweden	0.07	0.07	0.08	0.12	0.14	0.15	0.17	0.29	0.33	0.38	0.37	0.19	5,203
Switzerland	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.08	0.11	0.12	0.13	0.06	3,503
Taiwan	0.10	0.06	0.07	0.06	0.05	0.06	0.06	0.09	0.09	0.08	0.09	0.08	3,537
Thailand	0.14	0.15	0.16	0.15	0.16	0.16	0.16	0.15	0.16	0.17	0.17	0.16	7,288
Turkey	0.10	0.09	0.08	0.09	0.09	0.09	0.09	0.11	0.12	0.13	0.13	0.10	3,606
United Arab Emirates			0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01	820
United Kingdom	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.10	0.13	0.15	0.16	0.08	21,973
United States	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.10	0.12	0.13	0.14	0.08	66,061
Venezuela	0.07	0.06	0.04	0.06	0.07	0.09	0.11	0.13	0.13	0.13	0.14	0.08	280
Total	0.07	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.13	0.13	0.08	393,833

Notes. This table shows the share of female directors across 53 countries between 1998 and 2017. The figures in this table come from our director panel data set, which uses the Officers & Directors database by Thomson Reuters as its data source.

Appendix F. Additional Robustness Tests

Panel A: Return measurement (baseline: *CAR* [−2*d*; +2*d*])				
	1	2	3	4
	CAR		Raw	Excess
Variable	1%/99%	5%/95%	None	None
Female	−0.024***	−0.018***	−0.023***	−0.020***
	(−3.68)	(−3.65)	(−3.20)	(−2.75)
Events total	2,651	2,651	2,651	2,651
Events women	91	91	91	91
R^2	0.035	0.036	0.038	0.029
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Appendix F. (Continued)

Panel B: Alternative fixed effects (baseline: Y, I, C)

Variable	1	2	3	4
Female	−0.020**	−0.025***	−0.024***	−0.028**
	(−2.50)	(−3.50)	(−3.15)	(−2.42)
Events total	2,493	2,631	2,555	1,970
Events women	81	90	84	62
R^2	0.087	0.10	0.070	0.23
Fixed effects	Y × C, I	Y × I, C	C × I, Y	Y × I × C

Panel C: Alternative industry definition (baseline: FF12)

Variable	1 FF5	2 FF30	3 FF38	4 FF49
Female	−0.023***	−0.024***	−0.025***	−0.023***
	(−3.57)	(−3.67)	(−3.74)	(−3.43)
Events total	2,651	2,651	2,650	2,650
Events women	91	91	91	91
R^2	0.031	0.037	0.040	0.046
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Panel D: Alternative clustering of SEs (baseline: Person)

Variable	1	2	3	4
Cluster 1	Firm	Firm	Country	Country
Cluster 2	Director	N/a	Director	N/a
Female	−0.024***	−0.024***	−0.024***	−0.024***
	(−3.70)	(−3.87)	(−3.95)	(−3.94)
Events total	2,651	2,651	2,651	2,651
Events women	91	91	91	91
R^2	0.033	0.033	0.033	0.033
Fixed effects	Y, I, C	Y, I, C	Y, I, C	Y, I, C

Notes. The dependent variable is *CAR* [−2*d*;+2*d*] unless stated otherwise. In this table, the clustering of the standard errors is indicated in each column. N/a indicates that we only cluster along one dimension. Y, I, and C denote year, industry, and country fixed effects, respectively. A description of all variables can be found in Appendix D.

**$p < 0.05$; ***$p < 0.01$.

Endnotes

[1] The events are based on five different data sources, which are firms' annual reports, which we screen for keywords that indicate death events; director biographies from the Officers & Directors database by Thomson Reuters; announcements about director changes from Capital IQ; news about death events from the Ravenpack database; and director changes in the BoardEx database.

[2] In competitive assignment models, firms will choose the optimal board composition that maximizes firm value (Gabaix and Landier 2008, Terviö 2008). After a director passes away, the firm needs to deviate from this optimal composition and hire a successor for the deceased director. Ideally, this successor would represent an equally good match to the existing board in order to minimize the deviation from the optimal board composition.

[3] Consistent with the idea that entry barriers lead to selection effects, Chuprinin and Sosyura (2018) document that fund managers from poorer families perform better.

[4] Ferreira and Sah (2012), for instance, argue that the assignment of talents to different hierarchical levels cannot be explained by one-dimensional concepts, such as talent.

[5] This share is measured based on a large-scale director panel data set covering 38,023 firms from 53 countries. In this data set, women hold 8% of all board seats, but there are major differences across countries. For instance, the share of FDs is 3% in Japan, 8% in the United States, and 19% in Sweden.

[6] There are also other strands of the literature on FDs that are somewhat related to our research. First, there is a huge body of literature on the determinants and consequences of female labor market outcomes (e.g., Black and Juhn 1990, Albrecht et al. 2003, Wolfers 2006, Alesina et al. 2013, Adams and Kirchmaier 2015, Flory et al. 2015, Adda et al. 2017, Bertrand 2018, Guiso and Rustichini 2018, Keloharju et al. 2022, and Kleven et al. 2019). Second, another strand of the literature focuses on the gender pay gap (e.g., Blau and Kahn 2000, Bertrand et al. 2010, Goldin 2014, Carter et al. 2017, and Egan et al. 2022). Third, several recent papers investigate the role of beliefs about gender in a professional setting (e.g., Brown and Yang 2015, Bordalo et al. 2019, and Card et al. 2020).

[7] A related strand of the literature focuses on exogenous retirements of executives. Examples include Johnson et al. (1985), Jenter et al. (2018), Bennedsen et al. (2020), and Betzer et al. (2020).

[8] There are four reasons why we are unable to identify successors for all deceased directors. First, no explicit successor announcement is made in many cases. Second, it is sometimes difficult to ascertain the correct successor due to multiple contemporaneous director appointments (e.g., when two directors are simultaneously appointed

at annual meetings). Third, the director panel data set, one of our main data sources, ends in 2017, which makes it more difficult to identify successors afterward. Fourth, in rare cases, a director might not be replaced within a year.

[9] For comparison, Johnson et al. (1985) perform their analyses based on 53 deaths, Nguyen and Nielsen (2010) rely on 772 deaths, and Jenter et al. (2018) look at 458 deaths.

[10] To ensure the integrity of the data, some adjustments are made. Board data by Thomson Reuters can be biased by mergers and acquisitions (M&A). Thus, we carefully screen the raw data and eliminate data errors related to M&A transactions. In some cases, Thomson Reuters replaces a target firm's board data with board data of the acquiring firm. Therefore, people may be affiliated with an acquired firm, although they held no board seat in the firm prior to the acquisition. Such cases can easily be identified because both the target and the acquiring firm exhibit the identical affiliations. After the identification of these duplicate affiliations, we determine target firms (i.e., those with wrong affiliation data) by using the company status footnote (WC00000) from Worldscope, merger data from SDC Platinum, and board member biography information and then remove these firms from the sample.

[11] Because of data-availability constraints, the time period covered by this database does not perfectly match our death events, which occur between 1996 and 2019.

[12] First, we extract gender-indicating titles from board members' biographies, such as "Mr.," "Mrs.," or "Ms." We also search for equivalent country-specific titles in biographies—for example, Hindu honorific titles such as "Sri." ("Mr.") or "Smt." ("Mrs."). Second, we search biographies for pronouns such as "he," "she," "him," or "her." Third, we match forenames with gender-specific lists of forenames, paying careful attention to forenames that are not necessarily gender-specific (e.g., Kim) or whose gender differs across countries. Andrea, for instance, is typically a female forename in Germany and a male forename in Italy. Fourth, we aggregate the results from the previous three steps, manually check differing classifications, and manually search the gender of directors whom we could not classify in any of the previous steps.

[13] In Norway, about 28% of all board members are women throughout the entire sample period. This number increases from 12% in 1998 to 38% in 2010 (due to the 40% gender quota as of 2008) and then slightly drops to around 35% in 2017. The share of FDs falls short of the 40% quota in our data set because some boards in our sample are relatively small (e.g., if the board has three directors, one FD is sufficient; cf. Ahern and Dittmar 2012). Consistent with our data, Adams and Kirchmaier (2015, table A.V) (using BoardEx data) report 37.9% FDs in 2010.

[14] In competitive assignment models, a replacement cannot improve the quality of the board. If there existed a director that had a better fit with the board, the firm would have hired that director in the first place. See Jenter et al. (2018) for a similar discussion in the context of CEOs.

[15] We re-estimate model 4 of Panel B of Table 4 for the subsample of death events for which we could identify a successor. The coefficient estimate for FDs changes from −0.024 (*t*-value: 3.70) in the full sample to −0.041 (*t*-value: 2.95). The number of observations drops from 2,651 (91 FDs) to 877 (31 FDs). Thus, our main result also holds in this subsample, with an even larger coefficient estimate for FDs.

[16] To arrive at a conservative estimate for the effect of gender quotas, we set the quota dummy to one for all events from a country, even though they might only apply to a subset of firms (e.g., firms in certain regions or state-owned enterprises). The reason for doing so is that there can be spillover effects related to the availability of FDs.

[17] In unreported tests, we do not detect a significant impact of accounting standards (Center for Financial Analysis and Research), creditor protection (La Porta et al. 1998), the disclosure of insider ownership (La Porta et al. 2006), antidirector rights (La Porta et al. 1998), trust within a population (World Values Survey), or the development of democratic institutions (Jaggers and Marshall 2000).

[18] In another test, we also exclude single sample years and rerun our baseline regression. The results, which are shown in Figure 3, provide no evidence for the existence of substantial time patterns.

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