The Role of Mandatory Director Retirement Policies in Corporate Governance

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Abstract: We construct a novel dataset on mandatory retirement policies for independent directors at U.S. public firms from 1994 to 2020 using machine learning and manual verification. Adoption of these policies has increased over time, particularly among S&P 1500 firms, and they are generally enforced in practice. Firms with greater monitoring needs are more likely to adopt such policies, while those with greater advising needs are less likely. After addressing endogeneity concerns, we find a positive relationship between policy adoption and firm value, suggesting that mandatory retirement can be an effective governance mechanism by promoting board turnover and strengthening monitoring.

JEL classifications: D22; C81; G30; G34

Keywords: Corporate governance, Board of directors, Board monitoring role, Mandatory retirement policy, Sarbanes-Oxley, Endogeneity, Machine learning

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1 Introduction

Mandatory retirement policies for independent directors—rules requiring directors to step down upon reaching a specified age—are a longstanding but understudied governance mechanism. While such age-based policies are common in other professional settings (e.g., law, military, judiciary), their role in corporate boards remains ambiguous. Proponents argue that mandatory retirement facilitates board refreshment and strengthens monitoring by removing entrenched directors. In contrast, critics contend that forcing directors to retire at a fixed age may lead to the premature loss of valuable firm-specific knowledge, particularly when directors play key advisory roles. Despite these competing views, empirical evidence regarding the prevalence, determinants, and consequences of board retirement policies in U.S. firms remains limited.

This paper aims to fill this gap by addressing two key research questions: (1) *What firm characteristics are associated with the adoption of a mandatory retirement policy?* and (2) *How is the mandatory retirement policy related to firm value?* By answering these questions, the paper contributes to a broader understanding of how firms tailor board structures to their governance needs, and how age-based independent director turnover mechanisms influence board effectiveness and firm performance.

The primary obstacle in studying mandatory retirement policies is the lack of coverage by commercial databases. To date, no commercial dataset provides historical information on which firms impose mandatory retirement ages for independent directors. To overcome this challenge, we construct a new, comprehensive dataset capturing mandatory retirement policy status and age thresholds for U.S. publicly traded firms from 1994 to 2020. We generate this dataset using a popular machine learning technique, the Random Forests (RF) Classifier, combined with textual analysis and manual inspection. Specifically, we apply a Random Forest classifier to firms' SEC filings to predict whether each company has a mandatory retirement policy in a given year. The RF Classifier is a well-established technique commonly applied across various scientific fields, though it is still relatively new in financial academic research (Varian, 2014).[1] The RF Classifier develops several decision trees, where each tree bootstraps the observations in the training set and randomly chooses a subset of predictors at each decision point to maximize the growth of the tree. Each tree produces a classification, and the forest then selects the classification with the highest accuracy.

To build our machine learning model, we start by randomly selecting 300 firms from Compustat and collecting four years of their SEC filings from the EDGAR database.[2] From these documents, we extract over 70,000 sentences mentioning terms like “age,” “retirement,” or “birthday.” We manually review each sentence to determine whether it indicates a mandatory retirement policy. We then use 80% of these labeled sentences to train the model and use the remaining 20% as a testing sample. Our model achieves an initial out-of-sample prediction accuracy rate exceeding 99.8% in predicting the mandatory retirement policy. In the final step, we apply our trained model with manual inspections to all U.S. public company filings from 1994 to 2020, resulting in a dataset of 117,761 firm-year observations.

Using our unique dataset, we begin the analysis by documenting an increasing trend of the mandatory retirement policy, particularly among S&P 1500 firms. At the beginning of the sample period (the mid-1990s), 11.9% of S&P 1500 firms had implemented a mandatory retirement policy, and this ratio has increased to 58.2% in 2020. Additionally, we document that the mandatory retirement policy is common across industries, although there are variations, with

[1] In the accounting and finance field, the papers use RF include Guernsey, Guo, Liu, and Serfling (2024) and Frankel, Jennings, and Lee (2022).
[2] We obtain company filings from Form DEF 14A, 10K, 10Q, 8K, 6K, 20F, and S1.

Chemical and Manufacturing industries having the highest percentages, and Healthcare and Business Equipment having the lowest percentages of firms adopting the policy.

The increased adoption of mandatory retirement policies does not necessarily imply effective enforcement. To evaluate the efficacy of such policies, we conduct a series of empirical tests. First, we compare trends in independent director tenure between firms that have implemented director age limits and those that have not. We find that, in firms with mandatory retirement policies, the age and tenure of independent directors increase at a slower rate as the firm ages, relative to firms without such policies. To refine our analysis, we compare the turnover age of independent directors in firms with mandatory retirement policies to those in a matched sample based on industry and firm size. The turnover age distribution in policy-adopting firms exhibits significant clustering around traditional retirement ages—most notably between ages 69 and 75—with a pronounced peak at age 72, a commonly adopted threshold. In contrast, the age distribution for matched firms without such policies is flatter and smoother, with no clear clustering. We further exploit within-firm variation by examining independent director turnover age distributions before and after policy adoption for the same firm. Consistent with our earlier findings, we observe that turnover becomes increasingly concentrated around the specified retirement age following implementation. Collectively, these patterns suggest that while the presence of a mandatory retirement policy does not guarantee compliance, firms that adopt such policies generally enforce them, effectively standardizing director turnover at the mandated threshold.[3]

Having established that mandatory retirement policies are both increasingly common and effectively enforced, we next investigate why firms choose to adopt these policies. We

[3] This observation is also supported by anecdotal evidence: for instance, long-serving directors Al Gore, with a twenty-one-year tenure, and James Bell, with nine years of service, departed from Apple Inc. in 2024 upon reaching the age of 75. https://www.cnbc.com/2024/01/11/apple-longtime-directors-al-gore-and-james-bell-retiring-from-board.html

hypothesize that the benefits of monitoring play a crucial role in a firm's decision to implement such policies. Monitoring is a key responsibility of the board of directors (Adams and Ferreira, 2007; Raheja, 2005), and mandatory retirement policies may enhance the effectiveness of this monitoring function. Prior research suggests that older adults may experience diminished perceptual abilities, potentially impacting their capacity to effectively monitor and respond to relevant information (Lindenberger and Baltes, 1994; Li and Lindenberger, 1999). Additionally, Ferris, Jagannathan, and Pritchard (2003) contend that older directors may have lower energy levels, pose a last-period risk, and view board positions as attractive part-time roles in retirement, which could reduce their monitoring incentives. Therefore, we anticipate that firms which find monitoring to be beneficial (and thus costly) will be more likely to adopt mandatory retirement policies, while those for whom monitoring is less critical will be less inclined to do so.

Another key role of the board of directors is to advise managers (Mace, 1986), and older directors may be particularly well-suited for this role. With decades of industry experience, they offer valuable insights and strategic guidance that can be instrumental for management. Additionally, their extensive professional networks can provide crucial support and resources, further enhancing their ability to advise and assist the management team effectively (Masulis, Wang, Xie, and Zhang, 2023). Therefore, we expect that firms that derive greater benefits from director advising will be less likely to implement mandatory retirement policies.

We follow the literature to construct proxies for monitoring benefits and advising needs. Using principal component analysis, we extracted the monitoring benefits and advising needs factors based on the firm monitoring and advising-related characteristics (Boone, Casares Field, Karpoff, and Raheja, 2007; Coles, Daniel, and Naveen, 2008; Linck, Netter, and Yang, 2008).

Consistent with our expectation, our results show that monitoring benefits (advising needs) are positively (negatively) associated with imposing the mandatory retirement policy.

We also examine the influence of two major events: the inclusion of firms in the S&P 1500 index and the passage of the Sarbanes Oxley Act in 2002, both of which have important implications for corporate governance. Inclusion in the S&P 1500 index leads to more institutional ownership and attracts the media's attention, which intensifies scrutiny of the firm's governance practices. Additionally, the U.S. Congress passed the SOX to improve corporate governance and protect investors from fraud. Our findings indicate that both events incrementally increase the likelihood that firms adopt mandatory retirement policies when monitoring benefits are high.

Having considered these external governance shocks, we next explore how internal firm characteristics shape the adoption of mandatory retirement policies. Specifically, we examine variation across the firm life cycle using the classification scheme of Dickinson (2011) and find that firms in the mature and shake-out stages are significantly more likely to adopt mandatory retirement policies than those in the introduction stage. These results are consistent with the view that mature firms benefit more from structured governance mechanisms aimed at board refreshment.

We next investigate whether and how mandatory retirement policies affect firm value. First, we analyze the relationship between mandatory retirement policies and firm value in a cross-sectional framework. Using Ordinary Least Squares (OLS) with industry and year fixed effects, we find that, on average, mandatory retirement policies are negatively associated with firm value, as measured by Tobin's Q. However, when we examine this relation in a time-series context, incorporating firm and year fixed effects, we observe a positive association between mandatory retirement policies and firm value. These time-series results suggest that the decision to adopt a mandatory retirement policy may be associated with an ex-ante lower firm value. For example, our determinants model shows firms with strong advising needs and those in the growth stage, presumably with higher firm value, are less likely to adopt mandatory retirement policies, while firms with strong monitoring needs and those in the mature or shake out stage, presumably with lower firm value, are more inclined to implement such policies. Indeed, we find that firms with lower value are substantially more likely to adopt mandatory retirement policies, and this reverse causality helps reconcile the negative cross-sectional association with the positive time series association.

We next implement a difference-in-differences (DID) analysis with two matched-sample that compare changes in firm value, over a five-year window before and after the adoption of a mandatory retirement policy. Treated firms are matched to control firms that did not implement such policies using the nearest size or nearest-neighbor propensity scores based on our predication model, industry classification, and fiscal year. We find that treated firms experience a statistically significant increase in firm value relative to their matched controls following policy implementation. A dynamic DID analysis confirms that this increase is not driven by pre-existing trends, as the value effect emerges in the year of adoption and persists thereafter.

To further strengthen the causal interpretation of our time-series results, we implement a dynamic system GMM approach, following the methodologies of Cremers, Litov, and Sepe (2017) and Wintoki, Linck, and Netter (2012). This method estimates a system in which firm value, the mandatory retirement policy, and other key corporate characteristics are treated as endogenous and dynamically interrelated. In the spirit of Cremers, Litov, and Sepe (2017), our identification strategy relies on the lagged prevalence of mandatory retirement policies among firms within the same industry. The dynamic GMM estimates, based on a system in which we can reject concerns of weak instruments, also reveal a positive association between adopting a mandatory retirement policy and firm value.

Lastly, we explore the mechanisms through which mandatory retirement policies enhance firm value. One key channel is increased board diversity. By requiring the turnover of older directors, these policies create vacancies that could be filled by women and international candidates, groups historically underrepresented in corporate boardrooms. Prior studies show that gender and cultural diversity improve monitoring, broaden expertise, and foster innovative decision-making (Adams and Ferreira 2009; Levi, Li, and Zhang 2014; Post and Byron 2015; Miletkov, Poulsen, and Wintoki 2017). Consistent with this evidence, we find that mandatory retirement policies significantly increase the share of female and foreign directors. This infusion of diverse perspectives provides a plausible mechanism through which these policies contribute to higher firm valuation.

We make three contributions to the literature. First, we provide the most comprehensive empirical analysis to date of mandatory retirement policies for independent directors, offering new data on a governance mechanism that is widely discussed but under-researched. Prior studies have examined various aspects of optimal board design, including board size, board independence, CEO duality, and the use of classified boards (e.g., Adams and Ferreira, 2007; Raheja, 2005; Linck, Netter, and Yang, 2008; Guernsey, Guo, Liu, and Serfling, 2024). We add to this literature by highlighting how age-based director exit policies interact with firms' needs for monitoring versus advising.

Second, our findings contribute to the literature on board structure and firm value (e.g. Bebchuk and Cohen, 2005; Faleye, 2007; Adams, Hermalin, and Weisbach, 2010; Cremers, Litov, and Sepe, 2017; Johnson, Karpoff, and Yi, 2015 and 2022; Guernsey, Guo, Liu, and Serfling, 2024). Although mandatory retirement policies are widely adopted among large firms, their impact on firm value has not been systematically analyzed, likely due to data limitations. We show that cross-sectional comparisons may misleadingly indicate that these policies are associated with lower firm value, since they are more likely to be adopted by lower-value, agency-prone firms. In contrast, our within-firm analyses reveal that adoption is followed by increases in firm value. Both our DID analysis and GMM estimation support a positive relation between policy adoption and firm value. Our analysis reinforces the importance of addressing endogeneity when evaluating the effects of board characteristics on firm performance, consistent with Cremers, Litov, and Sepe (2017). We also document post-adoption increases in gender diversity and foreign director representation, consistent with mandatory retirement serving as a board-refreshment mechanism. Together, the evidence suggests that mandatory retirement policies mitigate entrenchment, strengthen governance quality, and ultimately enhance firm value.

Lastly, we add to the expanding literature on the use of machine learning in constructing novel datasets that provide more accurate representations of sample populations. Following the approach of Guernsey, Guo, Liu, and Serfling (2024) and Miric, Jia, and Huang (2023), we combine manual labeling of a training sample with machine learning techniques to construct a large-scale and comprehensive database capturing the adoption of mandatory retirement policies among all publicly traded firms from 1994 to 2020.

2 Hypothesis Development

The composition and structure of a corporate board often reflect the specific governance needs of the firm. Prior literature emphasizes that a board's optimal structure depends on the firm's information environment and agency concerns (e.g., Demsetz and Lehn, 1985; Boone, Casares

Field, Karpoff, and Raheja, 2007). Two of the most important roles of independent directors are *monitoring* management and *advising* management, and the relative importance of these roles can vary across firms and over time (e.g., Adams and Ferreira, 2007; Adams, Hermalin, and Weisbach, 2010). Our hypotheses center on how the trade-off between these roles influences a firm's decision to adopt a mandatory retirement policy for its directors.

Independent directors are critical for monitoring senior management and protecting shareholders (Jensen, 1993). Over the past three decades, the need for stronger board monitoring has grown, especially after major corporate scandals like Enron and WorldCom in the early 2000s (Wintoki and Xi, 2019). These scandals exposed serious gaps in corporate oversight, leading to widespread calls for more stringent governance practices. In response, significant reforms were introduced, including the Sarbanes-Oxley Act of 2002 (SOX), which emphasized director independence, enhanced qualifications, and greater accountability. These changes, along with increased pressure from shareholders, have significantly expanded the role of the board, especially for independent directors. As a result, serving as an independent director is now more demanding and time-consuming, with a strong focus on preventing misconduct and ensuring compliance with regulations.

In recent years, corporate boards have been relying more on older directors due to a shortage of qualified executives. Companies are under pressure to find independent directors with the right experience and expertise, leading them to increasingly choose from an older pool of candidates (Masulis, Wang, Xie, and Zhang, 2023).[4] As firms rely more heavily on older directors

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[4] As documented in Masulis, Wang, Xie, and Zhang (2023), this trend is reflected in the rising median age of independent directors, which increased from 61 to 64 between 1998 and 2014 among large U.S. firms. Moreover, the proportion of companies with a majority of independent directors aged 65 or older nearly doubled during this period, climbing from 27% to 50%.

due to this constrained supply, concerns arise regarding the potential impact of age-related cognitive decline on their ability to perform effectively. Research in cognitive psychology suggests that as individuals age, certain cognitive abilities (particularly those required for quickly processing and recalling detailed information) may decline (Craik, Moscovitch, and McDowd, 1994). In a corporate governance context, this could impair an older director's ability to promptly detect and address complex problems or managerial missteps. Furthermore, older directors might have different work-life incentives: they may have lower energy and could be semi-retired, possibly treating the directorship as a capstone to their career rather than actively pushing for change (Ferris, Jagannathan, and Pritchard, 2003). Such factors could diminish the intensity of board monitoring.

Mandatory board retirement policies can help mitigate these risks by ensuring that directors do not serve beyond the point where age-related cognitive decline could compromise their effectiveness. Such policies can facilitate the regular infusion of fresh perspectives and energy into the boardroom while maintaining a balance between experience and cognitive agility, ultimately supporting the board's ability to oversee management and safeguard shareholders' interests effectively. Building on this rationale, we argue that mandatory retirement policies for independent directors can improve the quality of board monitoring. Indeed, these policies are widely used: according to the Harvard Corporate Governance Forum, as of 2018, approximately 70 percent of S&P 500 firms and 40 percent of Russell 3000 firms had implemented such policies.

The decision to adopt mandatory retirement policies is likely influenced by firm-specific governance needs. Prior literature suggests that board structure and practices are shaped by the demands of the firm's business environment and its informational needs (Boone, Casares Field, Karpoff, and Raheja, 2007; Demsetz and Lehn, 1985; Gillan, Hartzell, and Starks, 2003). In particular, the benefits of board monitoring become more pronounced in contexts where managerial discretion is high and the potential for private gains diverges from shareholder interests (Raheja, 2005; Harris and Raviv, 2008). Based on this literature, we posit that firms facing higher monitoring demands are more likely to implement mandatory retirement policies for their independent directors. This leads to our first hypothesis:

Hypothesis 1: Firms are more (less) likely to impose mandatory retirement policies for their independent directors when the benefits of board monitoring are high (low).

While board monitoring is a central component of corporate governance, another equally important function is the advisory role that directors play in supporting management (Mace, 1986). Independent directors often contribute to strategy development, offer guidance on executive decisions, and facilitate access to external resources. In this context, older directors can be particularly effective advisors. Their deep industry knowledge, accumulated over long careers, equips them to navigate complex and rapidly evolving market conditions. Additionally, their extensive professional networks can be instrumental in securing strategic partnerships, identifying business opportunities, and providing access to capital or expertise (Masulis, Wang, Xie, and Zhang, 2023). Furthermore, older directors often possess a level of wisdom and judgment that comes from managing through different business cycles, allowing them to offer balanced perspectives in decision-making processes.

For firms operating in complex, dynamic environments or those heavily dependent on innovation and strategic decision-making, these advisory capabilities can be critical. Imposing a mandatory retirement age in such settings could inadvertently lead to the loss of directors who, despite their age, remain highly effective and valuable advisors. Therefore, we expect that firms with greater reliance on board-level advising are less likely to adopt mandatory retirement policies for independent directors. For these firms, preserving access to experienced and well-connected directors outweighs the benefits of enforced board turnover. This leads to our second hypothesis:

Hypothesis 2: Firms are less (more) likely to impose mandatory retirement policies for their independent directors when the advising needs are high (low).

While the preceding discussion highlights the potential benefits and drawbacks of mandatory retirement policies depending on whether a firm prioritizes monitoring or advising, the overall impact of such policies on firm value remains theoretically ambiguous. This ambiguity arises from the inherent trade-off between the benefits of board renewal and the costs of losing seasoned directors.

On the one hand, mandatory retirement policies can enhance board effectiveness by increasing diversity of thought and potentially strengthening managerial oversight. Younger directors may bring fresh perspectives and a greater willingness to challenge entrenched norms—factors that can improve monitoring quality. On the other hand, these same policies may come at a cost, particularly in firms where advisory needs are high. Replacing older directors may result in the loss of valuable firm-specific knowledge and external networks. Given these opposing forces, the net effect of mandatory retirement policies on firm value is uncertain ex ante. As a result, we state our third hypothesis in the null form:

Hypothesis 3: There is no association between mandatory retirement policies and firm value.

3 Data and Methodology

3.1 Data sources

In this paper, we utilize multiple data sources. Our baseline sample is derived from the CRSP-Compustat merged database, covering the sample period from 1994 to 2020. We use

Compustat to gather accounting and segment data and the CRSP database to gather stock return information. We then augment this with several additional datasets to capture governance and other variables: board composition and director information from BoardEx and Compact Disclosure, analyst coverage data from I/B/E/S, and institutional ownership data from Thomson Reuters 13F filings. For one of our control variables – whether the firm has a classified (staggered) board – we utilize data provided by Guernsey, Guo, Liu, and Serfling (2024) on classified board status for U.S. firms.

3.2 Methodology and machine learning

Because no comprehensive commercial database covers board retirement policies, we employ a machine-learning approach to identify firms and years in which such policies are in place. Specifically, we use a Random Forests (RF) classifier to analyze textual disclosures in SEC filings and detect mentions of mandatory retirement policies.

3.2.1 Overview of Random Forests (RF) Classifier

The RF algorithm is a supervised machine-learning method built upon an ensemble of decision trees (Breiman, 2001). In our context, the RF classifier is used to predict whether a given piece of text from a firm's filing indicates the existence of a mandatory retirement age policy for directors. Compared to a single decision tree, the RF approach offers several advantages: First, it uses bootstrap aggregating (bagging) by training each decision tree on a random sample of the data. This means each tree sees a slightly different subset of observations, which helps reduce overfitting to idiosyncrasies of the training set. Second, at each split in a tree, the RF algorithm considers a random subset of predictor variables (in our case, words or phrases), which decorrelates the trees and further improves out-of-sample accuracy. Third, the RF makes no assumptions about the functional form of relations between predictors and the outcome, allowing it to capture complex patterns in textual data. The final RF classifier aggregates the predictions of all individual trees (typically by majority vote or averaging probabilities), yielding a robust classification.

The RF Classifier method has been effectively employed across various scientific disciplines and, more recently, in the realms of economics and business. For instance, the RF Classifier surpasses other statistical instruments in predicting future ecological shifts, offers the most precise forecasts of chemical compound classifications, attains a high level of accuracy in 3D object recognition, and exhibits superior properties in predicting microarray data (Díaz-Uriarte and de Andrés, 2006; Prasad, Iverson, and Liaw, 2006; Svetnik et al., 2003; Shotton et al., 2013). In the field of economics, Varian (2014) supports the utilization of RF in econometrics, and Bajari, Nekipelov, Ryan, and Yang (2015) apply RF to estimate demand functions. Most recently, Frankel, Jennings, and Lee (2022) argue that RF algorithms more accurately capture disclosure sentiment than alternative machine learning methods. In corporate governance research, Guernsey, Guo, Liu, and Serfling (2024) employ an RF classifier to predict which firms have classified boards, demonstrating the efficacy of this approach in constructing novel governance datasets. Building on this literature, our analysis is among the first to apply Random Forest text classification to identify a specific board policy (director retirement age) on a large scale.

3.2.2 Estimation steps and machine learning prediction

To construct our dataset on mandatory retirement policies, we follow a multi-step process. First, we create a training sample to implement a machine learning algorithm. Specifically, we randomly select 300 firms from Compustat that are covered by the SEC EDGAR database between 2013 and 2016, and we use DirectEDGAR to extract sentences containing keywords such as “age,” “retirement,” “birthday,” and their variants from their SEC filings. This process yields 72,030 sentences. We then manually read each sentence to determine whether it refers to a board mandatory retirement policy. For example, a sentence like *"Directors must retire at age 72 per the Company's corporate governance guidelines"* would be labeled as indicating a policy, whereas *"Director A retired from the board in 2015"* (a generic statement of a retirement event) would not.[5] Through this manual coding, we identified 836 sentences that explicitly mention a mandatory retirement policy for directors (these are our positive instances), with the remainder being non-policy-related references to age or retirement.

We pre-process the text by removing stop words and applying the Porter stemmer to reduce each word to its root form.[6] We then convert the sentences into unigrams and bigrams (i.e., one- and two-word phrases) and create binary indicators for whether each phrase appears in a sentence. We randomly allocate 80% of the labeled sentences to the training set and the remaining 20% to the test set. We train the RF classifier on the training subset of labeled sentences. The classifier learns combinations of words and phrases that are predictive of a sentence indicating a mandatory retirement policy. Following Frankel, Jennings, and Lee (2022), we employ a random forest model with 5,000 trees to classify whether a sentence indicates a mandatory retirement policy.

We then evaluate the model's performance using a held-out test set comprising previously unseen sentences. As an initial benchmark, we apply a 50% probability threshold: a sentence is classified as policy-related if its predicted probability exceeds 50%. Using this criterion, the RF classifier achieves an out-of-sample prediction accuracy of over 99.8% in identifying policy-related sentences. Internet Appendix IA2 tabulates the top 25 phrases with the highest predictive

[5] We provide some additional examples of sentences from SEC filings indicating a mandatory retirement policy in Internet Appendix IA1.
[6] Specifically, we remove the same set of stop words used in Frankel, Jennings, and Lee (2022), such as "and" and "the." We further remove all numbers with three or more digits, as they are less likely to be age-related. Next, we reduce each word to its stem using the Porter stemming technique, so that, for example, "retires," "retired," and "retirement" all become "retir".

power in determining a firm's mandatory retirement status. These 25 phrases account for 42.3% of the variable importance among all phrases, with the top three accounting for 10.6%. Intuitively, given that mandatory retirement typically occurs around age 72, the top five phrases based on the stemmed words are "72", "mandator", "director", "retir age", and "guidelin".

Turning to the confusion matrix of the testing sample, we find that the false positive rate—sentences incorrectly flagged as policy-related—is just 0.007%, while the false negative rate—policy-related sentences missed by the model—is 14.035%. This is unsurprising, given that 98.8% of sentences in our manually labeled sample do not pertain to mandatory retirement policies. Because the false positive rate is effectively zero, using a 50% threshold minimizes the risk of erroneously classifying a firm as having a policy when it does not. Additionally, since we classify a firm as having a mandatory retirement policy if at least one sentence in a given year is flagged, the firm-year level false negative rate falls to 8%, while the false positive rate remains at 0%.

We next extend the analysis to the broader population of firms by extracting approximately 5.5 million sentences from SEC filings containing keywords such as "age," "retirement," "birthday," and related terms, and apply the trained model. In the first pass, we flag sentences with predicted probabilities above 50% as policy-related. To reduce the risk of false negatives in this expanded sample and capture additional potentially relevant sentences, we retain those with predicted probabilities between 3.8% and 50% (totaling 174,186 sentences) for manual review. The 3.8% threshold is selected because it yields a zero false negative rate in the test sample. Based on the sentence-level classification, we determine for each firm-year whether the firm had a mandatory retirement policy in place. If at least one sentence in a firm's filings for a given year is flagged (by the model or by manual review) as indicating a mandatory retirement age policy, we set the Policy indicator to 1 for that firm-year. Through this exhaustive approach, we ultimately identify 2,024 firms that adopted a mandatory retirement policy during our sample period.

In implementing this, we assume that the first year in which we detect a policy disclosure corresponds to the adoption year of the policy. In some cases, a firm's filings in a subsequent year might not explicitly mention the policy (for instance, if the policy was described in a corporate governance charter that isn't repeated annually). However, based on our manual checks, once a firm adopts a mandatory retirement policy it rarely rescinds it. Thus, if a firm's filings indicate a policy in year t and then are silent in year $t+1$, we continue to treat the policy as in effect in $t+1$ (carrying the indicator forward) unless a filing explicitly states the policy was eliminated. This convention is supported by our hand-collection process, which identified very few instances of firms removing a previously adopted retirement age policy. In summary, once a firm's Policy indicator switches from 0 to 1, we leave it at 1 in all subsequent years for that firm (absent evidence to the contrary).

By following these steps, we construct a panel of firm-year observations with a high-confidence indicator of whether the firm had a mandatory retirement age for directors. This novel dataset allows us to empirically examine both the determinants and consequences of such policies across a broad cross-section of firms, as well as time-series variation spanning more than two decades.

3.3 Sample Overview and Trends in Mandatory Retirement Policy

Table 1 summarizes the construction of the mandatory retirement policy sample. We begin with 169,305 unique firm-year observations from the merged CRSP-Compustat dataset with non-missing Central Index Key (CIK) and Standard Industrial Classification (SIC) codes. Following common practice, we omit financial (SIC 6000–6999) and utility (SIC 4900–4949) firms due to their distinct regulatory environments. These steps reduce the sample to 117,761 firm-years, covering 13,386 unique firms from 1994 to 2020.

Table 2 presents descriptive statistics for key variables. *Tobin's Q* has a mean of 2.21 and a median of 1.56. The average firm age is 12.68 years, with a median of 9 years, reflecting a balanced mix of young and mature firms in our sample. The mean institutional ownership is 38.2%, consistent with significant institutional presence in many firms. The median number of business segments is 3, and the median board size is 8. Additionally, 46.0% of firms have a classified board structure. The average proportion of independent directors on the board is 75.8%. These figures offer a snapshot of the typical firm's governance and organizational complexity in our final sample. In the analysis that follows, several of these characteristics, such as firm size, age, complexity, serve as key control or proxy variables in examining the determinants and effects of mandatory retirement policies.

Building on the sample overview, we next examine adoption patterns of mandatory director retirement policies using our novel dataset. Panel A of Figure 1 and Panel A of Table 3 present the time-series trends from 1994 to 2020. We observe a marked increase in the prevalence of such policies over this period. In 1994, only 2.8% of all firms in our sample had a mandatory retirement age for directors; by 2020, this fraction had risen to 26.5%. The trend is especially pronounced among large firms: the adoption rate among S&P 1500 firms grew from 11.9% in 1994 to 58.2% in 2020. In contrast, adoption among smaller firms—those outside major indices—remained relatively modest, increasing from 0.8% to 14.0% over the same period. This widening gap suggests that larger firms have led the way in adopting formal director age limits, potentially reflecting greater investor scrutiny or the influence of standardized governance practices in that segment. In addition, we also observed a notable uptick in new policy adoptions following the enactment of SOX in 2002. The early 2000s show a sharp increase in the share of firms with mandatory retirement policies, hinting that heightened governance focus in the post-Enron era may have prompted boards to consider age limits as part of broader governance reforms.

Panel B of Figure 1 further breaks down the trends by index size tiers (S&P 500, 400, and 600). The largest firms (S&P 500) consistently have the highest prevalence of these policies, followed by mid-caps and small-caps firms. These patterns suggest that firm size and visibility play an important role in shaping governance practices.

Figure 2 and Panel B of Table 3 illustrate the distribution of firms that have adopted mandatory retirement policy across the Fama-French 12 industry categories. These industry categories classify companies into 12 distinct sectors based on their primary business activities. Notably, 33.7% of firms in the Chemicals sector implement mandatory retirement policies, 5.7% more than the next highest category, Manufacturing. The Healthcare (10.2%) and the Business Equipment (11%) sectors have the lowest percentages of firms adopting this policy.

3.4 Do firms enforce mandatory retirement policies?

To better understand whether the rise in adoption reflects meaningful implementation, we examine whether mandatory retirement policies are effectively enforced. Specifically, we analyze the relation between firm age and the average age of independent directors. Figure 3 compares the evolution of director age and tenure as firms mature, separating for firms with and without a retirement policy. Among firms without such policies, the average age of directors increases steadily with firm age. In contrast, firms that impose a retirement age exhibit a noticeably flatter trajectory—both director age and tenure rise more slowly with firm age. These patterns suggest that mandatory retirement policies are not merely symbolic; they appear to constrain board aging by facilitating regular turnover of older directors.

To further assess enforcement, we examine the age distribution of director departures. Figure 4, Panel A compares the turnover ages of independent directors in firms with a mandatory retirement policy (treated firms) to matched firms without such a policy.[7] The results reveal a striking contrast: in treated firms, director departures are heavily concentrated between ages 69 and 75, with a pronounced peak at age 72—a common mandatory retirement threshold. In contrast, control firms exhibit a much flatter and more dispersed distribution, indicating more flexible, case-by-case turnover.

Figure 4, Panel B provides complementary within-firm evidence by examining director departure ages *before* and *after* policy adoption for the same firm. We find prior to implementation, turnover occurs across a wide age range. However, post-adoption, departures cluster tightly around the mandated retirement age. Together, these patterns suggest that mandatory retirement policies are not only adopted but also actively enforced, leading to more standardized and predictable board turnover.[8]

4 Empirical analyses

4.1 The role of monitoring benefits and advising needs on the mandatory retirement policies

In this section, we test Hypotheses 1 and 2, which predict that firms with high monitoring benefits are more likely to adopt a mandatory retirement policy, while those with high advising needs are less likely to do so. Following prior literature, we quantify monitoring and advising benefits at the firm-year level using proxies based on observable firm characteristics.

[7] Matching is based on industry and size.
[8] We also present some evidence that firms with mandatory retirement policy are associated with shorter director tenure in Internet Appendix IA3.

To capture monitoring benefits, we draw on established frameworks and use two proxies. Linck, Netter, and Yang (2008) suggest that the monitoring benefits will be higher if insiders have a greater opportunity to extract more private benefits. Our first proxy is *free cash flow (FCFA)*, as Jensen (1986) argues that excess cash increases agency conflicts by enabling managers to pursue private interests over shareholder value. Our second proxy is *industry concentration (HHI)*. According to Gillan, Hartzell, and Starks (2003), firms in concentrated industries face less competitive pressure, giving managers greater latitude to secure private benefits. Hypothesis 1 predicts that both higher free cash flow and greater industry concentration are associated with a higher likelihood of adopting a mandatory retirement policy.

For advising needs, we focus on measures of a firm's operating complexity and innovation, which increase demand for board-level advisory input (Coles, Daniel, and Naveen, 2008). Specifically, we use two commonly employed proxies for operating complexity: *asset intangibility (Asset Intangibility)* and *R&D expenditures (R&D)*. Both are associated with higher uncertainty, making it more difficult for directors and stakeholders to evaluate firm value and the expected returns from innovation. This information complexity heightens the value of experienced directors who can provide strategic guidance. Consistent with prior studies (e.g., Coles, Daniel, and Naveen, 2008; Faleye, Hoitash, and Hoitash, 2011; Gomes, Gorton, and Madureira, 2007; Loughran and McDonald, 2023), we interpret higher levels of asset intangibility and R&D spending as indicators of greater advising needs. Hypothesis 2 predicts that such firms are less likely to adopt a mandatory retirement policy, as they may seek to retain directors who offer critical advisory expertise.

Table 4 examines the relation between the adoption of a mandatory retirement policy and firm characteristics related to monitoring and advising needs.[9] The dependent variable, mandatory

[9] All control variables in all tables are lagged.

retirement policy, is an indicator variable equal to 1 if a firm imposes an age limit for non-executive directors and 0 otherwise. The key independent variables are the proxies for monitoring benefits and advising needs described above. We control for a range of factors that may influence the adoption of such policies, including firm size, firm age, number of business segments (to capture organizational complexity), firm performance (return on assets), and growth opportunities (Tobin's Q). We also include board characteristics (board size and percentage of independent directors), CEO characteristics (an indicator for CEO duality and a dummy for whether the CEO is over age 65), governance structures (classified board indicator), and external governance pressure (institutional ownership and analyst coverage).[10] All specifications include year and industry fixed effects to account for macroeconomic trends and time-invariant industry factors.[11]

Columns (1) to (4) of Table 4 report regression results for the monitoring and advising proxies incrementally. Consistent with Hypothesis 1, we find that the coefficients on the monitoring-related variables (*FCFA* and *HHI)* are positive and statistically significant, indicating that firms with abundant free cash flow or operating in less competitive industries are more likely to impose a mandatory retirement age for directors. These results hold whether each proxy is considered individually or jointly. Consistent with Hypothesis 2, the coefficients on the advising-related variables (*Asset Intangibility* and *R&D*) are negative and significant coefficients, suggesting that firms with greater advising needs are less likely to adopt mandatory retirement policies. Column (5) includes all four proxies together and Column (6) adds additional controls (firm size, age, segments). The signs and significance of the key proxies remain robust. Finally, Column (7) estimates a Probit regression for robustness, yielding similar results.

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[10] *ROA* and *FCFA* are highly correlated, so we omitted *ROA* from the models that include *FCFA*.
[11] The sample size decreases to 67,795 because we require non-missing values for additional board characteristics, including board size and board independence, as well as other firm characteristics.

Table 4 also provides insights into how other firm characteristics relate to the adoption of mandatory retirement policy. The coefficients on firm size, firm age, and the number of business segments are positive and significant, suggesting these variables may also reflect agency concerns and the value of enhanced monitoring. We also find positive associations between the policy and several monitoring-enhancing factors, such as the number of analysts, institutional ownership, and the independence ratio, suggesting that mandatory retirement policies may complement other governance mechanisms. We do not find a consistent relationship between the adoption of the policy and other board characteristics such as classified boards or CEO-chairman duality. Overall, the evidence in Table 4 strongly supports our two main hypotheses: firms are more likely to adopt mandatory retirement policies when monitoring benefits are high and less likely to do so when the cost of losing valuable advisory expertise is greater.

4.2. External pressure and the adoption of the mandatory retirement policy

In addition to firm-level characteristics related to monitoring and advising benefits, external factors such as market visibility and regulatory pressure may also influence governance practices. In this section, we examine the impact of inclusion in the S&P 1500 index and the passage of the Sarbanes-Oxley Act of 2002 on the adoption of mandatory retirement policies.

4.2.1. The S&P 1500 inclusion

Figure 1 reveals a noticeable difference in the adoption of mandatory retirement policies between S&P 1500 firms and non-indexed firms. Prior research shows that inclusion in the S&P 500 increases a firm’s analyst coverage and media visibility, leading to greater investor scrutiny and higher institutional ownership (Chen, Noronha, and Singal, 2004). We therefore hypothesize that firms added to a major index are more likely to adopt mandatory retirement policies as part of broader efforts to align with heightened governance expectations.

Figure 5 presents how the likelihood of adopting a mandatory retirement policy changes following a firm's inclusion in the S&P 1500, using a difference-in-differences framework. In this setting, a firm's addition to the index serves as the treatment event. We construct the control group by matching treated firms to firms that are never included in the S&P 1500, based on firm size in the year of index inclusion and two-digit SIC industry classification. We then regress the mandatory retirement policy indicator on event-time indicators for years relative to index inclusion, controlling for firm and year fixed effects as well as other firm-level characteristics. Figure 5 plots the estimated coefficients from this regression. We find that firms are significantly more likely to adopt mandatory retirement policies in the five years following inclusion in the S&P 1500.

Next, we examine how governance changes triggered by S&P 1500 inclusion amplify the monitoring and advising benefits associated with implementing a mandatory retirement policy. Columns (1) to (4) of Table 5 presents the results from regressions of the mandatory retirement policy indicator on firm-level proxies for monitoring and advising benefits, interacted with an S&P 1500 inclusion. To summarize these benefits more systematically, we construct two composite variables: *MONBEN***,** the first principal component of *FCFA* and *HHI*; and *ADVBEN***,** the first principal component of *R&D* and *Asset Intangibility*. In Columns (5) and (6), we interact these components with the S&P 1500 indicator.[12] Consistent with Table 4, all models include year and industry fixed effects.

We observe a consistent pattern: interaction terms between the monitoring proxies and the S&P index dummy are positive and significant (with the exception of *HHI*), while those involving advising proxies are negative and significant. For example, the coefficient on *FCFA* × *SP1500* is

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[12] Similar to the reason we mentioned in footnote 10, we also omitted *ROA* from the models that include *MONBEN*.

positive, indicating that free cash flow has an incremental effect on policy adoption among S&P 1500 firms, whereas *R&D* × *SP1500* is negative, indicating indexed firms with high R&D are even less likely to adopt the policy. Similarly, the coefficient on *MONBEN* × *SP1500* is positive and the coefficient on *ADVBEN* × *SP1500* is negative in Columns (5) and (6). These results suggest that S&P 1500 inclusion amplifies the influence of monitoring and advising factors on mandatory retirement policy adoption, likely reflecting greater external governance pressure on indexed firms.

4.2.2 The effect of the Sarbanes-Oxley (SOX) Act of 2002

The regulatory environment can also shape firms' governance decisions. The Sarbanes–Oxley Act (SOX) of 2002, enacted in response to corporate scandals such as Enron and WorldCom, significantly strengthened governance requirements, particularly around financial reporting and board oversight. Linck, Netter, and Yang (2008) document that SOX led to larger and more independent boards. Figure 1 shows a rise in the adoption of mandatory retirement policies following SOX, which we interpret as reflecting firms' heightened attention to balancing monitoring and advising needs. To formally test SOX's impact, we modify the models in Table 6 by interacting each monitoring- and advising-related variable—as well as *MONBEN* and *ADVBEN*—with a *POSTSOX* indicator (equal to 1 for years after 2001, and 0 otherwise).

Consistent with the view that SOX raised governance expectations, Table 6 shows that interaction terms between monitoring benefits and *POSTSOX* are generally positive and significant, while those between advising needs and *POSTSOX* are negative and significant. This indicates that after 2001, the positive association between factors like free cash flow or leverage and the likelihood of adopting a retirement policy became stronger, while the negative association with factors like R&D intensity also intensified. For example, firms with high free cash flow were already more likely to adopt such policies (see Table 4), and this tendency was amplified post-

SOX. These patterns suggest that firms with greater agency concerns responded to SOX by signaling stronger governance through board refreshment. Conversely, firms with high advising needs became even less likely to impose retirement policies, possibly due to improved board independence reducing the marginal benefit of further monitoring, while preserving advisory expertise became more valuable. We interpret this as evidence that SOX and related reforms heightened firms' sensitivity to governance trade-offs, encouraging age-based turnover when monitoring needed strengthening, and discouraging it when advisory continuity was more valuable.

4.3. Retirement policy adoption across the firm life cycle

We next examine how the adoption of mandatory retirement policies varies with a firm's life cycle stage. Governance needs are not static; they evolve as firms grow and mature. Younger firms often prioritize advisory input to navigate growth opportunities, whereas mature firms are more likely to emphasize monitoring to minimize agency issues (Johnson, Karpoff, and Yi, 2022; Ewens and Malenko, 2020). If mandatory retirement policies align with these shifting priorities, we would expect them to be uncommon among young companies and more prevalent among mature firms.

Following Dickinson (2011), we classify each firm-year into one of five life-cycle stages – *Introduction*, *Growth*, *Mature*, *Shake-out*, or *Decline* – based on the firm's cash flow patterns (a standard approach that uses operating, investing, and financing cash flow signs to infer life-cycle stage), as shown in Panel A of Table 7. In Panel B, we regress the mandatory retirement policy indicator on each of the lifecycle dummies. Columns (1) through (5) examine each stage separately, while Column (6) includes all stages (excluding *Introduction* as the reference group).

The results show a clear pattern consistent with the monitoring-versus-advising tradeoff across the firm life cycle. Firms in the *Mature* and *Shake-out* stages are significantly more likely to adopt mandatory retirement policies, with positive and statistically significant coefficients compared to the Introduction stage. In contrast, firms in the *Growth* and *Decline* stages have a negative association with policy adoption. This suggests that young, growing firms, where advisory needs are high, tend to avoid strict retirement rules that might limit access to experienced board members. As firms mature and operations stabilize, the focus shifts toward increased monitoring and board refreshment, making retirement policies more appealing. Firms in the *Shakeout* stage, where growth slows and the focus shifts to efficiency, also show higher adoption rates, likely reflecting greater demand for oversight. Firms in *Decline* are less likely to adopt retirement policies, although the effects are smaller, possibly due to prior turnover or continued reliance on experienced board members. Overall, the findings suggest that retirement policy adoption reflects firms' evolving governance priorities.

In summary, the life cycle analysis supports the view that firms adopt mandatory retirement policies when monitoring becomes more important, and avoid them when advisory needs dominate. These results provide additional evidence that firms adjust governance practices over time to reflect shifting priorities.

4.4 Mandatory retirement policies and firm value

4.4.1 Cross-sectional and time series results

In this section, we examine both the cross-sectional and time series association between mandatory retirement policies and long-term firm value, as measured by *Tobin's Q*. Table 8 reports OLS regressions of Tobin's Q on the Mandatory Retirement Policy indicator using different fixed specifications. Columns (1) to (3)-which include no fixed effects, year fixed effects, and industry and year fixed effects, respectively-all show a *negative* and highly significant association between having a mandatory director retirement policy and firm value. These results suggest that, in a cross-sectional regression, firms with such policies tend to have lower valuations.

However, in Column (4), which includes firm fixed effects, the coefficient on *Mandatory Retirement Policy* becomes positive and significant at the 10% level. The negative association observed in the cross-sectional analysis, together with the positive association in the time-series analysis, suggests potential reverse causality. That is, firms with lower value may be more likely to adopt mandatory retirement policies. Supporting this interpretation, our determinants model shows that firms with strong advising needs and those in growth stages, both characteristics typically related to higher firm value, are less likely to adopt mandatory retirement policies. In contrast, firms with strong monitoring needs and those in mature or shakeout stages, which are commonly associated with lower firm value, are more likely to implement such policies. Including firm fixed effects in the panel regressions removes time invariant differences across firms and allows us to compare average firm value before and after policy adoption.

4.4.2 Reverse Causality Test

In this section, we further investigate the possibility of reverse causality, following the approach of Cremers, Litov, and Sepe (2017). Here, we model the decision to adopt a *Mandatory Retirement Policy* as a function of firm valuation and other firm characteristics. Table 9 presents three estimation approaches: a linear probability model (Column 1), a probit model (Column 2), and a Cox proportional hazards model (Column 3). The sample includes all firms that do not have a mandatory retirement policy until the year in which they adopt one; firms are dropped from the sample after adoption. This design focuses exclusively on the first adoption event, thereby avoiding contamination from post-adoption periods.

Across all three models, lagged Tobin's Q emerges as a strong predictor of policy adoption. Specifically, the coefficient on Tobin's Q in year *t–1* is negative and statistically significant in each specification. Economically, this means that firms with higher prior Q (i.e., better performance or growth opportunities) are significantly less likely to implement a mandatory retirement policy for directors, while firms with lower valuations are more likely to adopt the policy. These findings support the reverse causality hypothesis that firms adopt stricter governance practices when performance or outlook is weak. They suggest that the negative cross-sectional association reflects selection effects, as firms with lower expected value are more likely to adopt the policy rather than the policy itself causing lower value.[13]

4.4.3 Matched Sample Difference in Difference analysis

To further address endogeneity concerns, we implement a difference-in-differences (DID) approach using matched samples. Specifically, we compare changes in Tobin's Q over a five-year window before and after the adoption of mandatory retirement policies, comparing treated firms to a control group that did not adopt such policies during the sample period. We consider two methods for matching control firms with each treated firm. In the first approach, we match on firm size in the year of policy adoption and industry (based on two-digit SIC codes).[14] In the second approach, we use the propensity scores estimated from the determinants model in Table 4, Column (7), and select control firms with the closest propensity score, conditional on being in the same two-digit SIC industry as the treatment firm.

[13] We further confirm this reverse causality conjecture when we add the one-year lagged Tobin's Q as an additional control to pooled panel regressions in Columns (1) to (3) of Table 8, presented in Online Appendix IA4. The identified negative association between mandatory retirement policy and Tobin's Q becomes considerably weaker once we control for lagged Tobin's Q.

[14] We require the absolute difference in firm size between treatment and control firms to be less than 20%, and after matching, we find no statistical difference in firm size between the two groups in the year of policy adoption.

We define a *TREATMENT* indicator equal to one for firms that adopt a mandatory retirement policy and zero otherwise. *POST* is an indicator equal to one for firm-years after the adoption year and zero for the pre-adoption period. The DID estimator is the coefficient on the interaction term *TREATMENT* × *POST*, which captures the differential change in firm value following policy adoption for treated firms relative to the matched controls. Table 10 presents the results. Columns (1) and (2) report the baseline DID regression for these two matching methods, which includes the *TREATMENT* × *POST* interaction term, firm and year fixed effects, and controls used in Table 8. The estimated coefficients on the interaction term in Columns (1) and (2) are both positive and statistically significant, suggesting that mandatory retirement policies are associated with a subsequent increase in firm value.

To examine the dynamic effects surrounding policy adoption and to validate the parallel trends assumption, we augment the baseline specification by replacing the *POST* indicator with a set of leads and lags relative to the policy adoption year. Specifically, we include indicator variables for five (*Pre5*), four (*Pre4*), three (*Pre3*), and two (*Pre2*) years prior to adoption, and for the adoption year (*Adopt*), as well as one (*Post1*) through five (*Post5*) years following adoption. We omit the indicator for the year immediately preceding adoption to serve as the baseline. Each of the remaining year indicators is interacted with the *TREATMENT* indicator, and all standalone time and treatment effects are absorbed by the fixed effects. Columns (3) and (4) report these results for the two matching methods. We find that the interaction terms for the pre-adoption years are statistically insignificant, indicating an absence of pre-trends. In contrast, the interaction coefficients become significantly positive beginning in the year of adoption and persist in the following years. These results mirror the findings from the earlier firm-fixed-effects panel (Table 8 Column (4)), but with a cleaner identification: in essence, firms that adopt the policy experience value gains relative to firms that don't, holding other factors constant. This matched DID analysis therefore provides confirmation that mandatory retirement policies for directors can enhance shareholder value, and it mitigates endogeneity concerns by comparing each adopting firm to an appropriate counterfactual. Moreover, the dynamic pattern (no pre-policy run-up and a post-adoption rise) reinforces that the policy is the driving force behind the observed increase in Tobin's Q, rather than an artifact of reverse causality or omitted trends.

4.4.3. System GMM estimator

In our final approach to address endogeneity, we implement the dynamic system GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). This method treats corporate governance structures—such as the *Mandatory Retirement Policy*—and other firm characteristics as potentially endogenous, using their lagged values as instruments in a system of equations in both levels and first differences.

Following Wintoki, Linck, and Netter (2012), we include the first and second lags of Tobin's Q to capture value persistence and treat all firm-level controls, except for year fixed effects, as endogenous. These endogenous variables are instrumented with their third- and fourth-year lags (t–3 and t–4) in the first-differenced equation. We also incorporate exogenous industry-level instruments in the levels equation, the same way as in Cremers, Litov, and Sepe (2017) and Karpoff, Schonlau, and Wehrly (2017). These instruments include: (1) the percentage of industry sales from firms with a mandatory retirement policy in year t–5 in Column (1); (2) the percentage from firms that adopted the policy in year t–5 in Column (2); and (3) the combination of both in Column (3). These instruments are motivated by empirical evidence suggesting that governance practices often cluster by industry and over time.

The system GMM results reported in Table 11 remain in the same direction as the within-firm OLS estimate in Table 8 and are consistent with the treatment effects identified in the DID analysis. Across all specifications (Columns 1–3), the coefficient on *Mandatory Retirement Policy* is positive and statistically significant at the 1% level.

We also perform diagnostic tests to verify instrument validity and model assumptions, with the results reported at the bottom of Table 11. The Arellano–Bond test confirms first-order autocorrelation (as expected) but no second-order autocorrelation (AR(2) p-values range from 0.12 to 0.35), indicating that the use of lagged instruments is valid. The Sargan and Hansen tests do not reject the null hypothesis of instrument validity (p-values between 0.13 and 0.18), further supporting the reliability of the system GMM estimates.

In summary, the time-series OLS results, the reverse causality test, the DID analysis, and the GMM estimation all indicate a positive association between the adoption of a mandatory retirement age for directors and firm value, suggesting that such policies can enhance governance effectiveness.

4.5 Channel Analysis

In this final section, we explore the channels through which mandatory retirement policies may influence governance. By design, these policies generate board turnover. Such refreshment can expand the director candidate pool, increasing the likelihood of appointing individuals with underrepresented attributes or internationally relevant backgrounds. Prior research shows that gender and cultural diversity can enhance board effectiveness and firm outcomes (Adams and Ferreira 2009; Levi, Li, and Zhang 2014; Post and Byron 2015; Miletkov, Poulsen, and Wintoki 2017). Accordingly, if mandatory retirement operates as a governance lever, we would expect to observe shifts in board composition along the dimensions of diversity and international expertise.

Table 12 examines changes in board composition around the adoption of mandatory retirement policies. We find that adoption is followed by increases in gender diversity and the share of foreign directors. These patterns hold in both the t+1 and t+3 windows. The findings suggest that mandatory retirement creates board openings that are often filled by more diverse candidates. Prior research links such diversity to improved monitoring, broader expertise, and more innovative decision-making, providing a plausible channel through which mandatory retirement enhances firm value.

5 Conclusion

This paper is the first to provide large-sample empirical evidence on the determinants and consequences of mandatory retirement policies for corporate directors. We construct a novel dataset that identifies whether U.S. public firms enforced an age-based retirement policy for independent directors in each year from 1994 to 2020. To construct this dataset, we combine machine-learning-based text analysis with extensive manual verification of SEC filings, allowing us to overcome the data limitations that have previously restricted empirical research on this topic. Our final sample covers over 8,400 firms and allows us to uncover new empirical patterns and conduct a systematic analysis of the policy's determinants and its impact on firm value.

Our findings indicate that the adoption of mandatory director retirement policies is shaped by a firm's specific governance needs. Firms are significantly more likely to impose a mandatory retirement age when the benefits of board monitoring are high. In contrast, firms are significantly less likely to adopt such a policy when their need for board advising is high. These relations hold in multiple analyses and are strengthened under conditions of greater scrutiny (e.g., among S&P 1500 firms and in the post-SOX era), suggesting a consistent governance-driven rationale.

Furthermore, firms tend to implement the mandatory retirement policy when they are in mature or shake-out stages in which they are in stable conditions and take less risk.

In terms of firm value implications, our findings highlight the importance of addressing selection effects in governance research. Simple cross-sectional comparisons may misleadingly suggest that mandatory retirement policies are associated with lower firm value, as these policies are more likely to be adopted by lower-value, agency-prone firms. However, within-firm analyses show that when a firm implements a policy, its value tends to increase afterwards. Our DID analysis and the GMM estimation also indicate a positive relation between adopting the policy and firm value. We also find that adoption is followed by increases in gender diversity and foreign representation, consistent with mandatory retirement serving as a board-refreshment mechanism. Overall, the evidence suggests that mandatory retirement can mitigate entrenchment and enhance governance quality and firm value.

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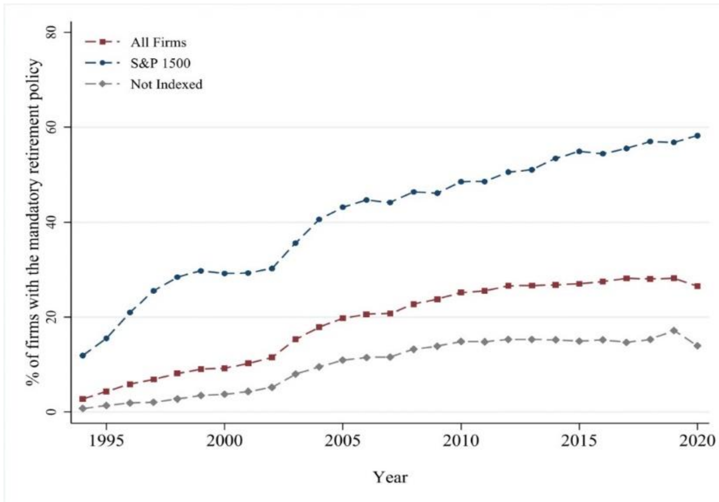
Panel A: Percentage of firms implementing the mandatory retirement policy across full sample, S&P 1500 firms and non-S&P1500 firms



Panel B: Percentage of firms implementing the mandatory retirement policy across S&P 500, S&P 400, and S&P 600 index firms

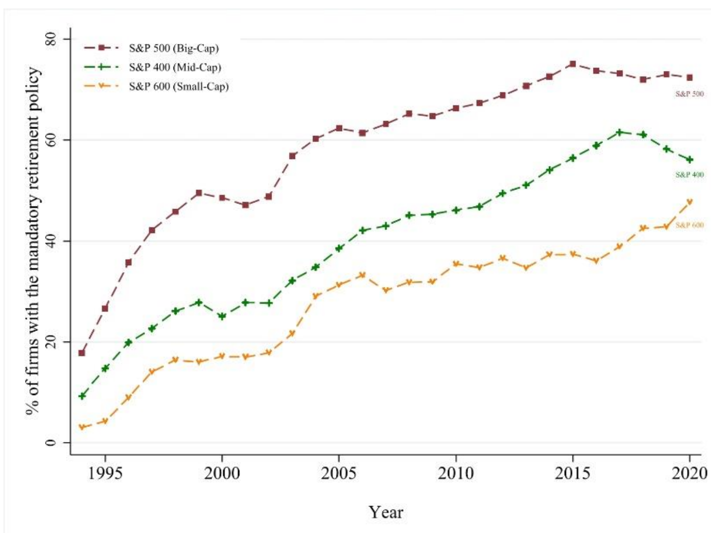


Figure 1. Effects of S&P indexing on implementing mandatory retirement policy for independent directors. Panel A of Figure 1 illustrates the percentage of firms implementing the mandatory retirement policy for independent directors between 1994 and 2020 across full sample, S&P 1500 firms and non-SP 1500 firms. Panel B of Figure 1 illustrates the percentage of firms implementing the mandatory retirement policy for independent directors between 1994 and 2020 across various S&P indices like S&P 500, S&P 400, and S&P 600.

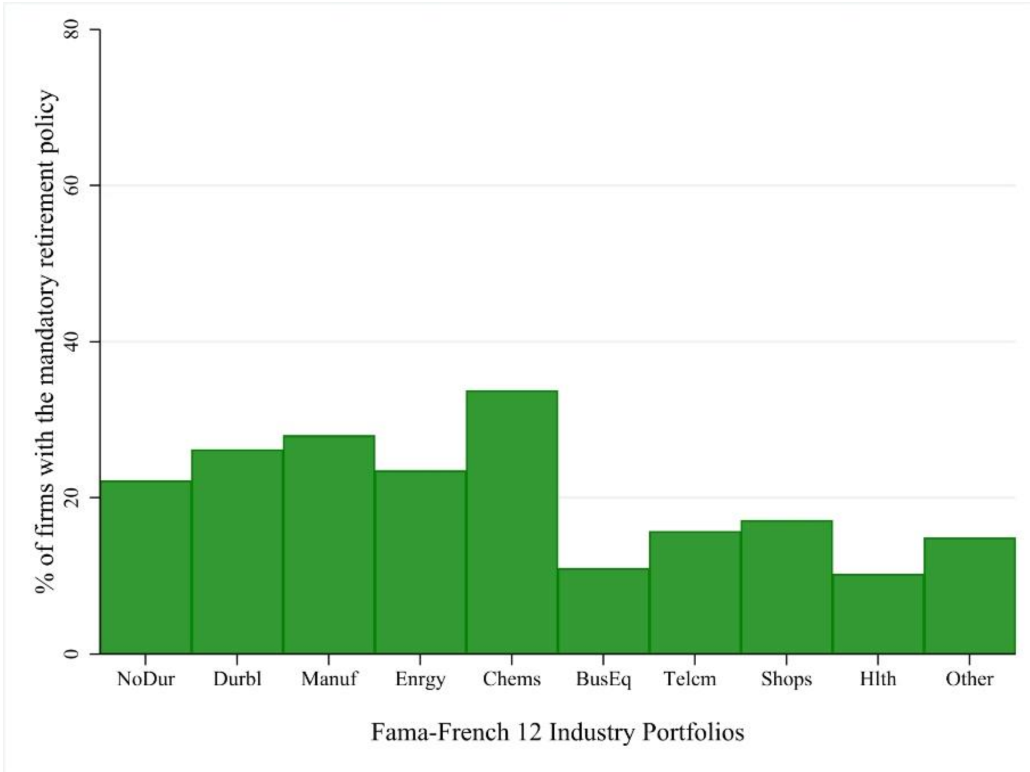
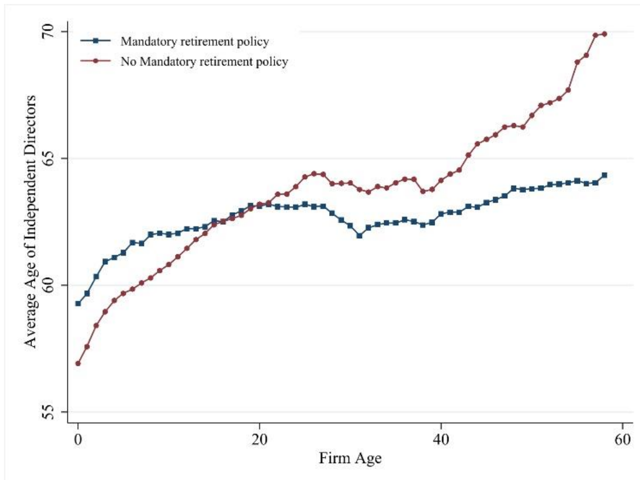


Figure 2. Distribution of firms that impose mandatory retirement policy for independent directors across Fama-French 12 industry classifications. This figure demonstrates the distribution of the mandatory retirement policy within the 12 Fama-French industry portfolios between 1994 and 2020. Groups 11 and 9, which correspond to financial and utility firms, are not shown in this figure because we omit financials (SIC 6000-6999) and utilities (SIC 4900-4949) from our dataset.

Panel A: Average age of independent directors



Panel B: Average tenure of independent directors

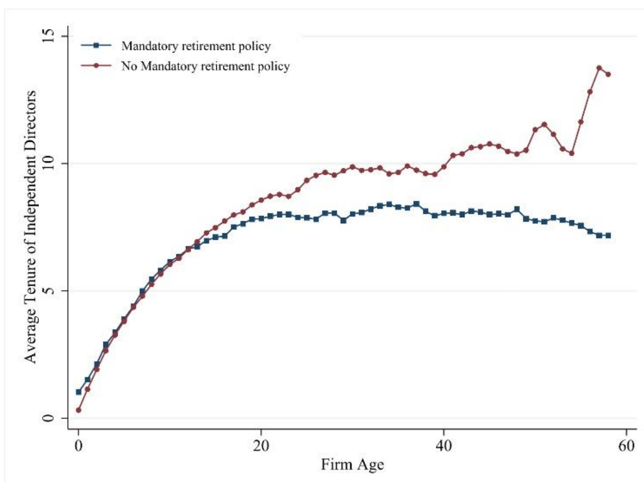
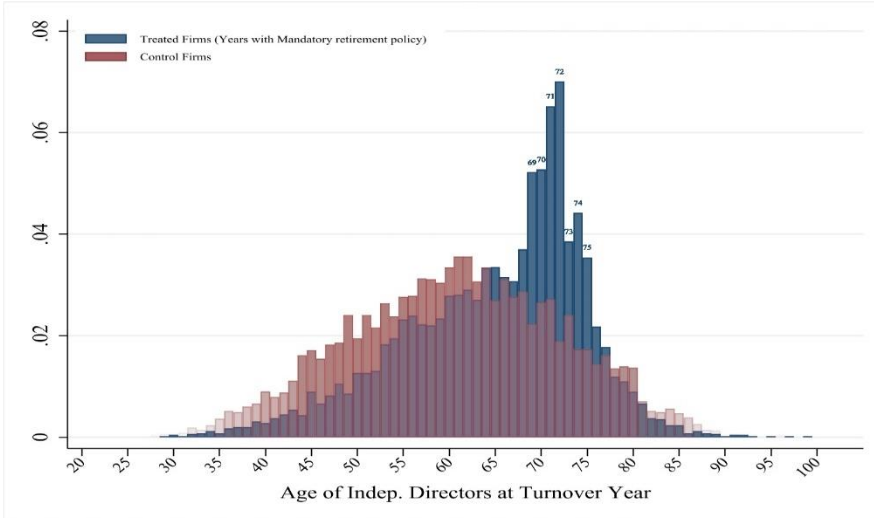


Figure 3. Impact of mandatory retirement policy for independent directors on independent directors' tenure and age. These figures show the average age (Figure A) and tenure (Figure B) of independent directors in firms that implemented the mandatory retirement policy between 1994 and 2020 and in firms that did not implement that policy based on the firm age.

Panel A The distribution of independent turnover age for firms with mandatory policy vs firms without mandatory retirement policy



Panel B The distribution of independent turnover age for firms before and after the implementation of mandatory retirement policy

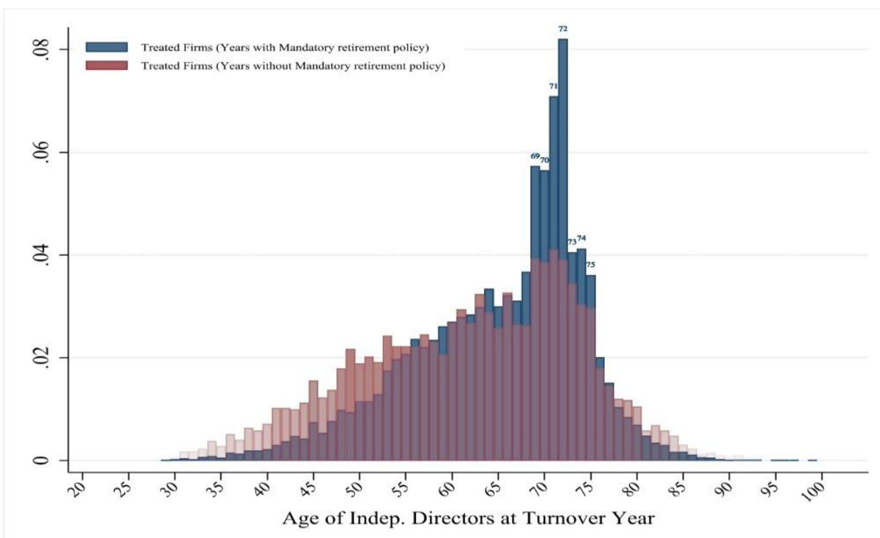


Figure 4. Distribution of independent director turnover age with or without mandatory retirement policy. Figure 4 Panel A shows the distribution of individual director turnover ages for firm-year observations with mandatory retirement policy vs firm-year observations without such policy (matched by similar firm size and industry). Figure 4 Panel B shows the distribution of individual director turnover ages for firm-year observations before and after the implementation of mandatory retirement policy.

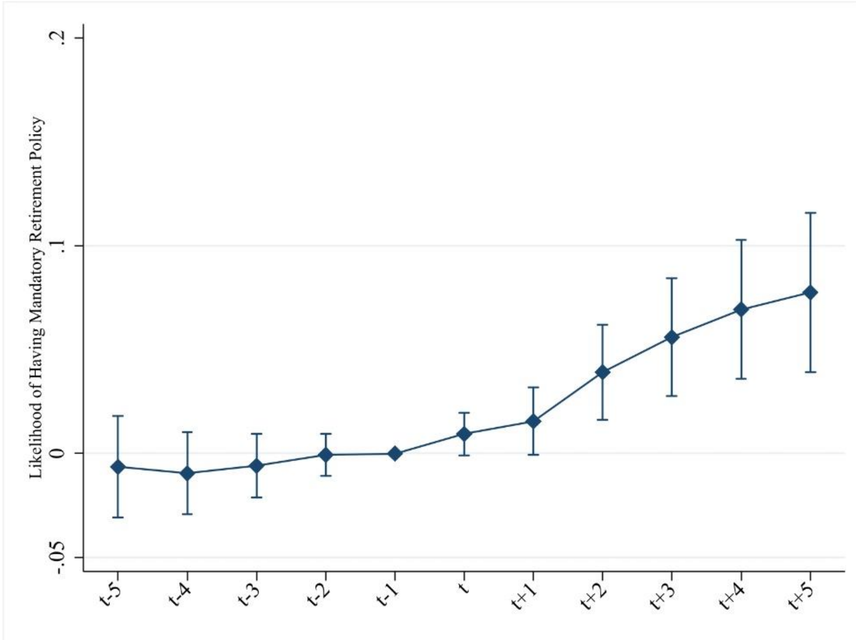


Figure 5. Effect of being added to the S&P 1500 on the likelihood of having mandatory retirement policy. This figure plots the coefficient from OLS regressions using a matched sample examining the effect of joining the S&P 1500 on the likelihood of having mandatory retirement policy.

$$Mandate\ Retirement\ Policy_{it} = \sum_{t=-5}^{5} \beta_t (Treat_i \times Time_t) + Controls + Firm/Year\ FE$$

The dependent variable mandatory retirement policy ($Mandate\ Retirement\ Policy_{it}$) is one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. $Treat_i$ equals one for the treatment firms that are added to the S&P 1500 Index, and zero otherwise. $Time_t$ equals one for observations in period t relative to the treatment year, and zero otherwise. $Time_{t-1}$ is the excluded based year. We control for firm-level characteristics used in Table 4, as well as firm and year fixed effects. 95% confidence intervals based on standard errors clustered by firm are reported.

Table 1

Sample Construction

This table presents the construction of the sample, which includes sample filters and the number of observations under each filter.

Sample filter	# of observations
CRPS-Compustat merged sample between 1994 and 2020 with non-missing CIKs and SICs	169,305
Exclude financial firms	(47,676)
Exclude utility firms	(3,868)
Initial Sample	117,671

Table 2
Descriptive statistics

This table shows summary statistics of the firm and board of directors' variables. The sample comprises 13,386 unique firms covering 117,761 firm-year observations from 1994 to 2020. This table presents the values of the variables' mean, median, standard deviation, 25th percentile, and 75th percentile. Continuous variables are winsorized at their 1st and 99th percentiles. The definitions of the variables are provided in Appendix A. We omit financials (SIC 6000-6999) and utilities (SIC 4900-4949) from our dataset.

Variable	N	Mean	SD	p25	Median	p75
Firm Characteristics						
Tobin's Q	117,068	2.209	1.910	1.132	1.561	2.470
FCFA	116,159	-0.051	0.265	-0.070	0.035	0.082
HHI	117,761	0.079	0.082	0.038	0.050	0.089
Asset Intangibility	117,425	0.734	0.242	0.606	0.818	0.925
R&D	117,546	0.063	0.128	0.000	0.002	0.070
Market Value of Equity ($ Millions)	117,182	4392.386	23340.233	61.940	303.687	1500.165
Firm Age	117,761	12.676	12.353	3.000	9.000	19.000
Num. of Bus. Segments	117,761	4.680	4.467	1.000	3.000	6.000
ROA	117,380	-0.075	0.307	-0.080	0.023	0.069
Num. of Analysts	117,761	5.286	6.453	1.000	3.000	7.250
IO	117,761	0.382	0.341	0.026	0.319	0.697
Board Characteristics						
Mandatory Retirement Policy	117,761	0.169	0.375	0.000	0.000	0.000
Independence Ratio	88,608	0.758	0.152	0.667	0.800	0.875
Board Size	88,673	7.939	2.554	6.000	8.000	9.000
CEO Chairman	87,879	0.475	0.499	0.000	0.000	1.000
CEO Retirement	84,067	0.223	0.416	0.000	0.000	0.000
Classified Board	94,137	0.460	0.498	0.000	0.000	1.000

Table 3
Sample Distribution

This table displays the sample distribution. Panel A details the annual allocation of companies that implemented the mandatory retirement policy for independent directors from 1994 to 2020, showing the percentage of these firms relative to the entire CRSP-Compustat merged sample and the (Non-) S&P 1500 firms. Panel B provides the number and percentage of companies implementing the mandatory retirement policy within the 12 Fama-French industry classifications. We omit financials (SIC 6000-6999) and utilities (SIC 4900-4949) from our dataset.

Panel A. Annual distribution of firms with the mandatory retirement policy in and outside of S&P 1500 firms and the entire CRSP-Compustat merged sample

Year	Mandatory retirement policy	Mandatory retirement policy (S&P 1500)	% of CRSP-Compustat	% of S&P 1500 firms	% of Non-S&P 1500 firms
1994	149	115	2.8%	11.9%	0.8%
1995	246	184	4.4%	15.5%	1.4%
1996	362	269	5.9%	21.0%	1.9%
1997	430	328	6.9%	25.5%	2.0%
1998	480	352	8.1%	28.4%	2.7%
1999	512	356	9.0%	29.7%	3.5%
2000	512	350	9.2%	29.2%	3.7%
2001	512	347	10.2%	29.3%	4.3%
2002	535	354	11.5%	30.2%	5.2%
2003	667	412	15.3%	35.6%	8.0%
2004	772	472	17.9%	40.6%	9.5%
2005	833	498	19.8%	43.2%	10.9%
2006	858	512	20.6%	44.7%	11.5%
2007	844	505	20.8%	44.1%	11.6%
2008	871	510	22.7%	46.4%	13.2%
2009	864	516	23.8%	46.1%	13.9%
2010	893	527	25.2%	48.5%	14.9%
2011	889	537	25.5%	48.6%	14.8%
2012	914	556	26.6%	50.5%	15.3%
2013	929	566	26.7%	51.0%	15.3%
2014	966	583	26.8%	53.4%	15.2%
2015	964	593	27.0%	54.9%	14.9%
2016	953	591	27.5%	54.4%	15.2%
2017	980	638	28.2%	55.5%	14.7%
2018	990	615	28.0%	57.0%	15.3%
2019	1005	563	28.2%	56.8%	17.2%
2020	993	619	26.5%	58.2%	14.0%
Total	19,923	12,468	16.9%	40.7%	8.6%

Panel B. Distribution of firms with mandatory retirement policy for independent directors within the Fama-French 12 industry classification.

Code	Name	Mandatory retirement policy	CRSP-Compustat	%
1	Non-Durables	1,623	7,323	22.2%
2	Durables	938	3,581	26.2%
3	Manufacturing	3,973	14,200	28.0%
4	Energy	1,448	6,165	23.5%
5	Chemicals	1,074	3,183	33.7%
6	Business Equipment	3,049	27,725	11.0%
7	Telecommunication	737	4,686	15.7%
9	Shops	2,335	13,643	17.1%
10	Healthcare	1,765	17,263	10.2%
12	Other	2,981	19,992	14.9%
Total		19,923	117,761	16.9%

Table 4
Determinants of the mandatory retirement policy for independent directors

This table displays the outcomes of OLS regressions (Column 7 is a probit model) that examine the connection between mandatory retirement policy for independent directors and firm characteristics related to the monitoring and advising benefits from 1994 to 2020. The dependent variable, *Mandatory Retirement Policy*, is one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. Variables associated with monitoring benefits are free cash flow (*FCFA*) and industry concentration (*HHI*). Characteristics of firms related to advising benefits include asset intangibility (*Asset Intangibility*) and R&D expenditure (*R&D*). Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable: Mandatory Retirement Policy						
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FCFA	0.123***				0.062***	-0.029**	0.258**
	(10.58)				(4.43)	(-2.20)	(2.01)
HHI		0.287***			0.286***	0.214***	0.709**
		(4.26)			(4.21)	(3.22)	(2.53)
Asset Intangibility			-0.106***		-0.093***	-0.070***	-0.411***
			(-4.17)		(-3.67)	(-2.92)	(-3.46)
R&D				-0.276***	-0.192***	-0.126***	-0.797***
				(-8.44)	(-5.70)	(-3.97)	(-2.83)
Firm Size						0.028***	0.126***
						(8.88)	(7.56)
Firm Age						0.009***	0.029***
						(20.35)	(17.99)
Num. of Bus. segments						0.004***	0.010**
						(3.78)	(2.40)
ROA		0.082***	0.079***	0.011			
		(8.86)	(8.52)	(1.05)			
Num. of Analysts	0.006***	0.006***	0.006***	0.006***	0.006***	0.001	-0.003
	(6.33)	(6.35)	(6.31)	(6.77)	(6.59)	(1.33)	(-0.84)
IO	0.119***	0.125***	0.125***	0.125***	0.119***	0.059***	0.388***
	(7.24)	(7.57)	(7.59)	(7.58)	(7.23)	(3.40)	(5.06)
Independence Ratio	0.301***	0.302***	0.301***	0.312***	0.308***	0.275***	2.270***
	(12.29)	(12.44)	(12.38)	(12.81)	(12.57)	(11.54)	(11.87)
Board Size	0.043***	0.043***	0.043***	0.042***	0.042***	0.023***	0.093***
	(20.87)	(21.12)	(20.87)	(20.69)	(20.50)	(11.21)	(10.37)
CEO Chairman	0.034***	0.034***	0.034***	0.031***	0.032***	0.015**	0.039
	(4.90)	(4.87)	(4.82)	(4.51)	(4.58)	(2.25)	(1.21)
CEO Retirement	-0.006	-0.005	-0.006	-0.006	-0.008	-0.034***	-0.095***
	(-0.85)	(-0.68)	(-0.84)	(-0.82)	(-1.07)	(-4.68)	(-2.95)
Classified Board	-0.023***	-0.022***	-0.024***	-0.022***	-0.022***	0.005	0.088**
	(-2.72)	(-2.70)	(-2.86)	(-2.63)	(-2.67)	(0.61)	(2.26)
Constant	-0.608***	-0.716***	-0.553***	-0.602***	-0.651***	-0.696***	-5.935***
	(-9.99)	(-11.22)	(-9.16)	(-10.53)	(-9.59)	(-10.41)	(-13.63)

Fixed effects	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year
R^2 /Pseudo R^2	0.260	0.259	0.260	0.261	0.264	0.329	0.341
Observations	67,855	68,300	68,237	68,300	67,814	67,795	67,655

Table 5
Determinants of the mandatory retirement policy for independent directors — S&P-indexed firms

The table presents the results of OLS regressions investigating the relation between mandatory retirement policy for independent directors and firm characteristics related to the monitoring and advising benefits for S&P 1500 firms from 1994 to 2020. The dependent variable, *Mandatory Retirement Policy*, is one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. *SP1500* variable is one if the firm is indexed in one of the S&P indices. X represents one of the proxies for monitoring benefits (*FCFA* and *HHI*), proxies for advising benefits (*Asset Intangibility* and *R&D*), *MONBEN*, and *ADVBEN*. *MONBEN* (Monitoring Benefits) is the factor extracted from *FCFA* and *HHI*. *ADVBEN* (Advising Benefits) is the factor extracted from *Asset Intangibility* and *R&D*. Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable: Mandatory Retirement Policy					
Independent variables	FCFA	HHI	Asset Intangibility	R&D	MONBEN	ADVBEN
SP1500	0.090***	0.086***	0.180***	0.119***	0.090***	0.091***
	(7.61)	(6.08)	(5.46)	(9.16)	(7.54)	(7.82)
X	0.001	0.165**	-0.042*	-0.129***	0.007*	-0.018***
	(0.14)	(2.27)	(-1.81)	(-4.48)	(1.84)	(-4.03)
X × SP1500	0.162***	0.151	-0.113***	-0.642***	0.028***	-0.046***
	(2.72)	(1.41)	(-2.75)	(-5.32)	(2.81)	(-4.24)
Firm Size	0.021***	0.023***	0.024***	0.023***	0.021***	0.025***
	(6.84)	(7.16)	(7.58)	(7.43)	(6.80)	(7.81)
Firm Age	0.008***	0.008***	0.008***	0.008***	0.008***	0.008***
	(17.85)	(18.04)	(17.97)	(17.85)	(17.84)	(17.82)
Num. of Bus. segments	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(3.71)	(3.85)	(3.91)	(3.50)	(3.74)	(3.71)
ROA		-0.016*	-0.017**	-0.049***		-0.043***
		(-1.84)	(-2.03)	(-5.20)		(-4.42)
Num. of Analysts	0.000	0.000	-0.000	0.001	0.000	-0.000
	(0.30)	(0.20)	(-0.15)	(0.53)	(0.31)	(-0.05)
IO	0.021	0.023	0.024	0.023	0.019	0.024
	(1.21)	(1.35)	(1.41)	(1.33)	(1.11)	(1.41)
Independence Ratio	0.263***	0.260***	0.259***	0.267***	0.263***	0.263***
	(11.20)	(11.18)	(11.13)	(11.46)	(11.20)	(11.28)
Board Size	0.022***	0.022***	0.022***	0.021***	0.023***	0.021***
	(11.15)	(11.12)	(10.88)	(10.42)	(11.21)	(10.49)
CEO Chairman	0.015**	0.015**	0.014**	0.012*	0.015**	0.013*
	(2.27)	(2.24)	(2.14)	(1.88)	(2.30)	(1.92)
CEO Retirement	-0.034***	-0.033***	-0.034***	-0.034***	-0.034***	-0.034***
	(-4.64)	(-4.49)	(-4.60)	(-4.58)	(-4.66)	(-4.66)
Classified Board	0.005	0.005	0.004	0.004	0.005	0.003
	(0.67)	(0.67)	(0.43)	(0.53)	(0.67)	(0.37)
Constant	-0.616***	-0.677***	-0.595***	-0.596***	-0.644***	-0.625***

	(-10.36)	(-10.85)	(-10.11)	(-10.71)	(-10.40)	(-10.88)
Fixed effects	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year
R^2	0.334	0.334	0.335	0.336	0.334	0.337
Observations	67,836	68,280	68,217	68,280	67,836	68,217

Table 6
Determinants of the mandatory retirement policy for independent directors –pre- and post-SOX

The table presents the results of OLS regressions investigating the impact of the enactment of the Sarbanes-Oxley Act (SOX) on relation between mandatory retirement policy for independent directors and firm characteristics related to the monitoring and advising benefits from 1994 to 2020. The dependent variable, *Mandatory Retirement Policy*, is one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. *POSTSOX* variable equals one if the sample year is after 2001. X represents one of the proxies for monitoring benefits (*FCFA* and *HHI*), proxies for advising benefits (*Asset Intangibility* and *R&D*), *MONBEN*, and *ADVBEN*. *MONBEN* (Monitoring Benefits) is the factor extracted from *FCFA* and *HHI*. *ADVBEN* (Advising Benefits) is the factor extracted from *Asset Intangibility* and *R&D*. Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable: Mandatory Retirement Policy					
Independent variables	FCFA	HHI	Asset Intangibility	R&D	MONBEN	ADVBEN
X	-0.078***	0.117	-0.016	-0.059**	-0.012***	-0.010**
	(-7.99)	(1.46)	(-0.67)	(-1.99)	(-3.07)	(-2.00)
X × POSTSOX	0.128***	0.118	-0.096***	-0.188***	0.031***	-0.026***
	(9.05)	(1.46)	(-3.88)	(-6.16)	(6.50)	(-5.78)
Firm Size	0.027***	0.028***	0.028***	0.028***	0.026***	0.029***
	(8.43)	(8.76)	(8.85)	(8.89)	(8.25)	(8.93)
Firm Age	0.009***	0.009***	0.009***	0.009***	0.009***	0.009***
	(20.49)	(20.75)	(20.75)	(20.59)	(20.42)	(20.55)
Num. of Bus. segments	0.005***	0.005***	0.005***	0.004***	0.005***	0.004***
	(3.93)	(4.14)	(4.09)	(3.71)	(3.94)	(3.75)
ROA		-0.018**	-0.021**	-0.068***		-0.062***
		(-2.08)	(-2.48)	(-6.69)		(-6.06)
Num. of Analysts	0.001	0.001	0.001	0.001	0.001	0.001
	(1.41)	(1.25)	(1.16)	(1.45)	(1.48)	(1.33)
IO	0.059***	0.064***	0.065***	0.063***	0.058***	0.063***
	(3.41)	(3.71)	(3.75)	(3.64)	(3.34)	(3.67)
Independence Ratio	0.272***	0.267***	0.267***	0.271***	0.271***	0.271***
	(11.48)	(11.33)	(11.36)	(11.50)	(11.41)	(11.48)
Board Size	0.023***	0.023***	0.023***	0.022***	0.024***	0.022***
	(11.57)	(11.44)	(11.29)	(11.17)	(11.60)	(11.08)
CEO Chairman	0.016**	0.016**	0.016**	0.014**	0.017**	0.014**
	(2.49)	(2.43)	(2.36)	(2.17)	(2.50)	(2.15)
CEO Retirement	-0.033***	-0.033***	-0.034***	-0.033***	-0.034***	-0.034***
	(-4.54)	(-4.41)	(-4.55)	(-4.49)	(-4.60)	(-4.60)
Classified Board	0.006	0.006	0.005	0.007	0.006	0.006
	(0.75)	(0.70)	(0.61)	(0.84)	(0.78)	(0.76)
Constant	-0.660***	-0.721***	-0.661***	-0.652***	-0.681***	-0.672***
	(-11.18)	(-11.34)	(-10.96)	(-11.60)	(-10.80)	(-11.36)
Fixed effects	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year

R^2	0.328	0.327	0.329	0.329	0.328	0.330
Observations	67,836	68,280	68,217	68,280	67,836	68,217

Table 7
Firm life cycle

The table presents the results of OLS regressions examining the relation between mandatory retirement policies for independent directors and firms' life cycles from 1994 to 2020. Panel A presents firm-specific life cycle measures constructed using cash flow statement data following Dickinson (2011). Dickinson (2011) argues that cash flows reflect a firm's profitability, growth, and risk characteristics. Accordingly, cash flows from operating activities (OANCF), investing activities (IVNCF), and financing activities (FINCF) are used to classify firms into different life cycle stages—namely, introduction, growth, maturity, decline, and shake-out. Detailed descriptions of these stages are provided in Panel A. Panel B reports the results of OLS regressions examining the relationship between mandatory retirement policies for independent directors and the corporate life cycle from 1994 to 2020. The dependent variable, *Mandatory Retirement Policy*, is equal to one if the firm has adopted a mandatory retirement age policy for independent directors, and zero otherwise. Life cycle stages are based on Dickinson (2011). In Column 6, the *Introduction* stage serves as the reference category; coefficients for other life cycle stages are interpreted relative to this baseline. Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Different life stages by Dickinson (2011)

	Cash Flow from:		
Firm stages	Operating (OANCF)	Investing (IVNCF)	Financing (FINCF)
Introduction	< 0	< 0	> 0
Growth	> 0	< 0	> 0
Maturity	> 0	< 0	< 0
Shake-Out	All Other combinations		
Decline	< 0	> 0	< 0 Or > 0

Panel B. Mandatory retirement policy for independent directors and firm life cycle

	Dependent variable: Mandatory Retirement Policy					
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)
Introduction (Life Cycle)	-0.016***					
	(-3.58)					
Growth (Life Cycle)		-0.025***				0.001
		(-5.69)				(0.24)
Mature (Life Cycle)			0.030***			0.036***
			(6.41)			(5.58)
Shake_Out (Life Cycle)				0.013**		0.030***
				(2.14)		(4.18)
Decline (Life cycle)					-0.010	0.001
					(-1.64)	(0.19)
Firm Size	0.028***	0.029***	0.028***	0.028***	0.028***	0.028***
	(8.86)	(8.97)	(8.79)	(8.89)	(8.79)	(8.85)
Firm Age	0.009***	0.009***	0.009***	0.009***	0.009***	0.009***
	(20.65)	(20.52)	(20.32)	(20.78)	(20.83)	(20.11)
Num. of Bus. segments	0.005***	0.005***	0.005***	0.005***	0.005***	0.005***
	(4.10)	(4.15)	(4.08)	(4.12)	(4.13)	(4.05)
ROA	-0.024***	-0.012	-0.029***	-0.019**	-0.021**	-0.033***
	(-3.00)	(-1.34)	(-3.50)	(-2.15)	(-2.43)	(-4.11)
Num. of Analysts	0.001	0.001	0.001	0.001	0.001	0.001
	(1.17)	(1.18)	(1.19)	(1.20)	(1.23)	(1.15)
IO	0.062***	0.067***	0.063***	0.064***	0.064***	0.063***
	(3.60)	(3.88)	(3.67)	(3.71)	(3.71)	(3.63)
Independence Ratio	0.266***	0.266***	0.267***	0.267***	0.268***	0.266***
	(11.32)	(11.32)	(11.35)	(11.34)	(11.37)	(11.33)
Board Size	0.023***	0.023***	0.023***	0.023***	0.023***	0.023***
	(11.37)	(11.27)	(11.21)	(11.38)	(11.39)	(11.16)
CEO Chairman	0.016**	0.016**	0.016**	0.016**	0.016**	0.016**
	(2.43)	(2.42)	(2.37)	(2.43)	(2.40)	(2.39)
CEO Retirement	-0.033***	-0.033***	-0.033***	-0.033***	-0.033***	-0.033***
	(-4.45)	(-4.41)	(-4.48)	(-4.41)	(-4.42)	(-4.49)
Classified Board	0.005	0.006	0.005	0.005	0.005	0.006
	(0.63)	(0.69)	(0.67)	(0.65)	(0.64)	(0.71)
Constant	-0.652***	-0.647***	-0.659***	-0.658***	-0.656***	-0.664***
	(-11.57)	(-11.54)	(-11.61)	(-11.72)	(-11.63)	(-11.76)
Fixed effects	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year	Ind., year
R^2	0.327	0.328	0.328	0.327	0.327	0.328

Observations	68,280	68,280	68,280	68,280	68,280	68,280

Table 8
Mandatory retirement policy for independent directors and firm value

This table presents the results of OLS investigating the relation between firm value (Tobin's Q) and mandatory retirement policy for independent directors by controlling for various firm characteristics from 1994 to 2020. The dependent variable, *Tobin's Q*, is defined as the ratio of the book value of assets plus the market value of common equity minus the book value of common equity to the book value of assets. *Mandatory Retirement Policy* is set to one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Independent variables	Tobin's Q	Tobin's Q	Tobin's Q	Tobin's Q
Mandatory Retirement Policy	-0.299***	-0.303***	-0.243***	0.065*
	(-8.18)	(-8.27)	(-7.15)	(1.69)
Firm Size	0.466***	0.466***	0.449***	0.381***
	(33.70)	(33.36)	(32.98)	(23.35)
Firm Age	-0.008***	-0.009***	-0.008***	-0.006
	(-6.83)	(-6.98)	(-6.51)	(-1.45)
Num. of Bus. segments	-0.043***	-0.042***	-0.039***	-0.014***
	(-14.83)	(-13.47)	(-13.08)	(-5.10)
ROA	-1.945***	-1.939***	-1.629***	-0.681***
	(-25.05)	(-24.36)	(-19.63)	(-9.80)
Num. of Analysts	-0.023***	-0.024***	-0.022***	-0.042***
	(-6.87)	(-7.05)	(-6.77)	(-10.39)
IO	-0.729***	-0.712***	-0.676***	-0.552***
	(-13.12)	(-12.43)	(-12.21)	(-9.14)
Independence Ratio	-0.108	-0.107	-0.283***	-0.064
	(-1.12)	(-1.02)	(-2.83)	(-0.68)
Board Size	-0.129***	-0.129***	-0.112***	-0.061***
	(-18.51)	(-18.33)	(-16.46)	(-10.08)
CEO Chairman	-0.093***	-0.083***	-0.057**	-0.015
	(-3.97)	(-3.41)	(-2.50)	(-0.69)
CEO Retirement	-0.055**	-0.061**	-0.026	0.043**
	(-2.13)	(-2.32)	(-1.04)	(2.15)
Classified Board	0.007	0.006	-0.045*	-0.049
	(0.23)	(0.23)	(-1.66)	(-1.09)
Constant	1.364***	1.353***	1.400***	1.096***
	(18.22)	(16.59)	(18.21)	(9.23)
Fixed effects	No	Year	Ind, Year	Firm, year

R^2	0.189	0.187	0.151	0.046
Observations	68,161	68,161	68,161	66,997

Table 9
Mandatory retirement policy and firm value: reverse causality tests

This table presents the results for the adoption of a mandatory retirement policy as a function of the valuation of the firm (as captured by Tobin's Q in year t-1) plus other characteristics. The sample includes all firms that do not have a Mandatory Retirement Policy until the year in which they adopt mandatory retirement policy, and are dropped from the sample afterward. The dependent variable, *Mandatory Retirement Policy,* is set to one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. We use linear probability model in column (1), probit in column (2), and Cox proportional hazard model in column (3). Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
Independent variables	Mandatory Retirement Policy		
Tobin's Q [t-1]	-0.008***	-0.060***	-0.056**
	(-3.65)	(-3.67)	(-1.96)
FCFA	-0.021	-0.124	0.625**
	(-0.80)	(-0.75)	(2.19)
HHI	0.087	0.392	-0.638*
	(1.31)	(1.14)	(-1.73)
Asset Intangibility	-0.009	-0.043	-0.291
	(-0.40)	(-0.36)	(-1.60)
R&D	0.013	0.047	0.542
	(0.27)	(0.16)	(1.09)
Firm Size	-0.001	-0.005	-0.121***
	(-0.24)	(-0.22)	(-3.00)
Firm Age	0.001***	0.005***	0.011***
	(2.86)	(2.96)	(3.02)
Num. of Bus. segments	0.000	0.001	-0.021***
	(0.13)	(0.15)	(-2.59)
Num. of Analysts	0.001	0.005	0.012
	(1.12)	(1.28)	(1.41)
IO	-0.005	-0.023	-0.514***
	(-0.35)	(-0.30)	(-3.38)
Independence Ratio	0.096***	0.686***	-1.544***
	(3.81)	(3.73)	(-4.51)
Board Size	0.006***	0.034***	0.148***
	(3.61)	(3.52)	(7.30)
CEO Chairman	-0.002	-0.020	0.356***
	(-0.24)	(-0.54)	(4.85)
CEO Retirement	-0.022**	-0.107**	-0.522***

	(-2.51)	(-2.31)	(-6.44)
Classified Board	-0.002	0.008	0.130
	(-0.26)	(0.20)	(1.59)
Constant	Yes	Yes	Yes
Fixed effects	Ind, Year	Ind, Year	None
R^2	0.088	0.086	0.017
Observations	9,747	9,700	9,747

Table 10
Mandatory retirement policy and firm value: matched samples

This table presents matched-sample difference-in-differences (DID) analyses examining the relation between firm value (*Tobin's Q*) and mandatory retirement policies for independent directors, controlling for various firm characteristics from 1994 to 2020. The sample includes treated firms (those that adopt a mandatory retirement policy) and their matched peers, covering the period from t–5 to t+5. The dependent variable, *Tobin's Q*, is defined as the ratio of the book value of assets plus the market value of common equity minus the book value of common equity to the book value of assets. We construct matched samples by pairing treatment firms in the adoption year (t) with control firms that do not adopt a mandatory retirement policy during the sample period. Two matching methods are used. In Columns (1) and (3), treatment firms are matched with control firms of similar size (within 20% of firm size in year t) and the same two-digit SIC code. In Columns (2) and (4), we use propensity scores estimated from the determinants model in Table 4, Column (7), and select control firms with the closest propensity score (within a 2% caliper) and in the same two-digit SIC industry. The dependent variable, *Mandatory Retirement Policy,* is set to one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. All control variables are lagged. Definitions of variables are provided in Appendix A. T-statistics, reported in parentheses, are based on standard errors clustered by firm. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Independent variables	Tobin's Q	Tobin's Q	Tobin's Q	Tobin's Q
POST × TREATMENT (-5,+5)	0.085**	0.078*		
	(2.05)	(1.89)		
Pre5 × TREATMENT			-0.043	-0.029
			(-0.65)	(-0.44)
Pre4 × TREATMENT			-0.009	-0.032
			(-0.15)	(-0.52)
Pre3 × TREATMENT			0.013	0.002
			(0.26)	(0.03)
Pre2 × TREATMENT			0.059	0.058
			(1.47)	(1.47)
Adopt × TREATMENT			0.065*	0.066**
			(1.92)	(2.11)
Post1 × TREATMENT			0.103**	0.109***
			(2.49)	(2.75)
Post2 × TREATMENT			0.133***	0.074
			(2.74)	(1.57)
Post3 × TREATMENT			0.132**	0.093*
			(2.38)	(1.69)
Post4 × TREATMENT			0.209***	0.137**
			(3.14)	(2.08)
Post5 × TREATMENT			0.238***	0.202***

			(3.22)	(2.73)
Control	Yes	Yes	Yes	Yes
Fixed effects	Firm, year	Firm, year	Firm, year	Firm, year
R^2	0.052	0.052	0.053	0.053
Observations	14,585	14,300	14,585	14,300

Table 11
Mandatory retirement policy and firm value in a dynamic GMM framework

This table presents the results for pooled system GMM Tobin's Q regressions on mandatory retirement policy for independent directors and control variables, allowing for the first and second lags of the dependent variable. In this system GMM estimation, we treat all firm-level control variables as endogenous, except for year fixed effects. The dependent variable, *Tobin's Q*, is defined as the ratio of the book value of assets plus the market value of common equity minus the book value of common equity to the book value of assets. *Mandatory Retirement Policy* is set to one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. The endogenous variables are instrumented using their third- and fourth-year lags (t–3 and t–4) in the first-differenced equation. The level equation additionally includes as instruments: (1) the percentage of industry sales from firms with a mandatory retirement policy in year t–5 in Column (1), (2) the percentage of industry sales from firms that adopted the policy in year t–5 in Column (2), and a combination of these two instruments in Column (3). Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
Independent variables	Tobin's Q	Tobin's Q	Tobin's Q
Tobin's Q [t-1]	0.614***	0.664***	0.658***
	(3.31)	(3.96)	(4.21)
Tobin's Q [t-2]	-0.034	-0.021	-0.060
	(-0.31)	(-0.19)	(-0.64)
Mandatory retirement policy	0.511***	0.583***	0.542***
	(2.76)	(3.12)	(3.16)
FCFA	-1.254*	-1.376**	-1.215*
	(-1.88)	(-1.97)	(-1.82)
HHI	-8.211***	-5.250*	-7.784***
	(-3.22)	(-1.85)	(-3.46)
R&D	-0.497	-3.952	-0.858
	(-0.24)	(-1.24)	(-0.47)
Asset Intangibility	-1.567	-4.269**	-2.150**
	(-1.01)	(-2.21)	(-2.49)
Firm Size	-0.292	-0.769	-0.276
	(-1.31)	(-1.57)	(-1.24)
Firm Age	-0.042***	-0.097**	-0.043***
	(-2.72)	(-2.00)	(-2.71)
Num. of Bus. segments	-0.002	-0.017	-0.002
	(-0.21)	(-1.01)	(-0.21)
Num. of Analysts	0.013	0.018	0.015
	(0.83)	(1.05)	(0.96)
IO	-0.970***	-1.200***	-0.962***
	(-3.53)	(-3.32)	(-3.50)
Independence Ratio	-1.052	-3.075*	-1.279
	(-0.84)	(-1.70)	(-1.09)
Board Size	-0.125**	-0.158***	-0.128***
	(-2.57)	(-2.97)	(-2.68)
CEO_Chairman	-0.171*	-0.193*	-0.177*
	(-1.73)	(-1.82)	(-1.81)
CEO_Retirement	0.057	0.092	0.054

	(0.84)	(1.13)	(0.81)
Classified Board	0.022	-0.130	0.020
	(0.09)	(-0.45)	(0.08)
Constant	7.386***	14.613**	7.878***
	(2.96)	(2.44)	(3.45)
Observations	47,732	47,733	47,732
F-stat	361.78	139.92	360.95
AR(1) test (p-value)	0.00	0.01	0.00
AR(2) test (p-value)	0.27	0.35	0.12
Sargan test of overid. (p-value)	0.13	0.14	0.18
Hansen test of overid. (p-value)	0.11	0.18	0.15

Table 12
Channel Analysis

The table presents the results of OLS regressions examining the relation between mandatory retirement policies for independent directors and various board outcomes from 1994 to 2020. Results are reported for horizons from year t+1 to year t+3. The dependent variables are the ratio of female directors in year t+1 and t+3 (Columns 1 and 2) and the ratio of foreign directors in year t+1 and t+3 (Columns 3 and 4). *Mandatory Retirement Policy* is set to one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. Variable definitions are provided in Appendix A. T-statistics (in parentheses) are calculated using standard errors clustered by firm. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Independent variables	(1) Female Director [t+1]	(2) Female Director [t+3]	(3) Foreign Director [t+1]	(4) Foreign Director [t+3]
Mandatory retirement policy	0.012***	0.007**	0.013**	0.011**
	(4.04)	(2.25)	(2.50)	(1.97)
Firm Size	0.003***	0.002**	0.004**	0.003**
	(2.92)	(2.47)	(2.39)	(1.99)
Firm Age	0.001	0.001	-0.002	-0.001
	(1.58)	(1.39)	(-1.48)	(-1.30)
Num. of Bus. segments	0.000	0.000*	-0.001	-0.000
	(1.64)	(1.78)	(-1.49)	(-1.03)
ROA	0.005*	0.001	0.002	-0.001
	(1.69)	(0.27)	(0.36)	(-0.23)
Num. of Analysts	0.001***	0.001***	0.000	0.000
	(3.85)	(3.60)	(0.61)	(1.36)
IO	0.007**	0.011***	-0.017**	-0.012*
	(1.97)	(2.68)	(-2.35)	(-1.71)
Independence Ratio	0.028***	0.006	0.024*	-0.009
	(3.18)	(0.91)	(1.74)	(-0.73)
Board Size	0.001	0.001**	0.003***	0.002***
	(1.55)	(2.16)	(3.32)	(2.84)
CEO_Chairman	0.000	-0.003*	0.001	-0.001
	(0.26)	(-1.88)	(0.34)	(-0.18)
CEO_Retirement	-0.003**	-0.002	-0.001	-0.001
	(-2.04)	(-1.10)	(-0.30)	(-0.39)
Classified Board	-0.013***	-0.011***	-0.000	0.000
	(-3.91)	(-3.16)	(-0.03)	(0.04)
Constant	0.042***	0.063***	0.058**	0.079***
	(3.49)	(5.28)	(2.25)	(3.43)
Fixed effects	Firm, Year	Firm, Year	Firm, Year	Firm, Year
R^2	0.748	0.750	0.722	0.722
Observations	47,626	41,743	44,789	39,280

Appendix A. Variable definitions

Variable	Definition
Tobin's Q	Tobin's Q is the ratio of the book value of assets plus the market value of common equity minus the book value of common equity to the book value of assets.
FCFA	Free Cash Flow is earnings plus depreciation minus capital expenditure divided by total assets.
HHI	The Herfindahl index of industry sales is calculated using data on Compustat-listed firms.
Asset Intangibility	Asset Intangibility is one minus Property, Plant, and Equipment over total assets.
R&D	R&D is R&D expenditure over total assets (xrd/at, with xrd=0 if missing)
Firm Size	Firm size is the natural logarithm of the market value of equity.
Firm Age	The number of years since the firm first appeared on CRSP.
Num. of Bus. segments	The number of business segments.
ROA	Return on assets is as income before extraordinary items over total assets.
Num. of Analysts	Num. of Analysts is the number of analysts following the firm in a fiscal year.
IO	IO is the fraction of the firm owned by institutions.
Mandatory retirement policy	An Indicator variable set to one if the firm adopted a mandatory retirement policy by age for the independent directors zero otherwise. (carried forward)
Independence Ratio	Board independence is the ratio of independent directors to the total size of the board.
Board Size	Board size is the number of directors on the board.
CEO Chairman	An indicator variable is set to one if the CEO is also the chairman of the board of directors and zero otherwise.
CEO Retirement	An indicator variable is set to one if the CEO is over 65 years old and zero otherwise.
Classified Board	An indicator variable is set to one if the board structure is staggered and zero otherwise.
Female Director	The proportion of female directors on the board.
Foreign Director	The proportion of non-American directors on the board.

The Role of Mandatory Director Retirement Policies in Corporate Governance

INTERNET APPENDIX

Appendix IA1. Some examples of the mandatory retirement policy in the firms' documents on the EDGAR system:

- Apple Inc. proxy statement on January 11, 2024:

  "After years of dedicated and valuable service, James Bell and Al Gore will be retiring from the Board effective as of the 2024 Annual Meeting, having reached the age of 75."

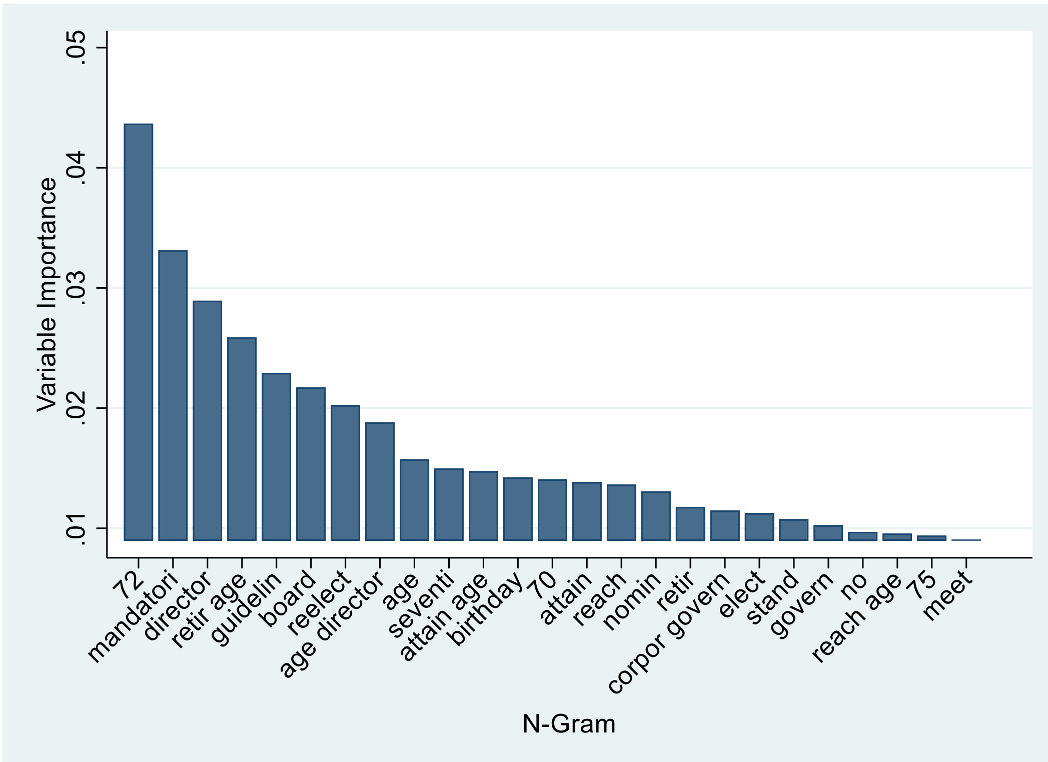
- Delta Air Lines proxy statement on May 10, 2024 (under the BOARD COMPOSITION AND REFRESHMENT section):

  "Retirement age of 72 for outside directors."

- TARGET CORP proxy statement on April 29, 2024 (under the Corporate governance highlights section):

  "Our director tenure policies include mandatory retirement at age 75 and a maximum term limit of 20 years. These policies encourage Board refreshment and provide additional opportunities to maintain a balanced mix of perspectives and experiences."

Appendix IA2 Variable importance.
This figure tabulates the variable importance values of the top 25 N-Grams that predict a firm's mandatory retirement status.



Appendix IA3. Mandatory retirement policy and director tenure

The table presents the results of OLS estimations investigating the relation between director tenure and mandatory retirement policy for independent directors by controlling for various firm characteristics from 1994 to 2020. The dependent variable, *Director Tenure*, is defined as average director tenure. *Mandatory Retirement Policy* is set to one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Indep. Dir. Tenure (Avg.)
Independent variables	(1)
Mandatory Retirement Policy	-0.834***
	(-6.21)
MONBEN	0.126**
	(2.17)
ADVBEN	0.046
	(0.75)
Firm Size	-0.003
	(-0.09)
Firm Age	0.030
	(1.45)
Num. of Bus. segments	0.002
	(0.18)
Num. of Analysts	0.044***
	(5.57)
IO	0.791***
	(5.00)
Independence Ratio	-0.330
	(-0.84)
Board Size	0.049**
	(2.41)
CEO Chairman	-0.092
	(-1.30)
CEO Retirement	0.257***
	(3.99)
Classified Board	0.499***
	(3.67)
Constant	6.062***
	(11.07)
Fixed effects	Firm, year
R^2	0.106
Observations	47,481

Appendix IA4. Mandatory retirement policy and firm value: controlling lagged firm value in the cross-sectional tests

This table presents the results of OLS investigating the relation between firm value (Tobin's Q) and mandatory retirement policy for independent directors by controlling for various firm characteristics and lagged Tobin's Q from 1994 to 2020. The dependent variable, *Tobin's Q*, is defined as the ratio of the book value of assets plus the market value of common equity minus the book value of common equity to the book value of assets. *Mandatory Retirement Policy* is set to one if the firm adopted a mandatory retirement policy by age for independent directors and zero otherwise. Definitions of variables are provided in Appendix A. All control variables are lagged. T-statistics in parentheses are calculated from standard errors clustered by firm. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
	Tobin's Q	Tobin's Q	Tobin's Q
Mandatory retirement policy	-0.043***	-0.050***	-0.038***
	(-3.01)	(-3.62)	(-2.79)
Tobin's Q [t-1]	0.683***	0.690***	0.672***
	(90.63)	(94.10)	(86.56)
Firm Size	-0.007	-0.006	-0.007
	(-1.30)	(-1.10)	(-1.31)
Firm Age	0.001	0.000	0.000
	(1.61)	(0.25)	(0.07)
Num. of Bus. segments	-0.008***	-0.007***	-0.007***
	(-7.47)	(-6.20)	(-6.02)
ROA	-0.549***	-0.498***	-0.413***
	(-14.41)	(-12.86)	(-10.24)
Num. of Analysts	0.014***	0.012***	0.014***
	(10.42)	(9.63)	(10.48)
IO	-0.007	-0.031	-0.013
	(-0.33)	(-1.42)	(-0.60)
Independence Ratio	0.211***	0.101**	0.036
	(4.83)	(2.15)	(0.77)
Board Size	-0.010***	-0.007**	-0.006**
	(-3.57)	(-2.47)	(-2.18)
CEO_Chairman	-0.040***	-0.016	-0.008
	(-3.93)	(-1.50)	(-0.78)
CEO_Retirement	0.011	-0.018	-0.012
	(1.01)	(-1.60)	(-1.03)
Classified Board	-0.004	0.000	-0.014
	(-0.33)	(0.00)	(-1.22)
Constant	0.552***	0.609***	0.688***
	(16.05)	(16.71)	(18.35)
Fixed effects	NO	Year	Ind., year
R^2	0.551	0.561	0.518
Observations	68,161	68,161	68,161