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Does Board Overlap Promote Coordination Between Firms?

Finance Working Paper N° 803/2021
October 2022

Heng Geng
Victoria University of Wellington

Harald Hau
University of Geneva, CEPR, Swiss Finance Institute and ECGI

Roni Michaely
University of Hong Kong and ECGI

Binh Nguyen
Victoria University of Wellington

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We are grateful to the seminar participants at the Frankfurt School of Finance and Management, the annual SFI Research Conference, the 2021 China International Conference in Finance, and New Zealand Finance Colloquium (2022) for feedback. Particular thanks extend to Tobias Berg, Ofer Eldar, Falko Fecht, Jan Feld, Jillian Grennan, Martin Schmalz, Sascha Steffen, and Hannes Wagner and conference participants of EFA 2021 and CICF 2021 for their helpful comments on an earlier draft.

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Abstract

We investigate how board overlap affects coordination and performance among public firms. Our identification exploits the staggered introduction of Corporate Opportunity Waivers (COWs) in nine U.S. states since 2000. By reducing legal risk to directors serving on multiple boards, the COW legislation increased intra-industry board overlap for research-intensive firms that benefit most from coordination. We find that intra-industry board overlap results in greater sales revenues, increased operating margins, and higher firm profitability. These outcomes are achieved through reduced investment and lower R&D expenditure, greater bilateral product differentiation, and more information sharing reflected in higher rates of patent cross-citation.

Keywords: Board overlap, corporate opportunity waivers, firm coordination

JEL Classifications: G30, G38, K21, K22

Heng Geng
Lecturer
Victoria University of Wellington, School of Economics and Finance,
Rutherford House, 23 Lambton Quay
Wellington 6012, New Zealand
e-mail: griffin.geng@vuw.ac.nz

Harald Hau*
Professor of Finance
University of Geneva, Geneva School of Economics and Management
42 Bd du Pont d'Arve
CH1204 Genève, Switzerland
phone: +41 22 379 9581
e-mail: prof@haraldhau.com

Roni Michaely
Professor of Finance and Entrepreneurship
University of Hong Kong, HKU Business School
Pokfulam Road
Hong Kong, Pokfulam HK, China
e-mail: ronim@hku.hk

Binh Nguyen
Senior Lecturer in Data Science
Victoria University of Wellington, School of Mathematics and Statistics,
Rutherford House, 23 Lambton Quay
Wellington 6012, New Zealand
e-mail: binh.nguyen@vuw.ac.nz

*Corresponding Author

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Heng Geng
Victoria University of Wellington

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University of Geneva, Swiss Finance Institute, and CEPR

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Binh Nguyen****

RMIT University Vietnam

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*School of Economics and Finance, Rutherford House, 23 Lambton Quay, Wellington, New Zealand. E-mail: griffin.geng@vuw.ac.nz. **Geneva Finance Research Institute, 42 Boulevard du Pont d'Arve, 1211 Genève 4, Switzerland. E-mail: prof@haraldhau.com. ***HKU Business School, K.K. Leung Building, Hong Kong. E-mail: ronim@hku.hk. ****School of Business and Management, 702 Nguyen Van Linh District 7, Ho Chi Minh City, Vietnam. E-mail: binh.nguyen44@rmit.edu.vn. We are grateful to the seminar participants at the Frankfurt School of Finance and Management, the annual SFI Research Conference, the 2021 China International Conference in Finance, and New Zealand Finance Colloquium (2022) for feedback. Particular thanks extend to Tobias Berg, Ofer Eldar, Falko Fecht, Jan Feld, Jillian Grennan, Martin Schmalz, Sascha Steffen, and Hannes Wagner and conference participants of EFA 2021 and CICF 2021 for their helpful comments on an earlier draft. The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

1 Introduction

Board overlap is a common feature of modern corporations and has been the subject of policy debate since the early 20th century. Predicated on the notion that board overlap between competing firms impedes competition, the Clayton Act of 1914 outlawed board overlap between direct competitors. But social science research has struggled to produce convincing evidence on whether board overlap limits firm competition. The early empirical literature on the consequences of board overlap suffered from data and measurement shortcomings due to limited board and corporate data. Since the 1980s, these issues have been superseded by methodological concerns about proper identification stemming from the endogenous nature of board composition (Mizruchi, 1996; Hermalin and Weisbach, 2001). While a more recent debate has centered on the controversial coordinating role of overlapping shareholders (Azar, Schmalz, and Tecu, 2018; Eldar, Grennan, and Waldock, 2020), much less attention has been devoted to the question of whether board overlap affects firms' performance.

On the one hand, two agency conflicts of board overlap may adversely affect firm performance. First, servicing on the board of multiple firms dilutes the commitment of interlocked directors and thus compromises the effectiveness of board monitoring (Core, Holthausen, and Larcker, 1999; Fich and Shivdasani, 2006; Field, Lowry, and Mkrtchyan, 2013). Second, legal scholars have questioned if interlocked directors can always uphold an undivided fiduciary duty of loyalty and contend that conflicts of interest could arise when interlocked firms have business overlap (Talley, 1998).

On the other hand, board overlap may improve firm performance by facilitating better coordination across firms. The firm coordination may include information exchange and collaboration on new commercial and/or technological opportunities or even take on a collusive nature in pursuit of enhanced market power (Azar, Schmalz, and Tecu, 2018). Important for coordination stability, interlocked directors can deter cheating on coordination agreements (Harrington and Skrzypacz, 2011) because they uniquely enhance the mutual observability of the strategic decision-making among collaborating firms. Equally important, board overlap can mitigate the issues of contractual incompleteness that undermine the enforceability of the collaborating agreement *ex post* (Dasgupta, Zhang, and Zhu, 2021). Board overlap can stabilize firm coordination by facilitating continuous adaptation and re-negotiation.[1]

Conceptually, the benefits of coordination can originate from the interaction between board overlap and two types of spillovers distinguished by Bloom et al. (2013): (i) a positive spillover, which refers to the diffusion of technological and commercial opportunities from one firm to another, and (ii) a negative spillover inherent in firm rivalry. Board overlap can facilitate the positive spillover by accelerating the diffusion and exploitation of new technological and commercial opportunities as well as mitigate the negative spillover by softening competition. Importantly, as both types of spillovers are most pronounced in R&D-intensive sectors and among firms competing in the same product market[2], the benefit of coordination by board overlap should be greatest in these firms. Accordingly, our empirical focus is on R&D-intensive firms that operate in the same industry.

An important obstacle to documenting the causal effects of board overlap on corporate outcomes is the difficulty of isolating exogenous influences (Hermalin and Weisbach, 2001). Our paper overcomes this challenge by exploiting a major change in U.S. corporate law, namely the introduction of Corporate Opportunity Waivers (COWs), which removed a roadblock for establishing board overlap between U.S. firms. Before the law change, corporate directors were bound by the corporate opportunity doctrine, which prohibits directors from pursuing outside corporate opportunities without first presenting them to the company on the board of which they serve. The doctrine generates potential legal risks for directors appointed to multiple boards. If any business opportunity that such a director learns about in his or her capacity as the director of the first firm also affects the second firm, questions arise as to whether this interlocked director can fulfill his/her fiduciary duties to both firms. The New York supreme court judge Bernard Shientag highlights this legal conflict as follows: "It is only when a business opportunity arises which places the director in a position of servicing two masters, and when, dominated by one, he neglects his duty to the other, then a wrong has been done." The introduction

[1]The contractual incompleteness refers to the difficulty of foreseeing and contracting all possible contingencies in an *ex ante* contracting. In a related study, Geng, Hau, and Lai (2021) show that common shareholders can alleviate patent holdup problems by facilitating contract re-negotiation between upstream and downstream innovators *ex post*.

[2]Both spillovers are stronger for firms in the same industry because these firms are more likely to benefit from each other's spillover of opportunities and engage with more intense firm rivalry due to similar product offerings. The spillovers are prevalent in R&D intensive sectors because a firm's R&D expenditure can benefit other firms' productivity through knowledge spillovers but can also hurt rival firms if product cycles accelerate and their products become obsolescent (Bloom et al., 2016).

of COWs explicitly allows the suspension of the corporate opportunity doctrine by means of private contracting, thus eliminating an important deterrence for the establishment of board overlap.

We argue that the timing of the COW legislation is exogenous to firm performance and product market structure. First, the COW legislation itself occurred in response to two specific Delaware court decisions, which highlight that directors' fiduciary duty could only be made contractible if changes to state corporate law would explicitly allow this. The particular timing of these verdicts is related to Delaware's legal history and unlikely to be related to any macroeconomic events—making the COW legislation exogenous to macroeconomic conditions. Second, board overlap among public firms does not appear to have been the legal intent behind the COW legislation. Prior to the legislation, the debate focused on how the fiduciary duty of loyalty had adversely impacted financing for small private firms, and public firms were seldom concerned. Third, examining the lobbying scripts for COWs, Eldar, Grennan, and Waldock (2020) do not find evidence of lobbying by public firms.[3]

We note that the law only matters for board overlap between intra-industry firms. The corporate opportunity doctrine represents an effective obstacle to board overlap only if such board overlap occurs between firms with overlapping lines of business, i.e., mostly firms in the same industry. Generally, courts require a director's breach of fiduciary duty to occur in the firm's line of business (Talley, 1998). Hence, within overlapping business lines, any corporate opportunity developed by one firm can be alleged to result from a fiduciary failure by the interlocked director with respect to the second firm.

The first part of the analysis (in Section 3) explores the effect of the COW legislation on board overlap and its consequence on firm performance. We highlight two main results: First, the corporate liability reform triggered an economically significant increase in intra-industry board overlap by 2.7 percentage points (or 12.7 percent of the mean) among firms with high

[3]Critics of the corporate opportunity doctrine argue that the duty of loyalty impedes firms' ability to raise capital. However, these critics point toward small private firms often held by venture capital and private equity, which found it difficult to invest in multiple firms in the same industry before the COW legislation. These investors usually require a board seat as a condition for investment, and the joint board representation by a common investor would be considered a breach of fiduciary duty. By contrast, institutional investment in public firms does not usually condition on board representation (Geng, Hau, Michaely, and Nguyen, 2022). Thus the law's intent of facilitating firm financing is less relevant to public firms. Consistent with this line of argument, Eldar, Grennan, and Waldock (2020) find that the COW legislation significantly improves startup financing ability and contributes to startup success.

R&D intensity, but not for firms with low R&D intensity. Given a mean corporate board size of eight members, this corresponds to roughly one new intra-industry board overlap for every fifth firm ($0.027 \times 8 = 21.6\%$). We observe no parallel increase in board overlap between research intensive firms operating in different industries. Our baseline analysis defines the industry at the level of three-digit SIC codes. Our main empirical findings remain unchanged if we use four-digit NAICS codes instead or if we infer firm rivalry from a textual analysis of product similarity (Hoberg and Phillips, 2010).

Second, firms experiencing an increase in intra-industry board overlap show systematically higher profitability as measured by a higher return on assets (ROA), a higher gross profit margin, a bigger operating margin, increased sales revenue, reduced costs, and a lower cost share relative to sales. The estimated effects suggest a 5.3% average increase in sales revenue and a simultaneous reduction in costs of goods sold (COGS) by 5.2% for an additional one percentage point of intra-industry board overlap, which is economically large. The evidence of increased profitability is consistent with intra-industry board overlap facilitating coordination between firms.

The second part of the analysis (in Section 4) identifies three different channels through which board overlap facilitates firms' cooperation and increases firms' profitability. Mapping into the conceptual framework discussed earlier, we respectively provide evidence on how board overlap attenuates negative spillovers and promotes positive spillovers.

First, we show that new intra-industry board overlap has statistically and economically strong negative effects on general investment expenditure, R&D expenditure, and patenting activities. The evidence suggests that firms seek to soften firm rivalry by reducing investment in new products or product innovation. The reduced investments can result from higher investment efficiency if improved corporate governance due to increased board overlap eliminates wasteful spending. But such an interpretation is less plausible because overinvestments (e.g., empire building) mostly occur among firms with high free cash flows (Jensen and Meckling, 1976). The research intensive firms in the sample feature a very weak cash flow and feature a negative average operating margin. Hence, they are unlikely to be afflicted by free cash flow problems.[4]

The second channel of firm coordination under board overlap is increased product differ-

[4] To address the issue more rigorously, we perform additional tests showing that neither reduced investments nor increased board overlap is concentrated in firms with greater free cash flows, which is inconsistent with board overlap remedying overinvestment problems.

entiation. We show that firm pairs with new intra-industry board overlap also feature lower product similarity as deduced from the textual analysis of regulatory filings by Hoberg and Phillips (2010, 2016). The increased product differentiation is not caused by an expansion into new product segments but rather by more differentiation within existing segments. More product differentiation is consistent with the attenuation of negative spillovers and can account for the increased profit margins identified in Section 3.

Thirdly, we explore if intra-industry board overlap promotes bilateral information flows related to technological opportunities. Here we focus on the relative frequency of reciprocal patent citations following the exogenous increase in intra-industry board overlap. The idea of tracing the diffusion of technology opportunities using patent citations goes back to Jaffe (1986) and has been widely adopted by follow-on studies in economics and finance (e.g., Bena and Li, 2014; Fitzgerald, Balsmeier, Fleming, and Manso, 2021). We find that new intra-industry board overlap comes with more cross-citations. The finding suggests that board overlap fosters the diffusion of R&D-related opportunities between firms, which is consistent with board overlap facilitating positive spillovers.

We acknowledge that board overlap may also influence the intrinsic quality of boards. In particular, board overlap can emerge due to a limited talent pool for competent board members. By allowing more firms to share the expertise of high-quality directors, board overlap could contribute to better governance, improve firms' strategic decision-making, and increase investment efficiency.

Consistent with this human resource view of board overlap, Field, Lowry, and Mkrtchyan (2013) show that, despite the general monitoring deficiencies of busy directors, interlocked directors exhibit valuable advisory functions but only for *young* firms. To reduce the potential confounding effect of the "advisory role" of overlapping directors, we remove all firms with recent IPOs from the sample; yet we find no economically significant change to our findings.[5]

In an important and related paper, Eldar, Grennan, and Waldock (2020) use the same sequence of law changes but examine a sample of startups. They find that common ownership by venture capital investors has a significant positive impact on startup growth. They document

[5] Like Field, Lowry, and Mkrtchyan (2013), we also show that firms with a recent IPO feature a relatively larger increase in intra-industry board overlap. However, among the firms for which intra-industry board overlap expands most significantly after COWs, we find more old and established firms than young firms. This evidence suggests that the advisory function of busy directors operates independently from firms' coordination examined in our paper.

that interlocked directors, often appointed by overlapping venture capital investors, represent an important channel of influence emanating from ultimate investors. Our paper differs from their study by focusing on a sample of publicly listed firms that are more established than startups. As we will discuss in the next paragraph, board overlap among public firms is often unrelated to common institutional ownership. This contrasts with board overlap among startups which usually emanates from common venture capital investors. Our findings suggest that board overlap can independently facilitate firm coordination without the involvement of common ownership, implying that the ultimate cause for our findings differs from that of Eldar *et al.* (2020).[6]

Our inquiry into board overlap raises questions about its relationship with shareholder overlap by institutional investors (Azar, 2012, chapter 5; Azar, Schmalz, and Tecu, 2018; Eldar, Grennan, and Waldock, 2020). However, institutional ownership is unlikely to represent a plausible explanation for the firm effects shown in our natural experiment: First, our results remain unchanged when we control for common ownership with other firms in the industry. Second, Geng, Hau, Michaely, and Nguyen (2022) undertake a detailed analysis of the board representation of common institutional investors. They find that such representation is very rare and that common shareholding almost never extends to joint representation on rival firm boards. This suggests that common institutional ownership is not the ultimate cause of our findings.

In a contemporary and related study, Fich, Harford, and Tran (2021) also use the COW legislation as an exogenous event, focusing on its impact on shareholder value. They too report a decrease in firms' internal R&D activities accompanied by an increase in external acquisition of R&D. They further report that stock price, on average, reacts positively toward COW legislations, with a more pronounced effect for small-cap stocks. While those results are similar for both papers, our paper focuses on the observed increase in intra-industry board overlap and the coordination role it plays in influencing two firm spillovers established in Bloom et al. (2013). Following our conceptual framework, we discuss and empirically show three underlying channels, namely, reduced investments, differentiated product offerings, and accelerated information sharing, which can collectively account for how board overlap coordinates firms to achieve greater profitability.

[6] Our findings are robust to the exclusion of recent IPO firms, which may overlap with firms examined in Eldar *et al.* (2020). This implies the underlying economic channel is different between our study and Eldar *et al.* (2020)

Our study contributes to an extensive literature on director networks that establishes the role of board overlap in propagating governance practices, which include options backdating (Bizjak, Lemmon, and Whitby, 2009), earnings management (Chiu, Teoh, and Tian, 2013), disclosure policy (Cai, Dhaliwal, Kim and Pan, 2014), and other corporate policies such as CEO and director remuneration, the board size, the share of outside directors, and CEO duality (Bouwman, 2011; Hallock, 1997). Based on a causal identification strategy, our analysis goes beyond documenting an *auxiliary role of board overlap* in facilitating information flows in a different setting. Instead, we establish board overlap as the source of increased firm coordination with economically significant effects on firm conduct and market outcomes.

To summarize, using the staggered introduction of Corporate Opportunity Waivers (COWs) across U.S. states, we establish that intra-industry board overlap is an important determinant of profitability for research intensive firms. Three identified channels, namely, reduced R&D expenditure, greater product differentiation, and more information sharing, collectively contribute to the observed profitability surge. Our findings reveal that intra-industry board overlap plays an important role in firms' coordination and significantly influences firm conduct.

2 Institutional Background and Research Design

2.1 Corporate Law Reform as a Natural Experiment

A cornerstone of U.S. corporate law has been the fiduciary duty of loyalty by directors towards the company they serve. This fiduciary obligation has long been viewed as an underpinning of credible conflict-of-interest management barring directors from pursuing or representing outside interests that can diverge from the commercial interests of the company. The fiduciary duty of loyalty prevents, in particular, the appropriation of any business opportunity without first offering it to the company. This so-called corporate opportunity doctrine can create serious legal conflicts for interlocked corporate directors serving on multiple corporate boards if the respective companies pursue similar lines of business. As such, the fiduciary duty of loyalty creates a backstop for intra-industry board overlap because of the legal liability that could ensue.

To determine whether an opportunity belongs to a corporation, the courts employ a four-factor model set forth by *Guth v. Loft* and its progeny. The courts will examine whether (1) the corporation had adequate financial resources to undertake the opportunity, (2) the opportunity was within the lines of business for the corporation, (3) the corporation had an interest and reasonable expectancy in the opportunity, and (4) the director's interest conflicts with that of the corporation if the director pursues the opportunity. Condition (2) is more likely to be met if interlocked directors occur between firms in the same industry (Nili, 2019).

In legal practice, the courts constantly encountered difficulties in delineating corporate opportunities in the context of fiduciary duty (e.g., Clark, 1986). For example, Walter F. Rogosheske wrote in the case of *Miller v. Miller*: "We have searched the case law and commentary in vain for an all-inclusive or 'critical' test or standard by which a wrongful appropriation can be determined and are persuaded that the doctrine is not capable of precise definition." In his textbook of corporate law, Clark (1986) claims that "the traditional tests are extremely ambiguous and uncertain in their application." More recent work by Rauterberg and Talley (2017) remarks that "The law's attempt to regulate fiduciaries' independent pursuit of business opportunities has produced a doctrine of startling complexity and unpredictability."

To eliminate the legal liabilities for the breaches of the corporate opportunity doctrine, some companies attempted to contract on the fiduciary duty privately. But this practice quickly met a legal challenge. In the famous case *Siegman v. Tri-Star Pictures, Inc.* in 1989, a Delaware court ruled against the private contractual suspension of the corporate opportunity doctrine on the basis that the duty of loyalty should be "immutable"—immune to private efforts to dilute or eliminate it.

The verdict in *Siegman v. Tri-Star Pictures, Inc.* thus maintained the corporate opportunity doctrine with its inherent ambiguities in situations where board overlap or shareholder overlap cannot be avoided. A notable example is small private firms controlled by venture capital and private equity firms. These investors usually seek representation on the board of their portfolio firms. Without waiving the corporate opportunity doctrine, these investors find it hard to invest in multiple firms in the same industry. The challenge posed by the corporate opportunities in the situation of overlapping boards or overlapping ownership was also recognized in the opinions of two Delaware cases (*Thorpe v. CERBCO* and *In Re Digex*), which are considered a catalyst for the law change examined in this paper.

In the year 2000, Delaware dramatically departed from this tradition by allowing companies to contract on and limit directors' fiduciary duties. In particular, they could wave the requirement of loyalty with respect to corporate opportunities, thereby lowering the legal standard to which directors were held with respect to conflicts of interest. Over the next two decades, other states followed the example of Delaware and made a previously "immutable" fiduciary standard contractible. Table 1 provides an overview of the statutory changes enabling corporations to waive the corporate opportunity doctrine for directors and officers by changes in their corporate charter or bylaws. The corporate law reforms had a narrow scope in the sense that they were only concerned with this particular option to waive the fiduciary liability of directors, corporate officers, or shareholders.

The opportunity of granting directors a corporate opportunity waiver was widely embraced by U.S. corporations, as documented by Rauterberg and Talley (2017). For example, the state of Delaware had an adoption rate for COWs of approximately 52% of corporations. As Delaware incorporates a large share of all American corporations, the new contractibility of fiduciary standards represents a significant "regime change" for a large number of firms across all industries. We document that this regime change lowered the barriers for intra-industry board overlap. On average, intra-industry board overlap made up 4.4% of board directors in the year before the legislation and significantly increased to 8.2% five years after the legislation. In contrast, the change in inter-industry board overlap was more moderate: The average inter-industry board overlap increased from 37% to 41.6% over the same period.

2.2 Sample Selection and Summary Statistics

We retrieve board director information of U.S. publicly listed firms in the period 1998–2019 from the BoardEx database. BoardEx covers the educational background, prior employment, and connections of directors and executives for publicly listed firms and notable private firms across the globe. The database has been widely used in prior studies for research related to corporate board directors (see, e.g., Cohen, Frazzini, and Malloy, 2008; Adams and Kirchmaier, 2016). The director employment information permits the identification of cases where a firm's board director sits concurrently on the boards of external firms. For example, from the database, we can see Marc Andreessen (director id: 337150) simultaneously sat on the boards of Facebook and eBay in the years 2012–2014. Aggregating the individual director information to the firm level, we construct firm-level board overlap.

Our baseline data set comes from the intersection of Compustat and BoardEx. After we drop financial firms (SIC: 6000-6999) and utility firms (SIC: 4900-4999), the baseline sample comprises $49,957$ firm-year observations of $4,251$ distinct firms covering the period 1998–2019. Table 2, Panel A, reports the summary statistics. The median firm observation has US$461 million in assets [$ln(Assets) = 6.133$], US$470 million in sales [$ln(Sales) = 6.152$], and employs $1,782$ workers [$1000 \times e^{0.578}$].

A firm's *Board Size* measures the number of board directors with a mean (median) value of 8.5 (8); firms at the 25% (75%) quartile of *Board Size* have 7 (10) directors. In light of the variation in board size, we define various measures of board overlap as the ratio of the number of external board seats by board members and *Board Size*. Otherwise, larger boards are (*eo ipso*) more likely to feature interlocked board members. The overall board overlap (*All_ OvLapDir*) is defined as the number of all (intra- and inter-industry) external board seats by all board members relative to *Board Size*. If a single board member is affiliated with multiple other boards, we count each overlap separately.

The overall board overlap (*All_ OvLapDir*) has a mean value of 45%, suggesting the mean board with 8 board members features 3.6 (0.45×8) board overlaps with other companies. Decomposing the 45% overall board overlap, we find that intra-industry board overlap (*Intra_ OvLapDir)* constitutes 6.8% and inter-industry board overlap (*Inter_ OvLapDir)* 38.1%. Inter-industry director overlap is thus five times more common than intra-industry director overlap.

2.3 Board Overlap and R&D Intensity

First, we investigate the unilateral relation between board overlap and R&D intensity. To this end, we sort firms into four quartiles by their R&D intensity. The three industries with the largest number of firms in the top quartile (Q4) are Drugs, Computer and Data Processing Services, and Electronic Components and Accessories (see Table A1 of the Internet Appendix for details). Table 2, Panel B, shows that intra-industry board overlap is strongly conditioned by the level of R&D intensity. As firms feature progressively more R&D intensity in quartiles Q1 to Q4, the mean intra-industry board overlap (*Intra_ OvLapDir*) increases monotonically from a relatively low level of 2.2% in Q1 and Q2, to 5.8% in Q3, and to 20.9% in Q4. This implies that the 25% most R&D-intensive firms have roughly nine times more intra-industry board overlap than the 25% least R&D-intensive firms.

To better characterize those firms in Q4, we further compare the R&D-intensive firms in Q4 to those in Q3: Their average *R&D intensity* is four times larger, their average value for $ln(Assets)$ is 17% lower, their average market-to-book ratio (*MTB ratio*) is 51% higher, their average sales-to-asset ratio is 31.6% lower, and their average *operating margin* is only −13.4% compared with 5.9% for firms in Q3. These accounting measures indicate that firms in Q4 (despite their stock market listing) appear to be at an early development phase with high growth potential.

Table 2, Panel B, Columns (7) and (8) condition the Q4 firm sample further on the existence of intra-industry board overlap and its absence, respectively. We find that firms with intra-industry board overlap show a very negative *operating margin* at −16.3% compared with −9.8% for firms without it. We conclude that a lack of profitable sales revenue and strong competitive pressure are important covariates for the prevalence of intra-industry board overlap.

The distribution of intra-industry board overlap is visualized in Figure 1, Panel A, where we break down the board overlap in each quartile into three roughly equal periods 1998–2003, 2004–2009, and 2010–2016. We observe a substantial increase in the average intra-industry board overlap over time across all R&D intensity quartiles. However, the most pronounced inter-temporal increase occurs in quartile Q4.

Figure 1, Panel B, shows that the frequency of inter-industry board overlap is less sensitive to the level of R&D intensity. Only firms in quartile Q4 feature a significantly lower inter-industry board overlap and a downward time trend. Table A2 in the Internet Appendix reveals that this downward adjustment of inter-industry overlap is a *response to previous increases* in intra-industry overlap among treated firms. In particular, Panel A of Table A2 shows that, in response to a prior increase in intra-industry overlap, firms in Q4 feature a switching probability of 46% for a *decrease* in inter-industry board overlap as opposed to 41% for an *increase* in the subsequent three years. No such asymmetry in switching probabilities is found when we analyze the adjustment in inter-industry board overlap in response to decreased or unchanged intra-industry board overlap, as shown in Table A2, Panels B and C, respectively. This evidence suggests that the adoption of more intra-industry board overlap crowded out inter-industry board overlap.

The frequency of intra-industry board overlap appears surprising in light of existing antitrust laws. Section 8 of the Clayton Act of 1914 explicitly prohibits any interlocked directorates between competing firms. Notwithstanding this statutory prohibition, enforcement action was sporadic and ineffective. According to a staff report by the Antitrust Subcommittee of the House Judiciary Committee in 1965, the Federal Trade Commission (FTC) filed only 13 complaints under Section 8 of the Clayton Act in the first 50 years after the law's enactment in 1914, of which one complaint resulted in a cease-and-desist order. The Department of Justice undertook its first investigation with respect to Section 8 only in 1952. In the following decades, enforcement of the Clayton Act hardly improved and even declined in the late 1970s. Stucke and Ezrachi (2017) note that even horizontal corporate mergers have rarely been challenged in the past five decades. Similarly, in a legal briefing, Bailey (2020) highlights that the FTC only occasionally investigates and pursues violations of Section 8 of the Clayton Act.

2.4 Empirical Design

Our empirical specification combines a staggered difference-in-difference design with a two-stage least squares (2SLS) model. The first-stage regression examines how the staggered adoption of COW legislation across nine U.S. states changed the incidence of intra-industry board overlap. The second stage then explores how the predicted changes in board overlap affect firm outcomes.

The first-stage regression estimates the following triple-difference specification

$$Intra\_OvLapDir_{i,t} = \alpha_1 R\&D\_Q4_i \times COW_{k,t} + \alpha_2 COW_{k,t} + Z_{i,t}\gamma' + \eta_{I\times t} + \theta_i + \epsilon_{i,t}, \qquad (1)$$

where i indexes firms, I indexes industries, k indexes states of incorporation, and t indexes time. The dependent variable *Intra_ OvLapDir* denotes the ratio of interlocked director positions with other companies in the same three-digit SIC industry relative to the firm's board size. The variable $COW_{k,t}$ equals one (and zero otherwise) if state k adopts the corporate opportunity waiver in year t.[7] We interact $COW_{k,t}$ with a set of dummies *R&D_ Qx* marking the x-th quartile of a firm's R&D intensity. For example, *R&D_ Q4* denotes the fourth firm quartile

[7] We follow the suggestion of Baker, Larcker, and Wang (2021) and include firms incorporated in U.S. states that have never adopted COW legislation in the estimation.

of R&D intensity. To alleviate concerns that the sorting by R&D could itself be influenced by changes related to the corporate law changes, we sort firms by their initial R&D intensity in the first sample year of 1998 (or when they enter the sample) and then leave the quartile affiliation unchanged.[8] Separate *R&D_ Qx* dummies do not appear in this specification because they are time-invariant and thus absorbed by firm fixed effects (θ_i).

Our key instrumental variable is the interaction term $R\&D\_Q4_i \times COW_{k,t}$, which defines a triple difference. Its coefficient α_1 measures the incremental effect of COW legislation on intra-industry board overlap for the top 25% of firms by R&D intensity (marked by $R\&D\_Q4_i = 1$) as compared to the baseline effect for all firms captured by the coefficient α_2.

Our analysis focuses on firms in R&D quartile Q4. As we discussed in the introduction, R&D-intensive firms feature strong externalities in terms of firm rivalry and opportunity diffusion, making coordination particularly valuable to these firms. The triple difference approach thus provides a suitable refinement compared to an IV strategy that only relies on the inter-temporal variation in law changes at the state level.

The vector of control variables $Z_{i,t}$ comprises the log assets [*ln(Assets)*], asset tangibility (*Tangibility*), and the market-to-book ratio (*MTB ratio*). We denote by $\eta_{I\times t}$ and θ_i industry-by-year and firm fixed effects, respectively. The state of legal incorporation often differs from the geographic location of firm headquarters, and this greatly diminishes the potential role of geographic factors as explanatory covariates. In particular, our results are robust to including headquarter-state-by-year fixed effects as discussed in Section 5.3.

The second-stage regression examines the effect of intra-industry board overlap on firm outcome variables, namely *ROA*, *Gross (Profit) Margin*, *Operating Margin*, log sales [*ln(Sales)*], and log cost of goods sold [*ln(COGS)*] and the log cost share [*ln(COGS/Sales)*]. Formally,

$$y_{i,t} = \delta_1 \widehat{Intra\_OvLapDir}_{i,t} + \delta_2 COW_{k,t} + Z_{i,t}\gamma' + \eta_{I\times t} + \theta_i + \vartheta_{i,t}. \quad (2)$$

$\widehat{Intra\_OvLapDir}$ represents the instrumented intra-industry board overlap and the control variables and fixed effects are the same as those in Eq. (1).

As board overlap always concerns two firms, and the dummy instrument *R&D_ Qx* marks only the first firm conditional on high R&D intensity in quartile Q4, it is natural to ask about

[8] We confirm that annual dynamic updating of the quartiles yields quantitatively similar results. This suggests that the endogeneity concern with respect to quartile classification is of minor quantitative importance.

the research intensity of the second (or partner) firm. Figure A1, Panel A, in the Internet Appendix, shows a histogram of the research intensity of all firms with $R\&D\_Qx \times COW = 1$, and Panel B the research intensity of their partner firms with which board overlap occurs. Panel C shows the histogram of the R&D intensity of all sample firms for comparison. Partner firms feature a considerably higher mean (median) R&D intensity at 15.67% (10.52%) compared with 8.13% (1%) in the full firm sample. We conclude that the observed board overlap increase occurs primarily between firm pairs in which *both* firms feature high R&D intensity.

2.5 Exclusion Restriction

Our identification strategy hinges on the staggered adoption of the COW legislation in nine U.S. states. For the setting to be valid, the timing of COW legislation in any given state needs to be exogenous and unrelated to any cyclical economic variable that could simultaneously influence firm performance.

The adoption of COW legislation in Delaware resulted from specific legal events. This makes the required temporal exogeneity highly plausible. According to Rauterberg and Talley (2017), the introduction of the COW legislation in Delaware represents a reaction to judicial decisions by a Delaware court. As recognized in court opinions, the two cases *Thorpe v. CERBCO* and *In Re Digex* highlight the intractable challenges posed by corporate opportunity claims in cases involving overlapping ownership and boards. Both cases made apparent the need for a law change to explicitly allow parties to waive corporate opportunities. The same case-based judicial developments could have occurred 10 or 15 years later. The consecutive COW legislation in eight other states appears to fit with a general pattern of corporate law diffusion across U.S. states: Delaware advances a legal innovation, which is subsequently copied by some other states (Romano, 2006). However, our baseline results are robust to the exclusion of subsequent COW adoptions by other states.

We also note that the COW legislation does not appear concerned with board overlap between public firms. Instead, the primary intent of the law change was to facilitate the financing for small privately held companies, which are usually invested by venture capital or private equity firms (Grossman, 2009; Rauterberg and Talley, 2017). These investors often hold overlapping ownership or overlapping boards in multiple firms, making their compliance with the corporate opportunity doctrine highly challenging. By contrast, institutional investment in public firms rarely comes with board representation (Geng, Hau, Michaely, and Nguyen, 2022). Thus the legal intent behind COW legislation was unrelated to public firms.

Examining the lobbying transcripts, Eldar, Grennan, and Waldock (2020) find little evidence of corporate lobbying before the law change, which further alleviates the concern that specific interests of public firms triggered the COW legislation. Their findings support that the legal repercussions for public firms occurred in an unintended and accidental manner.

The 2SLS regressions in our analysis identify the transmission channel through which COW legislation influences firm outcomes. Yet this benefit comes at the price of more stringent exclusion restrictions than for simple reduced form regressions: We require here that the effect of COW legislations on firm performance does not bypass the channel of new board overlap and influences firm outcomes through other channels. Specifically, if the COW legislation also provides pre-existing board overlap with a more effective coordination mechanism, this exclusion restriction is violated, and the second-stage coefficients are biased (upwards). We verify in Section 5.2 the robustness of our findings by excluding firms with pre-existing board overlap from our sample.

3 Main Results

3.1 Corporate Law Reform and Its Impact on Board Overlap

First, we discuss the first-stage results that examine the effect of COW legislation on board overlap between firms in the same industries. In Table 3, Panel A, we present the first-stage regression with intra-industry board overlap ($Intra\_OvLapDir$) as the dependent variable. For notational convenience, we scale up the outcome variable (i.e., percentage of board members with other board seats) by a factor of 100. The first two regressions in Columns (1) and (2) show the effect of the COW legislation for firms in each R&D quartile. The positive coefficient for the term $COW \times R\&D\_Q4$ is statistically significant and implies an increase in intra-industry board overlap for firms with high research intensity (i.e., $R\&D\_Q4$). By contrast, no statistically significant change is observed for firms of lower research intensity (i.e., $R\&D\_Q1$ to $R\&D\_Q3$).

Columns (3) and (4) of Panel A report the more parsimonious specification in Eq. (1). Here, we distinguish firms of high research intensity (in a triple difference) and include a *COW* dummy, which captures a general treatment effect across all firms. Since the treatment effect is concentrated among firms in Q4, we use this parsimonious specification for the subsequent second-stage analyses.

The first-stage result is economically sizable. For example, in Column (4), the point estimate for the interaction term $COW \times R\&D\_Q4$ implies an intra-industry board overlap increase of 2.7 percentage points after COWs. It amounts to a 12.9% overlap increase relative to the mean intra-industry overlap value of 20.9% among firms of high research intensity in quartile Q4. As the average board has 7.7 members for these firms, a 2.7 percentage point increase in overlap per average board member aggregates to 20.8% ($= 0.027 \times 7.7$) at the firm level, or roughly one new interlocked board member for every fifth firm.

Table 3, Panel B, reports in Columns (1)-(2) and (3)-(4) the regression results for overall board overlap ($All\_OvLapDir$) and inter-industry overlap ($Inter\_OvLapDir$), respectively. Overall board overlap in Columns (1) and (2) shows no statistically significant change after the COW legislation. By contrast, inter-industry board overlap decreases for the firms in the two highest quartiles of R&D intensity following the COW legislation. In many cases, intra-industry board overlap appears to substitute for (presumably less valuable) inter-industry board overlap. To verify this substitution effect, we carry out a separate test in Table A2 of the Internet Appendix. We demonstrate that a firm is more likely to reduce inter-industry overlap after a recent increase in intra-industry overlap compared with situations where intra-industry overlap was stable or declined. This evidence is consistent with a substitution effect between inter- and intra-industry board overlap. We discussed Table A2 in more detail in Section 2.3.

An important validity check for our empirical design is the absence of diverging trends in intra-industry board overlap between treated and non-treated firms prior to the COW legislation. Any differential surge in intra-industry board overlap (among treated firms in quartile Q4) should occur only after the COW legislation is passed. To empirically check the pre-trending of board overlap, we run a dynamic version of the first-stage regression given by

$$Intra\_OvLapDir_{i,t} = \sum_{T=-4}^{7} \alpha_T \; R\&D\_Q4_i \times COW_{k,t}(T) + \delta COW_{k,t} + Z_{i,t}\gamma' + \eta_{I\times t} + \theta_i + \epsilon_{i,t}, \quad (3)$$

where the dummy $COW_{k,t}(T)$ is equal to one if firms incorporated in state k become subject to COW legislation T $(-T)$ years after (before) its introduction in year t and zero otherwise. Firm observations that concern years more than three years prior to the COW legislation are pooled as $T =$ *Before,* and those more than six years later are pooled as $T =$ *After.* For firms incorporated in states without any COW legislation, the dummy $COW_{k,t}(T)$ is always zero. Like the specification in Eq. (1), this dynamic model controls for the same set of control variables $Z_{i,t}$ and the same interacted industry-year fixed effects $\eta_{I\times t}$ and individual firm fixed effects θ_i.

Figure 2 describes the dynamic evolution of intra-industry board overlap relative to the reference year of its introduction in year $T = 0$, by depicting in solid red dots the point estimates $\widehat{\alpha}_T$. The vertical bars around each point estimate $\widehat{\alpha}_T$ represent a 95% confidence interval. We find that the coefficient estimates in the pre-legislation period are statistically indistinguishable from zero. For year $T = -3$ and before, we obtain large standard errors due to a lack of observations used for estimating $\widehat{\alpha}_T$, as illustrated by the height of grey-shaded bars. As the coverage of high-quality director information in BoardEx only extends to 1998, only two-year observations are available for firms incorporated in Delaware, which accounts for a significant share of sample firms and passed the law in 2000. Yet, the three years $(T = -2, -1, 0)$ do not indicate any pre-trend growth in intra-industry board overlap.

Figure 2 also shows that board overlap gradually picks up after $T = 0$ and steadies only in year $T = 4$, and thereafter, suggesting that board changes adjusted slowly to the new legal environment. The sluggish adjustment of board overlap is consistent with the finding by Rauterberg and Talley (2017) of delayed firm-level adoptions of COWs. Such a delayed response is not surprising, as the required changes to corporate statutes and the new board appointments have implementation lags.

Overall, the evidence indicates that the surge of intra-industry board overlap occurs for firms with high R&D intensity. The consequences of this surge in board overlap are explored next.

3.2 Board Overlap Effects on Firm Outcomes

Does the increased board overlap result in different firm outcomes? To answer this question, we use the instrumented intra-industry board overlap obtained from Eq. (1) and relate it to a set of firm-level variables, including return on assets (*ROA*), the *Gross (Profit) Margin*, the

Operating Margin, the log of the sales [*ln(Sales)*], the log of costs of goods sold [*ln(COGS)*], and the log of cost share [*ln(COGS/Sales)*].

The regression results are reported in Table 4. For each outcome variable, we report alternatively two regression specifications controlling for log assets only (suffixed as Column Xa) or the full set of control variables $Z_{i,t} = \{ln(Assets), Tangibility, MTB\ ratio\}$ (suffixed as Column Xb). The Montiel Olega-Pflueger (MOP) effective F-statistics are above 20, suggesting that our estimation does not suffer from a weak instrument problem.

Table 4, Column (1b), reports a statistically highly significant increase in ROA by 2.74 percentage points for every one-percentage-point increase in intra-industry board overlap. An average 2.7-percentage-point increase in intra-industry overlap for firms in quartile Q4 [see Table 3, Panel A, Column (4)] then implies an increase in ROA by 7.4 percentage points, which is a large improvement on the average negative ROA of −11.9% for firms operating in the high-R&D-intensity quartile Q4. Thus, the corporate law change and the associated board overlap increase significantly improve firm profitability. The relationship between predicted intra-industry board overlap and ROA after filtering for firm and industry-by-year fixed effects and the three firm controls is depicted in the scatter plot in Figure 3. The graph uses red dots to distinguish treated firm observations in quartile Q4 from all other observations in blue; the former, located to the northeast, combines both higher predicted board overlap and a higher ROA value. The histograms in red and blue depict the shift in the distribution of board overlap triggered by COW legislation.

Examining other outcome variables also shows improved performance following an increase in intra-industry board overlap. For a one-percentage-point increase in intra-industry board overlap, Columns (2b) and (3b) in Table 4 show an increase in the gross profit margin and in the operating margin by 4.4 and 2.5 percentage points, respectively. Therefore, the profit margin increase suggests that at least part of the profitability increase can be explained by higher product prices and/or lower production costs. Columns (4b) and (5b) show a corresponding increase in log sales (value) [*ln(Sales)*] of 5.3% and an equally large cost decrease [*ln(COGS)*] of −5.2%. This implies that the log cost share of sales [i.e., *ln(COGS)−ln(Sales)*] decreases by a total of 10.5%, which matches the point estimate of −10.3% in Column (6b).[9]

[9] We also perform an OLS analysis (untabulated) corresponding to Table 4. The Hausman test for equality of the OLS and IV estimates is generally rejected, which we attribute to the endogeneity of the board overlap measures.

As a robustness exercise, we also undertake reduced form regressions, which relate firm outcomes directly to the treatment dummy $COW \times R\&D\_Q4$. The results reported in the Internet Appendix, Table A3, confirm that firm outcome changes are concentrated in the high-R&D-intensity quartile $R\&D\_Q4$, as the treatment dummy COW itself is small and statistically insignificant. This confirms that only firms with high R&D intensity experience any change as a consequence of the COW legislation.

In sum, we document in this section that the introduction of COW legislations triggers more incidences of intra-industry board overlap for research intensive firms. Reduced-form and 2SLS estimates consistently show that firms with increased intra-industry board overlap experience increased profitability and operating margin as well as reduced cost, suggesting that board overlap has a real effect on firm conduct and market outcome.

4 Dimensions of Firm Coordination

4.1 Investment and R&D Expenditure Reduction

High investments in R&D-intensive sectors can accentuate firm rivalry as one firm's investment tends to undermine its rival's market share. While such competition may accelerate product innovation, it might be less desirable for competing firms. In particular, patent races can culminate in a situation where the winner collects all benefits, and the loser ends up with considerable sunk R&D costs (Dasgupta and Stiglitz, 1980). Thus, firms have incentives to coordinate and reduce investments in new product development. Therefore, we expect that intra-industry board overlap is associated with reduced investment in general and lower levels of R&D expenditure in particular.

We examine investment in both tangible and intangible assets. The former is measured by $ln(Capex)$, and the latter by a set of firm innovation variables, including *R&D intensity* (measured as R&D expenditure relative to assets), the (log) of successful patent filings [*ln(1+Patents)*], and the (log) of the dollar value of all successful patents [*ln(1+PatVal)*] (Kogan *et al.*, 2017). Table 5 reports the regression results. We find that board overlap has an economically and statistically strong negative effect on tangible and intangible capital investment. In Column (1), a one-percentage-point increase in intra-industry board overlap is associated with a decrease in capital expenditure [*ln(Capex)*] by 7.06%. The reduced investment is also observed for intangible capital. In Column (2), *R&D intensity* decreases by 1.64 percentage points for each additional percentage point of intra-industry overlap among firms in the high-R&D-intensity quartile Q4. This implies a 7.5% reduction relative to an average R&D intensity of 0.218 for firms in quartile Q4. The negative effect is also strong on (log) patent output [*ln(1+Patents)*] and the dollar value of firm patents (*PatVal*).

An alternative explanation for reduced investments is that board overlap enables firms to eliminate wasteful spending (i.e., empire building) and increase investment efficiency. However, this presupposes that R&D-intensive firms examined in this study have greater free cash flows that are conducive to overinvestment problems (Jensen and Meckling, 1976). But this is not the case. As shown in Table 2, Panel B, firms in R&D quartile Q4 have low cash flows and even feature a negative average operating profit margin. To further address the concern that board overlap remedies overinvestment problems, we perform additional regressions and show in Table A4 that the increased intra-industry board overlap and decreased investments documented earlier do not appear to vary systematically with free cash flows, alleviating the concern that reduced investments reflect the elimination of wasteful spending.

4.2 Increased Product Market Differentiation

The second channel of firm coordination is increased product differentiation. We predict that board overlap helps firms avoid similar products and diminish their overlap in the product spaces, which reduces firm rivalry and repetitive investments (as we discussed in subsection 4.1). Unlike firm profitability and investment discussed above, a change in product differentiation occurs at the firm pair level. Accordingly, we construct a sample of firm pairs combining all firms within the same three-digit SIC industry.

Again, we estimate a 2SLS model for which the first and second stage takes the form

$$Intra\_PairOvLapDir_{p,t} = \beta_1\ PairR\&D\_Q4_p \times PairCOW_{p,t} + \beta_2 PairCOW_{p,t} + \theta_p + \epsilon_{p,t} \quad (4a)$$

$$PairHPSS_{p,t} = \beta_3\ Intra\_\widehat{PairOv}LapDir_{p,t} + \beta_4 PairCOW_{p,t} + \theta_p + \vartheta_{p,t}, \quad (4b)$$

respectively. In Eq. (4a), $Intra\_PairOvLapDir_{p,t}$ denotes the number of interlocked directors between firms in pair p relative to the total board size of both firms. The dummy variable

$PairR\&D\_Q4_p$ indicates whether both firms in pair p are in the top 25% quartile of R&D intensity. As in Eq. (1), R&D is measured in 1998 or the first year when a firm enters the sample. The dummy $PairCOW_{p,t}$ is one if the COW legislation covers both firms of pair p in year t, and zero otherwise.

The variable $Intra\_\widehat{PairOvLapDir}_{p,t}$ in Eq. (4b) represents the instrumented board overlap predicted by the first stage. We draw on the Hoberg-Phillips data library and use *PairHPSS* as our proxy for product differentiation, which represents a text-based pairwise product similarity score widely used in the literature.[10] A higher similarity score indicates that two firms commercialize more similar products.

The control variables in Eqs. (4a) and (4b) include firm-pair fixed effects, θ_p, and also year fixed effect. Adding additional firm-level variables to control for the intertemporal evolution of firm characteristics is problematic for firm pairs as regression outcomes generally depend on the arbitrary ordering of firm variables.[11] We follow de Bodt, Eckbo, and Roll (2020) and define for each firm characteristic a vector of dummies that describe two firms' distributional relationships. Specifically, for each firm variable and year, we divide firms into terciles and use a dummy to indicate one of six possible distributional relationships based on tercile ranks ($6 = \frac{3\times(3+1)}{2}$). For example, one firm in the top tercile of total assets and the other firm in the second tercile defines one of six dummies for total assets. A total of 18 ($= 6 \times 3$) such dummy variables are generated for the three firm variables used as controls, namely total assets, the asset tangibility (i.e., property, plant, and equipment relative to total assets), and the market-to-book ratio.

Table 6, Panel A reports summary statistics for variables used in the pair analysis, and Panel B tabulates the 2SLS regression results. We scale the pairwise intra-industry board overlap ($Intra\_PairOvLapDir$) by a factor of 1,000 for ease of tabulation. In Panel B, Columns (1) and (2) report first stage regressions with and without control variables, respectively. Similar to the firm-level regressions in Table 3, the COW legislation significantly increases intra-industry board overlap for firm pairs with high R&D intensity. No statistically significant effect is found for the remaining firm pairs, as indicated by the coefficient *PairCOW* marking all firm pairs subject to COW legislation.

[10] The website for the data library is https://hobergphillips.tuck.dartmouth.edu

[11] For example, when we include variables $Asset1$ and $Asset2$ in a pair regression to control for the respective size for firms i and j, regression estimates can vary depending on whether we use $Asset1_i$ and $Asset2_j$ and controlling $Asset1_j$ and $Asset2_i$.

Columns (3) and (4) in Panel B relate the proxy for product similarity to the (instrumented) board overlap. Pairwise intra-industry board overlap shows a negative effect on product similarity. The coefficient of -0.0183 in Column (4) suggests that the COW legislation decreases product similarity by 0.56 percentage points ($= -0.0183 \times 0.3035$), equivalent to 3.09% ($= -0.0056/0.018$) of the mean of the dependent variable. As reduced product similarity implies enhanced market power, this result is consistent with the evidence of higher profit margins in Section 3.

We next explore whether product differentiation results from the introduction of new products or from the segmentation of the existing product lines. To this end, we adopt two new measures that capture the changes in a firm's product lines. The first is the number of product segments a firm operates in [i.e., $ln(\#Segments)$]. Second, following Hoberg and Phillips (2018), we generate the variable *Product Offering Growth* that gauges the degree to which a firm increases its annual product offering and is proxied by the growth rate of the length of the 10-K business description (in terms of word count) relative to last year. Table 7 shows that new board overlap is not significantly related to either $ln(\#Segments)$ or *Product Offering Growth*. This suggests that firms do not expand the scope of their product offering. Therefore, we conclude that the evidence of increased product differentiation discussed earlier is largely driven by firms segmenting existing product lines.

4.3 More Information Sharing

Reduced investment and more product differentiation highlighted in the previous two subsections show how board overlap attenuates firm rivalry or negative spillover. Yet, board overlap may also foster information exchange about technological and commercial opportunities, which represents a positive spillover.

Identifying such technological and commercial opportunity sharing is difficult due to a lack of corresponding disclosure. However, we can measure information flows related to technological opportunities based on patent citations. The citation information recorded on a patent document points to sources of underlying or complementary knowledge that triggers, inspires, or just relates to the patent under consideration. Jaffe (1986) was among the first to use patent citation as a tracer of technological information flows, and this idea has been widely adopted by subsequent research (e.g., Bena and Li, 2014; Fitzgerald, Balsmeier, Fleming, and Manso, 2021).

Following the spirit of Jaffe (1986), we construct a knowledge flow measure based on pairwise cross-citations between firms. Consider firms i and j operate in the same industry I. Let $cite_{i,t}(j)$ measure the number of citations made by firm i in year t of patents owned by firm j. To convert this count statistics into a suitable metric, we make two adjustments. First, $cite_{i,t}(j)$ depends on the idiosyncratic citation pattern by firm i as firms may cite more or less patents. Hence, we normalize $cite_{i,t}(j)$ by the overall number of industry citations $cite_{i,t}(I)$ by firm i in a given year, which yields the ratio $(\frac{cite_{i,t}(j)}{cite_{i,t}(I)})$. Second, the count statistics $cite_{i,t}(j)$ also depends on the number of valid patents $patents_{j,t}$ firm j has filed relative to all industry patents outstanding denoted by $patents_{I,t}$. A higher share of industry patents by firm j should be matched by a higher citation share. In the special case that citations are unbiased and sampled randomly from the industry's overall patent distribution, we expect the ratio $\frac{cite_{i,t}(j)}{cite_{i,t}(I)}$ to approximately equal $\frac{patents_{j,t}}{patents_{I,t}}$. These considerations suggest a normalized citation measure $\frac{cite_{i,t}(j)}{cite_{i,t}(I)} / \frac{patents_{j,t}}{patents_{I,t}}$, for which a greater value suggests greater technological relevance of firm j for the patent process of firm i. As we are interested in reciprocal technological externalities, we define our (pairwise) cross citation measure as

$$PairCrossCite_{i,j,t} = \frac{cite_{i,t}(j)}{cite_{i,t}(I)} / \frac{patents_{j,t}}{patents_{I,t}} + \frac{cite_{j,t}(i)}{cite_{j,t}(I)} / \frac{patents_{i,t}}{patents_{I,t}}.$$

Again, we examine the relation between cross-citations for a firm pair and intra-industry board overlap using the same specifications as in Eqs. (4a) and (4b); only the dependent variable in the second stage is replaced by the log of $PairCrossCite_{i,j,t}$. Table 6, Panel B, Columns (5)-(6) report the regression results. The coefficients for $Intra\_\widehat{PairOvLapDir}$ are positive and statistically significant regardless of whether control variables are included. The coefficient of 0.031 in Column (6) suggests that the COW legislation increases cross-citations by 0.95 percentage points ($= -0.031 \times 0.3035$), roughly equal to 15.95% of the dependent variable's mean of 0.059. Thus, the citation evidence suggests that intra-industry board overlap redirects a firm to draw proportionally more knowledge from the partner firm, which is consistent with information spillovers intermediated by board overlap.

One might conjecture that more positive information spillovers under board overlap tend to increase patent productivity and predicts more R&D investment and patent output. Yet, as shown in Section 4.1., R&D expenditure and patent filings decrease in new board overlap. This suggests that the positive technological spillover effects of board overlap are limited in scope and do not dominate the firm's investment conduct.

5 Additional Explanations

5.1 Board Overlap and Common Ownership

Does new board overlap associated with the COW legislation reflect increased shareholder overlap, or does board overlap constitute an independent phenomenon? The recent finance literature has linked the rise of common (institutional) ownership (Elhauge, 2017; Dallas, 2018) to increased firm profitability and reduced investment and R&D expenditure (Azar, Schmalz, and Tecu, 2018). The similarity with our findings for board overlap gives importance to this question.

We first use BoardEx data and examine how often interlocked directors are categorized as "independent directors" and are therefore not linked to any specific shareholder. Using BoardEx data, we observe that 89% of all the interlocked directors hold non-executive positions. Among those interlocked non-executive directors, 86% are labeled as "independent directors," and only 14% potentially represent "specific" shareholders. This implies that interlocked directors only rarely represent common shareholders directly.

In addition, we directly control for the common ownership in the baseline regression. The empirical measure for common ownership follows Koch, Panayides, and Thomas (2021). The regression results are presented in Table A5. We still find that intra-industry board overlap represents a statistically significant covariate, which mitigates any concern that our findings are driven by contemporaneous changes in common ownership.

5.2 Pre-Existing Board Overlap

The exclusion restriction for the 2SLS regression requires that COW legislation does not change firm behavior and outcomes through channels other than new intra-industry board overlap. This raises the question of how the law changes affect pre-existing intra-industry board overlap. If such pre-existing board overlap has already fully exhausted the scope of firm coordination, then the COW legislation should not have any incremental effect on firm behavior in these cases, and the exclusion restriction is fulfilled. Yet, it is also plausible that pre-existing interlocked directors become more active in inter-firm coordination once the legal risk is removed. Such an effect would bypass the predicted change in new board overlap and violate the exclusion restriction.

We note that only 233 firms had at least one intra-industry director overlap in the year before the introduction of COWs. However, many of these firms experienced additional intra-industry director overlap in the five years following the COW legislation, which further diminishes the number of firm observations for which the exclusion restriction is potentially violated. We remove all firms from our sample which feature pre-existing board overlap prior to the COW legislation and maintain their level of board overlap thereafter. We explore the robustness of our results for this filtered sample in Table A6 of the Internet Appendix. The new regression results are qualitatively and quantitatively similar to Table 4.

5.3 More Robustness Analyses

This section discusses several other alternative mechanisms that may explain our findings. First, Board overlap could result from the fact that specific human capital is concentrated among a small number of highly qualified industry experts. If the director choice is further constrained by the professional networks of the respective CEOs, an even more limited choice set of potential directors can emerge with numerous interlocked directors. Therefore, it seems plausible that the improved firm performance reflects higher board quality after COWs if the reduced legal risk allows more firms to share the talent of high-quality directors through board overlap.

Consistent with board overlap representing better director quality, Field, Lowry, and Mkrtchyan (2013) emphasize that interlocked (or "busy") directors excel as advisors to management, but only for young firms that recently had an IPO. To test the existence of such advisory effects in our sample, we label with the dummy $PostIPO$ all firm-years for which an IPO occurred in the last three years and repeat the baseline specification with a triple interaction term $COW \times R\&D\_Q4 \times PostIPO$. Table A7 in the Internet Appendix reports the corresponding results. First, the positive coefficient for the interaction term $PostIPO \times COW$ in Column (2) indicates that young firms (marked by $PostIPO$) show a more pronounced increase in their intra-industry board overlap following the COW legislation. This is consistent with the finding of Field, Lowry, and Mkrtchyan (2013). Second, the negative coefficient of the triple interaction term indicates that the advisory effect of board overlap is less pronounced among research-intensive firms. Therefore, we conclude that the role of board overlap in firms' coordination represents a distinct aspect of corporate governance. As an alternative robustness check (untabulated), we exclude firm-years that recently had IPOs from our sample and find that our results remain unchanged.

Second, a more general concern about our statistical inference is that state law changes correlate inter-temporally with changes in the local business environment. To address this issue, we include in the 2SLS regression of Table 4 head-quarter-state-by-year fixed effects, which can absorb observable and unobservable time-variation in the local business conditions at the state level. As shown in Table A8 of the Internet Appendix, our results remain qualitatively and quantitatively unchanged.

Third, it is plausible that certain trends within high R&D-intensive firms coincide with changes in profitability and other outcome variables. However, for the trend to explain our findings, its variation needs to systematically correlate with the years each state passes corporate opportunity waivers. In addition, any trend pertaining to high R&D-intensive firms is likely to be caused by industry shocks, which can be absorbed by industry-by-year fixed effects.

Lastly, we note that a significant fraction of sample firms (68%) are incorporated in the state of Delaware. A robustness check excluding all Delaware incorporated firms shows that our results are not specific to this particular state. The regression results for this reduced sample are presented in Table A9. We find that the coefficients for $COW \times R\&D\_Q4$ remain significant and are consistent with those reported in Table 4.

6 Conclusion

This paper addresses the important question of whether board overlap facilitates firm coordination and what the effects are on corporate outcomes. We identify a causal effect of board overlap on firm coordination using the staggered introduction of corporate opportunity waivers

(COWs) in nine U.S. states. This legal innovation started in Delaware in 2000 and was triggered by an exogenous sequence of prior court decisions in Delaware. The law change reduced the fiduciary duty for corporate directors and created more intra-industry board overlap—mostly in firms with high R&D intensity for which coordination benefits are largest. Firms that increased their intra-industry board overlap in response to the new legislation show a sizeable increase in ROA, gross and operating margins, sales revenue as well as a reduction in their cost share.

The observed increase in corporate profitability is consistent with board overlap promoting firms' coordination. We explore three potential dimensions of such firm coordination: First, we find that new intra-industry board overlap reduces firm-level investment, R&D expenditure, and patent output. This finding is consistent with the view that board overlap attenuates firm rivalry in product markets through reduced investment and R&D activity. Second, we find evidence that firm pairs with new board overlap increase their bilateral product differentiation, which enhances firms' market power. Third, intra-industry firm pairs with new board overlap tilt their patent citations towards each other, suggesting positive information spillovers and greater coordination of research activities.

The three channels provide direct evidence on how intra-industry board overlap influences firm spillovers discussed in the conceptual framework. Closely tying our empirical analyses to the conceptual framework is not only important for validating the coordination hypothesis but also useful for separating the coordination hypothesis from other competing hypotheses. For example, using COW legislation as a natural experiment, Fich, Harford, and Tran (2021) find similar results in firm innovation and profitability but attribute the findings to the increased scope for CEO disloyalty and self-dealing after the relaxation of fiduciary standards. However, this alternative explanation is unlikely to invalidate the coordination hypothesis because the former cannot account for the evidence of product differentiation and information sharing between intra-industry firms, which are important channels for firms' coordination. Therefore, we consider the increased scope for self-dealing in the post-COW era independent of the coordination hypothesis we establish in this study.

Overall, our evidence suggests that board overlap has significant real effects on firm conduct, specifically for R&D-intensive firms. More generally, board overlap could be a contributing factor for simultaneously low investment levels and high firm profitability observed for U.S. listed firms after 2000 (Barkai, 2020; Grullon, Larkin, and Michaely, 2019; Gutiérrez and Philippon, 2016).

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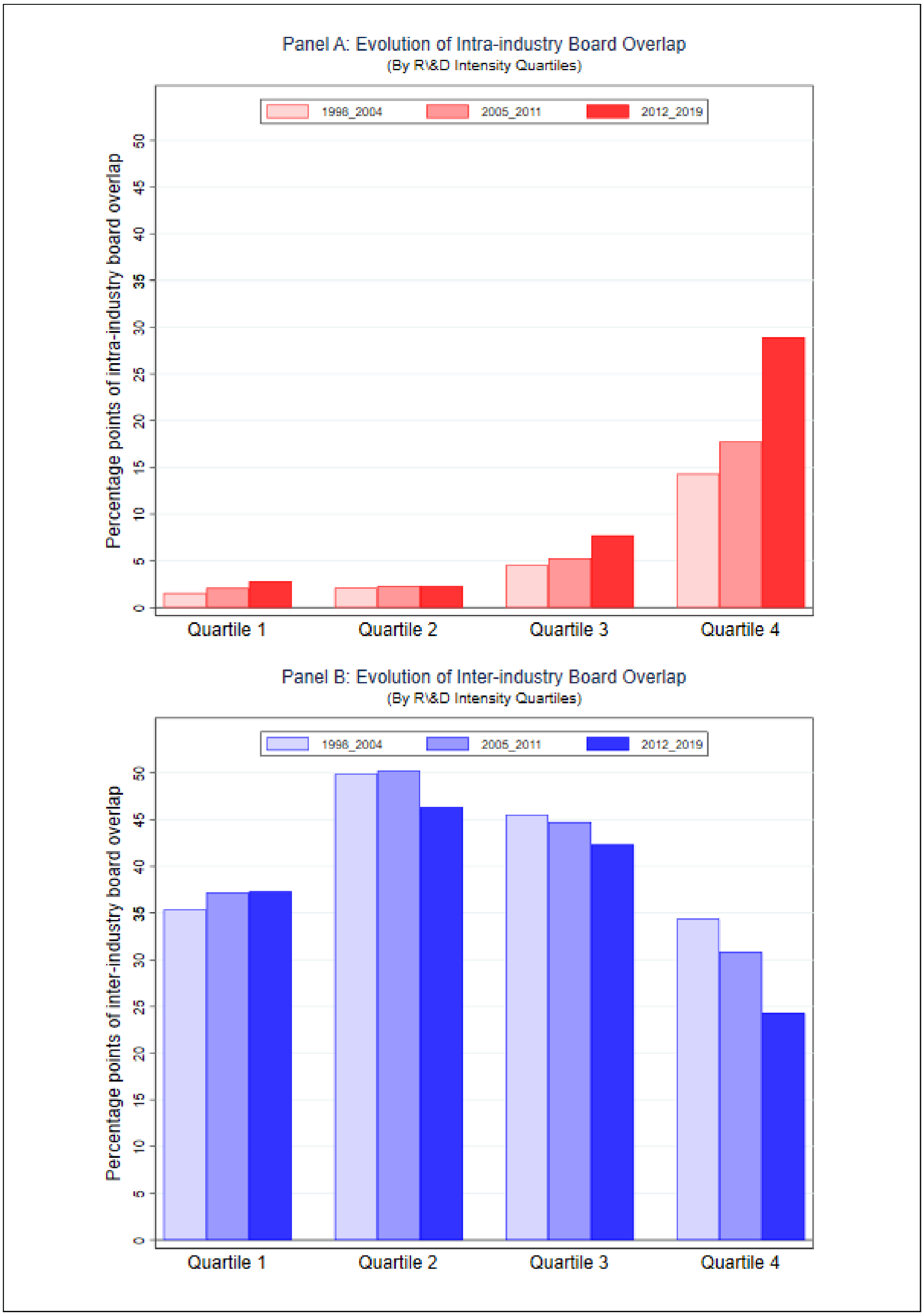

Figure 1: The evolution of intra-industry board overlap (Panel A) and inter-industry board overlap (Panel B) is depicted for three time periods and by the level of a firm's R&D intenstiy (Q1: low; Q4: high). Board overlap is the averge percentage of board members serving on at least one other corporate board.

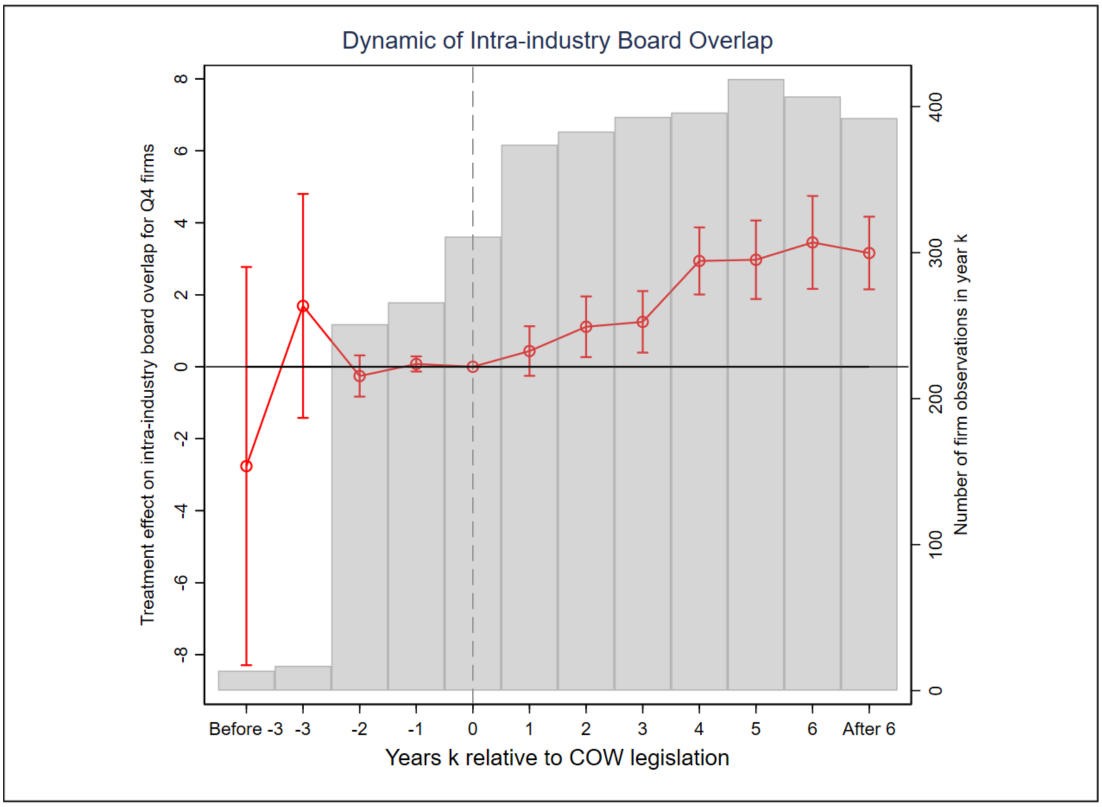

Figure 2: We plot the dynamics of intra-industry board overlap for firms with high R&D intensity (Q4) relative to the year $k = 0$ when COW legislation was introduced into U.S. state corporate law. Depicted by the red line is the coefficient estimate $\widehat{\alpha}_k$ in Eq. (3) with the vertical bars representing a 95% confidence interval. The grey histogram in the background represents the number of firm observations entering the estimation of $\widehat{\alpha}_k$.

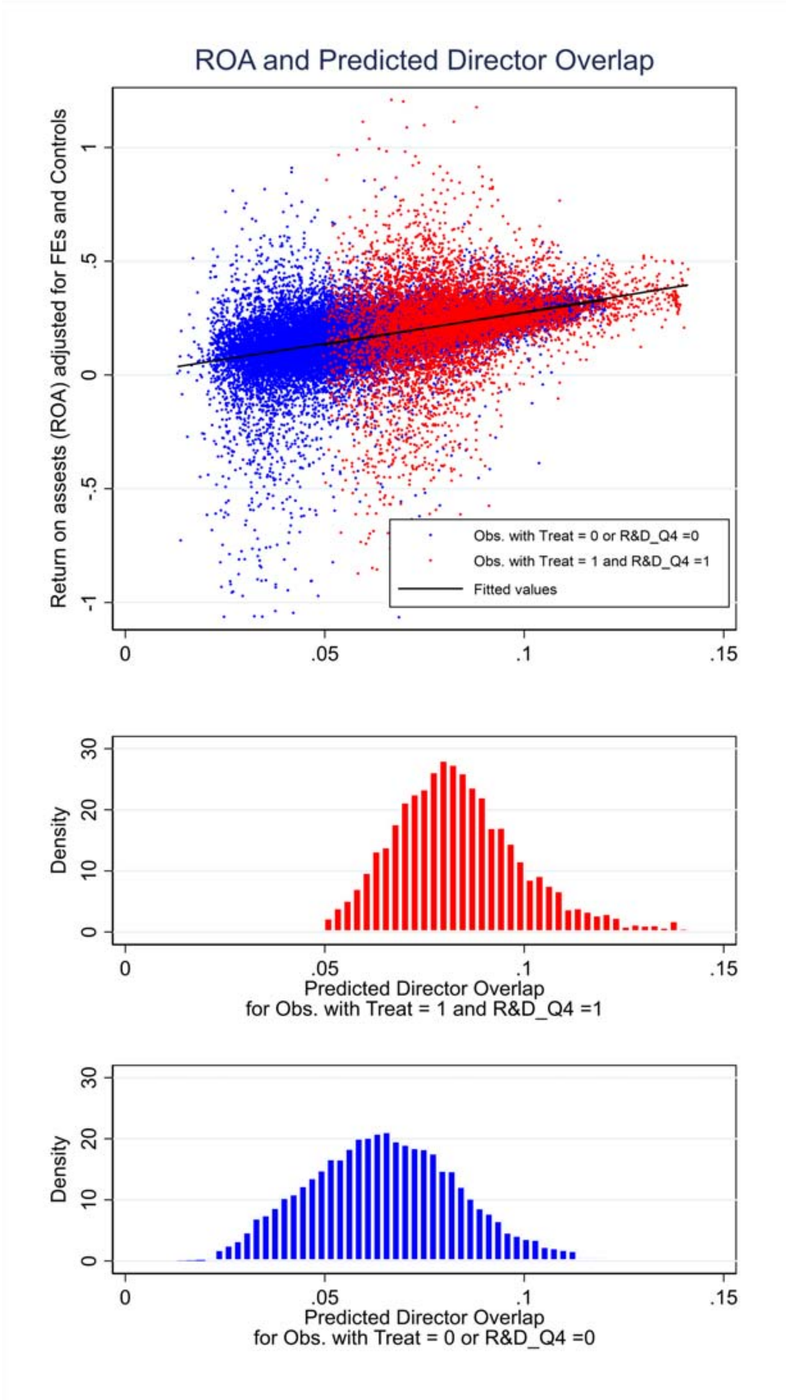

Figure 3: We graph a scatter plot of 49,957 firm-year observations for the return on assets (ROA) on the y-axis against the predicted (intra-industry) director overlap ($Intra\_\widehat{OvLapDir}$) on the x-axis, where we filter (subtract) firm and industry-by-year fixed effects and the three control variables based on the regression in Table 4, Column (1b). Firms in the high R&D intensity quartile Q4 ($R\&D\_Q4$ = 1) and observations simultaneously subject to COW legislation ($Treat = 1$) are marked by a red dot, and all other observations by blue dots. We show their corresponding histograms below the scatter plot.

Table 1: Corporate Law Changes by State

We list changes in state law that allow for corporate opportunity waivers relaxing the fiduciary duties of board members. Listed are the state, the specific statute, the date of effectiveness of corporate law changes, and the scope or coverage of the waiver. Rauterberg and Talley (2017) is the source for the information.

Corporate Law Change			Scope/Coverage (of)		
State	Statute	Date	Directors	Officers	Shareholders
(1)	(2)	(3)	(4)	(5)	(6)
DE	Code Ann. tit. 8, §122(17)	01/07/2000	Yes	Yes	Yes
OK	Ann. tit. 18, §1016(17)	01/11/2001	Yes	Yes	Yes
MO	Ann. Stat. §351.385(16)	01/10/2003	Yes	Yes	Yes
KS	Stat. Ann. §17-6102 (17)	01/01/2005	Yes	Yes	Yes
TX	Bus. Orgs. Code Ann. §2.101(21)	01/01/2006	Yes	Yes	Yes
NV	Rev. Stat. Ann. §78.070(8)	01/10/2007	Yes	Yes	No
NJ	Stat. Ann. 14A:3-1(q)	11/03/2011	Yes	Yes	Yes
MD	Code Ann., Corps. & Ass'ns §2-103(15)	01/10/2014	Yes	Yes	Yes
WA	Code Ann. §23B.02.020(5)(k)	01/01/2016	Yes	Yes	Yes

Table 2: Descriptive Statistics

Panel A reports summary statistics on all variables. The accounting variables are return on assets (*ROA*), the *Gross (Profit) Margin* [i.e. *(Sales-COGS)/Sales*], *Operating Margin* (i.e. *Operating Profit/Sales*), the log values of sales and costs of goods sold (in USD millions), the log cost share [*ln(COGS/Sales)*], log assets [*ln(Assets)*], log capital expenditure [*ln(Capex)*], asset tangibility (*Tangibility*), and the market-to-book ratio(*MTB ratio*). The governance variables comprise the number of board members (*Board Size*), the overall percentage of overlapping directors on a firm board (*All_ OvLapDir*), the percentage of intra-industry overlapping directors (*Intra_ OvLapDir*), and the percentage of inter-industry overlapping directors (*Inter_ OvLapDir*). The patent data include the ratio of R&D expenditure and assets (*R&D Intensity*), the log (cumulative) patent count for a firm [*ln(1+Patents)*], and the log (dollar) value of these patents [*ln(1+PatVal)*]. In Panel B, we report mean values of all variables for the full sample and subsamples sorted according to *R&D Intensity* into quartiles Q1 to Q4 capturing different degrees of R&D expdentiture. Column (6) provides the variable difference between the means of Q4 and Q1, and tests for statistical difference based on a non-parametric rank test. Columns (7) and (8) split the sample Q4 of firms subject to high R&D intensity into those with (*Intra_ OvLapDir* > 0) and without (*Intra_ OvLapDir* $= 0$) intra-industry board overlap.

Panel A: Summary Statistics

	Obs. (1)	Mean (2)	S.D. (3)	Median (4)	P25 (5)	P75 (6)
Accounting						
ROA	49,957	0.068	0.213	0.111	0.049	0.166
Gross margin	49,957	0.367	0.287	0.365	0.222	0.549
Operating margin	49,957	0.031	0.206	0.068	0.006	0.133
ln(Sales)	49,957	6.05	2.212	6.152	4.648	7.555
ln(COGS)	49,957	5.544	2.167	5.555	4.008	7.065
ln(COGS/Sales)	49,957	−0.512	0.749	−0.454	−0.795	−0.25
ln(Capex)	49,587	2.776	2.404	2.877	1.165	4.426
ln(Assets)	49,957	6.198	1.987	6.133	4.763	7.547
Tangibility	49,957	0.243	0.224	0.166	0.072	0.344
MTB ratio	49,957	1.86	1.666	1.315	0.877	2.166
Governance						
Board Size	49,957	8.509	2.57	8	7	10
All_ OvLapDir	49,957	0.45	0.401	0.375	0.143	0.667
Intra_ OvLapDir	49,957	0.068	0.178	0	0	0
Inter_ OvLapDir	49,957	0.381	0.371	0.286	0.1	0.583
Innovation						
R&D Intensity	49,957	0.06	0.118	0.007	0	0.071
ln(1+Patent)	45,443	0.778	1.372	0	0	1.099
ln(1+PatVal)	45,443	1.545	2.594	0	0	2.673

Table 2 continued

Panel B: Firm Variables Means by Level of R&D Intensity

	Full Sample	Subsamples by R&D Intensity Quartiles				Difference	Q4 Split	
		Q1 (Low)	Q2	Q3	Q4 (High)	Q4-Q1	*Intra_ OvLapDir* > 0 Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Accounting								
ROA	0.068	0.123	0.119	0.097	−0.119	−0.241***	−0.144	−0.088
Gross margin	0.367	0.330	0.329	0.445	0.364	0.034***	0.325	0.411
Operating margin	0.031	0.077	0.079	0.059	−0.134	−0.210***	−0.163	−0.098
ln(Sales)	6.050	6.601	6.917	6.106	4.365	−2.236***	4.449	4.261
ln(COGS)	5.544	6.144	6.487	5.431	3.937	−2.208***	4.107	3.728
ln(COGS/Sales)	−0.512	−0.457	−0.434	−0.676	−0.454	0.003	−0.373	−0.553
ln(Capex)	2.776	3.350	3.516	2.700	1.249	−2.101***	1.472	0.976
ln(Assets)	6.198	6.520	6.966	6.209	5.144	−1.376***	5.473	4.740
Tangibility	0.243	0.337	0.255	0.179	0.101	−0.237***	0.091	0.113
MTB ratio	1.860	1.445	1.464	1.917	2.904	1.459***	3.064	2.707
Governance								
Board Size	8.509	8.704	9.123	8.573	7.741	−0.963***	8.196	7.183
All_ OvLapDir	0.450	0.388	0.508	0.500	0.504	0.115***	0.672	0.296
Intra_ OvLapDir	0.068	0.022	0.022	0.058	0.209	0.187***	0.379	0.000
Inter_ OvLapDir	0.381	0.367	0.486	0.442	0.295	−0.072***	0.294	0.296
Innovation								
R&D Intensity	0.060	0.002	0.012	0.055	0.218	0.216***	0.243	0.187
ln(1+Patent)	0.778	0.155	0.838	1.459	1.310	1.155***	1.454	1.144
ln(1+PatVal)	1.545	0.409	1.869	2.741	2.496	2.087***	2.872	2.060

Table 3: Corporate Law Change and New Board Overlap

We report the first-stage regression of various types of board overlap. The dummy *COW* marks firm i incorporated in states that in a given year t is allowed for a corporate opportunity waiver for board members ($COW = 1$). The dummy takes on the value of zero if the state law does not provide this option ($COW = 0$). We measure the treatment effect for different quartiles Qx of R&D intensity by using the interaction term $R\&D\_Qx \times COW$. The quartile dummy $R\&D\_Qx$ takes on the value of one for firms in the x-th quartile of the R&D intensity. The R&D intensity used to construct $R\&D\_Qx$ is measured at the year when a firm first appears in the sample. The missing R&D is replaced to zero and marked by a dummy. The interaction of the missing R&D dummy and *COW* is included in all specifications. Panel A reports regressions of the percentage of intra-industry overlapping directors on a firm's board (*Intra_ OvLapDir*), and Panel B reports regressions of the overall percentage of overlapping directors on a firm board (*All_ OvLapDir*) and the percentage of inter-industry overlapping directors (*Inter_ OvLapDir*). The dependent variables are expressed in percentages (×100). Control variables for various specifications are the log of total assets [*ln(Assets)*], the asset tangibility (*Tangibility*) (i.e., property, plant, and equipment relative to total asset), and the market-to-book ratio (*MTB ratio*). All specifications control firm fixed effects and industry-by-year fixed effects. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Panel A: Intra-Industry Board Overlap

Dep. Variables:	*Intra_ OvLapDir*			
	(1)	(2)	(3)	(4)
COW×R&D_ Q4	2.8025***	2.8626***	2.6259***	2.6718***
	(0.5871)	(0.5705)	(0.5811)	(0.5511)
COW×R&D_ Q3	0.2753	0.3084		
	(0.4428)	(0.4482)		
COW×R&D_ Q2	−0.2322	−0.2640		
	(0.7879)	(0.7889)		
COW×R&D_ Q1	0.1655	0.1477		
	(0.3749)	(0.3662)		
COW			0.1661	0.1757
			(0.4213)	(0.4234)
Controls				
ln(Assets)	0.8642***	0.9233***	0.8646***	0.9233***
	(0.1166)	(0.1395)	(0.1171)	(0.1402)
Tangibility		1.3416*		1.3307*
		(0.7009)		(0.6910)
MTB ratio		0.1258		0.1252
		(0.0857)		(0.0860)
Firm FEs	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes
Adjusted R^2	0.746	0.746	0.746	0.746
Observations	49,957	49,957	49,957	49,957

Table 3 continued

Panel B: Overall and Inter-Industry Board Overlap

Dep. Variables:	*All_ OvLapDir*		*Inter_ OvLapDir*	
	(1)	(2)	(3)	(4)
COW×R&D_ Q4	−0.5868	1.4626	−3.4494***	−1.2093*
	(1.2470)	(0.9403)	(1.0134)	(0.6991)
COW×R&D_ Q3	−2.8804*		−3.1888**	
	(1.4487)		(1.2948)	
COW×R&D_ Q2	−3.3711		−3.1070	
	(3.0071)		(2.7072)	
COW×R&D_ Q1	2.2598		2.1121	
	(2.3824)		(2.0890)	
COW		−1.6387		−1.8144*
		(1.2532)		(1.0803)
Controls				
ln(Assets)	4.2007***	4.2195***	3.2774***	3.2961***
	(0.2396)	(0.2425)	(0.2044)	(0.2038)
Tangibility	−2.7407	−2.7611	−4.0822*	−4.0918*
	(2.6325)	(2.6647)	(2.1780)	(2.2179)
MTB ratio	0.1172	0.1232	−0.0087	−0.0020
	(0.1697)	(0.1715)	(0.0916)	(0.0930)
Firm FEs	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes
Adjusted R^2	0.707	0.707	0.716	0.716
Observations	49,957	49,957	49,957	49,957

Table 4: Corporate Law Change and Firm Performance

We report the second-stage regressions on how firm performance respond to predicted change in intra-industry board overlap $\widehat{Intra\_OvLapDir}$ estimated in Table 3, Panel A. The dependent variables are the return on assets (*ROA*), the *Gross (Profit) Margin*, the *Operating Margin*, the log sales [*ln(Sales)*], the log costs of goods sold [*In(COGS)*], and the log cost share [*In(COGS/Sales)*]. Specifications (1a)-(6a) only include *In(Assets)* as the control variable and (1b)-(6b) include the all control variables. The variable of interest is the predicted (instrumented) intra-industry board overlap ($\widehat{Intra\_OvLapDir}_{i,t}$). The corresponding first-stage regressions with partial control variables and full control variables are separately stated in Table 3, Panel A, Columns (3) and (4). We report the Montiel Olea-Pflueger (MOP) effective F-statistics as a test for weak instruments. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	*ROA*		*Gross Margin*		*Operating Margin*	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
$\widehat{Intra\_OvLapDir}$	2.6082***	2.7448***	4.3025***	4.3623***	2.3497***	2.5271***
(instrumented)	(0.5936)	(0.5870)	(0.9116)	(0.8797)	(0.5252)	(0.5352)
COW	−0.0200*	−0.0193*	−0.0190	−0.0187	−0.0118	−0.0108
	(0.0109)	(0.0115)	(0.0167)	(0.0171)	(0.0097)	(0.0103)
Controls						
ln(Assets)	−0.0136	−0.0111	−0.0266**	−0.0257**	−0.0111	−0.0083
	(0.0085)	(0.0094)	(0.0114)	(0.0120)	(0.0093)	(0.0098)
Tangibility		−0.0113		−0.0278		−0.0628**
		(0.0261)		(0.0585)		(0.0301)
MTB ratio		0.0099**		0.0044		0.0129***
		(0.0042)		(0.0043)		(0.0033)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	49,957	49,957	49,957	49,957	49,957	49,957
MOP effective F-stats	20.42	23.50	20.42	23.50	20.42	23.50

Dep. Variables:	*ln(Sales)*		*ln(COGS)*		*ln(COGS/Sales)*	
	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
$\widehat{Intra\_OvLapDir}$	4.4289***	5.2686***	−5.8462***	−5.1869***	−10.1961***	−10.3426***
(instrumented)	(0.9196)	(0.9954)	(1.2909)	(1.0424)	(1.8058)	(1.7633)
COW	−0.0442**	−0.0407*	−0.0079	−0.0054	0.0374	0.0366
	(0.0219)	(0.0241)	(0.0320)	(0.0280)	(0.0388)	(0.0396)
Controls						
ln(Assets)	0.6555***	0.6749***	0.7074***	0.7239***	0.0552**	0.0531**
	(0.0188)	(0.0210)	(0.0111)	(0.0106)	(0.0219)	(0.0231)
Tangibility		0.4503***		0.5099***		0.0752
		(0.0846)		(0.0744)		(0.1621)
MTB ratio		0.0603***		0.0472***		−0.0107
		(0.0047)		(0.0050)		(0.0090)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	49,957	49,957	49,957	49,957	49,957	49,957
MOP effective F-stats	20.42	23.50	20.42	23.50	20.42	23.50

Table 5: Firm Investment and Board Overlap

We report the second-stage regression on how firm outcomes respond to predicted change in intra-industry board overlap (*Intra_ OvLapDir*). The dependent variables are log capital expenditure [*ln(Capex)*], the *R&D Intensity*, a firm's (log) patent count (plus 1) [*ln(1+Patents)*], and the log (dollar) value of these patents plus one (*ln(1+PatVal)*). The variable of interest is the predicted (instrumented) intra-industry board overlap (*Intra_ OvLapDir*). The corresponding first-stage regression with full control variables is stated in Table 3, Panel A, Column (4). We report the Montiel Olea-Pflueger (MOP) effective F-statistics as a test for weak instruments. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	*ln(Capex)*	*R&D Intensity*	*ln(1+Patents)*	*ln(1+PatVal)*
	(1)	(2)	(3)	(4)
$\widehat{Intra\_OvLapDir}$	-7.0633^{***}	-1.6410^{***}	-8.7708^{***}	-18.9781^{***}
(instrumented)	(1.7639)	(0.4927)	(2.2900)	(4.0907)
COW	0.0051	0.0127^{*}	-0.0135	-0.0518
	(0.0315)	(0.0075)	(0.0489)	(0.0819)
Controls				
ln(Assets)	0.9530^{***}	0.0008	0.2215^{***}	0.3594^{***}
	(0.0389)	(0.0060)	(0.0277)	(0.0476)
Tangibility	0.8705^{***}	0.0425^{***}	0.2971^{***}	0.5030^{***}
	(0.0905)	(0.0102)	(0.0546)	(0.0927)
MTB ratio	0.1562^{***}	0.0012	0.0296^{***}	0.0807^{***}
	(0.0108)	(0.0019)	(0.0090)	(0.0191)
Firm FEs	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes
Observations	49,587	49,957	45,443	45,443
MOP effective F-stats	23.42	23.50	19.70	19.70

Table 6: Firm Pair Regressions on Product Differentiation and Cross Citations

Panel A provides summary statistics on all intra-industry firm pairs, and Panel B reports 2SLS regressions capturing the effect of COW legislation on pairwise board overlap in Columns (1)-(2), and the consecutive effect of predicted pairwise board overlap on bilateral product market differentiation and cross-citations in patent filings.in Columns (3)-(4), respectively. The dummy *PairCOW* equals one if both firms in a pair are incorporated in states that have adopted corporate opportunity waivers (COWs) in a year. The dummy *PairR&D_Q4* equals one if both firms in a pair belong to the 4-th quartile of the R&D intensity measured at the beginning of the sample period or the year when a firm enters the sample. Missing R&D information is replaced by a zero and the respective firm pair is marked by a separate dummy. *Intra_PairOvLapDir* denotes the number of intra-industry overlapping directors in the firm pair scaled by a factor of 1000 for the convenience of tabulation. *PairHPSS* is the pairwise Holberg-Phillips product similarity measure, and .*PairCrossCite* represents the cross-citation statistics defined in Section 4.3. The control variables comprise 18 different dummies marking the joint tercile rank distribution of three (time-varying) firm characteristics, namely total assets, asset tangibility (i.e., property, plant, and equipment relative to total asset), and the market-to-book ratio . For example, total assets of one firm in tercile $i \in \{1, 2, 3\}$ and the other firm in tercile $j \in \{1, 2, 3\}$ generates 6 different dummies characterizing the joint asset size distribution of both firms. We include firm pair and year fixed regressions in all specifications. We report the Montiel Olea-Pflueger (MOP) effective F-statistics as a test for weak instruments. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Panel A: Summary Statistics

	Obs.	Mean	Median	S.D.	P25	P75
	(1)	(2)	(3)	(4)	(5)	(6)
PairCOW	1,639,142	0.598	1	0.49	0	1
PairCOW×*PairR&D_Q4*	1,639,142	0.181	0	0.385	0	0
Intra_PairOvLapDir (×1000)	1,639,142	7.021	0	96.421	0	0
PairHPSS	1,639,142	0.018	0	0.04	0	0.012
PairCrossCite	1,639,142	0.059	0	0.418	0	0

Panel B: 2SLS Regressions

	First stage		*Second stage*			
Dep. Variables:	*Intra_PairOvLapDir* (×1000)		*PairHPSS*		*PairCrossCite*	
	(1)	(2)	(3)	(4)	(5)	(6)
PairCOW×*PairR&D_Q4*	0.3132**	0.3035***				
	(0.1443)	(0.1142)				
$\widehat{Intra\_PairOvLapDir}$ (×1000)			−0.0181**	−0.0183**	0.0315**	0.0310***
(instrumented)			(0.0078)	(0.0072)	(0.0143)	(0.0118)
PairCOW	0.1950	0.1212	0.0049	0.0036	−0.0085	−0.0073
	(0.4529)	(0.4441)	(0.0083)	(0.0084)	(0.0143)	(0.0139)
Controls	No	Yes	No	Yes	No	Yes
Firm pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,639,142	1,639,142	1,639,142	1,639,142	1,639,142	1,639,142
MOP effective F-stats			4.712	7.063	4.712	7.063

Table 7: The Scope of Product Offering and Board Overlap

The regressions in this table relate instrumented intra-industry board overlap to the scope of product offering, which is respectively proxied by (i) the log number of product market segments of a firm (*ln(#Segments)*), and (ii) the Holberg-Phillips measure of *Product Offering Growth* inferred from the textual analysis of regulator filings. The corresponding first-stage regressions with partial control variables and full control variables are separately stated in Table 3, Panel A, Columns (3) and (4). We report the Montiel Olea-Pflueger (MOP) effective F-statistics as a test for weak instruments. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	*ln(#Segments)*		*Product Offering Growth*	
	(1)	(2)	(3)	(4)
$Intra\_\widehat{OvLap}Dir$	0.6424	0.5900	−0.0028	0.0957
	(0.6247)	(0.6043)	(0.2302)	(0.2385)
Treat	0.0006	0.0004	−0.0053	−0.0051
	(0.0159)	(0.0157)	(0.0067)	(0.0069)
Controls				
ln(Assets)	0.0418***	0.0404***	−0.0194***	−0.0171***
	(0.0084)	(0.0083)	(0.0033)	(0.0033)
Tangibility		−0.0487		0.0209
		(0.0349)		(0.0128)
MTB ratio		−0.0037***		0.0070***
		(0.0011)		(0.0008)
Firm FEs	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes
Observations	49,463	49,463	45,251	45,251
MOP effective F-stats	19.90	22.88	17.46	19.80

Internet Appendix

Not for Journal Publication

Table A1: Top Ten R&D-Intensive Industries

This table reports the top 10 three-digit SIC industries according to the number of firms assigned to R&D quartile Q4. For each industry tabulated in Column (1), Column (2) reports the total number of firm-years in the sample during 1998–2019, Column (3) the number of firm-years assigned to quartile Q4, and Column (4) the share of R&D-intensive firms (= (3)/(2)).

Industry (1)	All firms-year obs. (2)	R&D-intensive firms-year obs. (3)	Percentage share (4)
Drugs	4,202	3,158	75%
Computer and data processing services	5,418	2,308	43%
Electronic components and accessories	2,522	955	38%
Medical instruments and supplies	2,034	723	36%
Measuring and controlling devices	1,514	615	41%
Computer and office equipment	1,224	566	46%
Communications equipment	1,095	530	48%
Special industry machinery	570	270	47%
Research, development, and testing services.	366	128	35%
Electrical industrial apparatus	306	54	18%

Table A2: Conditional Distribution of Inter-Industry Board Overlap Adjustment

This table characterizes the distribution of variation in inter-industry board overlap conditional on prior increase in intra-industry board overlap (Panel A), conditional on prior unchanged intra-industry board overlap (Panel B), and conditional on prior decrease in intra-industry board overlap (Panel C) for firms assigned to Quartile Q4 of product similarity. For each year, we sort each firm into one of three groups reflecting its variation of the intra-industry board overlap. Conditional on each type of variation for intra-industry board overlap in the prior year, we summarize the distribution of inter-industry board overlap variation over the subsequent three-year period by subtracting the beginning-period value from the ending-period one. The last row provides a t-test for the null of equally frequent upward (A) and downward (C) adjustments in inter-industry board overlap.

	Three-year adjustment in inter-industry board overlap					
	Panel A Conditional on prior increase in intra-industry board overlap		Panel B Conditional on prior unchanged intra-industry board overlap		Panel C Conditional on prior decrease in intra-industry board overlap	
	Obs. (1)	Percentage (2)	Obs. (3)	Percentage (4)	Obs. (5)	Percentage (6)
(A) Upward	560	41%	1421	39%	568	46%
(B) Unchanged	178	13.1%	748	22%	133	11%
(C) Downward	617	46%	1431	39%	547	44%
Total	1,355		3,600		1,248	
Diff. (C)−(A)		5%		0%		−2%
P-value		0.0272		0.4048		0.801

Table A3: Reduced Form Estimates for Firm Outcomes

We report the reduced form regressions of firm outcomes directly on *COW×R&D_ Q4*. The dependent variables are the return on assets (*ROA*), the *Gross (Profit) Margin*, the *Operating Margin*, the log sales [*ln(Sales)*], the log costs of goods sold [*In(COGS)*], and the log cost share [*In(COGS/Sales)*]. Specifications (1a)-(6a) only include *In(assets)* as the control variable and (1b)-(6b) include the all control variables. The variable of interest is *COW×R&D_ Q4*. The robust standard errors are clustered at the state level.***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	*ROA*		*Gross Margin*		*Operating Margin*	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
COW×R&D_ Q4	0.0685***	0.0733***	0.1130***	0.1166***	0.0617***	0.0675***
	(0.0053)	(0.0054)	(0.0071)	(0.0071)	(0.0045)	(0.0045)
COW	−0.0157***	−0.0145***	−0.0119**	−0.0110**	−0.0079	−0.0063
	(0.0054)	(0.0052)	(0.0049)	(0.0049)	(0.0050)	(0.0048)
Controls						
ln(Assets)	0.0090***	0.0142***	0.0106***	0.0146***	0.0092***	0.0150***
	(0.0020)	(0.0019)	(0.0019)	(0.0024)	(0.0028)	(0.0023)
Tangibility		0.0252*		0.0303		−0.0292
		(0.0140)		(0.0396)		(0.0202)
MTB ratio		0.0133***		0.0098***		0.0161***
		(0.0014)		(0.0006)		(0.0008)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.700	0.705	0.756	0.757	0.695	0.703
Observations	49,957	49,957	49,957	49,957	49,957	49,957

Dep. Variables:	*ln(Sales)*		*In(COGS)*		*In(COGS/Sales)*	
	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
Treat×R&D_ Q4	0.1163***	0.1408***	−0.1535***	−0.1386***	−0.2677***	−0.2763***
	(0.0288)	(0.0267)	(0.0174)	(0.0172)	(0.0385)	(0.0379)
Treat	−0.0369*	−0.0315	−0.0176	−0.0145	0.0205*	0.0184
	(0.0205)	(0.0194)	(0.0156)	(0.0147)	(0.0114)	(0.0113)
Controls						
ln(Assets)	0.6938***	0.7236***	0.6569***	0.6761***	−0.0329***	−0.0424***
	(0.0108)	(0.0093)	(0.0143)	(0.0145)	(0.0060)	(0.0075)
Tangibility		0.5204***		0.4409***		−0.0625
		(0.0554)		(0.0514)		(0.1064)
MTB ratio		0.0669***		0.0407***		−0.0236***
		(0.0016)		(0.0016)		(0.0017)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.963	0.964	0.964	0.965	0.726	0.727
Observations	49,957	49,957	49,957	49,957	49,957	49,957

Table A4: Free Cash Flows and the Heterogeneous Effect of COWs

This table reports reduced-form regression results on how free cash flows influence the effect of COW legislations on intra-industry board overlap and firm investments. The dummy variable $HighFCF$ is equal to one if a firm's free cash flow is greater than the median value in a year and zero otherwise. The free cash flow is calculated as the operating profit plus depreciation and then divided by total assets. Intra-industry board overlap ($Intra\_OvLapDir$) is augmented by a factor of 100. Other dependent variables are the log of capital expenditure [$ln(Capex)$], the *R&D intensity*, a firm's (log) patent count (plus 1) [$ln(1+Patents)$], a firm's (log) patent dollar value (plus 1) [$ln(1+PatVal)$]. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	$Intra\_OvLapDir$	$ln(Capex)$	*R&D Intensity*	$ln(1+Patents)$	$ln(1+PatVal)$
	(1)	(2)	(3)	(4)	(5)
$COW \times R\&D\_Q4 \times HighFCF$	1.2128	−0.0292	−0.0078	0.0359	−0.0960
	(0.9337)	(0.0488)	(0.0047)	(0.0379)	(0.0849)
$COW \times HighFCF$	−0.1606	0.0619	0.0001	−0.0171	−0.1002***
	(0.1612)	(0.0383)	(0.0009)	(0.0131)	(0.0217)
$COW \times R\&D\_Q4$	2.1996***	−0.1548***	−0.0345***	−0.2260***	−0.4256***
	(0.3992)	(0.0301)	(0.0049)	(0.0212)	(0.0453)
$R\&D\_Q4 \times HighFCF$	−1.2362	0.1611***	−0.0417***	−0.0459	0.0588
	(0.8301)	(0.0413)	(0.0048)	(0.0389)	(0.0961)
$HighFCF$	0.1417	−0.2875***	−0.0015**	0.0185	0.0583***
	(0.1574)	(0.0253)	(0.0007)	(0.0128)	(0.0207)
COW	0.2170	−0.0374	0.0094***	−0.0280	−0.1212*
	(0.4570)	(0.0331)	(0.0017)	(0.0240)	(0.0614)
Controls					
ln(Asset)	0.9412***	0.8911***	−0.0137***	0.1469***	0.1473***
	(0.1412)	(0.0145)	(0.0010)	(0.0054)	(0.0185)
Tangbility	1.3409*	0.7660***	0.0204***	0.1723***	0.2497**
	(0.7031)	(0.1177)	(0.0048)	(0.0469)	(0.0958)
MTB ratio	0.1392	0.1508***	−0.0004	0.0213***	0.0496***
	(0.0834)	(0.0036)	(0.0002)	(0.0017)	(0.0057)
Firm FEs	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.746	0.929	0.799	0.850	0.799
Observations	49,772	49,586	49,772	45,260	49,772

Table A5: Corporate Law Change and Firm Performance with Common Ownership

We report the second-stage regressions on how firm performance respond to predicted change in intra-industry board overlap. We extend the regressions in Table 4 by controlling for the common ownership *CO*. We follow Koch, Panayides, and Thomas (2021) and define *CO* as percentage of intra-industry firm pairs with at least one common shareholder. We define a common shareholder as the shareholder holding at least 1% equity ownership in any firm of a pair. The dependent variables are the return on assets (*ROA*), the *Gross (Profit) Margin*, the *Operating Margin*, the log sales [*ln(Sales)*], the log costs of goods sold [*In(COGS)*], and the log cost share [*In(COGS/Sales)*]. Specifications (1a)-(6a) only include *In(Assets)* as the control variable and (1b)-(6b) include the all control variables. The variable of interest is the predicted (instrumented) intra-industry board overlap ($Intra\_OvLapDir_{i,t}$). The corresponding first-stage regressions with partial control variables and full control variables are separately stated in Table 3, Panel A, Columns (3) and (4). We report the Montiel Olea-Pflueger (MOP) effective F-statistics as a test for weak instruments. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	*ROA*		*Gross Margin*		*Operating Margin*	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
$\widehat{Intra\_OvLapDir}$	2.9163***	3.0556***	4.8362***	4.8926***	2.6343***	2.8160***
	(0.7097)	(0.6962)	(1.1041)	(1.0618)	(0.6337)	(0.6386)
Treat	−0.0242**	−0.0238*	−0.0250	−0.0248	−0.0144	−0.0137
	(0.0115)	(0.0121)	(0.0185)	(0.0188)	(0.0104)	(0.0109)
Controls						
CO	0.0106	0.0116	0.0160	0.0164	0.0048	0.0061
	(0.0113)	(0.0117)	(0.0237)	(0.0236)	(0.0086)	(0.0092)
ln(Assets)	−0.0174*	−0.0150	−0.0311**	−0.0304**	−0.0147	−0.0118
	(0.0097)	(0.0106)	(0.0128)	(0.0135)	(0.0101)	(0.0107)
Tangibility		−0.0305		−0.0351		−0.0683**
		(0.0249)		(0.0542)		(0.0277)
MTB ratio		0.0094**		0.0038		0.0123***
		(0.0046)		(0.0048)		(0.0035)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44891	44891	44891	44891	44891	44891
MOP effective F-stats	15.75	17.88	15.75	17.88	15.75	17.88

Dep. Variables:	*ln(Sales)*		*ln(COGS)*		*ln(COGS/Sales)*	
	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
$\widehat{Intra\_OvLapDir}$	4.6171***	5.5025***	−6.7344***	−6.0108***	−11.1844***	−11.3140***
	(1.0260)	(1.1697)	(1.5412)	(1.2607)	(2.2310)	(2.1634)
Treat	−0.0493**	−0.0479*	−0.0008	−0.0000	0.0502	0.0496
	(0.0220)	(0.0243)	(0.0354)	(0.0313)	(0.0413)	(0.0419)
Controls						
Density	−0.0243	−0.0188	−0.0606	−0.0563	−0.0339	−0.0348
	(0.0202)	(0.0222)	(0.0387)	(0.0350)	(0.0482)	(0.0482)
ln(Assets)	0.6410***	0.6628***	0.7008***	0.7202***	0.0629**	0.0614**
	(0.0212)	(0.0233)	(0.0123)	(0.0115)	(0.0253)	(0.0267)
Tangibility		0.4425***		0.5173***		0.0989
		(0.0917)		(0.0528)		(0.1491)
MTB ratio		0.0597***		0.0487***		−0.0088
		(0.0052)		(0.0061)		(0.0105)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44891	44891	44891	44891	44891	44891
MOP effective F-stats	15.75	17.88	15.75	17.88	15.75	17.88

Table A6: Pre-Existing Director Overlap

We report the second-stage regression of firm outcomes in a sample that excludes firms that have intra-industry board overlap in the year before the COW legislation and simultaneously observe a change in board overlap over the five-year period following the COW. The dependent variables are the return on assets (*ROA*), the *Gross (Profit) Margin*, the *Operating Margin*, the log sales [*ln(Sales)*], the log costs of goods sold [*In(COGS)*], and the log cost share [*In(COGS/Sales)*]. Specifications (1a)–(6a) exclude the control variables and (1b)–(6b) include them. The variable of interest is the predicted (instrumented) intra-industry board overalp ($\widehat{Intra\_OvLapDir}$). The corresponding first-stage specifications are consistent with those in Table 3, Panel A, Columns (3) and (4). We report the Montiel Olea-Pflueger (MOP) effective F-statistics as a test for weak instruments. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	*ROA*		*Gross Margin*		*Operating Margin*	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
$\widehat{Intra\_OvLapDir}$	2.5676***	2.6987***	4.0825***	4.1419***	2.3371***	2.5062***
	(0.5614)	(0.5563)	(0.8263)	(0.8013)	(0.5021)	(0.5124)
COW	−0.0204*	−0.0197*	−0.0196	−0.0192	−0.0124	−0.0114
	(0.0107)	(0.0114)	(0.0159)	(0.0163)	(0.0097)	(0.0103)
Controls						
ln(Assets)	−0.0135	−0.0110	−0.0255**	−0.0244**	−0.0113	−0.0084
	(0.0083)	(0.0091)	(0.0107)	(0.0113)	(0.0092)	(0.0097)
Tangibility		−0.0040		−0.0150		−0.0557
		(0.0288)		(0.0628)		(0.0334)
MTB ratio		0.0099**		0.0045		0.0130***
		(0.0041)		(0.0040)		(0.0032)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	49,760	49,760	49,760	49,760	49,760	49,760
MOP effective F-stats	22.20	25.45	22.20	25.45	22.20	25.45

Dep. Variables:	*ln(Sales)*		*In(COGS)*		*In(COGS/Sales)*	
	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
$\widehat{Intra\_OvLapDir}$	4.2583***	5.0834***	−5.5610***	−4.9125***	−9.7488***	−9.8920***
	(0.8997)	(0.9606)	(1.1944)	(0.9653)	(1.6834)	(1.6521)
Treat	−0.0445**	−0.0411*	−0.0067	−0.0043	0.0389	0.0380
	(0.0216)	(0.0236)	(0.0311)	(0.0273)	(0.0370)	(0.0379)
Controls						
ln(Assets)	0.6565***	0.6760***	0.7062***	0.7224***	0.0531**	0.0506**
	(0.0183)	(0.0203)	(0.0109)	(0.0104)	(0.0208)	(0.0218)
Tangibility		0.4658***		0.4953***		0.0454
		(0.0881)		(0.0783)		(0.1703)
MTB ratio		0.0605***		0.0471***		−0.0110
		(0.0045)		(0.0047)		(0.0085)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	49,760	49,760	49,760	49,760	49,760	49,760
MOP effective F-stats	22.20	25.45	22.20	25.45	22.20	25.45

Table A7: Corporate Law Change and Board Overlap in Young Firms

In this table, we interact key variables in the first stage regression with the dummy variable *PostIPO,* which marks marks firms with observations at most 3 years after their IPO and zero otherwise. The dependent variable *Intra_ OvLapDir* is the percentage of intra-industry overlapping directors and is expressed in percentages (×100). The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variable:	*Intra_ OvLapDir*	
	(1)	(2)
PostIPO×COW×R&D_ Q4		-1.1102^{*}
		(0.6229)
PostIPO×R&D_ Q4		-2.0664^{***}
		(0.6733)
PostIPO×COW		0.5349^{**}
		(0.2306)
COW×R&D_ Q4	3.0025^{***}	2.4536^{***}
	(0.4926)	(0.4811)
PostIPO		-0.6390^{***}
		(0.2267)
COW	-0.2286	-0.1969
	(0.3229)	(0.3178)
Controls		
ln(Assets)	0.9173^{***}	0.8923^{***}
	(0.1393)	(0.1374)
Tangibility	1.3223^{*}	1.1521
	(0.6954)	(0.7049)
MTB ratio	0.1231	0.1388
	(0.0855)	(0.0829)
Firm FEs	Yes	Yes
Industry-by-year FEs	Yes	Yes
Adjusted R^2	0.746	0.746
Observations	49,957	49,957

Table A8: Corporate Law Change and Firm Outcomes with Additional Fixed Effects

We report the second-stage regression on how firm outcomes respond to predicted change in intra-industry board overlap. We extend the regressions in Table 4 by including additional headquarter-state-by-year fixed effects. The dependent variables are the return on assets (*ROA*), the *Gross (Profit) Margin*, the *Operating Margin*, the log sales [*ln(Sales)*], the log costs of goods sold [*In(COGS)*], and the log cost share [*In(COGS/Sales)*]. Specifications (1a)–(6a) exclude the control variables and (1b)–(6b) include them. The variable of interest is the predicted (instrumented) intra-industry board overalp (*Intra_ OvLapDir*). The corresponding first-stage regressions with partial control variables and with full control variables are separately stated in Table 3, Panel A, Columns (3) and (4). We report the Montiel Olea-Pflueger (MOP) effective F-statistics as a test for weak instruments. The robust standard errors are clustered at the state level. ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	*ROA*		*Gross Margin*		*Operating Margin*	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
$\widehat{Intra\_OvLapDir}$	2.7760***	3.9601***	4.5875***	6.0678***	2.8416***	3.6981***
	(0.4120)	(0.7452)	(0.6119)	(1.1609)	(0.3363)	(0.6384)
COW	−0.0050	−0.0108	−0.0077	−0.0137	−0.0001	−0.0044
	(0.0067)	(0.0113)	(0.0108)	(0.0174)	(0.0074)	(0.0112)
Controls						
ln(Assets)	−0.0180***	−0.0232**	−0.0371***	−0.0433**	−0.0183**	−0.0202*
	(0.0059)	(0.0111)	(0.0086)	(0.0162)	(0.0073)	(0.0117)
Tangibility	−0.0053	−0.0159	−0.0200	−0.0319	−0.0652**	−0.0690*
	(0.0225)	(0.0303)	(0.0555)	(0.0645)	(0.0298)	(0.0355)
MTB ratio	0.0088**	0.0081	0.0021	0.0015	0.0114***	0.0115**
	(0.0035)	(0.0051)	(0.0037)	(0.0059)	(0.0032)	(0.0043)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
HQ-state-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	No	Yes	No	Yes	No	Yes
Observations	49,875	49,875	49,875	49,875	49,875	49,875
MOP effective F-stats	103.2	33.55	103.2	33.55	103.2	33.55

Dep. Variables:	*ln(Sales)*		*In(COGS)*		*In(COGS/Sales)*	
	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
$\widehat{Intra\_OvLapDir}$	4.5114***	7.7975***	−6.2195***	−6.7837***	−10.6450***	−14.3244***
	(1.5404)	(1.8170)	(0.9898)	(1.4885)	(1.9767)	(2.8144)
COW	−0.0030	−0.0237	0.0119	−0.0001	0.0132	0.0233
	(0.0156)	(0.0254)	(0.0217)	(0.0252)	(0.0258)	(0.0426)
Controls						
ln(Assets)	0.6727***	0.6465***	0.7455***	0.7382***	0.0768***	0.0941***
	(0.0155)	(0.0242)	(0.0132)	(0.0154)	(0.0187)	(0.0322)
Tangibility	0.4404***	0.4250***	0.4778***	0.4950***	0.0556	0.0831
	(0.0582)	(0.0950)	(0.0930)	(0.0847)	(0.1537)	(0.1803)
MTB ratio	0.0593***	0.0570***	0.0519***	0.0508***	−0.0050	−0.0040
	(0.0026)	(0.0065)	(0.0053)	(0.0061)	(0.0074)	(0.0121)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
HQ-state-by-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Industry-by-year FEs	No	Yes	No	Yes	No	Yes
Observations	49,875	49,875	49,875	49,875	49,875	49,875
MOP effective F-stats	103.2	33.55	103.2	33.55	103.2	33.55

Table A9: Regression Results When Excluding Delaware Firms

This table reports the robustness test for the sample excluding firms incorporated in the state of Delaware. We use the reduced-form specification that directly links firm outcomes to the instrumental variable *COW×R&D_Q4* for the 2SLS model. The dependent variables are the return on assets (*ROA*), the *Gross (Profit) Margin*, the *Operating Margin*, the log sales [*ln(Sales)*], the log costs of goods sold [*In(COGS)*], and the log cost share [*In(COGS/Sales)*]. Specifications (1a)-(6a) only include *In(assets)* as the control variable and (1b)-(6b) include the all control variables. The variable of interest is *COW×R&D_Q4*. The robust standard errors are clustered at the state level.***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

Dep. Variables:	*ROA*		*Gross Margin*		*Operating Margin*	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
COW×R&D_Q4	0.1117*	0.1149*	0.1799**	0.1799**	0.0857*	0.0874*
	(0.0579)	(0.0619)	(0.0859)	(0.0871)	(0.0467)	(0.0500)
COW	−0.0144*	−0.0119	−0.0110	−0.0107	−0.0084	−0.0068
	(0.0083)	(0.0071)	(0.0078)	(0.0075)	(0.0109)	(0.0102)
Controls						
ln(Assets)	0.0102	0.0143*	0.0088	0.0098	0.0153**	0.0183***
	(0.0072)	(0.0073)	(0.0059)	(0.0061)	(0.0058)	(0.0058)
Tangibility		−0.0088		−0.0809*		−0.0851***
		(0.0251)		(0.0408)		(0.0306)
MTB ratio		0.0181***		0.0091***		0.0182***
		(0.0026)		(0.0021)		(0.0024)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.623	0.635	0.727	0.729	0.611	0.625
Observations	16,070	16,070	16,070	16,070	16,070	16,070

Dep. Variables:	*ln(Sales)*		*In(COGS)*		*In(COGS/Sales)*	
	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
COW×R&D_Q4	0.4787***	0.4993**	−0.2274	−0.2071	−0.6929***	−0.6916***
	(0.1749)	(0.1899)	(0.1456)	(0.1349)	(0.2476)	(0.2498)
COW	−0.0279	−0.0138	0.0004	0.0135	0.0332*	0.0332*
	(0.0737)	(0.0695)	(0.0622)	(0.0576)	(0.0174)	(0.0167)
Controls						
ln(Assets)	0.7297***	0.7504***	0.7045***	0.7226***	−0.0228	−0.0241
	(0.0208)	(0.0204)	(0.0167)	(0.0163)	(0.0159)	(0.0163)
Tangibility		0.4229***		0.6157***		0.2532***
		(0.0794)		(0.0793)		(0.0937)
MTB ratio		0.0644***		0.0412***		−0.0212***
		(0.0056)		(0.0066)		(0.0055)
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.974	0.975	0.972	0.972	0.707	0.709
Observations	16,070	16,070	16,070	16,070	16,070	16,070

Table A10: Variable Definitions

Variable	Description
ROA	The return on assets is calculated as operating income before depreciation (OIBDP) divided by total assets (AT). Source: Compustat
Gross Margin	Sales (SALES) less cost of goods sold (COGS), then divided by sales (SALES). Source: Compustat
Operating Margin	The ratio of operating profit to sales. Operating profit is defined as sales (SALES) - cost of goods sold (COGS) - SG&A (XSGA) - depreciation (DP). Source: Compustat
ln(Sales)	The natural logarithm of sales (SALES). Source: Compustat
ln(COGS)	The natural logarithm of cost of goods sold (COGS). Source: Compustat
ln(Capex)	The natural logarithm of capital expenditure (CAPEX). Source: Compustat
R&D Intensity	The amount of R&D expenditure (XRD) divided by total assets (AT). Source: Compustat
R&D_ Qx	A quartile dummy set equal to one for firms assigned to the x-th quartile of the R&D intensity, and set to 0 otherwise. Source: Compustat
ln(1+Patent)	The natural logarithm of one plus the number of patents applied by a firm in a year. Source: Kogan *et al* (2017)
ln(1+PatVal)	The natural logarithm of one plus the estimated dollar value of patents filed by a firm in a year. Source: Kogan *et al* (2017) and Compustat
COW	A dummy variable that equals to one for firms incorporated in states that have already passed COW legislation in a given year. Source: Compustat
ln(Assets)	The natural logarithm of total assets (AT). Source: Compustat
Tangibility	It is defined as net fixed assets (PPENT) divided by total assets (AT). Source: Compustat
MTB ratio	Market to book ratio. It is defined as the market value of assets divided by the book value of assets (AT). The market value of assets is the sum of short-term debt (DLC) , long-term debt (DLTT), preferred stock (PSTK), and market value of equity (MKVALT) and then minus deferred taxes and investment tax credit (TXDITC). Source: Compustat
Board Size	The number of directors on a firm's board. Source: BoardEx
All_ OvLapDir	The overall percentage of overlapping directors on a firm board. We first count external board director positions concurrently held by a firm's board directors, and then divide the count by the number of board directors on the firm's board. Source: BoardEx
Intra_ OvLapDir	The percentage of intra-industry overlapping directors on a firm board. It is calculated as the number of overlapping directorships a firm has with external firms assigned to the same three-digit SIC code, then divided by the number of board directors on the firm's board. Source: BoardEx and Compustat
Inter_ OvLapDir	The percentage of inter-industry overlapping directors on a firm board. It is calculated as the number of overlapping directorships a firm has with external firms assigned to different three-digit SIC code, then divided by the number of board directors on the firm's board. Source: BoardEx and Compustat
PairCOW	A dummy variable that is one if both firms in a pair are covered by COW legislation and zero otherwise. Source: BoardEx
PairR&D_ Q4	A dummy variable that is one if both firms in a pair are sorted to quartile Q4 by R&D intensity and zero otherwise. The sorting is based on R&D intensity calculated in 1998 or the year a firm enters the sample if the firm did not exist in 2000. Source: Compustat
Intra_ PairOvLapDir	the number of intra-industry interlocked directors between firms in a pair. Source: BoardEx and Compustat
PairHPSS	Hoberg-Phillips similarity score deduced from the textual analysis of 10-K business description. Source: Source: Hoberg and Phillips (2010, 2016)
ln(#Segments)	The log number of product market segments of a firm, which is retrieved from Compustat
Product Offering Growth	The changes in product variety, which is measured as the log of the number of words in the business description in year t divided by the number of words in the business description in year t-1. Source: Hoberg and Phillips (2018)
CO	The percentage of intra-industry firm pairs with at least one common shareholder, which is defined as holding at least 1% of equity ownership in any firm of a pair. Source: Thomson Reuters 13F

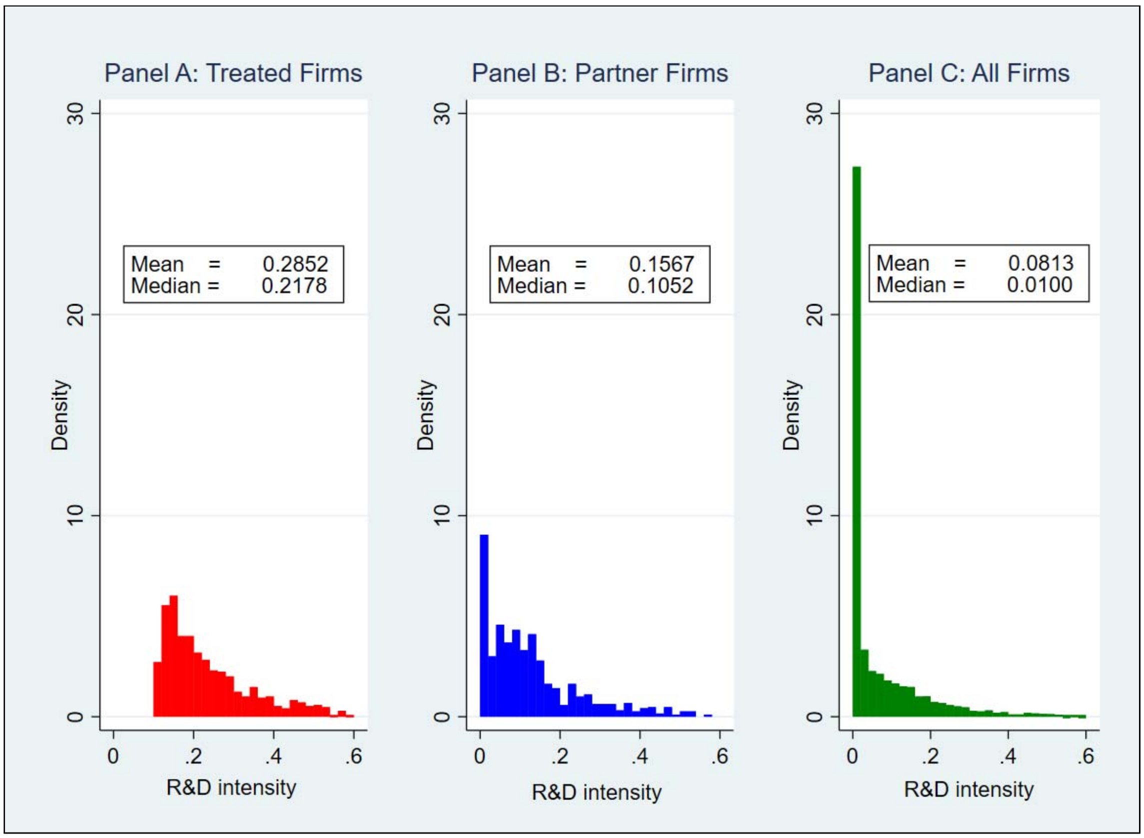

Figure 1: We plot histograms for the *R&D intensity* of different firm samples. Panel A shows the density distribution for all treated firms with *R&D_Q4* $= 1$ and *Treat* $= 1$, Panel B for the partner firms in which board overlap occurs, and Panel C for all firms in the sample.

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