Essays on Board of Directors Composition and Firm Outcomes

Raffaele Manini

THESIS SUPERVISOR:

Dr. Oriol Amat

Dr. Javier Gomez Biscarri

Department de Economia i Empresa

TESI DOCTORAL UPF / 2022

To my parents Maurizio e Luisella, my partner Bianca and my niece Iris

ACKNOWLEDGEMENTS

I would like to thank my supervisors, Oriol Amat and Javier Gomez Biscarri for their continuing guidance and support throughout my PhD journey. In particular, I thank Oriol for being close to me in every aspect of my development as an academic since I was just a master student. He always helped me figure out the best solutions to make the most out of my journey. As per Javier, I will always be extremely thankful to his thorough guidance when it comes to research, and to his very direct approach in doing so. He has guided me step by step throughout my development as a researcher and he was the one helping me assess the various options I had after the job market. A very special thank goes to April Klein. April is the one who welcomed me in her class in empirical research in financial accounting in NYU where she introduced me to her way of tackling, criticizing, and developing research. April took me in as her own PhD student and guided me through my first A level publication process as well as the development of my job market paper. I will never forget what these people have done to help me become a better researcher. Other people I should thank for their support are Baruch Lev who was the one who first sponsored me in NYU and Mircea Epure who has always been available to discuss research, to clarify my doubts and sometimes even to have a nice reinsuring chat.

ABSTRACT

This thesis focuses in understanding the relationship between board of directors' composition and firm outcomes. Chapter 1 investigates how US firms board of directors responded to a quasi-exogenous shift in the cyber risk environment as proxied by the General Data Protection Regulation (GDPR) and finds that those firms that are more affected by the regulatory shock tend to increase their focus on cyber-risk, add more directors with Cyber expertise on the board and assign more frequently the monitoring of cyber-risk to the board as a whole or to a specialized board committee. Chapter 2 instead, introduces the new dimension of board of directors' skill-sets fit to try to contribute to the empirical literature addressing the relationship between board of directors' composition and firm performance. This chapter shows that those firms presenting a board of directors fit dimension both on its internal and external fit dimensions perform better than their peers.

RESUMEN

Esta tesis se enfoca en comprender la relación entre la composición de la junta directiva y los resultados de la empresa. El Capítulo 1 investiga cómo la junta directiva de las empresas estadounidenses respondió a un cambio casi exógeno en el entorno de riesgo cibernético representado por el Reglamento General de Protección de Datos (GDPR) y encuentra que aquellas empresas que se ven más afectadas por el impacto regulatorio tienden a aumentar su enfoque sobre el riesgo cibernético, agregar más directores con experiencia cibernética en la junta y asignar con más frecuencia el monitoreo del riesgo cibernético a la junta en su conjunto o a un comité de la junta especializado. En cambio, el Capítulo 2 presenta la nueva dimensión de los conjuntos de habilidades de la junta directiva para tratar de contribuir a la literatura empírica que aborda la relación entre la composición de la junta directiva y el desempeño de la empresa. Este capítulo muestra que aquellas empresas que presentan una dimensión de ajuste de la junta directiva tanto en sus dimensiones de ajuste interno como externo se desempeñan mejor que sus pares.

PREFACE

In this thesis I explore how US firms use one of their main corporate governance mechanisms, the board of directors' composition, to both respond to externally imposed shift in the risk environment and to maximize their performance. In particular, this dissertation contributes to the literature examining the role of US firms board of directors' composition and firm outcomes. Overall, my research has been influenced by scholars such as April Klein, Renee Adams, Laura Starks, and Daniel Ferreira, among others who made the exploration of the relationship between board of directors' composition, characteristics, and firm outcomes one of their research pillars. Since the big corporate scandal of Enron in 2001, after which the regulators started calling for significant corporate governance adjustments, till today, the ESG era which advocates for higher diversity in the board of directors on the grounds of attaining greater social equality or deepening the directors' talent pool, understanding how board of directors' composition impacts firms' outcomes is always a pressing question. This preface places the above research line into the two chapters that form my dissertation and are at the base of my current work in progress.

Chapter 1 of the dissertation is a joint work with April Klein and Yanting (Crystal) Shi. This work started taking shape in 2018 during my first visit in NYU and culminated into its publication on *Contemporary Accounting Research* in 2022. In this chapter we exploit the EU General Data Protection Regulation (GDPR) as a quasi-exogenous shock to the cyber risk environment to assess whether US board of directors changed their focus and governance structure to deal with this new challenge. The GDPR encompasses a sweeping set of regulations aimed at protecting EU citizens from unwanted uses of their personal Internet data. Although an EU regulation, the GDPR applies to all US public firms with at least one EU user. Adopting a difference-in-differences methodology, we use firms that already fall under a US data privacy regulation as a control group and find that boards of treated US firms, on average, increase their focus on cyber risk, add more directors with cyber/IT expertise, and more frequently assign cyber risk oversight to the board or to a board committee. In cross-sectional tests, we show that these changes are positively associated with a firm's ex ante cyber risk but are unrelated to whether a firm had a large EU presence, suggesting a more global reaction to the GDPR. In addition, we examine some of the consequences of these board changes. We find boards that promptly responded by changing their board focus, expertise, and monitoring assignment of cyber risk around the passage of GDPR had fewer future cyberattacks/data breaches and less related media attention. Our findings suggest that, on average, American corporate boards promptly responded to changes in the cyber risk environment in ways that reduced their firms' overall future cyber risk. Our results have implications for the efficacy and flexibility of US corporate boards to respond to unexpected changes in risk.

While Chapter 1 focuses on how US boards of directors use as one of their tools the appointment of specialized directors to face a sudden shift in a very specific aspect of their business environment, Chapter 2 (my job market paper) tries to contribute to the empirical literature addressing the relationship between boards of directors' composition and firm performance. Exploiting the 2009 amendment to regulation S-K which requires firms to "*Briefly discuss the specific experience, qualifications, attributes or skills that led to the conclusion that the person should serve as a director for the registrant at the time that the disclosure is made, in light of the registrant's business and structure*", this chapter introduces the new concept of board of directors' skill sets fit. This new dimension is further divided into internal and external fit where internal fit represents the appropriate combination of a diverse range of directors' skill sets while maintaining a certain degree of complementarity and external fit represents the appropriate inclusion of directors' skill sets to meet externally imposed challenges. Using a combination of econometric techniques to address the endogeneity concerns that usually arise within the corporate governance literature, I find that firms that present both an internal and external fit dimension perform better than their peers.

Table of contents

Acknowledgments…………………………………………………………………. v

Abstract…………………………………………………………………………….. vii

Resumen…………………………………………………………………………..... vii

Preface…………………………………………………………………………… ix

List of Figure……………………………………………………………………. xiii

List of Tables……………………………………………………………………. xv

1. Across the Pond: How us firm's boards directors adapted to the passage of the General Data Protection Regulation……………………... 2

1.1. Introduction……………………………………………………………… 2

1.2. Institutional background: The GDPR and cyber privacy laws………... 6

a) The GDPR……………………………………………………….. 6

b) Pre- and post- periods around the passage of the GDPR………… 8

1.3. Literature review and hypotheses…………………………………….. 8

1.4. Sample selection, data sources, and description of data……………… 11

a) Sample selection…………………………………………………. 11

b) Board risk oversight and directors with cyber/IT expertise……... 12

1.5. Board monitoring of cyber risk before and after the approval of GDPR 15

a) First Differences…………………………………………………. 15

b) DiD regressions: Treatment and control groups…………………. 16

1.6. Cross-sectional variations in board responses to the GDPR…………. 19

a) EU exposure……………………………………………………... 19

b) Cyber risk exposure……………………………………………… 20

1.7. Consequences of GDPR and changes in board focus, composition, and monitoring……………………………………………………... 23

a) Future effects of board changes: Reduction in cyberattacks and cyber breaches………………………………………………... 23

b) Future effects of board changes: Reduction in subsequent media attention on data security……………………………………... 24

c) Future effect of passage of the GDPR: GDPR in the firm's 10-K filing………………………………………………………... 25

d) Future effect of passage of the GDPR: Brussels effect………….. 25
e) Summary………………………………………………………. 26
1.8. Robustness checks…………………………………………………. 26
1.9. Summary and suggestions for future research………………………... 27
1.10. Appendices………………………………………………………… 43
1.10.1. Variable definitions……………………………………………. 43
1.10.2. Major provisions of the GDPR……………………………… 45
1.10.3. GDPR events………………………………………………... 47

2. Board of directors' composition and directors' skill sets: it's all about fit!... 50
2.1. Introduction…………………………………………………………… 50
2.2. Literature Review and Hypothesis……………………………………. 53
2.3. Sample selection, data sources and description of data………………. 57
2.4. Board of Directors' Internal Fit and Firm Performance……………… 61
2.5. Board of directors' External Fit and Firm performance……………… 66
2.6. Summary and Suggestions for Future Research……………………… 69
2.7. Appendix……………………………………………………………… 84
2.7.1. Variable definitions……………………………………………. 84
References………………………………………………………………………. 86

List of figures

1.1. Parallel trend analysis for the difference-in-differences test of GDPR's impact on corporate boards' cyber focus expertise, and monitoring……….. 29

1.2. Percentage of Firms Mentioning "GDPR" or "General Data Protection Regulation" in their Form 10-K Reports……………………………………. 30

2.1. Parallel trend analysis for the difference-in-differences tests for firms in the energy vs non-energy sectors……………………………………………….. 72

2.2. Parallel trend analysis for the difference-in-differences tests for firms with more than one ESG expert director sitting on the board……………............ 73

List of Tables

1.1. Sample and summary statistics………………………………………….... 31

1.2. GDPR and corporate boards' cyber focus, expertise, and monitoring assignment in the pre- and post-GDPR periods……………….................... 32

1.3. DiD analysis of GDPR's impact on changes on boards' cyber focus, expertise, and monitoring assignments…………………………………… 34

1.4. Descriptive statistics and correlation of cross-sectional variables…………... 36

1.5. GDPR and changes in corporate boards' cyber awareness, expertise, and monitoring depending on firms' EU exposures…………………………... 37

1.6. GDPR and changes in corporate boards' cyber awareness, expertise, and monitoring assignment depending on firms' cyber risk exposures……….. 39

1.7. Changes in corporate boards' cyber focus, expertise, and monitoring assignment and firms' subsequent cyber risks………………………………. 41

2.1. Sample and Summary Statistics…………………………………………...... 74

2.2. Directors' Skill sets Comparison……………………………………………. 76

2.3. Factor Analysis and Correlation Table…………………………………… 78

2.4. Panel regression of Factors I, II and III on firm performance……………...... 79

2.5. Panel regression of Skills Categories on firm performance…………………. 80

2.6. Two-stage least square regression of Instrumented Skills Categories on firm performance……………………………………………………………………. 81

2.7. Difference-in-difference regressions analysis of Paris agreement impact on firms in the energy vs non-energy sectors……………………………........... 82

2.8. Difference-in-difference regressions analysis of Paris agreement impact on firms with more than 1 ESG director on the board…………………….......... 83

Klein, A., R. Manini, and Y. Shi. 2022. Across the Pond: How US Firms' Boards of Directors Adapted to the Passage of the General Data Protection Regulation. Contemporary Accounting Research.

https://doi.org/10.1111/1911-3846.12735

CHAPTER 1

Across the pond: how us firms' boards of directors adapted to the passage of the general data protection regulation

Joint with April Klein and Yanting (Crystal) Shi

1.1. Introduction

One of the prime responsibilities of the board of directors is to understand and oversee its firm's risk profile (SEC 2009a). However, firm risk is an ever-changing construct, a landscape subject to "increasing volatility, complexity, and ambiguity of the world" (COSO 2017). In this paper, we examine whether boards of directors of US firms increase their monitoring of cyber risk in response to a tangible change in the firm's cyber risk environment.[1] We then examine the consequences of these responses – for example, correlating changes in the boards' focus and expertise on cyber risk to subsequent changes in cyberattacks and data breaches. To our knowledge, this is the first paper to conduct this type of inquiry, thus providing an important first step in understanding how boards respond to changes in cyber risk.

We use a recent European Union (EU) regulation, the 2016 General Data Protection Regulation (GDPR), as an indicator for a quasi-exogenous change in the cyber risk environment that firms face. The GDPR encompasses a sweeping set of regulations aimed at protecting EU citizens from unwanted uses of their personal Internet data. It provides data privacy security for all EU citizens, despite where the internet site or the company is domiciled. Therefore, any US company with a website used by any EU resident(s) is subject to the GDPR. For example, Proctor and Gamble's (P&G) website includes a link allowing users to choose their location. If a user selects an EU country (e.g., Italy) then, in adherence to the GDPR, a privacy link opens up with information about how P&G uses its customers' private information and provides the user with various options for how to change privacy preferences.

[1] We use "cyber risk" to encompass risks related to cybersecurity, cyberattacks, and data privacy.

There are several advantages to our setting. Almost all US firms face cyber risk, with the amount of exposure varying across firms. Yet, the demand for cybersecurity and cyber privacy is unobservable to outsiders, making it difficult to correlate it with firm actions. Previous papers overcome this challenge by using data breaches (Liu 2020; Haislip et al. 2019) or cyberattacks (Amir et al. 2018; Kamiya et al. 2018) as firm-specific shocks. However, data breaches and cyberattacks are relatively rare events, and firm responses to them may not be representative of the entire economy.

In contrast, the GDPR is a plausible exogenous shock to the cyber risk landscape affecting almost all US firms, but in varying degrees. These risks include compliance and regulatory risks involved in adopting and adhering to the mandates within the new regulation. For example, the GDPR requires firms to manage their customers' data, to provide clear and wide latitudes to customers to opt in or out of data collection, to provide timely notices of data breaches, and to maintain privacy by designing protocols for the inclusion of data protection from the outset when designing new systems. Regulatory risks include possible fines by any of the 28 EU countries for noncompliance, which can be up to 4% of the firm's global annual revenues. In addition, future regulatory changes could result from European Court decisions on cases involving the GDPR[2] or jurisdictions outside of the EU subsequently passing GDPR-like regulations.

The GDPR also changed the business environment for firms as related to data collection. Prior to the GDPR, the risks associated with firms collecting and using their customers' data were negligible in that website users had little control over their data and were most likely unaware of how their data were being used by firms (e.g., sold to third-party vendors). With the institution of the GDPR, users are given unprecedented control over how their data could be used, thus altering a firm's business model of how it can attract and maintain Web users with different priorities. Aridor et al. (2021), using a proprietary data set from an online travel intermediary, find that the opt-in/opt-out requirement of GDPR resulted in a 12.5% drop in intermediary-observed consumers. This drop in users resulted in a short-term dip in advertising revenues for the affected firms. However, they

[2] For example, on July 16, 2020, the Court of Justice of the European Union ruled that the EU-US Data Protection Shield was invalid due to concerns around surveillance by US state and law enforcement agencies. Known as "Schrems II," this ruling significantly alters the way companies can transfer personal data from EU countries to the United States.

also find that the remaining consumers use the websites more frequently and for longer periods of time, thus mitigating the initial drop in advertising revenues.

By using the GDPR as our exogenous shock, we are able to conduct our analyses on a broad sample of over 2,000 companies. Using Form DEF14A proxy statement disclosures as our main source of information, we examine three board attributes: (i) whether the board pays more attention to cyber risk, cybersecurity and cyber privacy (focus), (ii) whether the board significantly adds directors with cyber risk or information technology (IT) expertise (composition), and (iii) whether the board increasingly assigns its cyber risk oversight to the board itself and/or one of its committees (monitoring assignment)**.** Our empirical results are consistent with boards significantly enhancing their oversight of cyber risk in the period around the passage of the GDPR. The percentage of boards discussing cyber risk in their proxy statements rises from 10.70% to 23.12% between the pre- and post-GDPR periods. The percentage of boards explicitly assigning cyber risk oversight to themselves and/or one of their committees increases from 8.93% to 17.30%, with audit committees seeing an almost threefold jump in cyber risk monitoring. Boards significantly increase their inclusion of a director with cyber/IT knowledge; in the post-GDPR period, almost one-quarter of all boards have at least one director with this expertise. Thus, we present evidence consistent with boards of directors, on average, enhancing their cyber risk monitoring in response to the new demands created by the GDPR.[3]

However, these new demands are not identical across firms. Accordingly, we examine cross-sectional variations to how boards reacted to the GDPR. Since the GDPR regulates EU residents only, we see if firms with higher business exposures to EU customers are more likely to make significant changes in their board oversight of cyber risk. Using three different measures of EU exposure, we find no evidence that a firm's relative dependence on EU residents influenced its board's immediate response to the GDPR. This non-containment is consistent with the GDPR's effect on cyber risk "leaping across the pond," impacting a broader group of US. firms. We also present evidence that differences in

[3] We acknowledge that the GDPR is not solely responsible for all changes in the cyber risk environment over our transition period. Other events –for example, prominent cyberattacks and data breaches– most likely also changed this environment. We address some of these issues throughout the paper, including the influence that these attacks and breaches may have had on our findings.

board responses across firms vary with their ex ante cyber risk exposure. Finally, using a difference-in-differences (DiD) methodology, we show that boards of firms in an already cybersecurity-regulated industry, healthcare, made fewer changes in response to the passage of the GDPR when compared to firms in other industries.

We then examine some of the economic consequences associated with the changes in board monitoring and with the approval of the GDPR itself. If board responses are due to an enhanced cyber risk environment, then we would expect to see a subsequent reduction in cyber risk for firms whose boards make the largest adjustments. On the other hand, if these changes are merely cosmetic in nature, then we should see no tangible outcomes. Our paper presents evidence consistent with the first hypothesis. We document a reduction in the likelihood of a firm receiving a cyberattack or data breach during the years 2017-2019 in accordance with the magnitude of the firm's board changes between 2014 and 2016. Cyber risk exposure, as measured by media coverage of the firm's data security, falls in a similar fashion. We also document a sharp increase in a firm's discussion of GDPR within the 10-K Report over time, culminating with almost 25% of all firms in our sample including a discussion of it in the "Business" or "Risk Factors" sections in 2019.

Our findings support the view that boards responded quickly and effectively to an unexpected shift in the cyber risk landscape. Over the period surrounding the passage of the GDPR, boards substantively increased their focus, expertise, and cyber risk assignment, with firms with higher ex ante cyber risk making the most changes. Furthermore, firms with boards that responded more quickly experience fewer future cyberattacks, data breaches, and media attention to its data security.

Our study contributes to several lines of research. First, we delve into the relatively unexplored area of board adaptability and effectiveness as it relates to an exogenous change in a firm's risk environment. This inquiry complements previous studies examining how changes in board composition impact firm performance (e.g., Duchin et al. 2010; Adams et al. 2018; and Van Peteghem et al. 2018), accounting transparency (Armstrong et al. 2014), and financial reporting quality (e.g., Bryan, et al. 2013; Kim and Klein 2017). Our study differs from these papers in that we examine voluntary changes in board structure instead of those mandated by a new law or regulation.

Second, our paper contributes to the overall literature on cyber risk. Previous papers examine how disclosures of cyber risk from the Form 10-K are priced by the stock market (Berkman et al. 2018, Gordon et al. 2010). Other studies examine firm or market responses to cyberattacks and data breaches (Kamiya et al. 2018; Amir et al. 2018; Haislip et al. 2019; Liu 2020). We complement these studies by using the GDPR as a plausible exogenous shock to the firm's cyber risk environment. Thus, we are able to examine board responses to cyber risk shocks for a broad group of firms.

Third, we add to the literature on how a regulation promulgated in one jurisdiction can have consequences on other regions of the world. Many papers examine global effects of US laws or regulations – for instance, PCAOB inspections (Oesch and Urban, 2019) or the Sarbanes-Oxley Act of 2002 (Piotroski and Srinivasan 2008). Our paper looks at how a European regulation transfers to an American setting.

1.2. Institutional background: The GDPR and cyber privacy laws

On May 25, 2016, the EU adopted the GDPR. A two-year transition period was enacted, making the regulation effective from May 25, 2018 onwards.

a) *The GDPR*

The GDPR is structured towards ensuring EU citizens' data privacy within the context of today's Internet and big data environment. It replaces an earlier EU data protection rule, the 1995 EU Data Protection Directive 95/46/EC. Two limitations of the 1995 Directive were that its scope of personal data was limited to identification (e.g., a person's name, photo, email addresses, phone numbers, and personal identification numbers, such as social security number, bank account number, credit card number) and, because it was a directive and not a regulation, EU member states could adopt their own rules (e.g., different data breach notification laws).

Appendix 1.10.2 contains a detailed summary of some of the major provisions of the GDPR. Article 3 states that the collection of personal data or behavioral information from *any* EU resident falls under the purview of the GDPR. Thus, the GDPR has extraterritorial jurisdiction, affecting all US. firms that have EU customers or users.

The GDPR increases data privacy. It requires firms to draw up detailed "data-protection impact assessments" (GDPR Article 35), which explain how personal data are processed. Privacy-enhancing IT techniques discussed in the GDPR are pseudonymization (replacing personally identifiable information with artificial identifiers) and encryption (converting personal information into a secret code). Other provisions mandate companies to give clear and simple instructions to website users on how to provide and withdraw consent on allowing companies to use and share their private data, the ability to receive private data stored by the company, and the right to ask the company to erase their stored data.

The GDPR enhances cybersecurity. Article 24 calls for the inclusion of data protection protocols when designing systems, thus placing a burden on firms to upgrade their data security. Articles 33 and 34 require firms to notify users of data breaches within 72 hours of becoming aware of the breach. Thus, the GDPR ties data privacy to how a firm handles cybersecurity.

Article 83 provides stiff penalties for violations of its regulations, with monetary fines reaching up to 4% of total global revenues or €20 million (whichever is greater). According to CoreView, 39 companies received "major" fines from May 2018 through May 2020 totaling almost €500 million for violations of the GDPR.[4] In January 2019, for example, Alphabet (Google) was fined €50 million by the French data regulator Commision Nationale de l'Informatique et des Libertés (CNIL) for a breach of GDPR rules on "transparency and lack of consent" (CNIL 2019).

The GDPR is the first mandated cyber privacy regulation to encompass all US. firms with at least one EU user.[5] It is in stark contrast to the existing US. regime, which is a self-regulator market-based system known as "Notice and Choice" (Davis and Marotta-Wurgler 2019). This system is overseen by the Federal Trade Commission (FTC), and it contains a series of recommendations about data privacy contained in the FTC Fair Information Practice Principles. These guidelines are not binding, and many studies show

---

[4] https://www.coreview.com/blog/alpin-gdpr-fines-list/

[5] The one exception is Section 312.8 of the *Children's Online Privacy Protection Rule,* which requires companies to "establish and maintain reasonable procedures to protect the confidentiality, security and integrity" of personal information collected on or off the internet for children under the age of 13."

that US firms' information practices comply poorly with these principles (see Davis and Marotta-Wurgler 2019).

b) *Pre-and post- periods around the passage of the GDPR*

Following most regulation papers, we define our pre- and post- periods as those immediately preceding and following the approval timeline of the regulation. We believe that the www.eugdpr.org, an external website devoted to the "education of the public about the main elements of the GDPR,"[6] provides the most appropriate record of dates. As Appendix 1.C shows, the passage of an EU regulation encompasses three phases: proposal, trilogue, and approval. Our first date, D1, is the approval of the GDPR proposal by the Council of the European Union on June 15, 2015. The trilogue is a series of private negotiations culminating in a final draft of the proposed regulation. The timeline ends on May 25, 2016 (D18), when the GDPR is approved. In all, our time period spans just 346 calendar days. We define the pre-period as the year prior to June 15, 2015 (D1), and the post-period as the year following May 25, 2016 (D18).

1.3. Literature review and hypotheses

The board of directors performs an oversight role within the firm by monitoring and advising top management on the firm's overall performance and risk profiles (Fama and Jensen 1983; Harris and Raviv 2008). In theory, firms and boards use cost-benefit analyses to structure their boards to meet their needs (Hermalin and Weisbach 1998). Empirical evidence generally supports this view with respect to board size and independence (Coles et al. 2008) and committee structures (Klein 1998; Ittner and Keusch 2015). Boards also strategically include directors with specialized professional skills – for example attorneys and politicians (Agrawal and Knoeber 2001), bankers (Guner et al. 2008), industry knowledge (Cohen et al. 2014; Wang et al. 2015; Faleye et. Al. 2018), and financial accounting knowledge (DeFond et al. 2005).

As these papers illustrate, board composition and structure are endogenously determined. We exploit this endogeneity to address our research questions, which are whether boards

[6] See https://gdpr.eu

adapt quickly to a shift in their cyber risk environment and whether these board changes reduce future cyber risk. There are several reasons to believe this may be true. First, in general, boards assume the responsibility of monitoring overall firm risk. This oversight is not only codified by the SEC (SEC 2009a), but also is advocated by COSO (2004, 2019), the National Association of Corporate Directors (NACD 2014, updated in 2017 and 2020), Big-4 accounting firms (Deloitte 2018) and corporate law firms (Gregory 2015/2016).

Further, a modest literature exists on the relation between board attributes and firm risk. Bernile et al. (2018) find that greater overall board diversity leads to lower stock return volatility, thus presenting a connection between board composition and managing firm risk. Ormazabal (2010) and Ittner and Keusch (2015) seek to understand the association between board structure and risk oversight. Ormazabal (2010) creates a five-dimensional "observable" risk oversight index, in which the inclusion of a risk oversight board committee is one of the factors. He finds a negative association between his index and credit risk and equity risk. Ittner and Keusch (2015) find no direct association between how the board assigns its risk oversight function – for example, to the board as a whole and/or to one of its committees – and equity risk, although they do report a positive association between overall board oversight and the sophistication of the firm's overall risk management. Dionne and Triki (2005) and Dionne et al. (2019) examine director characteristics and specific corporate risk-mitigating actions—for example, hedging activities. They find that director financial literacy correlates positively to a more effective hedging policy.

Second, the scope of firm risk has evolved over time, with firms increasingly managing a more comprehensive "enterprise risk" (Ormazabal 2010). Enterprise risk encompasses uncertainties beyond the traditional financial and operating risks. Its concept was introduced by COSO in 2004, which wrote:[7]

> Enterprise risk management is a process, effected by an *entity's board of directors*, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within

[7] COSO is a private sector initiative sponsored and funded by the American Accounting Association, the American Institute of Certified Public Accountants, the Financial Executives International, the Institute of Management Accountants, and the Institute of Internal Affairs.

> its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives (COSO 2004).

In 2017 and 2019, COSO updated its original document by including environmental, social and governance (ESG) risk, as well as cyber risk as two distinct risks to be monitored by the firm's board.

Third, several papers show that firms respond to an increase in idiosyncratic risk by changing their board structures. These risks include poor operating performance (Kaplan and Reischus 1990), bankruptcy (Gilson 1990), option backdating (Ertimur et al. 2011) and financial fraud (Srinivasan 2005; Fich and Shivdasani 2007). These papers suggest that boards may adapt to their new cyber risk environment by instituting changes in their focus, composition, and monitoring assignment of cyber risk.

However, an extensive literature is consistent with an opposite view: boards may not adapt effectively or quickly to the GDPR. In the management arena, Boivie et al. (2017) claim that boards inherently are ineffective monitors of top management. Many papers conclude that boards are entrenched, thus requiring new regulations to push them out of complacency (e.g., Duchin et al. 2010; Armstrong et al. 2014; Bryan et al. 2013). Furthermore, firms often skirt new corporate governance regulations by not having the required number or percentage of (truly) independent directors after the transition date (e.g., Duchin et al. 2010; Kim and Klein 2017). Since the GDPR is silent on board composition or board structure, it is very possible that boards will not change their cyber risk oversight after its passage. Moreover, there is mixed evidence on whether adding expertise actually improves board monitoring. Kim and Starks (2016) present evidence that board heterogeneity in directors' underlying skill sets improves firm performance, but Adams et al. (2018) come to an opposite conclusion. Thus, firms may choose to not add a director with cyber/IT expertise to the board following the passage of the GDPR.

We therefore state our first hypothesis in the null form.

> *HYPOTHESIS 1. Boards of directors, on average, do not change their monitoring of cyber risk after the approval of the GDPR.*

Our second hypothesis relates to the GDPR being an EU regulation that encompasses EU consumers only. Therefore, it is not clear whether US firms without a significant EU presence will make changes to their boards in response to this regulation. Frankenreiter (2021) and Davis and Marotta-Wurgler (2019) examine the extent to which US websites changed their US privacy policies in response to the GDPR's new requirements. They report dissimilar results, with Frankenreiter (2021) reporting no major modifications but Davis and Marotta-Wurgler (2019) finding more substantive changes. The difference in results can be attributed mainly to their sample selection criteria. Frankenreiter (2021) uses a broader sample of firms, whereas Davis and Marotta-Wurgler (2019) target a smaller sample of websites with obvious consumer privacy concerns —for example, dating apps.

We present our second hypothesis in the null form:

> *HYPOTHESIS 2. Boards of directors of firms with large exposures to the EU, on average, are equally likely to change their oversight of cyber risk after the approval of the GDPR as firms without large EU exposures*.

Our third hypothesis relates to ex ante cyber risk. If the GDPR is a shock to a firm's cyber risk environment, then firms with higher ex ante cyber risk may be more affected by its risk implications. This would suggest they would be more likely to make changes in their boards' focus and composition to deal more effectively with the expected changes. However, firms with high ex ante cyber risk may already be focused on cyber risk issues —that is, cybersecurity, data breaches, or data privacy. Thus, we would not expect to see substantive changes in cyber risk oversight for these firms.

The above discussion suggests we state our third hypothesis in the null form:

> *HYPOTHESIS. 3. Boards of directors of firms with greater ex ante cyber risk exposure, on average, are equally likely to change their oversight of cyber risk after the approval of the GDPR as firms with lesser ex ante cyber risk exposure.*

1.4. Sample selection, data sources, and description of data

a) Sample selection

Table 1.1, panel A, provides a description of our sample selection. Using the Compustat/CRSP merged database, we begin with 5,595 firms with a fiscal year ending in 2014. We eliminate 923 non-US firms and 1,056 firms with missing control variables in our pre-period. These control variables are from Compustat, Audit Analytics, and BoardEx. We remove 998 and 509 firms with missing Forms DEF14A (proxy statements) over the pre- and post- time periods, respectively, with the pre-period being the last proxy statement prior to June 15, 2015 (D1), and the post-period being the first proxy statement after May 25, 2016 (D18). We remove 16 firms that were cyberattacked between 2005 and 2014; Kamiya et al. (2018) document an increase in board risk management for victims of cyberattacks in the two-year period following the attack. The data for identifying these attacks are from the Privacy Rights Clearinghouse's (PRC) database, which collects information from required disclosures of data breaches from various sources, including the State Security Breach Notification Laws, the SEC Cybersecurity Disclosure Guidance for Form 8-K disclosures, and the Health Insurance Portability and Accountability Act (HIPAA). Our final sample consists of 2,093 firms, which we use in our cross-sectional regression analyses.

Table 1.1, panel B, contains summary statistics for our sample. Consistent with other papers using BoardEx data, there is a wide range of firm and board characteristics. For example, although the mean *Total Assets* is $8.7 billion, firm assets range from $3.76 million to $856.2 billion. Similarly, only 71% of firms use a *Big Four* auditor, a percentage substantively lower than for firms in the S&P 500 alone. In terms of board structure, the average board size is 8.66 directors and each board, on average, is comprised of 78% independent directors.

b) Board risk oversight and directors with cyber/IT expertise

We use disclosures on risk oversight and director skills from the firm's DEF14A (proxy statement) to create measures of board oversight and director skills related to cyber risk. In December 2009, the SEC adopted a new regulation, effective from February 2010 onward, mandating firms to provide more detailed information in their annual Form DEF14A about the risk oversight function of their boards (SEC 2009a). In describing these rules, the SEC noted they "were persuaded by commenters who noted that risk oversight is a key competence of the board, and that additional disclosures would improve investor and shareholder understanding of the role of the board in the organization's risk management practice" (SEC 2009b, 13).

> **Risk Oversight.** As part of regular Board and committee meetings, the directors oversee executives' management of risks relevant to the Company. While the full Board has overall responsibility for risk oversight, the Board has delegated responsibility related to certain risks to the Audit Committee and the Leadership Development and Compensation Committee. The Audit Committee is responsible for overseeing management of risks related to our financial statements and financial reporting process, data privacy and security, business continuity, and operational risks, the qualifications, independence, and performance of our independent auditors, the performance of our internal audit function, and our compliance with legal and regulatory requirements. (Emphasis added)

The new rule also mandates firms to describe in more detail a director's expertise. The new items to be disclosed include the "particular experience, qualifications, attributes or skills that led the board to conclude that the person should serve as director for the company as of the time that a filing containing this disclosure is made with the Commission" (SEC 2009b, 34).

To create our variables, we do a combination of textual analysis followed by hand-collection. As Kim and Starks (2016) note, the flexibility incorporated within the regulation makes the tool of technical analysis inexact due to the difficulty of finding a clear textual pattern within any section of the Form DEF14A. Specifically, we go over the paragraphs in the Form DEF14A that include the keywords "cyber," "information technology," or "data privacy." If they do not represent the meaning we intend to capture, we drop the observation. For instance, several "data privacy" keywords are related to companies' stock grants instead of protecting consumer data. For those sentences referencing a specific director, we download the respective Form DEF14A and manually read the original paragraph in the filing to collect the name of the director that possesses cyber, information technology, or data privacy skills. We then search for this director in the proxy statement to obtain committee assignments.[8]

[8] For those sentences addressing risk oversights, we read the proxy statements to understand the board or committee delegations regarding cyber risk. For instance, some boards require directors' training regarding cybersecurity, but they do not explicitly delegate the cyber risk monitoring roles; in these cases, we exclude them from risk monitoring.

We create three types of variables: cybersecurity awareness, director expertise in IT/cyber, and board/committee monitoring of cyber risk. In terms of cybersecurity awareness, *CyberAwarenessDEF14A* is an indicator if the proxy statement contains the keyword "cyber" at least once, and *CyberCountDEF14A* counts the number of times the keyword "cyber" is mentioned throughout the proxy statement. Panel A of Table 1.2 shows that, prior to the initiation of the GDPR proposal period, 10.70% of firms in our sample mentioned "cyber" at least once in their proxy statements, with an average of 0.18 mentions throughout the full sample.

In terms of how the board allocates its oversight of cybersecurity and data privacy, we create variables based on the firm's discussion in the Form DEF14A. *MonBoDOnly* is an indicator if the monitoring duties are given to the board as a whole; *MonAudComm*, *MonRiskComm*, and *MonTechComm* are indicators if the monitoring explicitly is given to the audit committee, risk committee, or technology committee, respectively. In panel A, we find that 8.93% of the proxy statements in the pre-period explicitly assign cyber risk or data privacy oversight to the board and/or one of its committees (*MonBoD/Comm*). More granularly, the percentage of cyber risk or data privacy monitoring primarily done by the board itself is 2.48%, by the audit committee 3.39%, by the risk committee 1.48%, by the technology committee 1.15%, and 0.67% (untabulated) by other committees. The designation of the audit committee as the overseer of cyber risk is consistent with the NYSE's requirement that the audit committee is responsible for "discussing policies with respect to risk assessment and risk management" (NYSE Listed Company Manual section 303A.07(b)(iii)(C); see also Lanz 2014).

In terms of director expertise, we look at each director's biography and list of qualifications in the Form DEF14A and label that director a cyber or IT expert if we find a background in information technology, cyber, or data privacy. Our designation is consistent with Adams et al. (2018) and Kim and Starks (2016). As panel A of Table 1.2 shows, the percentage of boards with at least one expert in the pre-GDPR period is 17.34%, with 11.32% of audit committees having at least one cyber/IT expert.

1.5. Board monitoring of cyber risk before and after the approval of GDPR

Hypothesis 1 examines if boards change their oversight of cyber risk in response to the passage of the GDPR.

a) First Differences

We begin by examining the unconditional changes in our output variables. As panel A of Table 1.2 shows, the form DEF14A filings show a sharp increase in board focus on cyber between the pre- and post-GDPR periods. The percentage of firms mentioning "cyber"(*CyberAwarenessDEF14A*) increases from 10.70% to 23.12%, and the average number of mentions (*CyberCountDEF14A*) grows from 0.18 times to 0.53 times. A *t*-test for the difference in means for the two measures yields a *p*-value less than 0.01.

In terms of director expertise, the percentage of boards with at least one cyber expert (*ExpBoD*) increases from 17.34% to 23.36%, with all three committees taking on new cyber experts. For differences in percentages, *t*-tests are significant at the 0.01 levels for change in the experts on the board and the audit committee, and at the 0.10 level for changes on the risk and technology committees.

The Risk Oversight section of the proxy statement reveals a large increase in boards being given a cyber risk oversight function. The percentage of firms assigning cyber risk oversight to the board and/or a board committee (*MonBoD/Comm*) almost doubles from 8.93% to 17.30%, with the three main board committees (audit, risk and technology) showing large increases in cyber oversight. *t*-tests for differences between pre- and post-period means are all significant at the 0.01 levels.

To control for other variables that might be related to our output variables, we estimate the following regression:

$$BdAttribute_{jt} = \beta_0 + \beta_1 Post + \Sigma\ Control_{jt} + FEIND + \varepsilon_{jt} \qquad (1)$$

where $BdAttribute_{jt}$ is the board attribute for firm *j* at time *t*, and Post is a dummy variable equal to one in the post-period and zero in the pre-period. The regression controls for various factors previously found to be correlated with cyber risk or data breaches—firm size, internal control weaknesses, institutional ownership, being audited by a Big 4 firm, and whether the firm pays cash dividends (Hilary et al. 2016; Kamiya et al. 2018; Liu 2020). We also include other board attributes—specifically, board size and board independence. *FEIND* are industry fixed effects for the 12 Fama-French industries (Fama and French 2014) to control for the possibility that a change in board attribute for firm *j* is due to overall changes in its industry. All regression models use robust standard errors for the estimation of coefficients to alleviate concerns of normality and homogeneity of the variances of the residuals. See Appendix 1.10.1 for all variable definitions.

Table 1.2, panel B, presents summary statistics from these regressions. After controlling for other factors, we find significantly positive coefficients on *Post* for regressions on the levels in cyber focus (columns (1) and (2)), cyber/IT experts on the board (column (3)) and assigning cyber risk oversight to the board and/or one of board committees (columns (7)–(10)). Thus, we show evidence consistent with boards unconditionally focusing more effort and director expertise toward monitoring cyber risk after the approval of the GDPR. With respect to our control variables, these changes are positively related to firm size and the percentage of independent directors, and to the amount of institutional ownership and leverage in some but not all specifications. Similarly, the changes are negatively related in some specifications to cash paid in dividends and whether the firm uses a Big 4 accounting firm.

b) DiD regressions: Treatment and control groups

The unconditional change in board attributes shows that, after the passage of the GDPR, boards increased their focus and monitoring of cyber risk, and also changed their composition by adding directors with cyber expertise. However, these changes might be related to other factors or trends related to cyber risk and not to the passage of the GDPR. One way of examining this alternative explanation is to perform a DiD regression, thus comparing the group of firms that are treated by the new regulation (Treatment group) to those firms that are relatively unaffected by the new regulation (Control group).

We therefore seek a control sample of firms that already had been under a data privacy cyber risk regulatory regime prior to the approval of the GDPR. Since these firms were regulated in the pre-GDPR period, their pre-period boards should be more aligned with monitoring cyber risks. Thus, we would expect to see fewer changes in board oversight for these firms. One such group of firms is US healthcare companies, which, since 1996, are covered under HIPAA. HIPAA is a health insurance privacy act, and it protects the privacy and security of electronic health records. All health insurance companies and healthcare providers are required to follow the laws within the Act. Our treatment group, by default, consists of firms in all other industries.[9]

We employ the following regression:

$$BdAttribute_{jt} = \beta_0 + \beta_1 Treated_j + \beta_2 Post + \beta_3 (Treated_j\ X\ Post) + \Sigma\ Control_{jt} + \varepsilon_{jt} \qquad (2)$$

where *Treated* is equal to one for all firms not in the healthcare sector and zero for all firms in the healthcare sector (Fama-French code = 12). The other variables are defined as before. Equation (2) does not contain industry fixed effects since our treatment and control samples are divided by industry.

Figure 1 presents parallel trend analyses from 2012 through 2017. We collect data from the proxy statements for the pre-period years of 2012–2015, and from the first post-period year 2017. Parallel trends assume that any divergence in the output variable in the post-period is not attributable to a divergence beginning in the pre-period. Figure 1, panels A and B, presents the percentage of firms with the term “cyber” in their proxy statements and the mean number of times “cyber” appears, respectively. As the panels show, from 2012 to 2015, the trends of the nonhealthcare (Treatment) and healthcare (Control) firms

[9]Some financial companies already were regulated with respect to consumer privacy rights before the GDPR. The Fair Credit Reporting Act (FCRA) mandates credit rating companies to offer consumers the rights to ask for a credit score, to dispute incomplete or inaccurate information, and to give consent before reports are provided to a third party. The Gramm-Leach-Bliley Act (GLBA) requires financial companies to explain their information-sharing practices to their customers when offering consumer financial products. On March 1, 2017, the New York Department of Financial Service (NYDFS) adopted Cybersecurity Regulation, suggesting that the previous regulations on the finance companies were insufficient. In contrast, subsequent state-level data privacy regulations usually exempt the healthcare industry (e.g., California Consumer Privacy Act (CCPA) 1798.145.(4)(c)(1)), suggesting that the HIPAA regulation was sufficient or comparable to these regulations. In an untabulated robustness test, we replicate Table 1.3 but exclude all finance companies, and find all results hold, suggesting that the observed board changes are not driven by the financial companies making changes anticipating the Cybersecurity Regulation by NYDFS.

track very closely to each other. However, in 2017, we see large divergences, with the Treatment group showing greater growth than the Control group. Figure 1, panel C, shows the percentage of boards with at least one director with cyber/IT expertise. The pre-period trends are similar for the non-healthcare and healthcare firms; both groups exhibit a rise in cyber expertise on the board in 2017, although we see no obvious divergence in growth rates between groups. Figure 1, panel D, presents the percentage of proxy statements assigning cyber risk monitoring to the corporate board and/or a board committee. Similar pre-period trends are found for the Treatment and Control firms. In 2017, we observe an increase in risk assignment for both groups, with the non-healthcare industry firms showing a greater rise than the healthcare industry firms. Thus, for the four output variables shown in Figure 1, the assumption of pre-period parallel trends holds.

Table 1.3 contains summary statistics for regression (2). We focus on the coefficients for the interactive term, Treated×Post. A significantly positive coefficient is consistent with a greater increase in the board attribute for the non-healthcare vis-à-vis the healthcare firms after the passage of the GDPR. As columns (1) and (2) show, the change in the use of the term "cyber" between the pre- and post-periods is significantly greater for non-healthcare firms. Thus, firms in industries not already regulated with respect to data privacy experience a sharper increase in their awareness of cyber risk than firms already under regulation. In addition, as columns (7), (8), and (10) show, the explicit assignment of cyber risk to the overall board or to the risk committee grows at a greater pace for the non-healthcare firms than for the healthcare firms in the post-period. In contrast, we see no evidence of a differential in the growth rates of placing a cyber/IT expert on the board or on one of its cyber risk monitoring committees for firms in the healthcare or non-healthcare fields (columns (3)–(6)). Thus, the increase in director cyber expertise that we found in Table 1.2 is similar across both groups of firms. The significantly positive coefficient on Post for the regression on Δ*ExpBoD* is consistent with this observation.[10]

[10] As a robustness check to the timing of our analyses, we estimate similar DiD regressions around the year 2013, with the pre-period encompassing the year 2012 and the post-period being the year 2014. In 2013, there were several major, publicized hacked data breaches against US companies, including Adobe, Dun & Bradstreet, Living Social, Snapchat, Tumblr, and Yahoo. If US companies reacted to these data breaches by instituting changes in the board focus or composition, then we should begin to see our treated firms changing their boards beginning in 2014, a full year before the pre-period we use in this study. Results (untabulated) show this is not true. None of the coefficients on the variable *Treated×Post* on the same 11

In summary, the DiD results are consistent with boards of firms in non-regulated industries adapting quickly to changes in cyber risk. In the year immediately following the passage of the GDPR (but prior to actual implementation), boards in non-regulated industries significantly changed their focus and board/committee assignments in ways consistent with their increasing their oversight of the increase in cyber risk.

1.6. Cross-sectional variations in board responses to the GDPR

In this section, we examine two cross-sectional variations in board responses to GDPR passage. First, we discern whether greater business exposure to the EU correlates with board changes. Since the GDPR directly affects EU customers and users only, it is possible that changes in cyber risk board oversight cluster within these firms. Second, we introduce a more global perspective on the effect that the GDPR has on board responsiveness. Specifically, we examine if the firm's cyber risk exposure in the pre-period has an effect on the board's responsiveness to its passage.

a) EU exposure

Hypothesis 2 proposes that boards of directors of US firms with larger or smaller EU presences are equally likely, on average, to change their cyber risk oversight after the passage of the GDPR. To test this hypothesis, we employ a first difference methodology similar to Duchin et al. (2010). Specifically, we estimate the following regression:

$$\Delta BdAttribute_j = \beta_0 + \beta_1 EU_j + \Sigma\ Control_j + FEIND + \varepsilon_j \quad (3)$$

where *EUj* is a proxy variable for the firm *j*'s pre-period EU exposure. All control variables are measured in the pre-GDPR period. Equation (3) also includes cyber-related board attributes—for example, whether the firm had a cyber or IT expert on the board before the proposal stage.

regressions as shown in Table 1.3 are significantly different from zero at the 0.10 level, with the exception of the regression on *MonRiskComm*, which has a coefficient of 0.02, significant at the 0.10 level (t = 1.81).

We measure a firm's EU exposure in three different ways. *Dummy_ EU Segment* is an indicator if, following FASB Statement 131 and ASC 280, the firm reports at least one customer segment located in one of the 28 EU countries. *%Rev_ EU Segment* is the percent of total revenues derived from the EU segment, and *EU Rev Growth* is the EU segment's revenue growth. All data are from Compustat's Segment Report database. Table 1.4, panel A, contains summary statistics on the three measures. Twenty-five percent of firms have an EU segment; the EU segment, on average, encompasses 5% of total revenues; and the average pre-period growth rate in EU revenues is 5%. As per GAAP rules, the correlation between a firm reporting a segment and the percent of revenues provided by that segment to overall revenues is very high, 0.7647 (panel B).

Table 1.5 has the summary statistics for equation (3). None of the coefficients on *EU* are significantly different than zero, with the exception of Δ*MonBoDOnly* in panel B (column (8)), which is significantly positive at the 0.10 level. Thus, our results do not support the view that our documented changes in board focus and composition are driven by the firm having a large EU presence. It appears, instead, that the GDPR's effect on the cyber risk environment encompasses a larger, more diverse group of US firms.

b) Cyber risk exposure

Hypothesis 3 examines whether a firm's pre-period cyber risk exposure is associated, on average, with board changes. To test this hypothesis, we estimate:

$$\Delta BdAttribute_j = \beta_0 + \beta_1 RiskExposure_j + \Sigma\ Control_j + \text{FEIND} + \varepsilon_j, \quad (4)$$

where $RiskExposure_j$ is a proxy variable for the firm *j*'s pre-period cyber risk exposure. The control variables are the same as for equation (3). All independent variables are measured over the pre-period.

We create four proxy variables for cyber risk exposure. The first two variables are derived from the firm's 2014 10-K report. In 2011, the SEC issued CF Disclosure Guidance: Topic No. 2 Cybersecurity (SEC 2011), which states that firms facing "material cyber-related issues" should disclose these issues in their MD&A and in Item 1A, Risk Factors, in their Form 10-K filings. Berkman et al. (2018) use textual analysis on these disclosures to create cybersecurity awareness scores for a sample of Russell 3000 firms over the period 2012–2016. They present evidence that the market positively values this awareness. We create two variables: *CyberAwareness10K* and *CyberCount10K*. *CyberAwareness10K* takes on a value of one if the 10-K has the keyword “cyber,” and zero otherwise. It is similar in spirit to Gordon et al. (2010), who use the presence or absence of an information security disclosure in the 10-K Report over the 2000–2002 period as their measure of cyber awareness. *CyberCount10K* is the number of times the keyword “cyber” appears in the 10-K Report. Because Berkman et al. (2018) incorporate disclosure length into their scores, *CyberCount10K* is similar to their measure.

MediaCov is an indicator if, during 2014, there is at least one media article (including social media, e.g., Twitter) referencing the firm’s “data security.” These articles are from TruValue Labs Insight360, a proprietary data set developed by TruValue Labs Inc. They use natural language processing and machine learning techniques to glean information from an array of third-party information sources, including traditional and social media. Thus, *MediaCov* encompasses cybersecurity and data privacy characteristics of the firm.

Our last proxy is *CAR*, the Fama-French five-factor cumulative abnormal return (Fama and French 2014) for each firm over the 18 events surrounding the passage of the GDPR (see Appendix 1.10.1). CARs rely on the efficient market theory, which assumes that stock market participants aggregate and transmit information about the GDPR into market prices. Since we examine risk, we interpret a firm’s *CAR* as partially reflecting the market’s assessment of how the GDPR changes the cyber risk profile of the firm. Thus, a drop in stock price surrounding the passage of the GDPR (i.e., a negative stock price reaction) is consistent with the market seeing the GDPR as increasing the company’s risk. We expect that changes in board cyber risk oversight are negatively related to a firm’s *CAR*.[11]

[11] Relating the CAR to changes in board behavior is consistent with theoretical papers proposing that managers (the board) learn from information embedded in stock prices when making corporate decisions (Dow and Gorton 1997; Dye and Sridhar 2002). Chen et al. (2006) and Edmans et al. (2017) present empirical evidence consistent with this hypothesis.

As panel A of Table 1.4, shows, 42% of firms in the pre-period had a 10-K disclosure relating to cyber risk, with an average of 1.48 disclosures per firm. Nineteen percent of firms had media coverage relating to cybersecurity or data privacy. The average *CAR* over the passage period was 0.45%, although the median firm had a *CAR* of 0.05%. Our four cyber risk exposure variables capture different measures of risk, as evidenced by their correlation coefficients being within the 0.01 and 0.020 ranges (untabulated).

Table 1.6 contains summary statistics on equation (4). The implications across the four panels are fairly consistent. Ex ante cyber risk is positively related to Δ*CyberAwarenessDEF14A* and Δ*CyberCountDEF14A* throughout the table, consistent with boards increasing their focus on cyber risk after the approval of GDPR for firms with higher pre-period cyber risk. To check whether this finding is a reflection of a mechanical relation between firms disclosing similar information about cyber risk in the 10-Ks and proxy statements, we calculate the correlations between the proxy and 10-K items. As panel C of Table 1.4 shows, the correlations between the source of the cyber risk disclosures range from 0.17 to 0.34, thus rejecting the view that we have a mechanical association. In addition, we control for the pre-period level of board cyber awareness, cyber/IT expertise, and monitoring in the regression analyses. Inclusion of these variables helps alleviate concerns of high correlations between the cyber awareness in 10-K and DEF14A influencing our results.

Looking further at Table 1.6 (columns (3)–(6)), we find evidence that boards more likely add a director with cyber/IT expertise (panels A, B, and D), or add to the risk (panel A) or audit committees (panel D) for firms with greater ex ante cyber risk. Furthermore, consistent with Ormazabal (2010), who shows that boards monitor risk both as a whole and through committees, we find that firms with higher ex ante cyber risk are more likely to increase the assignment of overseeing cyber risk to the board and/or to the audit or risk committee (columns (7)–(10)). We conclude that, cross-sectionally, firms facing higher cyber risk exposures prior to the proposal stage of the GDPR are more likely to change their boards' focus, composition, and monitoring assignment toward monitoring cyber risk after the passage of the GDPR.

1.7. Consequences of GDPR and changes in board focus, composition, and monitoring

Our main results are consistent with boards increasing their cyber risk monitoring. In this section, we examine whether these changes are associated with future reductions in the firm's cyber risk. Specifically, we look at future cyberattacks and data breaches, as well as data security media coverage. We also examine overall future consequences of the GDPR—that is, the extent to which firms include information about the GDPR in their Form 10-K, and whether other jurisdictions subsequently adopt GDPR-like laws and regulations.

a) Future effects of board changes: Reduction in cyberattacks and cyber breaches

We test for a negative association between changes in our 11 board monitoring variables and the future incidence of a cyberattack or data breach. Following other studies examining cyberattacks/ data breaches (e.g., Kamiya et al. 2018; Liu 2020), we use the PRC database to identify firms with breach incidents. The database collects voluntary disclosures of cyberattacks and data breaches for firms and public entities. We collect this data for our sample of firms over the 2017–2019 period. If any firm-year contains an attack or breach, then *Incidence* equals one, otherwise it is equal to zero. We sequentially estimate a probit and a logit model, in which Incidence is the dependent variable and the main independent variable of interest is one of the 11 board change variables (focus, composition, or monitoring assignment) over the GDPR passage period (2014–2016). We control for *Size*, *Big Four*, *InstOwn*, *ICW*, *Leverage*, *BoardSize*, *%IndDir*, and *PaidCashDiv* at the end of 2016, as well as the number of cyberattacks and data breaches during 2015 and 2016.

Table 1.7, panel A, contains summary statistics for the nine regressions that we are able to estimate.[12] As the panel illustrates, the incidence of a firm disclosing a cyberattack or

[12] We are unable to estimate the models with *ΔExpAudComm* and *ΔExpRiskComm* due to a lack of substantive variation in both the dependent (Incidence) and each of these two independent variables. As

data breach over 2017–2019 is negatively related to seven of the nine board change variables. Specifically, *Incidence* is negatively associated with changes in board focus (Δ*CyberAwarenessDEF14A* and Δ*CyberCountDEF14A*), cyber expertise (Δ*ExpBoD* and Δ*ExpTechComm*), and monitoring assignment ((Δ*MonBoDOnly*, Δ*MonRiskComm*, and Δ*MonTechComm*), and Δ*MonAudComm* for the logit model only).

These findings are robust to both the Probit and Logit model specifications. Thus, we document a negative association between board changes during the passage of the GDPR and future cyberattacks or data breaches.

b) Future effects of board changes: Reduction in subsequent media attention on data security

As before, we use media attention of a firm's data security, as collected by TruValue Labs, as a measure of the firm's cyber risk exposure. Recall that TruValue Labs collects media articles from traditional and online (e.g., Twitter) sources. Thus, their coverage encompasses cybersecurity and data privacy characteristics of the firm.

Table 1.7, panel B, presents summary statistics for Poisson regressions of *Media Attention* on changes in boards' cyber focus, expertise, and monitoring assignment. *Media Attention* is the number of media stories over the years 2017 through 2019. We estimate *Media Attention* using a Poisson distribution due to the random arrival of these events. Our control variables are the same as those used in panel A, except that we control for media attention in the years 2012–2014 instead of pre-period cyberattacks. Similar to the preceding section, we expect improvements in board monitoring to be associated with a reduction in future cyber risk; thus, using cross-sectional regressions, we expect negative coefficients on each of the 11 board change variables.

Overall, the empirical results in panel B are consistent with our expectation. The coefficients on Δ*ExpRiskComm* and Δ*ExpTechComm* are significantly negative at the

panel A of Table 1.2 shows, the number of audit and risk committees that experienced increases in cyber/IT experts were few, and, consistent with other studies, the number of cyberattack/data breaches during this time period is relatively small. Thus, the intersection between those firms with an increase in cyber expertise and cyberattacks/data breaches was zero for both groups.

0.01 levels, indicating a negative association between the board adding an IT/cyber expert to either its risk or technology committee and the number of media articles about data security. In terms of board monitoring, the coefficients on Δ*MonRiskComm* and Δ*MonTechComm* are significantly negative at the 0.01 levels, suggesting a negative association between increased monitoring of cyber risk on the risk and technology committees and future levels of *Media Attention*. We note, however, a significantly positive coefficient on Δ*MonBoDOnly* and no associations between the changes in cyber awareness variables and future media coverage of data security. Despite these disparate findings, we interpret our regression results as generally being supportive of the view that cyber-related board changes surrounding the passage of the GDPR are associated with a reduction in a firm's future cyber risk

c) Future effect of passage of the GDPR: GDPR in the firm's 10-K filing

Item 101 of Regulation S-K requires the disclosure of material information pertaining to the registrant's business, and Item 105 provides for the discussion of material factors that make an investment in the registrant speculative or risky. Thus, if the advent, initiation, or application of the GDPR affects (or may affect) the firm's business or riskiness in a material way, then one or both of these sections in the Form 10-K should contain disclosures about the GDPR. We examine each firm's Form 10-K and, using textual analysis, we determine whether the acronym "GDPR" or the phrase "General Data Protection Regulation" appears in the firm's document. Figure 2 illustrates the timeline of these disclosures. As the figure shows, for our sample, the mention of GDPR in the Form 10-K ramps up from 1.5% in 2016 and 4.3% in 2017 (the transition stage) to 17.3% in 2018 and 24.5% in 2019 (the effective stage). Thus, by 2019, close to one-quarter of all firms in our sample consider the GDPR to have a material effect on their business environment.

d) Future effect of passage of the GDPR: Brussels effect

Bradford (2012) presents evidence that the EU acts as a first mover in instituting new laws and regulations that protect its citizens. She calls this the "Brussels effect," a moniker derived from Brussels being the seat of the EU. As of July 2021, 48 non-EU countries or jurisdictions (e.g., Hong Kong) have adopted (34) or are considering (14) laws or regulations similar to those contained in the GDPR by year. Notably, although the United States is not on the list of countries adopting GDPR-type laws, 15 US states have approved (12) or are discussing (3) similar laws as of July 2021. The proliferation of this data privacy movement is consistent with the GDPR spawning a future enhancement of the cyber risk environment on a global basis.

e) Summary

In summary, we present evidence of a reduction in a firm's cyber risk emanating from changes in board cyber risk monitoring around the enactment of the GDPR. Specifically, we document a negative link between board monitoring and the firm's subsequent cyber risk, as evidenced by a reduction in the incidence of cyberattacks or breaches, and media coverage of data security. We also show that US firms responded to the passage of the GDPR by increasingly including discussions in the Form 10-K of its impact on the risk and business environment of the firm

1.8. Robustness checks

We perform untabulated robustness checks on our specifications. Equations (3) and (4) use the change in the board attributes as the dependent variables, but include control variables at preperiod levels. This specification allows for the possibility that a change in a board attribute is due to the actual value of the control variable and not to its change. We change this specification by using changes in control variables instead of levels. One advantage of using changes is that since the pre- and post-periods are 2014 and 2016, respectively, differences in control variables act as firm fixed effects. A disadvantage is that because we measure changes over a two-year window, the size of the changes is relatively small, giving us little cross-sectional variation. We find that using a changes specification has minimal effect on our overall findings. All coefficients on the EU exposure variables remain insignificantly different from zero, with the exception of the regression on Δ*CyberAwareness10K* for the *Dummy EU Segment*, which is significantly positive at the 0.05 level. Thus, our finding that board changes are not related to its EU exposure remains the same. Similarly, we find qualitatively similar results when analyzing the impact of ex ante cyber risk on changes in board cyber oversight when using changes in control variables instead of levels.

We also supplement our analysis of ex ante cyber risk by including all cyber risk variables in one regression instead of using them one at a time, as in Table 1.6. We omit *CyberCount10K* because it is highly correlated with *CyberAwareness10K*. Our results with the three remaining variables are the same as those in Table 1.6. Thus, our finding that the ex ante risk of the firm impacts the change in cyber risk oversight between the pre- and post-GDPR period remains unchanged

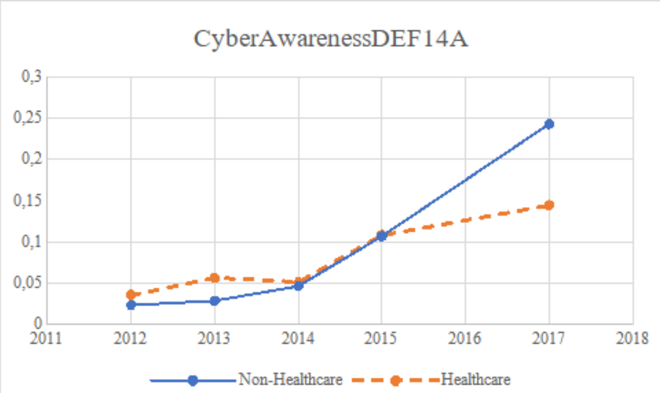
1.9. Summary and suggestions for future research

This study examines how boards change their cyber risk oversight around the passage of the GDPR in 2016. We find that boards adapt quickly to the change in the cyber risk landscape by focusing more on cyber risk, adding directors with cyber/IT expertise, and increasingly assigning cyber risk to the board and/or to their board committees. These results hold both unconditionally as well as in a DiD framework. We also find that boards in firms with higher ex ante cyber risk adapt more quickly, which is consistent with the GDPR reflecting an unexpected change in the cyber risk environment. Having a large EU presence, however, is not related to board changes, suggesting that the ramifications of the GDPR are more global—that is, not confined to firms with large footprints in the EU.

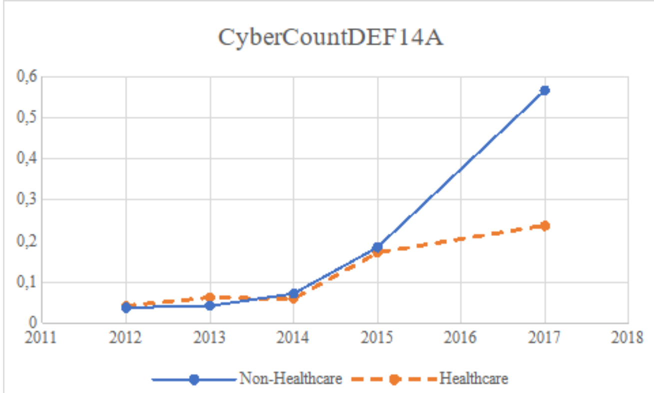
We also examine some of the consequences of these board changes as they relate to firms' future cyber risks. If the changes in board focus, composition, and monitoring are effective in attenuating future cyber risks, then we should see a negative association between board changes and these future risks. If these changes are merely cosmetic, then there will be no systematic associations. Our empirical results are consistent with the first view. Both the incidence of cyberattacks or data breaches and the number of media stories on a firm's data security decline after its board enhances its monitoring of cyber risk.

Cyber risk is part of a rapidly changing risk environment. Our finding that boards of large US firms are able to pivot their agenda and board expertise quickly after the passage of the GDPR is an indicator of the flexibility and efficacy of their corporate governance systems. That these changes occurred prior to the SEC mandating better disclosures of cyber risk (SEC 2018) or to COSO explicitly recognizing cyber risk as a distinct board agenda risk item (COSO 2019) can be seen as a contradiction of the view that boards inherently are ineffective monitors of top management (e.g., Boivie et al. 2017). Future research may wish to examine board reactions to other pressing, nascent components of enterprise risk—for example, climate change, pandemics, or human capital—to see how truly adaptable boards are. Understanding the board's role in managing changes in firm risk is critical for stakeholders when assessing their firm's ability to create and preserve value.

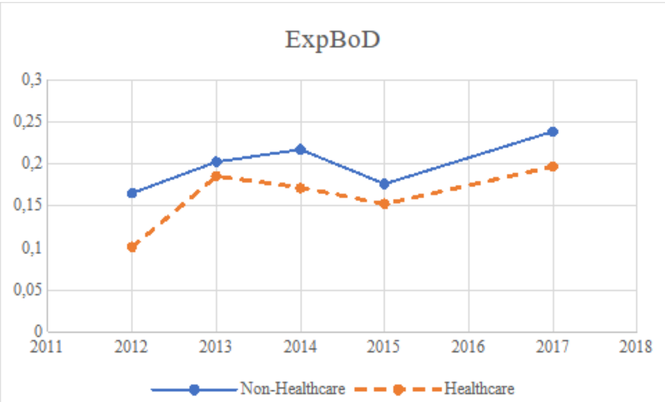
Figure 1.1 Parallel trend analysis for the difference-in-differences test of GDPR's impact on corporate boards' cyber focus expertise, and monitoring



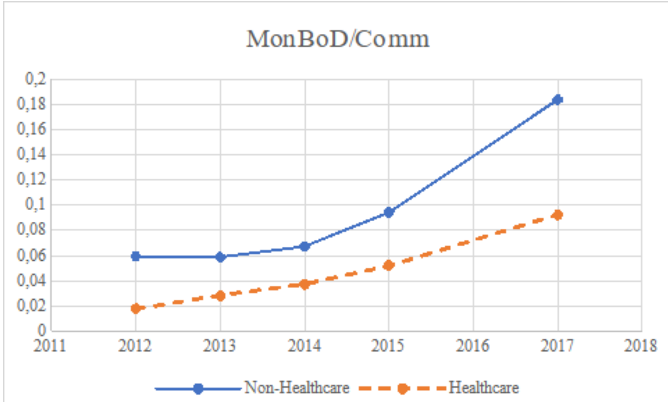
Panel A: Percentage of firms in having corporate boards's awareness of cyber issues for non-healthcare vs. healthcare firms



Panel B: Average number of "cyber" keywords per firm in DEF 14A for non-healthcare vs. healthcare firms



Panel C: Percentage of firms having board directors with cyber/IT expertise for non-healthcare vs. healthcare firms



Panel D: Percentage of firms assigning cyber risk monitoring to corporate boards and committees for non-healthcare vs. healthcare firms

Figure 1.2. Percentage of Firms Mentioning "GDPR" or "General Data Protection Regulation" in their Form 10-K Reports

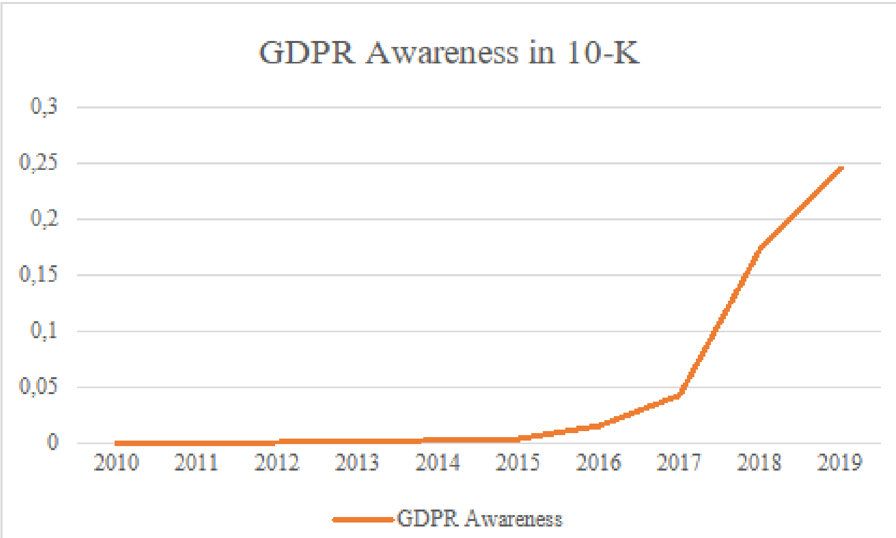


Table 1.1. Sample and summary statistics
Panel A describes our sample selection, and panel B reports the descriptive statistics.

Panel A. Sample Selection

	Number of Firms
Number of firms in Compustat/CRSP merged database at the year ended in 2014	5,595
Less: Non-US firms	-923
Less: Number of firms with missing control variables in the pre-period	-1,056
Less: Number of firms with missing proxy statements in the pre-period	-998
Less: Number of firms with missing proxy statements in the post-period	-509
Less: Number of firms that were cyber-attacked between 2005 and 2014	-16
Number of firms for the cross-sectional tests	2,093

Panel B. Descriptive statistics

Variables	*N*	Mean	Std. dev.	Min.	Median	Max.
Total Assets (in $millions)	2,093	8,686.24	39,721.77	3.76	1,213.85	856,240.00
Big Four	2,093	0.71	0.45	0.00	1.00	1.00
Institutional Ownership	2,093	0.49	0.39	0.00	0.58	1.00
ICW	2,093	0.04	0.20	0.00	0.00	1.00
Leverage	2,093	0.57	0.26	0.06	0.56	1.27
PaidCashDiv	2,093	0.57	0.50	0.00	1.00	1.00
Number of Board Directors	2,093	8.66	2.47	4.00	8.00	24.00
%IndDir	2,093	0.78	0.13	0.18	0.80	1.00

Notes: Panel A describes our sample selection, and panel B reports the descriptive statistics.

Table 1.2. GDPR and corporate boards' cyber focus, expertise, and monitoring assignment in the pre- and post-GDPR periods

Panel A: Univariate Analysis

		Pre-GDP		Post-GDPR		*t*-test of the Mean	
Variables	N	Mean (a)	S.D.	Mean (b)	S.D.	(b)-(a)	
CyberAwarenessDEF14A	2,093	10.70%	30.92%	23.12%	42.17%	12.42%	***
CyberCountDEF14A	2,093	0.18	0.74	0.53	1.60	0.35	***
ExpBoD	2,093	17.34%	37.87%	23.36%	42.32%	6.02%	***
ExpAudComm	2,093	11.32%	31.70%	11.85%	32.33%	0.53%	***
ExpRiskComm	2,093	1.43%	11.89%	1.58%	12.46%	0.15%	*
ExpTechComm	2,093	1.00%	9.97%	1.29%	11.29%	0.29%	*
MonBoD/Comm	2,093	8.93%	28.53%	17.30%	37.83%	8.37%	***
MonBoD Only	2,093	2.48%	15.57%	4.06%	19.74%	1.58%	***
MonAudComm	2,093	3.39%	18.11%	9.46%	29.27%	6.07%	***
MonRiskComm	2,093	1.48%	12.08%	2.82%	16.56%	1.34%	***
MonTechComm	2,093	1.15%	10.65%	2.34%	15.12%	1.19%	***

Panel B: Multivariate analysis

Variables	(1) *Cyber Awareness DEF14A*	(2) *Cyber Count DEF14A*	(3) *Exp BoD*	(4) *Exp Aud Comm*	(5) *Exp Risk Comm*	(6) *Exp Tech Comm*	(7) *Mon BoD/ Comm*	(8) *Mon BoD Only*	(9) *Mon Aud Comm*	(10) *Mon Risk Comm*	(11) *Mon Tech Comm*
Post	0.34***	0.11***	0.05***	0.01	-0.00	-0.00	0.08***	0.02**	0.06***	0.01*	0.01
	(7.21)	(8.24)	(3.45)	(0.56)	(-0.00)	(-0.62)	(6.12)	(2.49)	(6.91)	(1.76)	(1.62)
Size	0.12***	0.03***	0.03***	0.01***	0.01***	0.01***	0.02***	0.00	0.01***	0.00	0.01***
	(6.57)	(7.04)	(5.47)	(2.60)	(3.15)	(2.89)	(5.08)	(1.10)	(3.75)	(1.47)	(2.84)
Big Four	-0.07	-0.01	-0.02	-0.01	-0.00	-0.00	-0.00	-0.01	0.02*	-0.01	-0.01*
	(-1.51)	(-0.51)	(-1.10)	(-0.57)	(-1.31)	(-1.44)	(-0.32)	(-1.00)	(1.89)	(-1.33)	(-1.85)

(Table is continued on the next page)

Table 1.2 (continued)

Variables	*Cyber Awareness DEF14A*	*Cyber Count DEF14A*	*Exp BoD*	*Exp Aud Comm*	*Exp Risk Comm*	*Exp Tech Comm*	*Mon BoD/ Comm*	*Mon BoD Only*	*Mon Aud Comm*	*Mon Risk Comm*	*Mon Tech Comm*
InstOwn	0.00	0.06**	-0.07**	-0.04	0.00	-0.00	0.06***	0.02**	0.02	0.02**	0.00
	(0.05)	(2.19)	(-2.35)	(-1.64)	(0.21)	(-0.66)	(2.88)	(2.07)	(1.40)	(2.08)	(0.40)
ICW	-0.10**	-0.01	-0.02	-0.01	-0.00	-0.00**	-0.00	-0.00	-0.00	0.01	-0.00
	(-2.53)	(-0.49)	(-0.50)	(-0.39)	(-1.30)	(-2.54)	(-0.02)	(-0.18)	(-0.23)	(1.00)	(-0.27)
Leverage	-0.09	-0.01	-0.03	-0.00	0.01***	0.01	0.01	-0.02*	-0.00	0.01*	0.02**
	(-1.35)	(-0.57)	(-1.06)	(-0.04)	(3.28)	(1.47)	(0.55)	(-1.94)	(-0.12)	(1.77)	(2.10)
BoardSize	0.15*	0.06**	0.11***	0.07***	0.02**	-0.01	0.04	0.01	-0.00	0.03**	0.01
	(1.91)	(1.98)	(3.82)	(3.24)	(2.05)	(-0.78)	(1.44)	(0.59)	(-0.13)	(2.33)	(1.12)
%IndDir	0.77***	0.31***	0.40***	0.23***	0.01	0.01	0.13***	0.01	0.07**	0.03	0.04***
	(6.34)	(6.77)	(7.76)	(5.51)	(0.63)	(0.43)	(3.00)	(0.55)	(2.03)	(1.50)	(2.92)
PaidCashDiv	-0.11**	-0.01	-0.01	-0.03*	-0.00	0.00	-0.00	-0.00	-0.01	0.00	-0.00
	(-2.27)	(-0.86)	(-0.68)	(-1.73)	(-0.55)	(0.28)	(-0.05)	(-0.59)	(-0.92)	(0.47)	(-0.48)
Number of Firm-years	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700
Adjusted R^2	0.08	0.11	0.06	0.03	0.03	0.01	0.07	0.01	0.04	0.03	0.01

Notes: This table examines whether boards' cyber focus, expertise, and monitoring assignment change around the passage of the GDPR. Panel A summarizes corporate boards' cyber focus, expertise, and monitoring assignment in the pre- and post-GDPR periods. The pre-GDPR period is the last Form DEF14A before the first GDPR event date (June 15, 2015); the post-GDPR period is the first Form DEF14A after the last GDPR event date (May 25, 2016). Panel B presents multivariate analyses on the regressions on cyber awareness, expertise, and monitoring, controlling for firm risks and corporate governance characteristics as they may also lead to changes in board structures. We also control for industry fixed effects according to Fama-French 12 industry categories to capture unobservable industry trends. The *Post* indicator is a dummy variable equal to one when the observation is in the post-GDPR period described above and zero otherwise. Because of the availability of the control variables, the number of firms in Panel B is reduced to 1,850 (3,700 for two periods). Refer to Appendix 1.10.1. for variable definitions and data sources. Robust *t*-statistics are reported in parenthesis. *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively.

Table 1.3. DiD analysis of GDPR's impact on changes on boards' cyber focus, expertise, and monitoring assignments

VARIABLES	(1) Cyber Awareness DEF14A	(2) Cyber Count DEF14A	(3) Exp BoD	(4) Exp Aud Comm	(5) Exp Risk Comm	(6) Exp Tech Comm	(7) Mon BoD/ Comm	(8) Mon BoD Only	(9) Mon Aud Comm	(10) Mon Risk Comm	(11) Mon Tech Comm
Post	0.09	0.03	0.06*	0.03	-0.01**	-0.00	0.01	-0.01	0.05**	-0.01	0.00
	(1.31)	(0.83)	(1.68)	(1.22)	(-2.40)	(-0.07)	(0.53)	(-0.79)	(2.28)	(-1.46)	(0.09)
Treated	-0.08	-0.04*	0.04	0.05**	-0.00*	-0.00	-0.01	-0.00	0.00	-0.01*	-0.01
	(-1.58)	(-1.67)	(1.35)	(2.16)	(-1.71)	(-0.82)	(-0.34)	(-0.36)	(0.38)	(-1.83)	(-0.97)
Treated X Post	0.29***	0.10***	0.00	-0.02	0.01	-0.00	0.07***	0.03**	0.02	0.02**	0.01
	(4.00)	(2.91)	(0.07)	(-0.66)	(1.41)	(-0.01)	(2.59)	(1.97)	(0.95)	(2.45)	(0.81)
Size	0.11***	0.03***	0.02***	0.01*	0.01***	0.00**	0.02***	0.00	0.01***	0.00**	0.00***
	(6.59)	(6.77)	(3.93)	(1.65)	(3.70)	(2.26)	(5.10)	(1.07)	(3.66)	(2.45)	(2.75)
Big Four	-0.02	0.00	0.01	0.01	-0.01***	-0.00	0.00	-0.01	0.02***	-0.02***	-0.01*
	(-0.55)	(0.36)	(0.94)	(1.14)	(-2.62)	(-0.32)	(0.12)	(-1.05)	(2.63)	(-2.71)	(-1.83)
InstOwn	-0.10***	-0.01	-0.01	-0.01	-0.00**	-0.00**	0.00	-0.00	-0.00	0.01	-0.00
	(-2.64)	(-0.50)	(-0.42)	(-0.38)	(-2.15)	(-2.35)	(0.10)	(-0.02)	(-0.13)	(0.81)	(-0.36)
ICW	-0.08	-0.01	-0.04*	-0.01	0.02***	0.00	0.01	-0.02*	-0.00	0.02***	0.02**
	(-1.23)	(-0.38)	(-1.71)	(-0.57)	(3.99)	(0.84)	(0.68)	(-1.85)	(-0.34)	(3.37)	(2.39)
Leverage	0.01	0.04**	-0.02	-0.01	-0.01	0.00	0.04***	0.02**	0.02	0.00	0.00

(The Table is continued on the next page)

TABLE 1.3. (Continued)

VARIABLES	(1) Cyber Awareness DEF14A	(2) Cyber Count DEF14A	(3) Exp BoD	(4) Exp Aud Comm	(5) Exp Risk Comm	(6) Exp Tech Comm	(7) Mon BoD/ Comm	(8) Mon BoD Only	(9) Mon Aud Comm	(10) Mon Risk Comm	(11) Mon Tech Comm
	(0.17)	(2.44)	(-1.06)	(-0.89)	(-1.51)	(0.16)	(2.76)	(1.99)	(1.58)	(0.53)	(0.36)
BoardSize	0.01	0.01*	0.01***	0.01***	0.00**	-0.00	0.01*	0.00	-0.00	0.00**	0.00
	(1.62)	(1.71)	(3.33)	(2.82)	(2.19)	(-0.63)	(1.87)	(1.10)	(-0.08)	(2.22)	(0.99)
%IndDir	0.88***	0.33***	0.41***	0.23***	0.00	0.01	0.13***	0.01	0.06*	0.02	0.04***
	(7.19)	(7.14)	(8.27)	(5.75)	(0.30)	(0.60)	(2.80)	(0.32)	(1.88)	(1.09)	(3.24)
PaidCashDiv	-0.12**	-0.01	-0.04**	-0.05***	0.00	-0.00	0.01	0.00	-0.01	0.01**	-0.00
	(-2.40)	(-0.97)	(-2.52)	(-3.34)	(1.30)	(-0.50)	(0.65)	(0.37)	(-1.14)	(2.35)	(-0.22)
Constant	-1.21***	-0.39***	-0.36***	-0.18***	-0.05***	-0.02*	-0.24***	-0.01	-0.12***	-0.07***	-0.07***
	(-7.59)	(-9.35)	(-7.96)	(-4.81)	(-3.87)	(-1.84)	(-6.14)	(-0.24)	(-3.98)	(-4.44)	(-4.88)
Number of Firm-years	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700
Adjusted R^2	0.06	0.09	0.04	0.02	0.02	0.01	0.06	0.00	0.03	0.02	0.01

Notes: This table uses a DiD method to examine whether corporate boards' cyber focus, expertise, and monitoring assignment change after the passage of the GDPR. Because HIPAA, a stringent privacy regulation, already regulates healthcare firms before the GDPR, we identify companies in the healthcare industry as a control group for the GDPR treatment. The output variables, *Post*, the control variables, and the sample sizes are the same as in Table 1.2, Panel B. *Treated* is a dummy equal to one when the sample company does not belong to the healthcare industry, according to the Fama-French 12 industry categories. *Treated X Post* is the primary variable of interest. Refer to Appendix 1.10.1 for variable definitions and data sources. Robust *t*-statistics are reported in parentheses. *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively.

Table 1.4. Descriptive statistics and correlation of cross-sectional variables

Panel A: Descriptive statistics

Variable	*N*	Mean	SD	Min	Median	Max
Dummy_EU Segment	2,093	0.25	0.43	0.00	0.00	1.00
% Rev_EU Segments	2,093	0.05	0.11	0.00	0.00	0.54
EU Rev Growth	2,093	0.05	0.45	-1.00	0.00	6.12
CyberAwareness10K	2,093	0.42	0.49	0.00	0.00	1.00
CyberCount10K	2,093	1.48	3.36	0.00	0.00	53.00
MediaCov	2,093	0.19	0.39	0.00	0.00	1.00
CAR	2,093	0.45%	11.24%	-54.91%	-0.05%	132.71%

Panel B: Correlations among companies' EU exposure variables in the pre-GDPR period

	Dummy_EU Segment	*%Rev_EU Segments*	*EU Rev Growth*
Dummy_EU Segment	1.0000		
%Rev_EU Segments	0.7647***	1.0000	
EU Rev Growth	0.2229***	0.2049***	1.0000

Panel C: Correlations among companies' cyber awareness in 10K and DEF 14A in the pre-GDPR period

	Cyber-Awareness10K	*Cyber-Count10K*	*Cyber-AwarenessDEF14A*	*Cyber-CountDEF14A*
CyberAwareness10K	1.0000			
CyberCount10K	0.5175***	1.0000		
CyberAwarenessDEF14A	0.3411***	0.1708***	1.0000	
CyberCountDEF14A	0.2608***	0.1845***	0.7078***	1.0000

Notes: This table reports the descriptive statistics (panel A), the Pearson correlations among the three EU exposure variables (panel B), and the Pearson correlations among the cyber awareness variables from the firms' 10-K and proxy statements (panel C). All variable definitions are in Appendix 1.10.1. Except for the CAR, all the other cross-sectional variables are measured in the pre- GDPR period, that is, in 2014.*** represents significance level of 0.01.

Table 1.5. GDPR and changes in corporate boards' cyber awareness, expertise, and monitoring depending on firms' EU exposures

Panel A. EU Exposure Proxy #1: Dummy Variable If Firm Reports an EU Segment

Variables	(1) Δ*Cyber Awareness DEF14A*	(2) Δ*Cyber Count DEF14A*	(3) Δ*Exp BoD*	(4) Δ*Exp Aud Comm*	(5) Δ*Exp Risk Comm*	(6) Δ*Exp Tech Comm*	(7) Δ*Mon BoD/ Comm*	(8) Δ*Mon BoD Only*	(9) Δ*Mon Aud Comm*	(10) Δ*Mon Risk Comm*	(11) Δ*Mon Tech Comm*
Dummy_EU Segment	0.01	-0.03	0.02	-0.00	-0.00	-0.00	0.00	0.02	-0.00	-0.01	-0.00
	(0.54)	(-0.41)	(1.41)	(-0.49)	(-1.53)	(-1.06)	(0.09)	(1.60)	(-0.22)	(-0.92)	(-0.06)
Number of Firms	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093
Adjusted R-squared	0.12	0.05	0.08	0.01	0.01	-0.00	0.14	0.05	0.05	0.01	0.01

Panel B. EU Exposure Proxy #2: Percent of Revenues from EU Segment

Variables	(1) Δ*Cyber Awareness DEF14A*	(2) Δ*Cyber Count DEF14A*	(3) Δ*Exp BoD*	(4) Δ*Exp Aud Comm*	(5) Δ*Exp Risk Comm*	(6) Δ*Exp Tech Comm*	(7) Δ*Mon BoD/ Comm*	(8) Δ*Mon BoD Only*	(9) Δ*Mon Aud Comm*	(10) Δ*Mon Risk Comm*	(11) Δ*Mon Tech Comm*
% Rev_EU Segments	0.02	-0.14	0.07	-0.01	-0.00	0.00	0.05	0.08*	-0.02	-0.03	0.03
	(0.28)	(-0.61)	(1.15)	(-0.98)	(-1.44)	(0.09)	(0.68)	(1.72)	(-0.39)	(-1.06)	(0.91)
Number of Firms	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093
Adjusted R-squared	0.12	0.05	0.08	0.01	0.01	0.00	0.14	0.05	0.05	0.01	0.01

(The table is continued on the next page)

TABLE 1.5 (Continued)

Panel C. EU Exposure Proxy #3: EU Segment's Revenue Growth

Variables	(1) *ΔCyber Awareness DEF14A*	(2) *ΔCyber Count DEF14A*	(3) *ΔExp BoD*	(4) *ΔExp Aud Comm*	(5) *ΔExp Risk Comm*	(6) *ΔExp Tech Comm*	(7) *ΔMon BoD/ Comm*	(8) *ΔMon BoD Only*	(9) *ΔMon Aud Comm*	(10) *ΔMon Risk Comm*	(11) *ΔMon Tech Comm*
EU Rev Growth	-0.01	-0.01	0.03	0.00	-0.00	0.00	-0.01	-0.00	-0.01	0.01	-0.00
	(-0.79)	(-0.36)	(1.59)	(0.05)	(-0.67)	(0.46)	(-0.94)	(-0.42)	(-0.65)	(1.20)	(-0.15)
Number of Firms	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093
Adjusted R^2	0.12	0.05	0.08	0.01	0.01	0.00	0.14	0.05	0.05	0.01	0.01

Notes: This table examines whether the GDPR's impact on the changes in corporate boards' cyber awareness, expertise, and monitoring vary based on companies' business exposures to the EU market. We use different variables to proxy for companies' EU exposures: Panel A uses the *Dummy_EU Segment*, panel B uses the *% Rev_EU Segments*, and panel C uses *EU Rev Growth*. In all regression analyses, we control for the same set of control variables and industry fixed effects as in Table 1.2, Panel B, at the end of 2014. Furthermore, we control for the pre-GDPR period board cyber awareness (*PrePdAwareness*), expertise (*PrePdExp*), and monitoring (*PrePdMon*) to capture possible mean reversal effects. Refer to Appendix 1.10.1 for variable definitions and data sources. Robust t+statistics are reported in parentheses. * representing significance at level of 0.10.

Table 1.6. GDPR and changes in corporate boards' cyber awareness, expertise, and monitoring assignment depending on firms' cyber risk exposures

Panel A: Risk exposure proxy #1: Dummy variable in firms mention "cyber" keywords in pre-GDPR 10-K reports

Variables	(1) Δ*Cyber Awareness DEF14A*	(2) Δ*Cyber Count DEF14A*	(3) Δ*Exp BoD*	(4) Δ*Exp Aud Comm*	(5) Δ*Exp Risk Comm*	(6) Δ*Exp Tech Comm*	(7) Δ*Mon BoD/ Comm*	(8) Δ*Mon BoD Only*	(9) Δ*Mon Aud Comm*	(10) Δ*Mon Risk Comm*	(11) Δ*Mon Tech Comm*
CyberAwareness10K	0.03*	0.06	0.05***	0.00	0.00*	0.00	0.03**	0.00	0.03**	-0.00	0.00
	(1.72)	(1.23)	(3.31)	(1.03)	(1.69)	(0.26)	(2.20)	(0.32)	(2.42)	(-0.43)	(0.30)
Number of Firms	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093
Adjusted R^2	0.12	0.06	0.08	0.02	0.01	0.00	0.14	0.05	0.05	0.01	0.01

Panel B: Risk exposure proxy #2: Number of "cyber" keywords in pre-GDPR 10-K reports

Variables	(1) Δ*Cyber Awareness DEF14A*	(2) Δ*Cyber Count DEF14A*	(3) Δ*Exp BoD*	(4) Δ*Exp Aud Comm*	(5) Δ*Exp Risk Comm*	(6) Δ*Exp Tech Comm*	(7) Δ*Mon BoD/ Comm*	(8) Δ*Mon BoD Only*	(9) Δ*Mon Aud Comm*	(10) Δ*Mon Risk Comm*	(11) Δ*Mon Tech Comm*
CyberCount10K	0.01***	0.05*	0.00**	0.00	-0.00	-0.00	0.00*	0.00	0.00	0.00	-0.00
	(2.85)	(1.80)	(2.05)	(0.82)	(-1.60)	(-0.43)	(1.67)	(0.06)	(0.57)	(0.89)	(-0.27)
Number of Firms	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093
Adjusted R^2	0.12	0.06	0.08	0.02	0.01	0.00	0.14	0.05	0.05	0.01	0.01

(The table is continued on the next page)

TABLE 1.6 (continued)

Panel C: Risk exposure proxy #3: Dummy variable if firms have "data security"-related media news pre-GDPR

Variables	(1) Δ*Cyber Awareness DEF14A*	(2) Δ*Cyber Count DEF14A*	(3) Δ*Exp BoD*	(4) Δ*Exp Aud Comm*	(5) Δ*Exp Risk Comm*	(6) Δ*Exp Tech Comm*	(7) Δ*Mon BoD/ Comm*	(8) Δ*Mon BoD Only*	(9) Δ*Mon Aud Comm*	(10) Δ*Mon Risk Comm*	(11) Δ*Mon Tech Comm*
MediaCov	0.02	0.31**	0.02	0.00	0.00	-0.00	-0.02	-0.02**	0.00	0.00	-0.01
	(0.77)	(2.51)	(1.22)	(0.60)	(0.91)	(-0.62)	(-0.93)	(-2.09)	(0.14)	(0.31)	(-0.46)
Number of Firms	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093
Adjusted R^2	0.12	0.06	0.08	0.01	0.01	0.00	0.14	0.05	0.05	0.01	0.01

Panel D: Risk exposure proxy #4: Firm's CAR

Variables	(1) Δ*Cyber Awareness DEF14A*	(2) Δ*Cyber Count DEF14A*	(3) Δ*Exp BoD*	(4) Δ*Exp Aud Comm*	(5) Δ*Exp Risk Comm*	(6) Δ*Exp Tech Comm*	(7) Δ*Mon BoD/ Comm*	(8) Δ*Mon BoD Only*	(9) Δ*Mon Aud Comm*	(10) Δ*Mon Risk Comm*	(11) Δ*Mon Tech Comm*
CAR	-0.15**	-0.44***	-0.11**	-0.04**	-0.00	0.01	-0.01	0.01	-0.01	-0.03*	-0.01
	(-2.56)	(-2.66)	(-2.27)	(-2.03)	(-1.44)	(0.83)	(-0.15)	(0.42)	(-0.32)	(-1.79)	(-0.74)
Number of Firms	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093	2,093
Adjusted R^2	0.12	0.05	0.08	0.02	0.01	0.00	0.14	0.05	0.05	0.01	0.01

Notes: This table examines whether the GDPR's impacts on the changes in corporate boards' cyber awareness, expertise, and monitoring assignment vary based on companies' ex ante risk exposures (RE). We use four RE proxy variables, illustrated in the titles of panel A to panel D. In all regression analyses, we control for the same set of control variables and industry fixed effects as in Table 1.2, Panel B at the end of 2014. Furthermore, we control for the pre-GDPR period board cyber awareness (*PrePdAwareness*), expertise (*PrePdExp*), and monitoring (*PrePdMon*) to capture potential mean reversal effects. Refer to Appendix 1.10.1 for variable definitions and data sources. Robust *t*-statistics are reported in parentheses. *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively.

Table 1.7. Changes in corporate boards' cyber focus, expertise, and monitoring assignment and firms' subsequent cyber risks

Panel A: Changes in boards' cyber focus, expertise, and monitoring assignment and firms' subsequent cyberattacks/data breaches

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Dependent Variables	Subsequent Cyberattack/Data Breach (*Incidence*)										
Independent Variables	*ΔCyber Awareness DEF14A*	*ΔCyber Count DEF14A*	*ΔExp BoD*	*ΔExp Aud Comm*	*ΔExp Risk Comm*	*ΔExp Tech Comm*	*ΔMon BoD/ Comm*	*ΔMon BoD Only*	*ΔMon Aud Comm*	*ΔMon Risk Comm*	*ΔMon Tech Comm*
Probit Model	-0.60***	-0.25***	-0.22*	–	–	-0.41**	0.30	-0.40**	-0.27	-0.27**	-0.31***
	(-5.30)	(-4.12)	(-1.77)			(-2.15)	(0.81)	(-2.18)	(-1.54)	(-2.44)	(-2.98)
Number of Firms	1,862	1,862	1,862	–	–	1,862	1,862	1,862	1,862	1,862	1,862
Pseudo R^2	0.30	0.30	0.29	–	–	0.29	0.29	0.29	0.29	0.29	0.29
Logit Model	-1.62***	-0.69***	-0.77**	–	–	-1.28**	1.16	-0.83**	-1.00*	-0.85**	-0.86***
	(-5.14)	(-4.02)	(-1.98)			(-2.08)	(1.05)	(-1.99)	(-1.74)	(-2.07)	(-2.65)
Number of Firms	1,862	1,862	1,862	–	–	1,862	1,862	1,862	1,862	1,862	1,862
Pseudo R-squared	0.31	0.31	0.30	–	–	0.29	0.30	0.29	0.30	0.29	0.29

(The able is continued on the next page)

TABLE 1.7 (continued)

Panel B: Changes in board's cyber focus, expertise, and monitoring assignment and subsequent media attention on data security

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Dependent Variables	Subsequent media attention regarding data security (*Media Attention*)										
Independent Variables	Δ*Cyber Awareness DEF14A*	Δ*Cyber Count DEF14A*	Δ*Exp BoD*	Δ*Exp Aud Comm*	Δ*Exp Risk Comm*	Δ*Exp Tech Comm*	Δ*Mon BoD/ Comm*	Δ*Mon BoD Only*	Δ*Mon Aud Comm*	Δ*Mon Risk Comm*	Δ*Mon Tech Comm*
Poisson Model	0.74	0.01	0.06	0.57	-1.72***	-5.50***	-0.41	1.55**	1.02	-0.34***	-3.56***
	(1.18)	(0.32)	(0.33)	(0.74)	(-3.78)	(-9.47)	(-1.17)	(2.05)	(1.38)	(-2.82)	(-3.61)
Number of Firms	1,969	1,969	1,969	1,969	1,969	1,969	1,969	1,969	1,969	1,969	1,969
Pseudo R^2	0.46	0.44	0.44	0.44	0.44	0.62	0.45	0.49	0.46	0.49	0.55

Notes: This table examines whether the changes in corporate boards' cyber focus, expertise, and monitoring assignment have any economic consequences. In Panel A, we regress firms' subsequent cyber attack/data breach incidence over the years 2017-2019 on the changes in corporate boards' cyber focus, expertise, and monitoring assignment from the pre-GDPR period to the post-GDPR period (i.e., our dependent variable in Tables 1.5 and 1.6) using different models. In Panel B, we conduct the same regression analysis, but using the subsequent media attention between 2017 and 2019 as the output variable. In both panels, we control for *Size*, *Big Four*, *InstOwn*, *ICW*, *Leverage*, *BoardSize*, *%IndDir*, and *PaidCashDiv* at the end of 2016. We also control for the cyberattack/data breach incidences in 2015 and 2016 in Panel A and the number of media articles regarding data security between 2012 and 2014 in Panel B. We do not include the industry fixed effects in either panel to avoid the incidental parameter bias in nonlinear panel models. Refer to Appendix 1.10.1 for variable definitions and data sources. Robust *t*-statistics are reported in parentheses. *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively.

1.10. Appendices:

1.10.1. Variable Definitions

Variable	Definition	Source
Board Awareness/ Expertise/ Monitoring Variables		
CyberAwarenessDEF14A	Indicator variable if the keyword "cyber" appears at least once in a company's proxy statement.	Hand collected from Form DEF14A
CyberCountDEF14A	The total number of times the keyword "cyber" appears in a company's proxy statement.	Hand collected from Form DEF14A
ExpBoD	Indicator variable if the firm has at least one cyber/IT expert on its board.	Hand collected from Form DEF14A
ExpAudComm	Indicator variable if the firm has at least one cyber/IT expert on its audit committee.	Hand collected from Form DEF14A
ExpRiskComm	Indicator variable if the firm has at least one cyber/IT expert on its risk committee.	Hand collected from Form DEF14A
ExpTechComm	Indicator variable if the firm has at least one cyber/IT expert on its technology committee.	Hand collected from Form DEF14A
MonBoD/Comm	Indicator variable if the firm discusses the responsibility of the board or specific committees to monitor cyber/IT risks.	Hand collected from Form DEF14A
MonBoD Only	Indicator variable if the firm discusses the responsibility and explicitly states the board as a whole (rather than delegating to individual committees) monitors cyber/IT risks.	Hand collected from proxy statements
MonAudComm	Indicator variable if the firm discusses the responsibility and explicitly states the board delegates the responsibility of monitoring cyber/IT risks to its Audit Committee.	Hand collected from Form DEF14A
MonRiskComm	Indicator variable if the firm discusses the responsibility and explicitly states the board delegates the responsibility of monitoring cyber/IT risks to its risk committee.	Hand collected from Form DEF14A
MonTechComm	Indicator variable if the firm discusses the responsibility and explicitly states the board delegates the responsibility of monitoring cyber/IT risks to its technology committee.	Hand collected from Form DEF14A
EU Exposure Variables		
Dummy_EU Segment	Indicator variable if the firm reports at least one customer segment is located in one of the 28 European Union countries in year 2014	Compustat Segment Report

(The table is continued on the next page)

(Continued)

Variable	Definition	Source
% Rev_EU Segments	The percentage of a company's sales revenue from all EU segments divided by its total sales revenue in year 2014	Compustat Segment Report
EU Rev Growth	The companies' sales revenue from all EU segments in year 2014 over year 2013, subtract one	Compustat Segment Report
Cyber risk exposure variables		
CyberAwareness10K	Indicator variable if the keyword "cyber" appears in a company's 2014 Form 10-K	Hand collected from Form 10-K
CyberCount10K	The total number of times the keyword "cyber" appears at least once in a company's 2014 Form 10-K	Hand collected from Form 10-K
MediaCov	Indicator variable if the firm has at least one third-party media article related to data security issues in the past 12 months of December, 31, 2014	TruValue Labs Insight 360 TTM database
CAR	Cumulative abnormal returns over the GDPR events timeline using the Fama-French five-factor model for the expectation model (Fama and French 2014). The model is estimated as follows using the stock return data from June 1, 2015, to May 31,2016, inclusively: $R_{jt} - R_{ft} = \beta_{j0} + \beta_{j1}(R_{Mt} - R_{ft}) + \beta_{j2}SMB_t + \beta_{j3}HML_t + \beta_{j4}RMW_t + \beta_{j5}CMA_t + \sum_{k=1}^{18}\delta_{jk} * E_{kt} + \epsilon_{jt}$. E_{kt} indicates the k^{th} GDPR event date, which equals one if a date is an event date and zero otherwise. $CAR_j = \sum_{k=1}^{18}\hat{\delta_{jk}}$.	CRSP and Kenneth R. French's website
Economic Consequence Variables		
GDPRAwareness10K	Indicator variable if the keyword "General Data Privacy Regulation" or "GDPR" appear in a company's Form 10-K**.**	Hand collected from Form 10-K
Media Attention	The number of media stories related to data security issues over the years 2017 through 2019	TruValue Labs Insight 360 TTM database
Incidence	Indicator variable if the firm has any known cyber attacks or data breaches over the years 2017 through 2019	Privacy Rights Clearinghouse database
Control Variables		
Size	The natural logarithm of total assets at year-end.	Compustat
Big Four	Indicator variable if the firm has a Big 4 auditor.	Compustat
InstOwn	The natural logarithm of one plus the sum of total institutional ownership at year-end.	Thomson Reuters Database

(The table is continued on the next page)

(Continued)

Variable	Definition	Source
ICW	Indicator variable if the company has a 404 report indicating internal control weakness in the year	Audit Analytics
Leverage	Total liabilities over total assets at year-end	Compustat
Board Size	The natural logarithm of the number of board directors at year-end	BoardEx
%IndDir	The percentage of independent directors at year-end	BoardEx
PaidCashDiv	Indicator variable if the firm paid cash dividends in the year	Compustat
PrePdAwareness	Indicator variable if the firm mentions "cyber" keywords in the last proxy statement before the first GDPR event date	Hand collected from Form DEF14A
PrePdMon	Indicator variable if the firm discusses the responsibility of the board or specific committees to monitor cyber/IT risks in the last proxy statement before the first GDPR event date.	Hand collected from Form DEF14A
PrePdExp	Indicator variable if the firm discloses at least one Cyber/IT expert on its board in the last proxy statement before the first GDPR event date.	Hand collected from Form DEF14A

1.10.2. Major provisions of the GDPR

This Appendix presents the main changes GDPR imposes on the regulatory landscape of data security and data privacy. The content is taken directly from GDPR, but the exposition is summarized or abbreviated for presentation purposes.[13]

Increased Territorial Scope: The GDPR extends the EU's jurisdiction on compliance. Under Article 3, all processing of personal data by controllers and processors for subjects residing in the EU falls under the new regulation, irrespective of whether the processing takes place in the EU or not. Covered activities include the offering of goods or services and the monitoring of behavior that takes place within the EU.

[13] EU (European Union) (2016). See https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679 &from=EN

Penalties: Organizations in breach of GDPR can be fined up to 4% of annual global revenues or €20 million (whichever is greater). This is the maximum fine that can be imposed for the most serious infringements. There is a tiered approach to fines—for example, a company can be fined 2% for not having their records in order (Article 83). It is important to note that these rules apply to both controllers and processors—meaning "clouds" are not exempt from GDPR enforcement.

Consent: Under Article 7, the conditions for consent have been strengthened. Companies must ask for it in an intelligible and easily accessible form, using clear and plain language. The request for consent must be clear and distinguishable from other matters. The ability to withdraw consent must be as easy as it is to give consent.

Breach Notification: Breach notification is mandatory when a data breach is likely to "result in a high risk to the rights and freedoms of natural persons" (Article 34). This must be done within 72 hours of first becoming aware of the breach. Data processors are required to notify their customers, the controllers, "without undue delay" after first becoming aware of a data breach (Article 33).

Right to Access: Article 15 contains the right for data subjects to obtain from the data controller confirmation whether, where, and for what purpose their personal data are being processed. Furthermore, the controller must provide the data subject a copy of their personal data, free of charge, in an electronic format.

Right to be Forgotten: The right to be forgotten (Article 17) entitles the data subject to have the data controller erase personal data, cease further dissemination of the data, and potentially have third parties halt processing of the data. The conditions for erasure, as outlined in Article 17, include the data no longer being relevant to original purposes for processing, or a data subject withdrawing consent.

Data Portability: Data subjects have the right to receive their personal data in a "commonly used and machine-readable format" (Article 20).

Privacy by Design: Privacy by design calls for the inclusion of data protection from the onset of the designing of systems. Specifically: "The controller shall implement appropriate technical and organizational measures to ensure and to be able to demonstrate that processing is performed in accordance with this Regulation" (Article 24). Furthermore, Article 5 calls for controllers to hold and process only the data strictly necessary for the completion of its duties (data minimization).

Data Protection Officers: The appointment of a data protection officer (DPO) is mandatory only for those controllers and processors whose core activities consist of processing operations that require regular and systematic monitoring of data subjects on a large scale, or of special categories of data, or data relating to criminal convictions and offenses. The primary role of the DPO is to ensure that their organization processes the personal data of their staff, customers, and any other data subject in compliance with the applicable data protection rules.

1.10.3. GDPR events

Event	*Dates*	*Stages*	*Description*
D1	June 15, 2015	Proposal	The Council of the EU approved its version in Its First Reading allowing the regulation to pass into the final stage of legislation known as the "Trilogue"
D2	June 24, 2015	Trilogue	First Trilogue Meeting: Package approach; Agreement on the overall roadmap for Trilogue negotiations; General method and approach for delegated and implementing acts
D3	July 14, 2015	Trilogue	Second Trilogue Meeting: Territorial Scope (Article 3); Representative (Article 25); International Transfers (Chapter V) with related definitions
D4	September 16, 2015	Trilogue	First Day of the Third Trilogue Meeting: Data Protection Principles (Chapter II); Data Subjects Rights (Chapter III); Controller and Processor (Chapter IV)
D5	September 17, 2015	Trilogue	Second Day of the Third Trilogue Meeting: Data Protection Principles (Chapter II); Data Subject Rights (Chapter III); Controller and Processor (Chapter IV)
D6	September 29, 2015	Trilogue	First Day of the Fourth Trilogue Meeting: Data Protection Principles (Chapter II); Data Subjects Rights (Chapter III); Controller and Processor (Chapter IV)

(The table is continued on the next page)

(Continued)

Event	*Dates*	*Stages*	*Description*
D7	September 30, 2015	Trilogue	Second Day of the Fourth Trilogue Meeting: Data Protection Principles (Chapter II); Data Subjects Rights (Chapter III); Controller and Processor (Chapter IV)
D8	October 15, 2015	Trilogue	Fifth Trilogue Meeting: Independent Supervisory Authorities (Chapter VI); Cooperation and Consistency (Chapter VII); Remedies, Liability and Sanctions (Chapter VIII)
D9	October 28, 2015	Trilogue	Sixth Trilogue Meeting: Independent Supervisory Authorities (Chapter VI); Cooperation and Consistency (Chapter VII); Remedies, Liability and Sanctions (Chapter VIII)
D10	November 11, 2015	Trilogue	First Day of the Seventh Trilogue Meeting: Objectives and Material Scope (Chapter I): Specific Regimes (Chapter IX)
D11	November 12, 2015	Trilogue	Second Day of the Seventh Trilogue Meeting: Objectives and Material Scope (Chapter I); Specific Regimes (Chapter IX)
D12	November 24, 2015	Trilogue	Eight Trilogue Meeting: All open issues From Chapter I to IX
D13	December 10, 2015	Trilogue	Ninth Trilogue Meeting: Delegated and Implementing Acts (Chapter X); Final Provisions (Chapter XI); Remaining issues
D14	December 15, 2015	Trilogue	The Parliament and European Council come to an agreement
D15	April 8, 2016	Approval	GDPR is adopted by the Council of the European Union
D16	April 14, 2016	Approval	GDPR is adopted by the European Parliament
D17	May 4, 2016	Approval	GDPR is published in the Official Journal of the European Union
D18	May 25, 2016	Approval	GDPR effectively becomes law

Data Availability Statement

All data are publicly available from sources cited in the text, except for the TruValue Labs Insight360™ database, which is a proprietary database.

CHAPTER 2.

Board Of Directors' Composition and Directors' Skill Sets: It's All About Fit!

2.1. Introduction

A firm's board of directors performs an oversight role within the firm by advising and monitoring top management on the firm's overall performance and risk profiles (Fama and Jensen ,1983). At the same time, the board of directors needs to take into consideration the external business environment, the political landscape, the firm's competition, and the overall risk environment. Given the delicacy and complexity of the task, the set of skills that the different directors contribute to the board must be carefully considered (e.g., Dass et al., 2013; Guner, Malmeinder and Tate, 2008; Faleye, Hoitash and Hoitash, 2018). These skills not only have to be internally consistent (complementary), but also need to be appropriate to deal with the external environment firms face. In fact, a board of directors should be able to monitor and complement top management's assessments and decisions while reducing internal conflicts and supporting the overall firm decision-making process.

In this paper, I examine the relationship between board of directors' skills composition and firm performance. However, unlike other papers analyzing similar research questions (e.g., Adams, Akyol and Verwijimeren, 2018; Kim and Stark, 2015), I introduce the concept of "Fit". According to the dictionary, the word fit indicates someone or something of a suitable quality or standard to meet the required purpose[14]. Therefore, I investigate the impact of boards of directors' skill sets internal and external suitability to perform their main tasks on firms' performance. Organizational science and strategy are not new to the concept of fit and its two dimensions, internal and external fit (e.g., Miller, 1992; Burns and Stalker, 1961; Thompson, 1967). According to Miller (1992), internal fit is the ability of a firm to "establish complementarities among aspects of structure and process",

[14] See https://dictionary.cambridge.org/dictionary/english/fit

whereas external or environmental fit refers to the ability of a firm "to match their structures and processes to their external setting". Hence, this study borrows the definitions of fit and its two dimensions from the organizational science literature, tailors and uses them to address the issue of board of directors' skills composition and firm performance. To my knowledge this is the first paper introducing the concept of board of directors' fit, thus, providing an important first step towards understanding the reason behind the numerous conflicting findings within the literature addressing the relationship between board composition and firms' corporate outcomes.

Exploiting the 2009 amendment to Regulation S-K, which requires US firms to disclose for each director and each nominee for director the skills, qualification and expertise that qualified that person to serve on the board, I create a dataset mapping each firm listed in the Standard and Poor's 500 (S&P 500) index to its board of director's skill sets. By using this dataset as my main source of information, I examine two board attributes: (1) Whether boards of directors' skill sets have the right balance between skill diversity and complementarity [Internal Fit], (2) whether boards of directors` skill sets are properly assembled to meet the external firm environment [External Fit].

In order to analyze the issue of internal fit, I first adopt a factor analysis approach by which I extract the main dimensions along which directors' skills cluster together. I find that there are three main groups of skills that characterize the firms in my sample: The Legal and Political group, the Leadership and Operational group, and the Strategy and Technology group. The factor analysis results support the idea that a board of directors should be both diverse in its skills composition and have the right combination of complementary skills at the same time. In fact, while the three categories of skills are very different from each other, each category embeds very complementary skills. As such, I conclude that there is an internal fit dimension when looking into board of directors' skills composition.

To provide further evidence that internal fit is important, I investigate whether these three different categories of skills are related to firm performance as measured by Tobin's Q and ROA. This study wants to show that when boards of directors focus more on these three skill categories, firms perform better than their peers. However, given the endogenous nature of board composition, it is particularly challenging to establish the causality of these results (Hermalin and Weisbach, 1998). To overcome this challenge, I propose a novel instrumental variable approach that builds on the work of Knyazeva, Knyazeva and Masulis (2013), which is particularly suitable for this study. My main instrumental variable exploits the pool of qualified prospective directors employed by peer firms. Specifically, I focus on directors employed by firms listed in the S&P 500 index as the main source of prospective qualified directors. The rationale behind this choice is that qualified directors are a scarce human resource. They face opportunity costs to join companies' boards usually preferring firms that can offer more visibility and greater reputation benefits (Knyazeva, Knyazeva and Masulis, 2013). Therefore, I expect qualified directors already operating in one of the largest 500 US companies to be willing to join only companies of comparable status. Moreover, firms have better access to soft information about potential directors if these directors work on large and visible firms. Using the availability of qualified directors as an instrument in two-stage least squares (2SLS) regressions, I find strong and consistent support to the idea that greater board internal fit may cause higher firm performance.

To test the external fit's issue, I exploit the findings of previous studies that show that firms strategically appoint directors with specialized skills to face specific situations. For example, technology/cyber experts (Klein, Manini and Shi ,2021), financial accounting experts (DeFond, Hann and Hu, 2005), and directors with foreign experience (Giannetti, Liao, Yu, 2015).

Using a difference-in-differences methodology, I show that including specialized directors to face specific challenges is a way to achieve board of directors' external fit, hence firms that do so experience higher performance. I show that boards of directors of firms operating in environmentally related sectors that have more than 2 ESG expert directors sitting on their boards after the Paris Climate Accord, experience higher performance when compared to firms operating in the same sector which have less ESG experts sitting on their boards.

My study supports the view that achieving board of directors fit both in its internal and its external dimensions positively contributes to firm performance. The board of directors' internal fit represents the right combination of directors' skills' diversity and complementarity, whereas the board of directors' external fit is obtained when the firm carefully adds directors with specialized skills on the board to face external challenges. The better firms match their board of directors' skills composition with their internal and external environments, the higher the firm performance. Therefore, the larger the board of directors' fit, the higher the performance the firm achieves.

This study contributes to several lines of research. First, I introduce the concept of board of directors' fit, both in its internal and external dimensions. This new dimension of the board of directors complements previous studies examining whether board of directors' skills heterogeneity impact firm performance (Adams, Akyol and Verwijimeren 2018; and Kim and Stark 2016). My study differs from these papers in that I examine whether it exists an appropriate combination of skills that maximizes firm performance rather than examining whether heterogeneity or diversity of skills is performance enhancing per se.

Second, by introducing this new dimension of fit, I provide a possible explanation to the several contrasting results characterizing the literature that analyzes directors' skill composition and their contribution to performance (e.g., Dass et al 2013; Faleye et al 2018; Fich 2005). In fact, while these studies analyze whether one directors' skill can affect firm performance, I look at how each individual directors' skill fit into the board of directors as a multidimensional entity.

Finally, I provide further evidence that firms can use the board of directors' skill composition to face changes in the business and regulatory environment.

The rest of the paper proceeds as follows. Section II reviews the related literature and states the research hypotheses. Section III explains the sources of the data and how they are assembled. Section IV discusses and tests the board of directors' internal fit dimension. Section V discusses and tests the board of directors' external fit dimension. Section VI concludes and provides suggestions for future research.

2.2. Literature Review and Hypothesis

Boards of directors have always been under the spotlight of both the political and the academic worlds. The Sarbanes-Oxley Act of 2002 represents probably the greatest political intervention with respect to boards of directors' responsibilities and composition, but there are also more recent political interventions aimed at attaining greater social equality and advocating for boards of directors with a more extended set of skills, as an example, initiatives promoting gender diversity on boards fall within this spectrum.

The literature has inquired whether these external pressures add value to firms. For instance, Kim and Stark (2016) provide empirical evidence that having more women sitting on boards of directors provide unique skills, Billings, Klein and Shi, (2021) show that including women in the boardroom shapes the firm's culture and Dutchin, Matsusaka and Ozbas (2009) explain that directors' independence matters, and it is affected by the information environment.

At the same time, firms perform a cost/benefit analysis to meet their needs (Hermalin and Weisbach, 1998). This means that board composition and structure are endogenously determined. Many studies support this view with respect to the strategic inclusion of specialized directors in the board. For instance, DeFond, Hann and Hu (2005) find that the market responds positively to the appointment of financial accounting experts on the audit committee. Huang, Jiang, Lie and Yang (2014) show that directors with investment banking experience impact the firm's acquisition attitude and Klein, Manini, and Shi (2021) provide evidence that firms tend to appoint cyber/tech expert directors on their boards to respond to a significant change in the cyber-risk environment.

Taken all together, these findings provide empirical evidence that firms compose their boards to meet their internal needs as well as to face externally imposed requirements. There are several reasons to believe this may be true. First, in general, boards of directors perform an oversight role within the firm by monitoring and advising top management on the firm's overall performance and risk profile (Fama and Jensen, 1983). Second, boards of directors are called to assess, amend, and approve major strategic decisions made by management (Coles, Daniels and Naveen, 2020). These tasks may require strictly internal assessments, but sometimes firms need to take a broader perspective which needs a thorough evaluation of the external environment. For example, decisions about the firm's compensation policy or its top management hiring process are mainly internal in their nature. Whereas how to respond to an industry specific regulatory shock, the public opinion questioning the firm's reputation, or a significant shift in the industry's competitive landscape are decisions requiring a sound assessment of the external environment.

Considering how complex and diverse the role of the board is, it becomes important to analyze how directors' skills map to the board's monitoring and advising duties. Kim and Stark (2016) and Adams et al. (2018) tackle this research question by examining how boards of directors' heterogeneity of skills impact firm performance. Kim and Stark (2016) support the hypothesis that board of directors' heterogeneity of skills leads to greater advisory effectiveness. As a consequence, greater advisory effectiveness results into better decision making which in turn leads to greater firm performance. On the other hand, Adams et al (2018) conclude that greater directors' skill diversity has a negative and significant impact on firm performance while they provide empirical evidence that directors' skill diversity is the main dimension along which boards of directors vary.

The corporate governance literature addressing the impact of directors' skills on firm performance does not always generate clear results. Indeed, when analyzing one directors' skill at a time, the literature is not unambiguous about which directors' skill adds value. For example, contrary to Dass et al. (2013) and Faleye et al (2018), who find that directors' industry experience is value-enhancing, Kang et al (2018) find that directors' industry experience is not always beneficial to the firm. Also, Fitch (2005) and Fahlenbrach, Low and Stulz (2010) disagree about the importance of directors' CEO experience. In fact, while the first argue that CEO experience adds value, the latter support the opposite view.

A reasonable explanation behind the inconsistency of these results lies in the context in which directors' skills are employed. Directors with different characteristics have different priors, so they have different views and priorities. For instance, a director with strong marketing foundations might see a very expensive advertising campaign as a great opportunity for the firm to enhance its brand image and expand its customer base. Therefore, this director would be in favor of financing the initiative. At the same time, another director sitting on the same board who has a strong experience in the financial arena may not be so keen in supporting the marketing expert's decision because a costly advertising campaign can affect the firm's budget and costs allocation.

According to this interpretation, Garlappi, Giammarino and Lazrak (2017) provide theoretical arguments that a collection of different points of view, which the authors define as heterogeneous beliefs, leads to inefficient corporate decision making. Also, some of the management literature shares this conclusion. For example, Pelled, Eisenhardt and Xin (1999) show that diversity shapes conflict and that conflict shapes performance. One of their findings is that functional background diversity leads to task conflicts. Basically, both studies underpin the empirical findings of Adams et al. (2018) that lack of common priors and beliefs results in poor corporate decisions with negative effects on firm performance.

On the other hand, other studies prize the importance of diversity of skills because it helps firms overcome challenges and attain higher levels of innovation. For example, Lazear (2005) develops a model showing that entrepreneurs need to be sufficiently skilled in several areas to be able to assemble a successful business. D'Acunto, Tate and Yang (2020) show that startups with founding teams that have a more diverse collective set of skills, grow faster than their competitors and adapt their strategies more successfully when facing uncertain environments.

My first hypothesis relates to the firm's ability to create a heterogeneously skilled board of directors that is also internally consistent. A combination of directors' skill sets that provide a wide array of expertise while having a certain degree of complementarity among them.

I therefore state my first hypothesis as follows:

> *Hypothesis 1***:** There is an ideal board of directors' skills composition [Internal Fit] that combines an efficient decision-making process while drawing information from a diverse pool of expertise.

My second hypothesis relates to the firms' ability to quickly adapt to a constantly changing business environment while encouraging the firm's innovation. Given that many changes come from external forces such as regulators, the economy, and competitors, internal fit may not be enough: There might be the need for further specialized skills or a combination of them to face the external challenges.

Therefore, I present my second hypothesis as follows:

*Hypothesis 2***:** Boards of directors should include specialized directors' skills which guarantee the firm's adaptability to the external business and industry environment.

2.3. Sample Selection, Data Sources and Description of Data

I assemble a sample of U.S. public companies included in the S&P 500 Index at the end of 2019. After removing 131 firms that were not continuously listed in the S&P 500 throughout the period 2010 to 2019, I have an initial sample of 369 firms and 3,690 firm-year observations. As shown in Table 2.1 panel A, removing firms with missing ISS data (370 firm-year observations) and firms with missing COMPUSTAT data (145 firm-year observations) produces a final sample of 3,175 firm-year observations for my tests.

Table 2.1 panel B provides descriptive statistics of the sample. I use the ISS dataset as the main source of corporate governance data and COMPUSTAT as the main source of firms' fundamentals information. The typical firm in my sample (based on mean data) has 11 directors sitting on the board of which 19% are women and 83% are independent. The leverage ratio is 27% on average and the average return on assets (ROA) is 10%. I decided to analyze firms listed in the S&P 500 because it allows me to have access to all the relevant information as well as to have a benchmark corresponding to the largest US firms.

The core of my analysis revolves around the idea that the composition of skills of the board of directors has an impact on firm performance. Accordingly, I manually go through each firm's DEF14A form (proxy statements) and carefully read the description of each director's skills, experience, and qualifications included in the statement. According to the amendment to regulation S-K of 2010, "a company would be required to disclose for each director and any nominee for director the particular experience, qualifications, attributes or skills that qualified that person to serve as a director of the company, and as a member of any committee that the person serves on or is chosen to serve on, in light of the company's business".

I adopt a "hand collection" approach rather than an automated one for two main reasons. First, as Kim and Stark (2016) note, finding a clear textual pattern within any section of the proxy statements is extremely complex, so the use of textual analysis techniques might lead to inexact results. Second, as Frankenreiter et al (2021) suggest, a thorough interpretation of corporate governance documents is paramount to be able to claim accurate results. In fact, these authors argue that corporate governance documents have become increasingly complex over time, so they need to be interpreted by expert professionals, lawyers in their specific case, to be able to extract relevant and correct data. They support this thesis by creating a corpus of corporate charters and using it to challenge some of the main results in empirical corporate governance research. They find that some of these seminal results in corporate governance show errors. For example, they show that the construction of the G-Index, the most appreciated proxy for "good governance" yields an error exceeding eighty percent. As a consequence, papers using this index as the main source for their empirical analysis are affected by this issue (e.g., Gompers, Ishii, and Metrick, 2003).

After reading through the disclosures, I identify ten specific directors' skills which are recurringly mentioned in the narrative of the DEF14A forms: Finance, Marketing, Technology, Science, Operations, Law, Public Policy, Leadership, Strategy and ESG (Environmental, Sustainability and Governance). Using the disclosures from the firms' filings, I can delineate each director's skill sets. For example, the following is an excerpt from Apple Inc's 2016 proxy statement disclosure[15]:

> "**Al Gore** served as Chairman of Generation Investment Management, an investment management firm, since 2004, and as a partner of Kleiner Perkins Caufield & Byers, a venture capital firm, since 2007. Mr. Gore is also Chairman of The Climate Reality Project. Mr. Gore was elected to the US House of Representatives four times, to the US Senate two times, and served two terms as Vice-President of the United States. Among other qualifications, Mr. Gore brings to the board executive leadership experience, a valuable different perspective due to his extensive background in digital communication and technology policy, politics, and environmental rights, along with experience in asset management and venture capital."

[15] See https://www.sec.gov/Archives/edgar/data/0000320193/000119312516422528/d79474ddef14a.htm

Based on this disclosure, I attribute several skills to Al Gore; *Leadership* experience because of the relevant leadership positions he has occupied throughout his career (Partner, Chairman, and Vice-President); *Finance* given his career in the investment management and venture capital industries; *Public Policy*, because of his long and significant political career; *ESG* due to his being the chairman of The Climate Reality Project. My designations partially differ from Apple's DEF14A disclosure, which also attributes Technology expertise to Mr. Gore. However, since competence in Technology is not supported by any of Mr. Gore's disclosed qualifications and relevant professional experiences, for the purpose of this study, I do not include Technology as one of Mr. Gore's skills. Therefore, Al Gore is a Leadership, Finance, Public Policy and ESG expert.

Table 2.1 panel C shows descriptive statistics for the set of expertise for the boards of directors in my sample. Based on mean statistics, the four most represented skills are: Leadership (10.03), Finance (3.02), Operations (1.92) and Public Policy (1.01). The rest of the skills are on average less represented on the boards of directors with the rarest qualifications being ESG and Science. These two qualifications are the rarest because they depend significantly on the firm's external business environment, hence these are the type of skills that firms might want to consider when building their board of director's external fit. To illustrate similarities and differences in directors' skill sets, Table 2.2 panel A presents descriptive statistics of board of directors' skill sets for the entire sample, the manufacturing industry (two-digit SIC codes 20, 36 and 37) and the energy industry (two-digit SIC codes 13 and 49). I choose these sectors because they are clear examples of industries operating in two very different business environments. Data show that all three samples share very similar numbers (based on mean) in terms of Leadership, Finance, Operations and Public Policy expertise. However, if we look at the ESG specialists' representation among the three samples, the typical firm (based on mean) operating in the energy sector shows a much more significant presence of ESG qualified directors sitting on the board (0.39) than the typical company in the overall sample (0.16), and in the manufacturing sector (0.05). A *t*-test (shown in the bottom row of the panel) for the difference in percentages yields *p*-values less than 0.01. These results corroborate my approach of looking at the ideal board of directors' composition of skills both from an internal and from an external perspective.

As another example, Table 2.2 panel B compares descriptive statistics for directors' skill sets in the complete sample, the computer-programming sector (two-digit SIC code 73) and the chemicals and pharmaceuticals sector (two-digit SIC code 28). Once again, statistics show that all three samples share very similar mean numbers in terms of Leadership, Finance and Operations expertise. On the other hand, the Technology and Science specializations show very different mean numbers depending on the sector in which the firms operate. Specifically, firms operating in the pharmaceutical sector have a more important representation of scientific knowledge in their boards (1.28) than the typical company in the overall sample (0.30) and the typical company operating in the computer programming sector (0.13). Firms operating in the computer area give more weight to technology expertise (1.08) compared to firms representing the overall sample (0.47) and the pharmaceutical sector (0.28). T-tests (bottom row) for differences in percentages yield p-values less than 0.01.

I take several approaches in creating variables which represent boards of directors' skill sets composition. First, following Adams et al (2018), I create the variable *Skillsum* that represents the total number of unique skills that compose a board of directors. Each skill is measured with a dummy variable taking the value of one if there is at least one director providing that skill and zero otherwise.

Second, following several corporate governance studies that analyze topics such as boards of directors' composition and CEO characteristics (e.g., Adams et al, 2018; Custodio, Ferreira and Matos, 2013; Kaplan and Sorensen, 2021), I employ a factor analysis approach to extract the main dimensions along which boards vary with respect to directors' skills and qualifications. Table 2.3 panel A shows the results of factor analysis based on the ten directors' skills identified for this work. There are four factors representing four different categories of directors' skillsets. Factor I is defined by *Law*, *Public Policy* and *ESG*; Factor II by *Operations*, *Leadership* and *Marketing*; Factor III by *Strategy, Technology* and *Finance*; Factor IV is mainly made of *Science*.

The economic magnitude of the factor coefficients identified in the previous analysis may be difficult to interpret. Moreover, it might be difficult to discuss and claim instrumental validity when the endogenous variable of interest is a factor. Therefore, I create three variables to replace Factors I, II and III. Notice that I do not include factor IV in my analysis because I am interested in directors' skills combinations and Factor IV is defined mostly by *Science*. Each variable is the sum of the two most relevant skills defining each factor. Therefore, the *Law_exp* variable is the sum of *Law* and *Public Policy* experts sitting on the board, *Mgt_exp* is the sum of *Operations* and *Leadership* expert directors, and finally *Strategy_exp* is the sum of *Strategy* and *Technology* qualified directors sitting on the board.

Table 2.3 panel B presents the correlation coefficients among the factors generated through the factor analysis approach and the directors' skill sets variables I create. The results show a highly significant correlation among the variables. Factor I is highly correlated (79%) with *Law_exp*. Factor II is 92% correlated with *Mgt_exp* and Factor III is 91% correlated with *Strategy_exp*. These results support the approach I am taking generating more intuitive variables to replace the factor coefficients and to make further tests to address endogeneity that are easier to interpret.

2.4. Board of Directors' Internal Fit and Firm Performance

Hypothesis 1 examines if it exists an internal fit dimension of the board of directors' skills composition that favors efficient decision making while drawing information from a broad array of skills.

According to the organizational research literature, diversity should be an asset to efficient decision making because it brings more perspectives and resources to problem solving (Milinken and Martins, 1996; O'Reilly and Williams, 1998). On the other hand, diversity can also become a liability because different approaches and interpretations of a problem might lead to misunderstandings, hence a slower and less efficient decision-making process (Garlappi et al., 2017). Therefore, the first step of my analysis will be to address if it is possible to assemble a diverse board of directors that guarantees a wide array of tools for decision making and efficiency during the decision-making process.

The first step of my analysis will be to understand how boards of directors could generate this internal fit. The results of the factor analysis in Table 2.3 indicate that there are four dimensions through which boards of directors' skills vary, three of which are a relatively balanced combination of several skills. Looking at the first two skills generating Factors I, II and III, I notice the following combinations of skills: *Law* and *Public Policy*, *Operations* and *Leadership* and *Strategy* and *Technology*. While each factor is very different from the others based on the skills that constitute it, each skill composing each factor belongs to the same dimension of expertise. For example, *Law* and *Public Policy* are very much interconnected because the public policy arena is constantly engaged with regulations, public speaking, and legal matters in general. *Leadership* and *Operations* are at the base of the management science dealing with top level decision making and its optimal implementation. Lastly, *Technology* and *Strategy* are all about innovation and seeing the bigger picture. Hence, given the complementarity of the skills constituting each factor and the fact that each one of these bundles of directors' skills is related to different spheres of the decision-making process, factor analysis seems to support the idea that this internal fit dimension exists.

However, intuitively, whether a firm's board of directors implement an efficient decision-making process should be reflected in the firm's performance. Therefore, to assess whether this directors' skill sets internal fit dimension is associated to efficient decision making and consequently to higher firm performance, I estimate the following regression:

$$Performance_{j,t} = \beta_0 + \beta_1 Factor_{j,t} + \Sigma\ Controls_{j,t} + \text{TimeFE} + \text{FirmFE} + \varepsilon_{j,t} \quad (1)$$

Where $Performance_{j,t}$ is firm's j performance measured as Tobin's Q or ROA at time t, and $Factor_{j,t}$ is Factors I, II and III respectively for firm j at time t. The regression controls for various variables that might be correlated with firm performance: capital expenditures (CAPEX), firm size, total number of directors sitting on the board, the percentage of independent directors sitting on the board as well as the percentage of women representing the firm's board of directors. All regression models are estimated with heteroskedasticity-robust standard errors to reduce any concern related to the homogeneity of the variances of the residuals. See Appendix 2.7.1 for variable definitions.

Table 2.4 presents summary statistics from these regressions. I find significantly positive coefficients on Factor I and Factor II (Columns 1, 2, 4, 5, 6 and 8) both when performance is proxied with Tobin's Q and when it is proxied with ROA. Thus, I show evidence that boards of directors that combine clusters of skills including mainly *Law, Public Policy, Operations* and *Leadership* perform better than their peers. Factor III, the one incorporating mainly *Strategy* and *Technology* related skills, gives a negative and insignificant coefficient when performance is measured through Tobin's Q and a negative significant coefficient when performance is proxied through ROA.

Next, I re-estimate equation (1) using more intuitive directors' skill variables instead of the factors. These variables besides being more intuitive, they provide robustness to the results obtained in Table 2.4. As mentioned in Section III, each one of these variables is the sum of the main two skills making up the factor they substitute in the empirical analysis. Therefore, Factor I is replaced by *Law_exp*, Factor II by *Mgt_exp* and Factor III by *Strategy_exp*. See Appendix 2.7.1 for more details on the variables' descriptions. Table 2.5 provides results consistent with Table 2.4. Specifically, *Law_exp* and *Mgt_exp* are significantly positively correlated with both performance measures whereas *Strategy_exp* is negative and insignificant when correlated with Tobin's Q and negative and significant when correlated with ROA.

These results along with the correlation coefficients presented in Table 2.3 panel B justify the use of *Law_exp*, *Mgt_exp* and *Startegy_exp* as substitutes for Factors I, II and III. To show that my analysis does not simply capture the concept of board of directors' heterogeneity of skills, I follow Adams et al. (2018) approach and I create a variable, *Skillsum*, which is the sum of all the different skills represented in the board of directors. I estimate again equation (1) using *Skillsum* as my main independent variable of interest and I obtain positive, but insignificant results both when the dependent variable is Tobin's Q and when it is ROA. This result is particularly interesting because it shows that it is not enough to have a large sum of different skills on the board to obtain better performance, but a firm rather needs a board with a combination of diverse and complementary skills. Boards need to be internally fit.

However, given the endogenous nature of boards of directors' composition (Hermalin and Weisbach, 1998; Adams et al., 2010), it is complicated to give a causal relationship to the results in Table 2.4. For this reason, I will adopt an instrumental variable approach to circumvent the endogeneity issues that might affect the previous estimations. To do that, I need to have skill sets variables that lend themselves to the necessary arguments needed for instrumental validity and factor coefficients are not the best candidates for that (Adams et al., 2018). For this reason, I will use Table 2.5 as the basis for the IV analysis since it lends itself to a more intuitive discussion of the validity conditions. I rely on an instrumental variable (IV) based on an argument similar in spirit to that in (Knyazeva, Knyazeva and Masulis, 2013). The authors show that the firms' ability to attract talented directors is highly influenced by the local supply of talented directors. Their argument relies on the idea that locating qualified directors can be costly both for firms and directors, besides, qualified directors face also opportunity costs when deciding whether to join a new board of directors, usually preferring appointments at larger and more prestigious firms.

All firms in my sample belong to the S&P 500 Index, so it will be unlikely for a highly skilled director to find better appointment opportunities outside of the S&P 500 realm. Therefore, I rely on the supply of qualified directors within the firms listed in the S&P 500 index to construct the instrumental variables needed for the tests. Moreover, to avoid any possible concern of conflict of interests related to the possibility of directors of direct competitors joining the firm, I exclude firms in the same two-digit code industry. Therefore, my instrument is the availability (based on the category of skills) of particularly skilled directors in the pool of the directors already appointed in any of the S&P 500 firms available in my sample.

Notably, this instrument satisfies both the relevance condition because the availability of specialized directors is correlated with the possibility of a firm to hire specialized directors and the exclusion restriction. In fact, there is no reason to expect any possible correlation between firms' performance and the availability of specialized directors among firms of similar size operating in different industries.

Table 2.1 panel D provides descriptive statistics for the variables used to create the instruments needed for the IV regressions. Based on mean statistics, in my sample, there are over 7,775 directors that belong to the *Law_exp* group (*Total_pool_law*), 58,188 who belong to the *Mgt_exp* group (*Total_pool_mgt*) and 5,911 who belong to the *Strategy_exp* group (*Total_pool_strategy*). Each industry represented in the sample counts an average of 24.44 *Law_exp* (*Pool_law_exp*), 182.40 *Mgt_exp* (*Pool_Mgt_exp*) and 15.30 *Strategy_exp* (*Pool_strategy_exp*) directors. Finally, each firm in the sample could rely on a pool of (based on mean statistics) 7,750 *Law_exp* (*IV_Law*), 58,005 *Mgt_exp* and 5,892 *Strategy_exp* (*IV_Strategy*) potential directors. Table 2.6 shows the results of the second stage of the IV regressions. The coefficients on the first stage regressions have the expected signs and are statistically significant[16]. Moreover, the traditional F-statistics pass the weak instrument tests (see first row of the block of regression statistics of Table 2.6). Therefore, the instruments used seem to be (empirically) relevant. In the second stage IV regression (2SLS), the coefficients on *Law_exp* and *Mgt_exp* are all positive and significant both when performance is measured with Tobin's Q and when it is measured using ROA.

The results in Table 2.6 are consistent with the OLS estimations presented in Table 2.5 and suggest a positive (causal) effect from boards of directors' internal fit to firm performance. With respect to *Strategy_exp* the results on the 2SLS regression differ from the OLS specification. In fact, when performance is represented by Tobin's Q, the coefficient on *Strategy_exp* becomes positive and significant showing that once the endogeneity concerns are addressed, after controlling for other factors, the combination of Strategy and Technology skill sets yields positive performance outcomes in terms of the firm's growth opportunities as proxied by Tobin's Q. When the dependent variable of interest is ROA the coefficient on *Strategy_exp* becomes positive but insignificant, suggesting that the combination of the two skills does not have any tangible effect on

[16] The full first stage regressions table is available upon request

operational performance, which is consistent with the view that Strategy and Technology skills have a more long-term impact on the firm’s outcomes.

2.5. Board of directors’ External Fit and Firm performance

Hypothesis 2 states that the board of directors should include specialized skills to meet the firm’s external business environment’s needs and challenges. To test this hypothesis, I first need to identify a possible challenge brought to the firm by the external environment and then test whether firms can adjust their board of directors’ skill sets composition by adding specialized skills to meet the external challenge. Basically, I need to test whether firms can generate an external fit dimension using the appropriate combination of directors’ skills. To do that I identified a relevant external challenge that is supposed to impact firms’ performance.

Following other empirical studies exploiting regulatory shocks to test their hypotheses (e.g., Giannetti, Liao, Yu, 2015), I exploit a particular regulatory shock to show that the strategic inclusion of directors with specific expertise can contribute to the creation of a board of directors’ external fit dimension, hence improve firm performance. Specifically, I exploit the Paris Climate Accord of 2015 as a regulatory shock.

According to the official website of the United Nations for Climate Change (www.unfccc.int), the Paris Agreement is “a legally binding international treaty on climate change”. On December 12, 2015, at COP (the UN climate change conference) 21 in Paris 196 Parties joined this initiative. The Agreement entered into force on November 4, 2016, and its main goal is to reduce global warming and to disincentivize the emissions of greenhouse gas to finally achieve a climate neutral world. It is an ambitious step towards a more ESG (Environmental, Sustainability and Governance) oriented economy and society.

Given the nature of the regulation, which puts substantial emphasis on environmental change and actions, it is expected that firms operating in the energy sector to be the most affected by the initiative. To test whether this intuition is correct, I perform a difference-in-differences regression comparing two groups of firms, namely the firms which are likely to be the most affected by the new regulation (Treatment group) and the firms which are relatively unaffected by the new regulation (Control group).

I use as a treatment group those firms whose business is particularly associated with climate change. Thus, I would expect these firms to bear the highest burden of compliance with the new environmental requirements. These firms are those operating in the oil and gas drilling and field exploitation services, the natural gas transmission and distribution (two-digit SIC code 13) and in the waste management industry (two-digit SIC code 49). Notice that the firms in the treatment group belong to a subfield of the energy sector as defined by the SEC. The control group, by default, consists of all firms operating in all other industries.

I employ the following regression:

$$Performance_{j,t} = \beta_0 + \beta_1 Treated_j + \beta_2 Post + \beta_3 (Treated_j \times Post) + \Sigma\ Controls_{j,t} + \text{FirmFE} + \varepsilon_{j,t} \quad (1)$$

Where *Treated* is equal to one for all firms belonging to the oil and gas drilling exploitation services, the natural gas transmission and distribution services and the waste management services (two digits sic codes 13 and 49) and zero for all firms not operating in these industries. Post is a dummy equal to one in the post Paris Agreement period (from 2015 onwards) and zero otherwise.

Figure 3 presents parallel trends analyses from 2010 to 2019. Parallel trends assume that any difference in the output variable in the post-period is not due to a divergence starting in the pre-period. Figures 3.a and 3.b present the performance trends in terms of Tobin's Q and ROA respectively of the firms in the Treatment and Control groups. Both figures show very similar trends in performance between treated and non-treated firms. However, in 2015, when the Paris Agreement was subscribed, it is possible to observe a decrease in performance for the treated firms. This drop in performance is particularly evident when performance is measured with ROA. Thus, this analysis shows evidence consistent with parallel trends before the shock.

Table 2.7 contains summary statistics for regression (2). I focus on the interactive term *Treated* × *Post*. A significantly negative coefficient is consistent with firms operating in the treated group having to bear higher costs of regulatory compliance when compared with firms operating in the control group. As results show, firms in the treated group experience a significant drop in performance in comparison to firms in the control group.

The results in Table 2.7 substantiate the intuition that firms operating in environmentally related sectors are more heavily affected by the Paris Agreement. The next step is to exploit this situation to test whether and how firms operating in the treated industries can use their directors' skill sets composition to address this regulatory challenge. According to the existing literature, firms strategically appoint specialized directors to face specific challenges (e.g, Field and Mkrtchyan, 2017; Huang et al, 2014). Thus, Hypothesis 2 argues that to face challenges brought by the external environment, firms could add an appropriate number of specialized directors to tailor their board of directors' skills composition and generate an external fit dimension.

Given the nature of the regulatory shock levied by the Paris Agreement, I argue that a possible way to tailor the board of directors' skill set composition to obtain an external fit dimension is by adding an appropriate number of ESG experts on the board. ESG experts are individuals specialized in environmental, sustainability and governance issues. Therefore, having a significant representation of such professionals on the board should lead to greater monitoring and advising activities in relation to issues pertaining to the environmental protection. Firms operating in the treated industries identified in the previous analysis are expected to benefit from a board of directors that is skilled in understanding and addressing ESG related topics. Therefore, I estimate another difference-in-differences regression of the same form of equation (2), but with the following differences: the sample is limited to those firms belonging to the oil and gas drilling exploitation services, the natural gas transmission and distribution services and the waste management services (two-digit SIC codes 13 and 49), and the *Treated* variable is equal to one if the firm has more than one ESG expert director sitting on its board and zero otherwise. Notice that I use numbers greater than one to assign firms to the treated group to avoid any concern of a possible “tokenism approach” to board composition (Billings, Klein, Shi, 2021; Adams and Ferreira, 2009).

Figure 2.2 shows the parallel trends analysis from 2010 to 2019. Specifically, Figures 4.a and 4.b present the trends in performance of both treated and control firms. As the figures show, in terms of Tobin’s Q (Figure 2.a), both groups of firms seem to maintain very similar trends, even if in the period around 2015 seems that treated firms have a less sharp drop in performance with respect to control firms. In terms of ROA (Figure 2.b) instead, the difference in patterns between firms belonging to the treated group and their counterpart in the control group is much more evident, with firms having one or less ESG expert sitting on the board (control group) suffering a much more acute drop in performance than firms with two or more ESG specialists sitting on their boards.

Table 2.8 presents the coefficient estimates. As Figure 2.a seemed to suggest, our main variable of interest (*Treated* × *Post*) is positive, but not statistically significant when performance is measured through Tobin’s Q. On the other hand, when we focus on operational performance (ROA), the coefficient on the interactive term is positive and highly significant. These results seem to corroborate the hypothesis that a board of directors’ skill sets composition can be tailored towards facing challenges imposed by the external environment such as a regulatory shock, as in this case.

In summary, the empirical analysis presented in section V is consistent with the existence of a board of directors’ external fit of skills composition, which is achieved by strategically appointing an appropriate number of directors with specialized skills on the board to face externally imposed challenges.

2.6. Summary and Suggestions for Future Research

This paper examines how board of directors’ skills can be combined to generate both an internal and an external fit dimension that leads to higher firm performance. I find that there are three main categories of expertise that allow a board of directors to have both a wide array of expertise from where to seek advice and an efficient decision-making process. Empirical tests show that the combination of these three categories of skills has a positive relationship with firm performance.

Specifically, I find that by combining these three clusters of expertise within the board of directors' firms achieve higher Tobin's Q and ROA performance. These results hold both unconditionally and in an instrumental variable framework. I also provide evidence that boards of directors can further tailor their fit to meet externally imposed challenges by strategically adding specialized directors in their boards. These results hold within a difference-in-differences setting where I exploit the Paris Agreement on Climate Change as a regulatory shock to firms operating in very specific industries.

The relationship between boards of directors' composition and firm performance is a relevant theme in corporate governance research and many academics tried to figure out what is the best possible board of directors' composition which can maximize firms' performance. More related to this paper, several empirical studies sought to understand which directors' skills or combination of skills are the most desirable to obtain higher performance.

Due to the broad nature of the research question and its related endogeneity concerns, most studies about board of directors' skills composition and firm performance tend to find contrasting results among them. Through this paper, I provide a possible explanation to these discrepancies by introducing the concept of board of directors' fit, which has both an internal and an external perspective. In fact, both fit dimensions go beyond the idea of directors' skillsets diversity, which is important to generate fit, but diverse directors' skills need to be properly balanced in their complementarity to have internal fit and they need to be strengthened by an oculate inclusion of specialized directors' skills to face external challenges to be externally fit. This is just a step forward towards understanding the importance of directors' skill sets composition and its relation to firms' outcomes. In fact, future research might exploit this new dimension of fit to test its relationship to other key dimensions of the firm such as transparency, risk exposure and resiliency. Furthermore, this new dimension of fit can be further refined by understanding its implications in broader settings that go beyond the large companies included in the S&P

500 index. For instance, whether firms operating in different countries or of smaller size need different board of directors' fit dimensions.

Figure 2.1. Parallel Trend Analyses for the Difference-in-Difference Tests for firms in the energy vs non-energy sectors

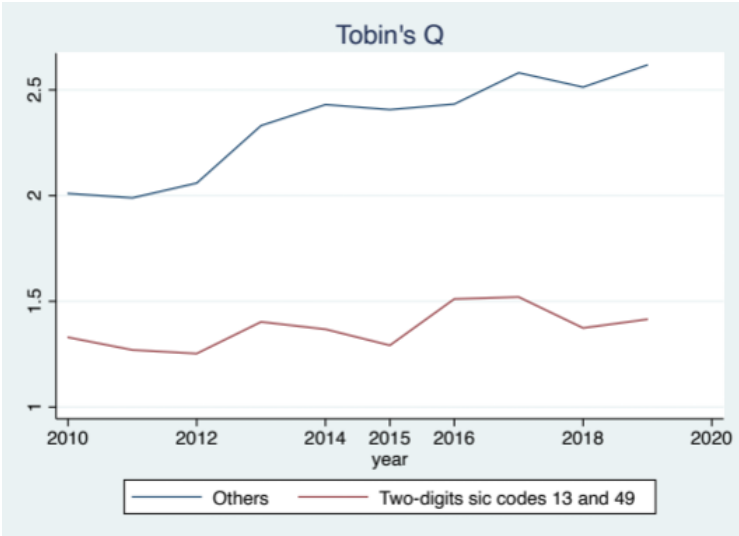


Figure 2.1.a Firms' Tobin's Q Trend for Non- Energy Vs Energy

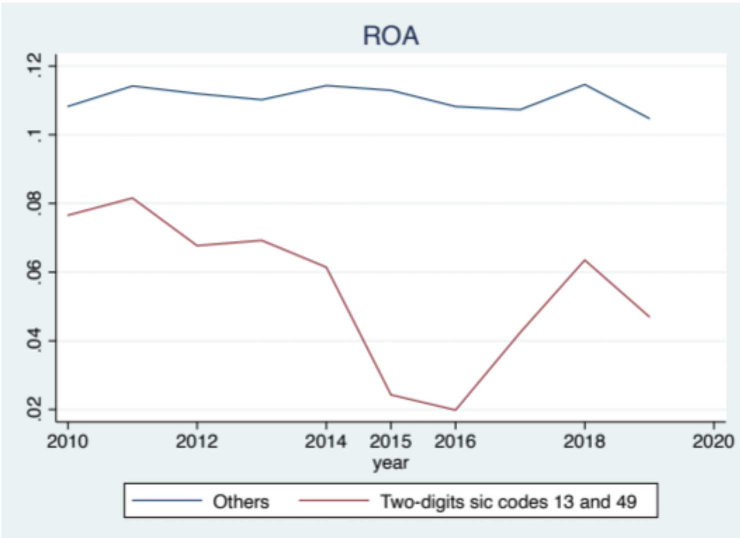


Figure 2.1.b Firms' ROA Trend for Non-Energy Vs Energy

Figure 2.2. Parallel Trend Analyses for the Difference-in-Difference Tests for firms with more than one ESG expert directors sitting on the board

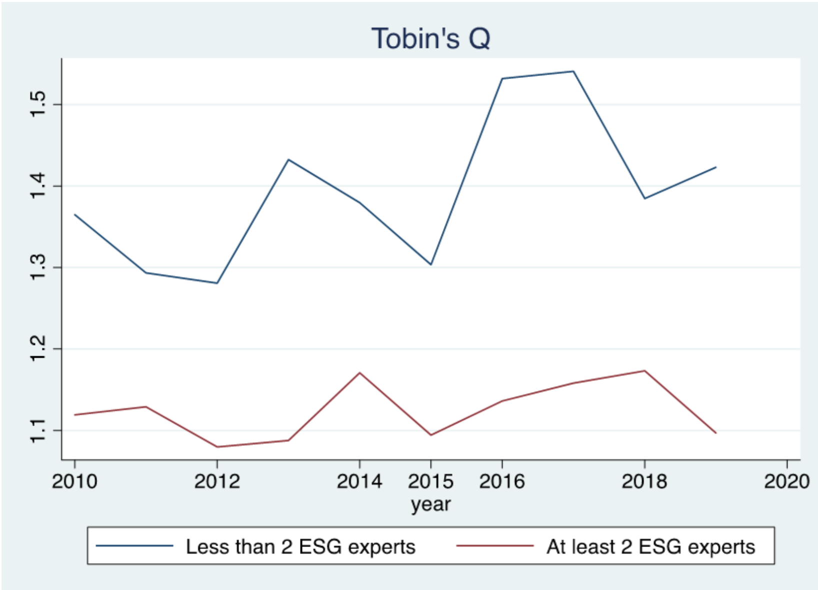


Figure 2.2.a Firms' Tobin's Q Trend for Firms with less than 2 ESG experts directors Vs Firms with more than one ESG expert directors sitting on the boar**d**

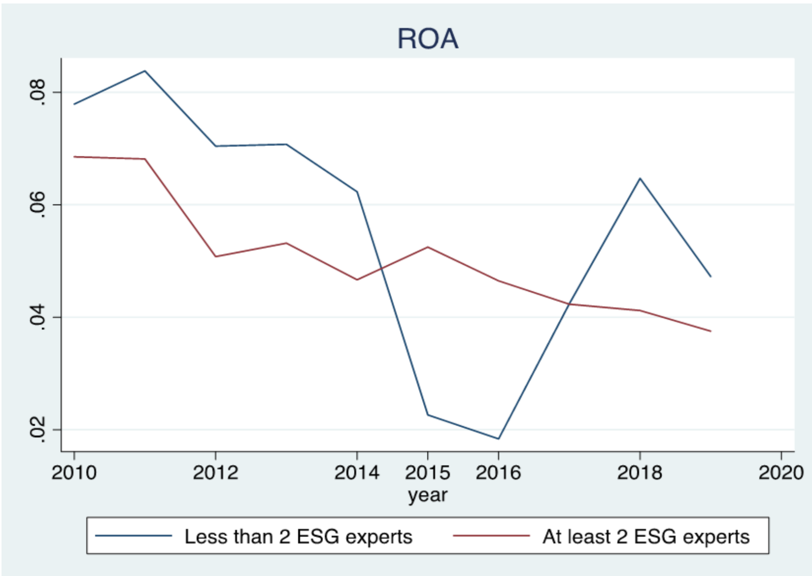


Figure 2.2.b Firms' ROA Trend for Firms with less than 2 ESG experts directors Vs Firms with more than one ESG expert directors sitting on the board.

Table 2.1. Sample and Summary Statistics

Panel A. Sample Selection	
Note	**Number of Observations**
Number of firms in the hand collected dataset at year ended 2019	3690
Less: Missing observations after merging with the ISS database	370
Less: Missing observations after merging with the COMPUSTAT database	145
Number of firms year observations for the cross-sectional tests	3175

Panel B. Descriptive Statistics of the Sample

Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
Tobin's Q	3175	2.23	1.50	0.95	8.97
ROA	3175	0.10	0.08	-0.04	0.35
CAPEX	3175	0.04	0.04	0.00	0.20
Leverage	3175	0.27	0.17	0.00	0.79
Size	3175	9.85	1.37	6.94	13.54
BoD Size	3175	10.59	1.95	7.00	16.00
Perc_Independent	3175	0.83	0.09	0.55	0.93
Perc_Women	3175	0.19	0.10	0.00	0.45

Panel C. Descriptive Statistics of Board of Directors' Individual Skill Sets

Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
Finance	3175	3.02	1.73	0.00	12.00
Marketing	3175	0.70	0.98	0.00	6.00
Technology	3175	0.47	0.77	0.00	6.00
Science	3175	0.30	0.74	0.00	6.00
Operations	3175	1.92	1.35	0.00	7.00
Law	3175	0.65	0.86	0.00	6.00
Public Policy	3175	1.01	1.23	0.00	7.00
Leadership	3175	10.04	2.10	4.00	20.00
Strategy	3175	0.65	0.88	0.00	6.00
ESG	3175	0.16	0.43	0.00	3.00

(The table is continued on the next page)

TABLE 2.1 (continued)

Panel D. Descriptive Statistics of the Variables Used to Create the IVs

Variable	Observations	Mean	St. Dev.	Min	Max
Pool_law_exp	3175	24.44	15.08	0	61
Pool_Strategy_exp	3175	18.43	15.30	0	70
Pool_Mgt_exp	3175	182.40	102.11	6	360
Total_pool_law	3175	7775.42	353.04	6885	8172
Total_pool_Mgt	3175	58188.18	5828.94	46689	66528
Total_pool_Strategy	3175	5911.029	1275.69	3888	7960
IV_Law	3175	7750.979	353.17	6830	8172
IV_Mgt	3175	58005.79	5819.69	46418	66520
IV_Strategy	3175	5892.599	1272.57	3846	7960

Table 2.2. Directors' Skill sets Comparison

Panel A. Overall Vs. Manufacturing Vs. Energy															
	Overall					**Manufacturing**					**Energy**				
Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Observations**	**Mean**	**Std. Dev**	**Min**	**Max**
Leadership	3175	10.04	2.10	4.00	20.00	351	10.35	2.20	0.50	16.00	370	10.62	2.03	6.00	20.00
Finance	3175	3.02	1.73	0.00	12.00	351	2.79	1.79	0.00	7.00	370	2.89	1.43	0.00	6.00
Operations	3175	1.92	1.35	0.00	7.00	351	2.10	1.27	0.00	6.00	370	1.96	1.19	0.00	7.00
Public Policy	3175	1.01	1.23	0.00	7.00	351	1.09	1.19	0.00	5.00	370	1.39	1.46	0.00	7.00
Marketing	3175	0.70	0.98	0.00	6.00	351	0.88	1.10	0.00	5.00	370	0.22	0.58	0.00	3.00
Law	3175	0.65	0.86	0.00	6.00	351	0.79	0.91	0.00	3.00	370	0.79	0.91	0.00	3.00
Strategy	3175	0.65	0.88	0.00	6.00	351	0.63	0.64	0.00	3.00	370	0.56	0.79	0.00	3.00
Technology	3175	0.47	0.77	0.00	6.00	351	0.76	0.92	0.00	4.00	370	0.28	0.46	0.00	2.00
Science	3175	0.30	0.74	0.00	6.00	351	0.37	0.70	0.00	3.00	370	0.24	0.50	0.00	2.00
ESG	3175	0.16	0.43	0.00	3.00	351	0.05	0.64	0.00	1.00	370	0.35	0.64	0.00	3.00
Variable						**Manufacturing**					**Energy**		**T-test of the mean (a)-(b)**		
ESG						0.05					0.35		-0.30**		

(The table is continued on the next page)

TABLE 2.2 (continued)

Panel B. Overall Vs. Computer Vs. Pharmaceuticals

	Overall					**Computer**					**Pharmaceuticals**				
Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Observations**	**Mean**	**Std. Dev**	**Min**	**Max**
Leadership	3175	10.04	2.10	4.00	20.00	290	9.26	1.94	4.00	15.00	230	10.21	2.03	5.00	16.00
Finance	3175	3.02	1.73	0.00	12.00	290	2.95	1.66	0.00	9.00	230	3.41	1.68	0.00	7.00
Operations	3175	1.92	1.35	0.00	7.00	290	1.75	1.19	0.00	5.00	230	2.08	1.41	0.00	6.00
Public Policy	3175	1.01	1.23	0.00	7.00	290	0.77	1.06	0.00	5.00	230	0.95	1.50	0.00	7.00
Marketing	3175	0.70	0.98	0.00	6.00	290	0.92	1.10	0.00	4.00	230	1.13	1.43	0.00	6.00
Law	3175	0.65	0.86	0.00	6.00	290	0.54	0.72	0.00	2.00	230	0.32	0.55	0.00	3.00
Strategy	3175	0.65	0.88	0.00	6.00	290	0.82	0.89	0.00	3.00	230	0.85	1.02	0.00	4.00
Technology	3175	0.47	0.77	0.00	6.00	290	1.08	1.13	0.00	6.00	230	0.28	0.56	0.00	2.00
Science	3175	0.30	0.74	0.00	6.00	290	0.13	0.34	0.00	1.00	230	1.28	1.75	0.00	6.00
ESG	3175	0.16	0.43	0.00	3.00	290	0.10	0.30	0.00	1.00	230	0.15	0.36	0.00	1.00

Variable	**Computer**	**Pharmaceuticals**	**T-test of the mean (a)-(b)**
Technology	1.08	0.28	0.80***
Science	0.13	1.28	-1.15***

Table 2.3. Factor Analysis and Correlation Table

Panel A. Factor Analysis

Variable	**Factor I**	**Factor II**	**Factor III**	**Factor IV**
Marketing	0.34	**0.33**	0.31	-0.13
Leadership	0.37	**0.72**	0.14	0.03
Finance	0.34	0.19	**0.43**	-0.12
Technology	-0.12	-0.10	**0.66**	-0.08
Science	-0.02	0.01	0.01	**0.91**
Operations	-0.14	**0.81**	-0.11	0.00
Law	**0.64**	-0.04	-0.06	-0.38
Public Policy	**0.61**	0.24	0.02	0.09
Strategy	0.04	0.02	**0.72**	0.11
ESG	**0.54**	-0.07	-0.01	0.19

Notes: This table presents the results of a factor analysis based on 10 expertise categories. I present rotated factor loadings for the first four factors using the principal component analysis approach.

Panel B. Correlation Table

Variable	*Law_exp*	*Strategy_exp*	*Mgt_exp*
Law_exp	1.00		
Strategy_exp	-0.00	1.00	
Mgt_exp	0.21	0.04	1.00
Factor I	0.79	-0.05	0.21
Factor II	0.16	-0.04	0.92
Factor III	-0.02	0.91	0.05

Notes: This table presents the correlation coefficients between Factors I, II and III and the variables constructed on the basis of the number of experts' count.

Table 2.4. Panel regression of Factors I, II and III on firm performance

	Tobin's Q				ROA			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Factor I	0.064*			0.104***	0.004*			0.005**
	(2.11)			(3.41)	(0.23)			(3.07)
Factor II		0.127***		0.157***		0.005**		0.006**
		(3.53)		(4.05)		(2.94)		(3.11)
Factor III			-0.019	0.009			-0.006**	-0.005**
			(-0.44)	(0.20)			(-3.24)	(-2.59)
CAPEX	6.451***	6.393***	6.436***	6.408***	0.568***	0.565***	0.567***	0.566***
	(5.17)	(5.11)	(5.16)	(5.13)	(7.52)	(7.51)	(7.56)	(7.57)
Leverage	0.644	0.556	0.623	0.587	-0.060***	-0.064***	-0.059***	-0.060***
	(1.93)	(1.68)	(1.87)	(1.76)	(-4.31)	(-4.65)	(-4.31)	(-4.35)
Size	-0.665***	-0.662***	-0.664***	-0.663***	-0.026***	-0.026***	-0.003***	-0.026***
	(-8.26)	(-8.25)	(-8.24)	(-8.29)	(-7.22)	(-7.18)	(-7.22)	(-7.25)
BoD_Size	0.011	-0.017	0.023	-0.043*	0.001	-0.001	0.002*	-0.001
	(0.88)	(-0.95)	(1.85)	(-2.07)	(0.83)	(-0.62)	(2.51)	(-1.19)
Perc_Independent	-0.13	-0.09	-0.123	-0.085	0.021	0.023	0.024	0.026
	(-0.42)	(-0.29)	(-0.40)	(-0.27)	(1.50)	(1.61)	(1.72)	(1.83)
Perc_Women	0.600*	0.645*	0.623*	0.616*	-0.001	-0.005	-0.005	-0.006*
	(2.31)	(2.49)	(2.40)	(2.38)	(-0.58)	(-0.40)	(-0.43)	(-0.47)
R-Squared	0.83	0.83	0.83	0.83	0.84	0.84	0.85	0.85
Observations	3175	3175	3175	3175	3175	3175	3175	3175
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents the results of Tobin's Q and ROA regressions on Factors I, II and III. The dependent variables are Tobin's Q or ROA. All variables are defined in Appendix 2.7.1. I control for year fixed effects as well as firm fixed effects. T-statistics are reported in parentheses below coefficient estimates and are based on heteroskedasticity corrected standard errors. ***, **, * indicate statistical significance at the 1%, 5% and 10% levels respectively

Table 2.5. Panel regression of Skills Categories on firm performance

	Tobin's Q					ROA				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Skillsum	0.020					0.000				
	(0.99)					(0.23)				
Strategy_exp		-0.008			-0.001		-0.003*			-0.003
		(-0.20)			(-0.03)		(-1.98)			(-1.77)
Law_exp			0.088***		0.086***			0.005***		0.004***
			(4.90)		(4.83)			(4.98)		(4.75)
Mgt_exp				0.451**	0.043**				0.002*	0.002*
				(3.16)	(3.05)				(2.12)	(2.09)
CAPEX	6.474***	6.440***	6.421***	6.413***	6.394***	0.553***	0.552***	0.551***	0.551***	0.550***
	(5.17)	(5.13)	(5.15)	(5.10)	(5.12)	(7.39)	(7.45)	(7.46)	(7.41)	(7.48)
Leverage	0.616	0.617	0.646	0.568	0.603	-0.055***	-0.053***	-0.053***	-0.057***	-0.053
	(1.85)	(1.86)	(1.95)	(1.71)	(1.81)	(-4.03)	(3.91)	(-3.92)	(-4.15)	(-3.93)
Size	-0.663***	-0.664***	-0.670***	-0.663***	-0.669***	-0.026***	-0.026***	-0.026***	-0.026***	-0.026***
	(-8.24)	(-8.24)	(-8.35)	(-8.26)	(-8.37)	(-7.32)	(-7.33)	(-7.49)	(-7.33)	(-7.49)
BoD_Size	0.019	0.022	0.006	-0.026	-0.040	0.001	-0.001	-0.000	-0.000	-0.002
	(1.52)	(1.80)	(0.46)	(-1.23)	(-1.87)	(1.34)	(-1.64)	(-0.10)	(-0.84)	(-1.46)
Perc_Independent	-0.140	-0.128	-0.117	-0.113	-0.096	0.019	0.022	0.020	0.020	0.023
	(-0.45)	(-0.41)	(-0.37)	(-0.36)	(-0.31)	(1.39)	(1.54)	(1.46)	(1.45)	(1.63)
Perc_Women	0.593*	0.622*	0.530*	0.658*	0.566*	-0.012	-0.012	-0.017	-0.010	-0.015
	(2.25)	(2.39)	(2.03)	(2.54)	(2.17)	(-0.96)	(-0.93)	(1.33)	(-0.84)	(-1.20)
R-Squared	0.83	0.83	0.83	0.83	0.83	0.85	0.85	0.85	0.85	0.85
Observations	3175	3175	3175	3175	3175	3175	3175	3175	3175	3175
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents the results of Tobin's Q and ROA regressions on the categories of skills. The dependent variables are Tobin's Q or ROA. All variables are defined in Appendix 2.7.1. I control for year fixed effects as well as firm fixed effects. T-statistics are reported in parentheses below coefficient estimates and are based on heteroskedasticity corrected standard errors. ***, **, * indicate statistical significance at the 1%, 5% and 10% levels respectively.

Table 2.6. Two-stage least square regression of Instrumented Skills Categories on firm performance

	Tobin's Q			ROA		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
IV_Strategy	0.641***			0.004		
	(3.49)			(0.62)		
IV_Law		0.290***			0.016***	
		(3.72)			(4.19)	
IV_Mgt			1.192**			0.022*
			(3.15)			(2.01)
CAPEX	6.513***	6.350***	5.676***	0.553***	0.549***	0.538***
	(5.16)	(5.45)	(3.08)	(7.83)	(7.97)	(7.24)
Leverage	0.235	0.733*	-0.566	-0.057***	-0.049***	-0.077***
	(0.67)	(2.32)	(-1.01)	(-4.33)	(-3.75)	(-4.41)
Size	-0.667***	-0.684***	-0.618***	-0.026***	-0.027***	-0.025***
	(-8.48)	(-9.05)	(-5.75)	(-7.78)	(-8.43)	(-6.94)
BoD_Size	-0.008	-0.031	-1.237**	0.000	-0.002*	-0.023
	(-0.50)	(-1.75)	(-3.08)	(1.05)	(-2.21)	(-1.92)
Perc_Independent	-0.600	-0.082	0.423	0.017	0.022	0.030
	(-1.81)	(-0.27)	(0.79)	(1.25)	(1.68)	(1.80)
Perc_Women	0.594*	0.308	1.558**	-0.012	-0.029	0.006
	(2.21)	(1.33)	(2.70)	(-1.02)	(2.27)	(0.37)
KP F-Stat	79.98	129.23	11.53	80.00	126.86	11.45
Observations	3175	3175	3175	3175	3175	3175
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents the results of firm performance regressions on the instrumented skills categories using the two-stage-least-square method (2SLS). The dependent variables are Tobin's Q and ROA. All variables are defined in Appendix 2.7.1. I control for year fixed effects as well as firm fixed effects. T-statistics are reported in parentheses below coefficient estimates and are based on heteroskedasticity corrected standard errors. ***, **, * indicate statistical significance at the 1%, 5% and 10% levels respectively.

Table 2.7. Difference-in-difference regressions analysis of Paris agreement impact on firms in the energy vs non-energy sectors

	Tobin's Q	ROA
Post	0.341*** (11.24)	0.007*** (5.21)
Treated	-1.816*** (-10.58)	-0.085*** (-10.88)
Treated × Post	-0.285*** (-6.80)	-0.029*** (-7.37)
CAPEX	6.078*** (4.76)	0.540*** (7.28)
Leverage	0.814* (2.44)	-0.059*** (-4.26)
Size	-0.504*** (-6.56)	-0.026*** (-7.72)
BoD_Size	0.015 (1.23)	0.001 (1.60)
Perc_Independent	0.137 (0.42)	0.024 (1.71)
Perc_Women	1.373*** (5.48)	0.015 (1.27)
Observations	3175	3175
R-Squared	0.83	0.84
Firm FE	Yes	Yes

Notes: This table uses a difference-in-difference analysis to examine whether companies' performance measured as Tobin's Q and ROA changes after the passage of the Paris Agreement on climate change. I identify the firms in the oil and gas drilling and field exploitation services, the natural gas transmission and distribution and the waste management sectors as the treated group. The output variable Post is a dummy variable equal to one for the years after the Paris agreement approval (2015 on) and zero otherwise. The Treated variable is a dummy equal to one when the sample firm belongs to the sector according to their two digits sic code and their SEC industry classification. The Treated × Post variable is the primary variable of interest, and it represents the interaction between the Post and Treated variables. I control for firm fixed effects. T-statistics are reported in parenthesis below coefficient estimates and are based on heteroskedasticity corrected standard errors. ***, **, * indicate statistical significance at the 1%, 5% and 10% level respectively.

Table 2.8. Difference-in-difference regressions analysis of Paris agreement impact on firms with more than 1 ESG director on the board

	Tobin's Q	**ROA**
Post	0.080** (2.75)	-0.017*** (-3.46)
Treated	-0.151** (-2.92)	-0.019 (-1.15)
Treated × Post	0.031 (0.54)	0.029** (3.21)
CAPEX	0.447 (0.69)	0.453*** (4.24)
Leverage	0.060 (0.13)	-0.318*** (-5.35)
Size	-0.253** (-3.24)	-0.017*** (-1.43)
BoD_Size	0.008 (0.65)	0.004 (1.93)
Perc_Independent	0.075 (0.21)	0.027 (0.64)
Perc_Women	1.325 (1.33)	0.114** (3.19)
Observations	370	370
R-Squared	0.67	0.50
Firm FE	Yes	Yes

Notes: A difference-in-difference analysis to examine whether firms' performance measured as Tobin's Q and ROA changes after the passage of the Paris agreement on climate change. This test uses only the companies in the oil and gas drilling and field exploitation services, the natural gas transmission and distribution and the waste management sectors within the sample. The output variable Post is a dummy variable equal to one for the years after the Paris Agreement approval (2015 on) and zero otherwise. The Treated variable is a dummy equal to one when the sample firm has more than one ESG director sitting on its board of directors. The Treated × Post variable is the primary variable of interest, and it represents the interaction between the Post and Treated variables. I control for firm fixed effects. T-statistics are reported in parenthesis below coefficient estimates and are based on heteroskedasticity corrected standard errors. ***, **, * indicate statistical significance at the 1%, 5% and 10% level respectively.

2.7. Appendix

2.7.1. Variable definitions

Variable	Definition
Skillsum	The sum of unique skills represented on the board
Law_exp	The total number of Law and Public Policy experts sitting on the board
Mgt_exp	The total number of Leadership and Operations experts sitting on the board
Strategy_exp	The total number of Strategy and Technology experts sitting on the board
CAPEX	Capital expenditures over total assets
Leverage	Total liabilities divided by total assets
Size	The natural log of total assets
BoD_Size	The total number of directors sitting on the board
Perc_Independent	The percentage of independent directors sitting on the board
Perc_Women	The percentage of women sitting on the board
Pool_Law_exp	The total number of Law and Public Policy expert directors in each industry
Pool_Strategy_exp	The total number of Strategy and Technology expert directors in each industry
Pool_Mgt_exp	The total number of Leadership and Operations expert directors in each industry
Total_pool_law	The total number of Law and Public Policy expert directors
Total_pool_Strategy	The total number of Strategy and Technology expert directors
Total_pool_Mgt	The total number of Leadership and Operations expert directors
IV_Law	The difference between Total_pool_law and Pool_law_exp
IV_Strategy	The difference between Total_pool_Strategy and Pool_Strategy_exp

(The table is continued on the next page)

(Continued)

Variable	Definition
IV_Mgt	The difference between Total_pool_Mgt and Pool_Mgt_exp
ROA	Operating income before depreciation divided by total assets
Tobin's Q	The sum of total assets and market value of equity less book equity divided by total assets

References

Adams, R. B., A. C. Akyol, and P. Verwijimeren. 2018. Director Skill sets. *Journal of Financial Economics* 130 (3): 641-62.

Adams, R. B., B. E. Hermalin, and M. S. Weisbach. 2010. The role of boards of directors in corporate governance: a conceptual framework and survey. *Journal of Economic Literature* 48 (1): 58-107

Adams, R. B., and D. Ferreira. 2009. Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics* 94 (2): 291-309

Agrawal, A., Knoeber, C. R. 2001. Do some outside directors play a political role? *The Journal of Law and Economics* 44 (1): 179-98.

Amir, E., S. Levi, and T. Livne. 2018. Do firms underreport information on cyber-attacks? Evidence from capital markets. *Review of Accounting Studies* 23 (3): 1177-1206.

Aridor, G., Y-K. Che, and T. Salz. 2021. The effect of privacy regulation on the data industry: Empirical evidence from GDPR. Working paper, NBER.

Armstrong, C. S., J. E. Core, and Guay, W. R. 2014. Do independent directors cause improvements in firm transparency? *Journal of Financial Economics* 113 (3): 383-403.

Berkman, H., J. Jona, G. Lee, and N. Soderstrom. 2018. Cybersecurity awareness and market valuations. *Journal of Accounting and Public Policy* 37 (6): 508-26.

Bernile, G., V. Bhagwat, and S. Yonker. 2018. Board diversity, firm risk, and corporate policies. *Journal of Financial Economics* 127 (3): 588-612.

Billings, M., A. Klein, and Y. Shi. 2021. Investors' response to the #MeToo movement: does corporate culture matter? Working paper. New York University.
Boivie, S., M. K. Bednar, R. V. Aguiliera, and J. L. Andrus. 2017. Are boards designed to fail? The implausibility of effective board monitoring. *Academy of Management Annals* 10 (1): 319-407.

Bradford, A. 2012. The Brussels effect. *Northwestern University Law Review* 107 (1): 1-68

Bryan, D., M. Liu, S. Tiras, and Z. Zhuang. 2013. Optimal versus suboptimal choices of accounting expertise on audit committees and earnings quality. *Review of Financial Studies* 18 (4): 1123-58.
Burns, T. and G. Stalker. 1961. *The Management of Innovation.* London: Tavistock

Chen, Q., I. Goldstein, and W. Jiang. 2006. Price informativeness and investment sensitivity to stock price. *The Review of Financial Studies* 20 (3): 619-50.

Cohen, J. R., U. Hoitash, G. Krishnamoorthy, and A. M. Wright. 2014. The effect of audit committee industry expertise on monitoring the financial reporting process. *The Accounting Review* 89 (1): 243-73.

Coles, J. L., N. D. Daniel, and L. Naveen. 2008. Boards: Does one size fit all? *Journal of Financial Economics* 87 (2): 329-56.

Coles, J. L., N. D. Daniel, L. Naveen. 2020. Director overlap: groupthink versus teamwork. Working paper. University of Utah, Drexel University, and Temple University.

COSO (Committee of Sponsoring Organizations of the Treadway Commission). 2004. Enterprise Risk Management – Integrated Framework. September 2004, https://www.coso.org/Documents/PR-09292004-ERM-Integrated-Framework.pdf

COSO (Committee of Sponsoring Organizations of the Treadway Commission). 2017. Enterprise Risk Management – Integrating with Strategy and Performance. June 2017, https://www.coso.org/documents/2017-coso-erm-integrating-with-strategy-and-performance-executive-summary.pdf

COSO (Committee of Sponsoring Organizations of the Treadway Commission). 2019. Managing Cyber Risk in a Digital Age. November 2019, https://www.coso.org/Documents/COSO-Deloitte-Managing-Cyber-Risk-in-a-Digital-Age.pdf

Custodio, C., M. Ferreira, and P. Matos. 2013. Generalists versus specialists: lifetime work experience and chief executive officer pay. *Journal of Financial Economics* 108 (2): 471-92

D'Acunto, F., G. A. Tate, L. Yang. 2021. Entrepreneurial teams: diversity of skills and early-stage growth. Working paper. Boston College, and The University of Maryland

Dass, N., O. Kini, V. Nanda, B. Onal, and J. Wang. 2013. Board expertise: do directors from related industries help bridge the information gap? *Review of Financial Studies* 27 (5): 1533-92

Davis, K. E., and F. Marotta-Wurgler. 2019. Contracting for personal data. *New York University Law Review* 94 (4): 662-705

DeFond, M. L., R. N. Hann, R, and X. Hu. 2005. Does the market value financial expertise on audit committees of board of directors? *Journal of Accounting Research* 43 (2): 153-93.

Deloitte. 2018. On the board's agenda: US Cyber risk in the boardroom: Accelerating from acceptance to action, https://www2.deloitte.com/content/dam/Deloitte/us/Documents/center-for-board-effectiveness/us-cbe-feb-otba-risk-in-the-boardroom.pdf

Dionne, G., O. M. Chun, and T. Triki. 2019. The governance of risk management: The importance of directors' independence and financial knowledge. *Risk Management and Insurance Review* 22 (3): 247-77.

Dionne, G., and T. Triki. 2005. Risk management and corporate governance: The importance of independence and financial knowledge for the board and the audit committee. Working paper, HEC Montreal.

Dow, J., and G. Gorton. 1997. Stock market efficiency and economic efficiency: Is there a connection? *The Journal of Finance* 52 (3): 1087-129.

Duchin, R., J. Matsusaka, and O. Ozbas. 2010. When are outside directors effective? *Journal of Financial Economics* 96 (2): 195-214.

Dye, R. A., and S. S. Sridhar. 2002. Resource allocation effects of price reactions to disclosures. *Contemporary Accounting Research* 19 (3): 385-410.

Edmans, A., S. Jayaraman, and J. Schneemeier. 2017. The source of information in prices and investment-price sensitivity. *Journal of Financial Economics* 126 (1): 74-96.

Ertimur, Y., F. Ferri, and D. A. Maber. 2011. Reputation penalties for poor monitoring of executive pay: evidence from option backdating. *Journal of Financial Economics* 104 (1): 118-44.

Fahlenbrach, R., A. Low, and R. Stulz. 2010. Why do firms appoint CEOs as outside directors? *Journal of Financial Economics* 97 (1): 12-32

Faleye, O., R. Hoitash, and U. Hoitash. 2018. Industry expertise on corporate boards. *Review of Quantitative Finance and Accounting* 50 (2): 441-79.

Fama, E. F., and K. R. French. 2014. A five-factor asset pricing model. *Journal of Financial Economics* 116 (1): 1-22.

Fama, E. F., and M. C. Jensen. 1983. Separation of ownership and control. *Journal of Law and Economics* 26 (2): 301-25.

Fich, E. M. 2005. Are some outside directors better than others? Evidence from director appointments by fortune 1000 firms. *Journal of Business* 78 (5): 1943-72

Fich, E. M., and A. Shivdasani. 2007. Financial fraud, director reputation, and shareholder wealth. *Journal of Financial Economics* 86 (2): 306-36.

Field, L. C., and A. Mkrtchyan. 2017. The effect of director experience on acquisition performance. *Journal of Financial Economics* 123 (3): 488-511

Frankenreiter, J. 2021. The missing California effect in data privacy law. Working paper, Washington University in St. Louis - School of Law.

Frankenreiter, J., C. Huang, Y. Nili and E: L. Talley. 2021. Cleaning corporate governance. *University of Pennsylvania Law Review*, Forthcoming

Garlappi, L., G. Ron, and A. Lazrak. 2017. Ambiguity and the corporation: group disagreement and underinvestment. *Journal of Financial Economics* 125 (3): 417-33

Giannetti, M., G. Liao, and X. Yu. 2015. The brain gain of corporate boards. Evidence from China. *Journal of Finance* 70 (4): 1629-82

Gilson, S. 1990. Bankruptcy, boards, banks, and bondholders: Evidence on changes in corporate ownership and control when firms default. *Journal of Financial Economics* 27 (2): 355-87.

Gompers, P. A., J. L. Ishii, and A. Metrick. 2003. Corporate governance and equity prices. *Quarterly Journal of Economics* 118 (1): 107-55

Gordon, L. A., M. P. Loeb, and T. Sohail. 2010. Market value of voluntary disclosures concerning information security. *MIS Quarterly* 34 (3): 567-94.

Gregory, H. J. 2015/2016. A board roadmap for 2016. *Practical Law*, https://content.next.westlaw.com/w-001-0036?transitionType=Default&contextData=(sc.Default)& lrTS=20180917132921681

Guner, A. B., U. Malmendier, and G. Tate. 2008. Financial expertise of directors. *Journal of Financial Economics* 88 (2): 323-54.

Haislip, J., K. Kolev, R. Pinskerf, and T. Steffen. 2019. The economic cost of cybersecurity breaches: A brad-based analysis. Working paper, Texas Tech University, Baruch College, Florida Atlantic University, Yale University.

Harris, M., and A. Raviv. 2008. A theory of board control and size. *The Review of Financial Studies* 21 (4): 1797-832.

Hermalin, B., and M. S. Weisbach. 1998. Endogenously chosen boards of directors and their monitoring of the CEO. *American Economic Review* 88 (1): 96-118.

Hilary, G., B. Segal, and M. H. Zhang. 2016. Cyber-risk disclosure: Who cares? Working paper, Georgetown McDonough School of Business.

Huang, Q., F. Jiang, E. Lie, and K. Yang. 2014. The role of investment banker directors in M&A. *Journal of Financial Economics* 112 (2): 269-86

Ittner, C. D., and T. Keusch. 2015. The influence of board of directors' risk oversight on risk management maturity and firm risk-taking. Working paper, University of Pennsylvania, Erasmus University of Rotterdam.

Kamiya, S., J. K. Kang, J. Kim, A. Milidonis, and R. M. Stulz. 2018. What is the impact of successful cyberattacks on target firms? Working paper, Fisher College of Business and NBER

Kang, S., E. H. Kim, and Y. Lu. 2018. Does independent directors CEO experience matter? *Review of Finance* 22 (3): 905-49

Kaplan, S., and D. Reischus. 1990. Outside directorships and corporate performance. *Journal of Financial Economics* 27 (2): 389-410.

Kaplan, S. N., and M. Sorensen. 2021. Are CEOs different? *Journal of Finance* 76 (4): 1773-811

Kim, S., and A. Klein. 2017. Did the 1999 NYSE and NASDAQ listing standard changes on audit committee composition benefit investors? *The Accounting Review* 92 (6): 187-212.

Kim, D., and L. Starks. 2016. Board heterogeneity of expertise and firm performance. Working paper. Rotman School of Management, The University of Toronto and University of Texas Austin, McCombs School of Business.

Kim, D., and L. Stark. 2016. Gender diversity on corporate boards: do women contribute unique skills? *American Economic Review: papers and Proceedings* 106 (5): 267-71

Klein, A. 1998. Firm performance and board committee structure. *The Journal of Law and Economics* 41 (1): 275-304.

Klein, A., R. Manini, and Y. Shi. 2022. Across the Pond: How US firms' boards of directors adapted to the passage of the General Data Protection Regulation. *Contemporary Accounting Research*. https://doi.org/10.1111/1911-3846.12735

Knyazeva, A., D. Knyazeva and R. Masulis. 2013. The supply of corporate directors and board independence. *Review of Financial Studies* 26 (6): 1561-605

Lanz, J. 2014. Cybersecurity governance: The role of the audit committee and the CPA. *The CPA Journal*. November: 6-10.

Lazear, E. 2005. Entrepreneurship. *Journal of Labor Economics* 23 (4): 649-80

Liu, L. Y. 2020. Do auditors help prevent data breaches? PhD dissertation, University of Chicago Booth School of Business.

Milliken, F. J., L. L. Martins. 1996. Searching for common threads: understanding the multiple effects of diversity in organizational groups. *Academy of Management Review* 21 (2): 402-33

Miller, D. 1992. Environmental fit versus internal fit. *Organization Science* 3 (2): 159-78

NACD. 2014. Cyber-risk oversight. *Director Handbook Series*. NACD in collaboration with AIG and ISA.

Oesch, D., and F. Urban. 2019. International PCAOB inspections and earnings management transmissions within multinational business groups. Working paper, University of Zurich.

O'Reilly, C. A., and K. Y. Williams. 1998. Demography and diversity in organizations: a review of 40 years of research. *Research in Organizational Behavior*. 20: 77-140

Ormazabal, G. 2010. The role of the board in corporate risk oversight. Working paper, Stanford University.

Pelled, L. H., K. M. Eisenhardt, and K. R. Xin. Exploring the black box: an analysis of work group diversity, conflict, and performance. *Administrative Science Quarterly* 44 (1): 1-28

Piotroski, J. D. and S. Srinivasan. 2008. Regulation and bonding: the Sarbanes-Oxley act and the flow of international listings. *Journal of Accounting Research* 46 (2): 383-425.

SEC. 2009a. *SEC Approves Enhanced Disclosure about Risk, Compensation and Corporate Governance*, https://www.sec.gov/news/press/2009/2009-268.htm.

SEC. 2009b. *Proxy Disclosure Enhancement*, https://www.sec.gov/rules/final/2009/33-9089.pdf.

SEC. 2011. *CF Disclosure Guidance: Topic No. 2*, https://www.sec.gov/divisions/corpfin/guidance/cfguidance-topic2.htm.

SEC. 2018. *Commission Statement and Guidance on Public Company Cybersecurity Disclosures*, https://www.sec.gov/rules/interp/2018/33-10459.pdf.

Srinivasan, S. 2005. Consequences of financial reporting failure for outside directors: Evidence from accounting restatements and audit committee members. *Journal of Accounting Research* 43 (2): 291-334.

Thompson, J. D. 1967. *Organizations in Action*. New York: McGraw-Hill

Van Peteghem, M., L. Bruynseels, and A. Gaeremynck. 2018. Board diversity: A tale of faultiness and frictions in the board of directors. *The Accounting Review* 93 (2): 339-67.

Wang, C., F. Xie, and M. Zhu. 2015. Industry expertise of independent directors and board monitoring. *Journal of Financial and Quantitative Analysis* 50 (5): 929-962.