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**„Three Essays on Firm Value and Firm Risk and
their Relation to IT-Exposure, Corporate Social
Responsibility, and Religiosity“**

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Preface

For several years now, society and economy have been undergoing an increasingly strong and rapid change, which is generally attributed to the subject of globalization. In particular, the topics of information technology (IT) and corporate social responsibility (CSR), especially the sustainability aspect, have strongly gained in importance. With respect to information technology, countries, firms and managers face an ever more complex world, driven by the dissemination of new digital technologies that can boost productivity while causing disruption. At the same time, it is clear to all parties that both the payoffs for success as well as the penalties for failure will be higher than before (McKinsey Global Institute, 2019; Boston Consulting Group, 2021). McKinsey Global Institute (2019) estimated that global GDP could increase by \$13 trillion between 2018 and 2030 due to digitization, automation, and artificial intelligence as these technologies create new business opportunities. In terms of sustainability, the Boston Consulting Group (2022a) estimates that the Nordic countries alone (Denmark, Finland, Norway, and Sweden) will generate approximately €14 trillion in additional revenue by 2050 from the sale of sustainable technologies and solutions to tackle climate change and ensure energy security.

Sustainability and good corporate governance, generally subsumed under corporate social responsibility, have also gained massive importance in recent decades. While CSR was still considered a “nice to have” feature in the 1990s, reports about companies implementing CSR can now be found in every business newspaper (Benabou and Tirole, 2010; Portney, 2008). In recent history there are many examples where poor CSR has led to huge economic and financial damage. Catastrophes such as the Deepwater Horizon oil spill in April 2010 and the Fukushima Daiichi nuclear reactor incident including mismanagement in March 2011, triggered by an

earthquake, have led to massive stock market collapses (Capelle-Blancard and Petit, 2019). In contrast, top performers in CSR are more than twice as likely to generate higher shareholder returns, obtain higher valuation multiples that are 3% to 19% above median CSR performers, and do more easily at attracting and retaining talented employees (Boston Consulting Group, 2022b).

Current academic research has also been addressing these issues for some time. When it comes to the economic evaluation of changing factors that are relevant for companies, the research literature usually analyzes the relationship to firm performance, including firm value, and firm risk. With regard to IT, early studies found either no or a negative relationship between IT spending and productivity, firm value, and firm performance (e.g., Roach, 1987, 1991; Strassmann, 1990; Loveman, 1994; Berndt and Morrison, 1995; Morrison, 1997). However, numerous later studies were able to document a positive effect of IT spending on output and productivity (e.g., Brynjolfsson and Hitt, 1995, 1996, 2003; Barua et al., 1995; Tambe and Hitt, 2012; Tambe et al., 2012) as well as on firm value (e.g., Brynjolfsson and Yang, 1997; Brynjolfsson et al., 2002; Bharadwaj et al., 1999; Bardhan et al., 2013). Common feature for most of the studies is the database used, which is based on surveys to measure exclusively tangible IT expenditures (Bharadwaj et al., 1999; Hitt and Brynjolfsson, 1996; Dewan et al., 2007). Thus, a significant portion of IT-generated benefits (e.g., software, databases), which are not captured by traditional measures of IT capital stock indicators but may account for a large portion of a company's IT-related expenditures, are neglected (Tambe and Hitt, 2014). Brynjolfsson and Yang (1997) find that the ratio of intangible IT assets to tangible IT assets may be 10 to 1. This literature forms the starting point for the first paper that examines for the first time the impact of a continuously changing technological environment on the business model of companies and their firm value, thereby focusing on a firm's IT-Exposure.

Regarding CSR, early literature has examined the relationship between corporate social performance and corporate financial performance and has found diverging results, that point to be weakly positive overall (e.g., Margolis and Walsh, 2003; Margolis et al., 2009). Furthermore, the literature is dichotomous between proponents and opponents of CSR. The proponents show, among other things, that a more pronounced CSR level reduces the risk for companies to be sued (Nofsinger and Varma, 2014), has a positive impact on firm reputation, brand equity, and workforce quality (Cornell and Shapiro, 1987; Brown and Dacin, 1997; Turban and Greening, 1997; Greening and Turban, 2000), and can be interpreted as a signal of superior management skills (Waddock and Graves, 1997). Accordingly, several studies document, on average, a firm risk mitigating influence of CSR (e.g., Albuquerque et al., 2019; Sassen et al., 2016), that manifests in reduced costs of capital (e.g., El Ghouli et al., 2011; Goss and Roberts, 2011) and ultimately increases firm value (e.g., Albuquerque et al., 2019; Servaes and Tamayo, 2013). Building on this literature, the second paper analyzes the relationship between corporate social responsibility and the resulting impact on firm risk as well as firm value. For the first time, the influence on the overall distribution of firm risk and firm value is examined.

Is the focus on social factors (the “S” component of CSR) that exert influence on companies, the topic of local religious norms in particular has been studied in recent years. Numerous studies document that local religious norms influence firm behavior and stakeholders’ assessments of a firm’s underlying behavioral tendencies (Hillary and Hui, 2009; McGuire et al., 2012; Shu et al., 2012; Callen and Fang, 2015; Zolotoy et al., 2019). While local religious norms can avoid undesirable corporate behavior and managerial opportunism (McGuire et al., 2012; Grullon et al., 2010; Dyreng et al., 2012), they are primarily associated with higher risk aversion and lower firm risk (Hillary and Hui, 2009; Adhikari and Agrawal, 2016) as well as lower costs of capital (El Ghouli et al., 2012; Chen et al., 2016; Jiang et al., 2018). Regarding firm value, the literature finds no influence of local religious norms (Zolotoy et al., 2019; Amin

et al., 2021). This stream of literature forms the basis for the third paper, that examines the influence of religiosity on firm risk and firm value. As in the second paper, the focus is on the first-time analysis of the effect on the entire distribution of firm risk and firm value. Overall, the focus of the three papers is on firm value and, in the case of the second and third paper, also on firm risk and the question to what extent IT, CSR and religion influence these aspects.

The first paper (“IT-Exposure and Firm Value”), as mentioned earlier, focuses on the impact of information technology progress on firm value. It has long been known that innovations enable new business models and lead to economic growth (Abramovitz, 1956), specifically through the substitution of existing products, processes, and forms of industrial organization by improved ones (Kamien and Schwartz, 1975; Schumpeter, 1942). In general, no company can escape this technological competition, but different industries are affected to varying degrees depending on the new types of emerging technologies. For example, the development of the Internet enabled the foundation of Amazon with its new business model of selling books exclusively online. Amazon became the biggest challenge for ordinary bookstores, forcing them to build their own online presence to protect their market share (Kotha, 1998). The literature to date has focused on the impact of IT expenditures on firm performance, using data for IT expenditures that generally covers a period between the late 1980s and early 2000s and was collected through surveys of private firms (Bharadwaj et al., 1999; Hitt and Brynjolfsson, 1996, Dewan et al., 2007). This leads to an incomplete coverage of IT (expenditure) and is associated with measurement errors in the estimates (Mitra and Chaya, 1996; Brynjolfsson and Hitt, 1996; Brynjolfsson et al., 2002; Tambe and Hitt, 2014).

This paper proposes an alternative approach to analyze the impact of IT on firm value. It focuses on the estimation of partial IT-Exposure using a Fama-French 3-factor model (Fama and French, 1993) extended by an IT proxy. The IT-Exposure can be interpreted as the degree of challenge to a company’s business model caused by current and newly released information

technology. It allows companies to be differentiated into those with a business model that is affected by IT changes above market average (positive IT-Exposure) and those with a business model that is affected below market average (negative IT-Exposure). Since companies with a positive IT-Exposure are challenged above market average, a reduction in firm value is expected if the companies do not adapt their business model to the new conditions. If, on the other hand, companies adapt their business model to the new challenges, they experience a value premium. The more negative the IT-Exposure of a firm is, the less pressure there is on the business model to adapt. Therefore, a value premium is expected that increases with the level of IT-Exposure. A firm's effort in sufficiently and not sufficiently adapting their business model is distinguished by investigating its investment behavior and differentiating between firm internal solutions (proxied by R&D expenditures) and firm external solutions (proxied by CapEx).

The analysis is based on an extensive dataset of more than 48,000 observations consisting of companies listed in the Russel 3000 index between 1990 and 2018. After having estimated IT-Exposure, the exposure is related to firm value, approximated by Tobin's Q. In addition to univariate and multivariate portfolio sorting, the focus is on a (conditional) logit regression and classic panel data methods, including 2SLS. The empirical analysis yields the following results. First, univariate as well as multivariate portfolio sortings suggest a u-shaped relationship between IT-Exposure and Tobin's Q, i.e., the more extreme the IT-Exposure, the higher the firm value. Applying (conditional) logit regression shows that the probability of a company having a high firm value (80th percentile) decreases with more extreme (positive and negative) IT-Exposure, but sufficient investments in R&D or CapEx significantly increase the probability of a high firm value with more extreme (positive and negative) IT-Exposure, revealing a u-shaped and reverse u-shaped relationship. Controlling for endogeneity, fixed effects regressions confirm a fundamentally negative influence of IT-Exposure on Tobin's Q, that can be

overcompensated by sufficient investments in form of R&D and CapEx. The negative IT effect is, due to sufficient investments, on average, overcompensated by a factor of up to 2.1, giving a firm with an average Tobin's Q a premium of 14.8% to 19.2%. The study shows that, on average, companies can successfully overcome IT challenges if they show appropriate investment behavior, thus increasing the value of the firm.

The second paper ("Corporate Social Responsibility, Risk, and Firm Value: An Unconditional Quantile Regression Approach") examines the influence of corporate social responsibility (CSR) on firm risk as well as firm value. CSR is a concept that defines what role a company should play in society and is perceived as a relevant factor by both customers and investors worldwide (Albuquerque et al., 2019; Cheng et al., 2014; Oikonomou et al., 2014). Especially in recent years, the importance of CSR has risen sharply, as evidenced, for example, by the high level of spending on sustainability and corporate philanthropy (Stellner et al., 2015; Deng et al., 2013; Drempetic et al., 2019; Di Giuli and Kostovetsky, 2014). Although there is no universally accepted definition and interpretation of the CSR concept (Griffin, 2000; van Beurden and Gössling, 2008), CSR can be understood as a process whereby companies incorporate ESG (environmental, social, and governance) factors into the corporate decision-making process and account for the quality of their relationship with their different stakeholders (Stellner et al., 2015; Oikonomou et al., 2014; Renneboog et al., 2008).

The literature on CSR can be classified into two strands, shareholder theory and stakeholder theory (Deng et al., 2013; Mishra and Modi, 2013). Friedman (1962, 1970), as a proponent of shareholder theory, was among the first to argue that the social responsibility of corporations is solely to maximize shareholder value, since the implementation of CSR in corporate decisions at best has no impact on shareholder value and at worst destroys value as CSR increases costs to the firm, thus creating a competitive disadvantage (Aupperle et al., 1985; Friedman, 1970; McWilliams and Siegel, 1997; Jensen, 2002). In contrast, stakeholder theory (Freeman, 1984)

argues that positive (negative) CSR can have a positive (negative) impact on shareholder value (Mishra and Modi, 2013) and companies accordingly invest in CSR for value-enhancing reasons. Based on stakeholder theory, several studies find a risk reducing influence of CSR on total, systematic, and idiosyncratic risk (e.g., Sassen et al., 2016; Jo and Na, 2012; Mishra and Modi, 2013; Albuquerque et al., 2019; Luo and Bhattacharya, 2009). Consequently, this risk-mitigating effect reduces cost of capital (e.g., El Ghouli et al., 2011; Goss and Roberts, 2011) and ultimately increases firm value (e.g., Albuquerque et al., 2019; Servaes and Tamayo, 2013).

This paper differs from previous literature by applying an unconditional quantile regression (UQR) according to Firpo et al. (2009), as the relationship between CSR and firm risk (total risk, idiosyncratic risk, and systematic risk) and firm value (approximated by Tobin's Q) may be non-constant. UQR allows to analyze the relationship across the entire distribution of firm risk and firm value, rather than focusing exclusively on the average relationship estimated using ordinary least squares (OLS). The use of UQR makes it possible to perform a nuanced analysis of the relationship between the entire distribution of the dependent variable and the regressors, as the relationships are estimated for each unconditional quantile of the dependent variable. This permits for heterogeneous coefficients to be estimated for each unconditional quantile, which can vary in sign, magnitude, and significance.

The study is based on all U.S.-headquartered companies listed on the major exchanges NYSE, NASDAQ and AMEX and covers the period from January 2002 to December 2019. We utilize CSR scores from Refinitiv and MSCI. This provides us with approximately 12,000 (Refinitiv CSR score) and 11,000 (MSCI CSR score) effectively usable firm-year observations. Using fixed effects OLS regression, partly confirms the statistically significant risk-reducing effect of CSR on firm risk found in the literature (e.g., Albuquerque et al., 2019; Sassen et al., 2016). Regarding Tobin's Q, we find a value-enhancing effect of CSR, which is in line with the literature (e.g., Albuquerque et al., 2019). In contrast, the empirical analysis of unconditional

quantiles via UQR reveals strong heterogeneous effects in terms of coefficients significance, magnitude, and sign, along the entire distribution of the risk variables and Tobin's Q, respectively. Thereby, the influence of CSR is for total risk, idiosyncratic risk, and Tobin's Q, respectively, more pronounced in the lower and middle parts of the distribution than in the high quantiles. For systematic risk we find stronger effects in the low and high quantiles of the distribution. The study shows that the risk-reducing and value-enhancing effect of CSR is heterogeneous. Thus, the impact of CSR on companies can deviate significantly from the average impact measured so far.

The third paper ("Heterogeneous Effects of Religiosity on Firm Risk and Firm Value: An Unconditional Quantile Regression Approach") analyzes the impact of local religious norms (religiosity) on firm risk and firm value, focusing on an unconditional quantile analysis, similar to the second paper. Cultural factors, such as the prevailing religion, are known to shape human beliefs and social values through their function as an informal institution, and thus also have a significant impact on individual behavior (Casson et al. 2010; Kennedy and Lawton 1998; Zolotoy et al., 2019; Ma et al., 2019). Since individuals adapt to prevailing values, norms, and group behavior (Cialdini and Trost, 1998), not only religious adherents but also non-adherents are significantly influenced and shaped by the prevailing religious social norms (Zolotoy et al., 2019; He and Hu, 2016; Spicer and Bailey, 2007). As most employees reside in the immediate vicinity of the company, a firm's culture is also shaped by the prevailing religious and social norms. Thus, the dominant local culture and social norms influence the culture and behavior of the company (He and Hu, 2016; Cai and Shi, 2019). Previous literature shows that companies in more religious environments are less likely to engage in ethically questionable practices (e.g., McGuire et al., 2012; Callen and Fang, 2015), which is why investors are expected to have less agency concerns regarding the investment decisions of these firms (Callen and Fang, 2015; Zolotoy et al., 2021). In addition, religiosity is primarily associated with higher risk aversion

and consequently lower firm risk (Hilary and Hui, 2009; Adhikari and Agrawal, 2016). Regarding firm value, the literature to date finds no relationship with religiosity (Zolotoy et al., 2019; Amin et al., 2021), although the risk-reducing effect leading to lower costs of capital is confirmed (El Ghouli et al., 2012; Chen et al., 2016; Jiang et al., 2018).

This paper aims to extend this stream of literature by reinvestigating the relationship on religiosity, firm risk (comprising total, idiosyncratic risk, and systematic risk), and firm value, approximated via Tobin's Q. While previous literature exclusively focuses on the average relationship estimated using OLS regression, this study applies UQR (Firpo et al., 2009) to account for non-constant relationships. Thereby, allowing for heterogeneous coefficients to be estimated for each unconditional quantile of firm risk and firm value, that may vary in sign, magnitude, and significance.

The study is based on all U.S.-headquartered companies listed on the major exchanges NYSE, NASDAQ and AMEX, and covers the period from January 1980 to December 2020, leaving us with nearly 80,000 usable firm-year observations. Applying fixed effects OLS regression confirms the statistically significant risk-reducing impact of religiosity on total risk and idiosyncratic risk (e.g., Hilary and Hui, 2009). However, for systematic risk and Tobin's Q no significant effect of religiosity can be found. Using UQR reveals strong heterogeneous effects in terms of coefficients' significance, magnitude, and sign, respectively, along the entire distribution of the risk variables and Tobin's Q. Thereby, the influence of religiosity is more pronounced in the medium and high quantiles than in the low quantiles of the distribution for total risk and idiosyncratic risk, respectively. For systematic risk the risk-mitigating effect of religiosity is the strongest in the medium quantiles and nonexistent in the extreme quantiles. For Tobin's Q a value-decreasing effect is observed in the extreme quantiles as well as a value-enhancing effect in the middle of the distribution. The coefficients' high heterogeneity confirms the appropriateness of applying UQR as opposed to exclusively analyzing the average effect

via standard OLS. Moreover, for the first time, a significant value-increasing and value-decreasing effect of religiosity can be found for Tobin's Q when UQR is applied.

In summary, the three studies in this thesis analyze currently discussed factors influencing firms and thus contribute to a better understanding of important determinants of firm value and firm risk. First, it is shown that the business model of firms is challenged by constantly changing technological opportunities resulting in a negative impact on the value of the firm. This initial disadvantage can be turned into an advantage through appropriate investment behavior, which is reflected in a higher firm value (Paper 1). Second, the analysis of potentially heterogeneous effects shows that the impact of CSR on firm risk and firm value varies depending on the unconditional quantile considered. Thus, firms with different levels of risk and firm value, respectively, are affected by CSR to different degrees (Paper 2). Third, analyzing the influence of religiosity also reveals a non-constant influence on firm risk and firm value. In addition, the consideration of a potentially heterogeneous relationship enables the identification of an influence of religiosity on firm value (Paper 3).

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1 | IT-Exposure and Firm Value*

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Abstract

We analyze the joint influence of a firm's information technology (IT)-Exposure and investment behavior on firm value. Estimating a firm's (partial) IT-Exposure allows for distinguishing between firms with a business model that is challenged by IT above and below market average. Hence, we estimate the annual IT-Exposure of a firm using a 3-factor Fama-French model extended by an IT-proxy. Subsequently, we analyze the relationship with Tobin's Q in a panel data context, accounting for the relationship between IT-Exposure and investments proxied by R&D as well as CapEx. We use more than 48,000 firm-year observations for firms in the Russell 3000 Index covering the period 1990 to 2018. Although IT-Exposure has a negative impact on firm value, this discount can be overcompensated by up to 2.1 times by sufficient investments through R&D and CapEx, giving a firm with an average Tobin's Q a premium of 14.8% to 19.2%, while controlling for endogeneity.

Keywords: Firm Value, Information Technology, IT-Exposure, CapEx, R&D

JEL classification: G30; G32

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1 Introduction

Through centuries, scientific and technological innovations are known as the driving forces for economic development and firm growth (Bresnahan and Trajtenberg, 1995; Belvedere et al., 2013; Francis et al., 2012; Liao et al., 2017; Jones, 1995). Technological competition is the essential form of competition and constitutes the basis for continuous progress (Schumpeter, 1942; Chan et al., 1990). Moreover, investments in innovation enable new business models and lead to productivity growth (Abramovitz, 1956; Solow, 1957; Griliches, 1979), as well as yield a positive long-term abnormal operating performance (Eberhart et al., 2004).

Previous studies, as discussed later on, aimed to show the fundamental relationship between IT investments and the potential positive benefits, *inter alia*, for productivity and firm performance. To the best of our knowledge, however, there are no studies that (i) consider IT progress as a challenge to the design of a firm's business model, (ii) differentiate between how successful firms are in dealing with changing IT circumstances and (iii) examine the impact on business performance.

New technological developments force firms to rethink the design of their current business model and to adapt if necessary. In the early years, Amazon purely focused on the distribution of books, thus having the same business model as the bookstores next door, with the crucial difference that distribution and business presence were limited to the world wide web. Initially sneered at for the design of the business model, Amazon developed into the biggest challenge for the ordinary bookstores, forcing them to build their own online presence using IT (Kotha, 1998).

This paper contributes to the impact of IT progress on firm value. In contrast to former studies, we focus on a firm's (partial) IT-Exposure instead of IT expenditures, thus distinguishing between firms with above and below market average IT-Exposure. This

distinction is important because technological advancements and innovations do not have to affect every industry equally. For example, for the agricultural industry, topics such as the use of GPS and autonomously operating tractors have become increasingly important in recent years to increase efficiency (Finger et al., 2019; Stafford, 1999; Kutzbach, 2000). In comparison, the self-development of new software is particularly important for the automotive industry in order to provide customers with tailored services (Boston Consulting Group, 2021). At the same time, other industries may not be affected at all by the IT transformation taking place in certain industries. Within industries, there will be firms that lead the way in implementing new technologies to adapt their business model, while other companies are laggards. The use of IT-Exposure has the advantage that we do not have to make our own classification of relevant IT that changes the business model of firms, especially since current IT challenges can change at different rates for different industries. Instead, the appraisal of the need for adaptation for an industry is based on the independent assessment of the capital markets via IT-Exposure.

We expect the business model of firms with a positive IT-Exposure to be challenged above market average, leading to a reduction in firm value if the firms do not adapt their business model to the new conditions. If, on the other hand, firms adapt their business model to the new challenges, they experience a value premium. The business model of firms with a negative IT-Exposure is also challenged, but below market average. The more negative the IT-Exposure, the less pressure there is on the business model to adapt, that is why we expect the value of these firms to increase with the level of IT-Exposure. Empirically, we also find a discount in firm value and attribute this to a lack of investment behavior. To distinguish between firms' efforts of sufficiently and not sufficiently adapting their business model we investigate their investment behavior and differentiate between firm internal solutions (proxied by R&D expenditures) and firm external solutions (proxied by CapEx).

To this end, we conduct a two-stage analysis. In stage one, we estimate the IT-Exposure of each firm in each year using a Fama-French 3-factor model (Fama and French, 1993) extended by an IT-proxy. We interpret IT-Exposure as the level of challenge to a firm's business model. With this approach we can determine the so-called partial IT-Exposure as a deviation from the market average IT-Exposure.¹ This allows us to distinguish firms with positive IT-Exposure, i.e., with a business model challenged above market average due to IT progress, from firms with negative IT-Exposure, i.e., firms with a business model challenged below market average. In the second stage of the analysis, we examine the relationship between the estimated IT-Exposure, investments, and firm value. In addition to univariate and multivariate portfolio sorting, the focus is on a (conditional) logit regression as well as fixed effects regression. The (conditional) logit regression examines the influence of IT-Exposure and its interactions with R&D and CapEx on the probability that a firm's Tobin's Q is in the lower 20th or upper 80th percentile. We then perform fixed effects regressions to (i) analyze the quantitative impact of IT-Exposure on firm value and (ii) to investigate the IT-Exposure-Investment channel, that is the effect of IT-related investments on firm value. Finally, we apply a two-stage least squares (2SLS) regression procedure to control for the present endogeneity problem between investments and firm value. This study is based on weekly stock returns and annual accounting data for the U.S. firms listed in the Russell 3000 index covering the period January 1990 to December 2018, giving us a total of up to 48,952 effectively usable observations for our research.

To summarize our findings: (i) approximately 89% of the firms surveyed have a positive Total IT-Exposure, i.e., react positively to changes in IT; (ii) even after considering various controls, the univariate as well as multivariate portfolio sortings suggest a u-shaped relationship

¹ We also estimate the total exposure by regressing the market proxy on the IT-proxy in advance, thus achieving an orthogonalization of the market proxy. This orthogonalized market proxy is then used instead of the regular market proxy in the extended Fama-French 3-factor model.

between IT-Exposure and Tobin's Q, i.e., the more extreme the IT-Exposure, the higher the firm value; (iii) the (conditional) logit regression shows that the probability of a firm having a high firm value (80th percentile) decreases with more extreme (positive and negative) IT-Exposure, but sufficient investments in R&D or CapEx significantly increases the probability of a high firm value with more extreme (positive and negative) IT-Exposure, revealing a u-shaped and reverse u-shaped relationship; (iv) the fixed effects regressions show a fundamental negative influence of IT-Exposure on Tobin's Q, that can be overcompensated by sufficient investments in form of R&D or CapEx; (v) after checking for endogeneity, the qualitative interpretation of the results remains identical, the quantitative effects have increased significantly, i.e., the negative IT effect is, due to sufficient investments, on average overcompensated by a factor of up to 2.1, giving a firm with an average Tobin's Q a premium of 14.8% to 19.2%.

Our results include important implications. We show that two types of investment opportunities are available to firms to compensate for the negative effect of IT-Exposure: (i) investments in firm internal solutions via R&D spending, and (ii) investments in firm external solutions via CapEx. Since both R&D and CapEx, respectively, include IT expenditures (Tambe and Hitt, 2012; Barua et al., 1995; Brynjolfsson and Hitt, 1996; Mitra and Chaya, 1996), which account for a high proportion of a firm's total expenditures at the same time (Kobelsky et al., 2008), our methodology (IT-Exposure and interaction terms) allows us to identify the positive impact of IT-related effects on firm value.

In contrast to other studies, considering interaction effects between IT-Exposure and R&D and CapEx, respectively, has the advantage of avoiding the need for exact data regarding IT expenditures. While the definition of R&D and CapEx is given by various accounting standards, which allows a fairly accurate recording, this definition is partly missing for IT. It is difficult to measure the value of physical IT expenditure within a firm, due to incomplete inventory lists

for IT-related goods and rapidly changing quality-adjusted prices for IT products, which complicate their market value measurement. In comparison, the assessment of intangible benefits of IT is accompanied by much greater problems. On the one hand, there are different dimensions of the intangible components to which a value cannot easily be assigned (Brynjolfsson and Hitt, 2000). On the other hand, a considerable part of the benefits generated by IT (e.g., software, databases) is not captured by classic measurements of IT capital stock indicators but may represent a large part of a firm's IT-related expenditure (Tambe and Hitt, 2014b).²

Incorporating R&D and CapEx interactions in our model is important for two further reasons. Firstly, a large proportion of firms, more than 50% in our study, do not spend any R&D at all (see also Chan et al., 2001; Lewis and Tan, 2016; Flannery and Rangan, 2006; Hirschey et al., 2012) and therefore cannot rely on firm internal solutions. Secondly, even in times of crisis in which firms try to keep R&D spending constant as a priority compared to CapEx (Brown and Petersen, 2015), they can effectively compensate for the negative IT-Exposure effect.

While early studies focusing on progress in IT, found no or a negative effect of IT spending on productivity, firm value and firm performance (e.g., Roach, 1987, 1991; Strassmann, 1990; Loveman, 1994; Berndt and Morrison, 1995; Morrison, 1997), numerous subsequent studies have stated a positive impact of IT spending (see Schryen (2013) and Dedrick et al. (2003) for a comprehensive review).

Brynjolfsson and Hitt (1995, 1996, 2003), Barua et al. (1995), Hitt and Brynjolfsson (1996), Black and Lynch (2001), Tambe and Hitt (2012), and Tambe et al. (2012) find evidence of a positive effect of IT spending on output and productivity at firm level, while controlling for potential endogeneity. These results could also be observed on governmental level (postal

² Brynjolfsson and Yang (1997) find that the ratio of intangible IT assets to tangible IT assets may be 10 to 1.

service, federal agencies) by Mukhopadhyay et al. (1997), and Lehr and Lichtenberg (1998). Further studies indicate that higher IT expenditures lead to lower cost structures, with the exception of personnel costs (Mitra and Chaye, 1996), that IT expenditures can be regarded as a net substitute for both capital and labor in all economic sectors (Dewan and Min, 1997), and that IT spending positively impacts consumer welfare (Brynjolfsson, 1996). Studies focusing on spillover effects show that: (i) IT investments by suppliers lead to an increase in their productivity and also have a positive effect on customer output (Cheng and Nault, 2007; Tambe and Hitt, 2014b); (ii) even in the long term, firms receive significant spillover effects, whereby these are stronger for IT-intensive firms (Chang and Gurbaxani, 2012); (iii) spillover effects are caused by labor movements, which are caused by IT workers moving from one firm to another (Wu et al., 2018; Tambe and Hitt, 2014a).

Meanwhile, other studies focus more on the relationship between IT spending and risk, firm value as well as firm performance. Dewan et al. (2007) find higher risk levels for IT capital investments and a substantial risk premium for IT returns. Brynjolfsson and Yang (1997), and Brynjolfsson et al. (2002) show higher (stock) market valuations as a result of IT investments and Bharadwaj et al. (1999), Anderson et al. (2006) and Bardhan et al. (2013) document higher firm values as measured by Tobin's Q for firms with higher IT expenditures. In line with this, Bharadwaj et al. (2009) conclude that implementation-related IT failures negatively impact firm value. Finally, IT investments lead to higher performance as well as a positive impact on returns (Kobelsky et al., 2008; Alpar and Kim, 1990; Bharadwaj, 2000).

The central common feature for most of these studies is the database, which (i) usually refers to a subperiod between the late 1980s and early 2000s, and (ii) is often based on surveys conducted by private firms (e.g., InformationWeek, International Data Group/Computerworld, Computer Intelligence Infocorp (Bharadwaj et al., 1999; Hitt and Brynjolfsson, 1996; Dewan et al., 2007)). This leads (i) to incomplete coverage of IT (expenditure) and (ii) severe

measurement errors in the estimates (Mitra and Chaya, 1996; Brynjolfsson and Hitt, 1996; Brynjolfsson et al., 2002; Tambe and Hitt, 2014b).

The remainder of the paper is organized as follows. Section 2 starts with some theoretical foundations. Section 3 focuses on the estimation process of our IT-Exposure, describes the sample selection in general (Section 3.1), the relevant database in specific (Section 3.2) as well as the estimation design (Section 3.3), and provides first results (Section 3.4). Section 4 analyzes the interrelationship between IT-Exposure and firm value, with Section 4.1 and Section 4.2 describing the relevant database and providing descriptive statistics, respectively. The remaining sections of Chapter 4 focus on the methodology as well as empirical results of portfolio sortings (Section 4.3), logit regression (Section 4.4), classic panel data analysis, including two-stage least squares regressions (Section 4.5), and robustness checks (Section 4.6). Finally, Section 5 presents concluding remarks.

2 Firm value, IT-Exposure, and investments

Our expectations regarding the relationship between a firm's IT-Exposure and its firm value are shown in Figure 1. While innovations generally enable new business models and lead to productivity growth (Abramovitz, 1956), this more precisely includes growth through substitution of previously existing products, processes, and forms of industrial organization by improved ones (Kamien and Schwartz, 1975; Schumpeter, 1942). Accordingly, we would theoretically expect that the business model of firms with a positive IT-Exposure will be challenged above market average and consequently lead to a reduction in firm value if the firm does not adapt its business model to the new prevailing conditions (quadrant I). If, on the contrary, a firm adapts its business model to the new challenges, e.g., by developing and

deploying new production methods, processes, and products, or, e.g., using new technology to open up new distribution channels, the firm experiences a value premium (quadrant II). Firms with a negative IT-Exposure are also challenged by technological changes, but in contrast to the positive IT-Exposure, below market average. The more negative the IT-Exposure, the less pressure is on the firm to adapt its business model. This means that more of the firm's resources are available for the actual nature of the firm and are not needed for transforming the firm. Hence, we expect the firm value of such firms to increase with the level of negative IT-Exposure (quadrant III). Empirically we also find a firm value discount (quadrant IV) and attribute this to a lack of investment behavior.

[Figure 1 about here]

To distinguish between firms' efforts of sufficiently and not sufficiently adapting their business model we investigate their investment behavior and differentiate between firm internal solutions (proxied by R&D expenditures) and firm external solutions (proxied by CapEx). The literature agrees that R&D expenditures among other things serve the creation of new ideas, resulting in intangible assets as well as the development of new products, services and processes (Griliches, 1981, 1992; Kamien and Schwartz, 1975; Cockburn and Griliches, 1988; Iansiti, 1997; Hitt et al., 1990). This is supported by US-GAAP accounting standard FASB ASC 730-10-20.³ Furthermore, it is known that R&D expenditures increase cash flows and a firm's competitiveness that allows firms to prevail against competitors with more advanced

³ FASB ASC 730-10-20 defines R&D expenditures as follows: "Research is a planned search or critical investigation aimed at discovery of new knowledge with the hope that such knowledge will be useful in developing a new product or service (referred to as product) or a new process or technique (referred to as process) or in bringing about a significant improvement to an existing product or process. Development is the translation of research findings or other knowledge into a plan or design for a new product or process or for a significant improvement to an existing product or process whether intended for sale or use. It includes the conceptual formulation, design, and testing of product alternatives, construction of prototypes, and operation of pilot plants".

technology, thus directly affecting firm value (Chauvin and Hirschey, 1993; Connolly and Hirschey, 2005; Chan et al., 1990; Doukas and Switzer, 1992). Taken together, this confirms the appropriateness of using R&D expenditures as a proxy for firm internal solutions, i.e., solutions (e.g., products, services, processes, etc.) developed by the firm itself. In addition to the development of internal solutions, a firm has the option of making investments in the form of purchasing external solutions. This can be understood as investments in the form of CapEx to acquire, improve and maintain physical assets such as property, plants, machinery, buildings, equipment, and technology. Therefore, we use CapEx as a proxy for firm-external solutions. The literature shows a positive relationship between CapEx and firm value (McConnell and Muscarella, 1985; Lev and Thiagarajan, 1993; Kerstein and Kim, 1995).

Literature related to IT, states that IT expenditures (i) include both, R&D expenditures and CapEx (Tambe and Hitt, 2012; Barua et al., 1995; Brynjolfsson and Hitt, 1996; Mitra and Chaya, 1996), and (ii) account for a high proportion of a firm's total expenditures (Kobelsky et al., 2008). In terms of CapEx, half of these are used for investments in technology (Barua et al., 1995; Kriebel, 1989; Mitra and Chaya, 1996; Mahmood and Mann, 1993).

3 IT-Exposure – first-stage analysis

To study the relationship between a firm's exposure towards IT and its firm value, we apply a two-stage analysis. As part of the first stage, we estimate the yearly *IT-Exposure* for each firm and use these estimates in the second stage as the predominant explanatory variable. The second stage starts with a univariate and multivariate portfolio-level analysis, followed up by panel-data regression analysis including (conditional) logit, fixed effects and instrumental variable regressions.

3.1 Sample selection in general

Our sample includes all U.S. firms that have been at least once listed in the Russell 3000 Index during 01/01/1990 and 12/31/2018 to avoid survivorship bias and backfilling bias, resulting in 4,900 firms. Via Refinitiv Datastream (formerly Thomson Reuters Datastream), we obtain weekly stock prices and yearly accounting data, where annual observations are defined on the basis of fiscal years instead of calendar years, since firms differ along their fiscal year ends (Flannery and Rangan, 2006). Following the literature, we exclude financial firms (SIC 6000-6999) (Glaser and Müller, 2010; Flannery and Rangan, 2006), since their annual statements are not comparable to non-financial firms. We also drop firms with missing observations, leaving us with 3,381 firms and 48,952 firm-year observations.

3.2 Database for first-stage analysis

In our first-stage analysis, we focus on the estimation of the *IT-Exposure* using a 3-factor Fama-French model (Fama and French, 1993) extended by an IT-proxy. We apply four different market proxies (Russell 3000 Index, Wilshire 5000 Index, S&P 500 Index, and Fama and French market) and five different IT-proxies (S&P 500 Information Technology Index, Dow Jones Technology Index, MSCI World Information Technology Index, iShares S&P 500 Information Technology Sector UCITS ETF, and MSCI World Information Technology Index UCITS ETF (DR) 1C)) to ensure the independence of our results from the choice of the proxy. Portfolio returns for the 3-factor Fama-French risk factors size (SMB) and value (HML) are received via Kenneth French's website along with the risk-free interest rate proxied by the 1-

month Treasury bill return, and the Fama and French market return.⁴ To ensure the validity of our regressions, we require a minimum of 20 consecutive weekly observations per firm.

3.3 Empirical design and methodology – estimation of IT-Exposure

The literature on exposure mainly focuses on the estimation of foreign exchange rate exposure (Jorion, 1990, 1991), interest rate exposure (Stone, 1974; Flannery and James, 1984; Sweeney and Warga, 1986), and commodity exposure like gold or oil and gas (Tufano, 1998; Jin and Jorion, 2006) and applies an extended market-model approach. We follow this stream of literature and incorporate a 3-factor Fama-French model (Fama and French, 1993) that is extended by an IT-proxy (IT index) to capture a firm's *IT-Exposure*. We estimate the following equation for each firm i and each year using weekly t simple return data:

$$(R_{i,t} - rf_t) = \alpha_i + \beta_{m,i,j} * (R_{m,t,j} - rf_t) + \beta_{SMB,i} * R_{SMB,t} + \beta_{HML,i} * R_{HML,t} + \beta_{IT,i,k} * R_{IT,t,k} + \varepsilon_{i,t} , \quad (1)$$

where $R_{i,t}$ denotes a firm's weekly return, $R_{m,t,j}$ is the market return with j one of our four market proxies (Section 3.2), $R_{SMB,t}$ and $R_{HML,t}$ are the portfolio returns of the small-minus-big and high-minus-low risk factors which are incorporated to avoid potential biases from return differences between small versus large ($R_{SMB,t}$) and value versus growth stocks ($R_{HML,t}$) (Fama and French, 1993). $R_{IT,t,k}$ is the return for one of our five (k) IT-proxies (Section 3.2), rf_t is the risk-free return on 1-month treasury bills and $\varepsilon_{i,t}$ indicates the error component. The

⁴ Data for the market return and the risk-free return are obtained from Kenneth French's Website (<http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html>). The Fama and French market consists of all CRSP firms incorporated in the U.S. and listed on the NYSE, NASDAQ, and AMEX.

coefficient of interest is $\beta_{IT,i,k}$ which captures a firm's exposure towards our IT-proxy, showing a firm's sensitivity towards a 1-unit change of $R_{IT,t,k}$. This model estimates the partial exposure of a firm, i.e., the exposure portion that exceeds the market average exposure, captured through $R_{m,t,j}$. This approach allows us to distinguish firms with above-market (positive) exposure from those with below-market (negative) exposure (Priestley and Odegaard, 2007).⁵ We also estimate a common modification to this model: we orthogonalize the market factor⁶ in order to estimate a firm's *Total IT-Exposure* (Griffin and Stulz, 2001; Jorion, 1991) but which comes with the drawback of producing inconsistent (downward biased) standard errors (Liu et al., 2015). Another option to estimate a firm's *Total IT-Exposure* is to include only the IT-proxy and to neglect all other explanatory variables, but induces omitted variable bias if accounting for the explanatory variables is justifiable (Priestley and Odegaard, 2007; Adler and Dumas, 1984).

3.4 Empirical results

3.4.1 Descriptive statistics

Table 1 shows correlation coefficients between the market proxies, IT-proxies, Fama and French's risk factors SMB and HML, as well as the risk-free interest rate used. The high correlation (99%-100%) between the four market proxies suggests that the choice of market proxy is likely to have no significant impact on the estimates. Accordingly, we choose to define the Russell 3000 as our market proxy since the firms in our sample are based on the Russell

⁵ Since the relationship between Tobin's Q and IT-Exposure is quadratic, as we will show later, the absolute value of the IT-Exposure can also be determined and used for the analysis, with the advantage that the entire data set can be used and not only the part that belongs to the positive or negative IT-Exposure.

⁶ The market factor is regressed on all other regressors and the resulting residuals are further on used as an orthogonalized market factor in the main regression instead of the raw variable itself.

3000. Furthermore, we find high correlation coefficients (91%-99%) for the IT-proxies, which also suggest that the choice of the proxy will have no decisive influence on the analysis. We choose the renowned S&P 500 Information Technology Index. Of greater importance is the correlation between the market and the IT-proxies, which also lies in a high range of 80%-88%. This high correlation has no influence on the validity of our estimator, it is still unbiased. But the standard errors are affected and turn out higher, which leads to more conservative (smaller) test statistics.

[Table 1 about here]

Given the high correlation between the market and IT-proxies and the moderate correlation between the Fama and French risk factors and the IT-proxies, the question arises as to the exclusive explanatory content of the IT-proxies and thus their relevance. A regression of the IT-proxies on the market proxies, SMB and HML results in an average adjusted R^2 of about 67%⁷, showing that the IT-proxies have an exclusively explanatory content.

Panel A of Table 2 shows descriptive Statistics for different *IT-Exposures*. As expected, the winsorized (Section 4.1) *IT-Exposures* have both a mean and median of close to zero. However, the values vary widely between -5.26 and 4.77. The percentiles show that the distribution is not very skewed. In most firm-years (89%) firms hold a positive *Total IT-Exposure* and are thus challenged by IT advancements.

[Table 2 about here]

⁷ The R^2 of our specific market IT-proxy combination (Russell 3000 - S&P 500 IT) is slightly higher with 73%.

3.4.2 Persistence analysis

The decisive question for further investigation is whether the estimated *IT-Exposure* of a firm contains a certain systematic structure or is completely random and thus has no meaningful content. To this end, we analyze the persistence of the *IT-Exposure* by answering the question of how high the proportion of firms is that are placed in the same quartile in a year-on-year comparison (Figure 2). For this purpose, the firms are divided into quartiles each year based on their estimated *IT-Exposure*. Subsequently, for each year and each quartile, the number of firms allocated into the same exposure quartile in the current year and one year before is determined. A random allocation to the quartiles would lead us to expect migration rates of 25% (red horizontal line). Deviations from this indicate a certain *IT-Exposure* persistence. For example, in 2017, 33.43% of the firms listed in Quartile 4 will still be in Quartile 4 in 2018 and thus have the highest *IT-Exposure*. The graph shows that the migration rates between the quartiles, almost for the entire period, deviate upwards from a random migration probability of 25%. This result shows that the magnitude of the estimated *IT-Exposure* in a year-on-year comparison is not random but reflects a systematic relationship. The *IT-Exposure* is thus suitable for further analysis.

[Figure 2 about here]

4 Firm value – second-stage analysis

4.1 Database for second-stage analysis

In this section we focus on the relationship between *IT-Exposure* and firm value. Table A.1 gives variable definitions and shows the expected relationship between dependent and independent variables. To proxy for a firm's market value, we follow Coles et al. (2008), Hong and Kacperczyk (2009), and Doidge et al. (2004) and calculate *Raw Tobin's Q* as book value of assets minus book value of equity plus market value of equity all divided by book value of assets, measured at fiscal year end t . This approach is only an approximation, since, e.g., we do not have data on replacement cost of assets or market value of debt (Lindenberg and Ross, 1981), but is likely to be strongly correlated with actual Tobin's Q. Chung and Pruitt (1994) show a minimum R^2 of 96.6% for a regression of the Lindenberg and Ross (1981) Tobin's Q on this Tobin's Q approximation. We calculate the natural logarithm of *Raw Tobin's Q* to obtain a more symmetric distribution (*Tobin's Q*).

Our main explanatory variables are *IT-Exposure* and interaction effects between *IT-Exposure* and CapEx as well as R&D expenditures. For *IT-Exposure* we expect a negative impact on *Tobin's Q*, since almost all firms are affected by IT changes in one way or another (for 89% of firm-year observations the *Total IT-Exposure* is positive, i.e. these firms are challenged by IT progress) and it forces them to adapt their business model, which means that some of the resources are not available for the actual nature of the firm.

As argued by Myers (1977) and Smith and Watts (1992), future investment opportunities impact firm value. To proxy for investment growth, we apply two different proxies: (i) *CapEx* is defined as capital expenditures divided by total assets and can be considered as investments in firm external solutions; (ii) *R&D* is defined as R&D expenditures divided by total assets. Since R&D proxies for intangible assets like technological know-how and expertise it can be

considered as investments in firm internal solutions (Allayannis and Weston, 2001; Morck and Yeung, 1991; Lang and Stulz, 1994). Following the common practice in previous research, we substitute missing R&D expenditures with zero.⁸ For both types of investment, we expect a positive relationship with *Tobin's Q*.

To analyze the relationship between *IT-Exposure* and *CapEx* and *R&D*, respectively, we incorporate two *interaction effects*. Thereby *IT-Exposure* is interacted with a *CapEx-Dummy* and a *R&D-Dummy*, respectively. The *CapEx-Dummy* (*R&D-Dummy*) takes the value 1 if *CapEx* (*R&D*) for a certain firm is larger than the median of *CapEx* (*R&D*) for a specific year and 2-digit SIC code industry, and 0 otherwise. For both interactions we expect a positive influence on firm value that compensates the value discount induced by *IT-Exposure*. If a firm makes sufficient IT-related investments to proactively shape the necessary adaptation process of the business model, this will on average have a positive effect on firm value.

Furthermore, we apply control variables common for the literature such as *Capital Intensity*, *Diversification-Dummy*⁹, *Dividend-Dummy*¹⁰, *Leverage*, return on assets (*ROA*), *Size*, and *Sales Intensity*. *Sales Intensity* is included to account for firms with high intangible assets, meaning low tangible assets but high sales, to ensure that *IT-Exposure* does not capture those effects (Kobelsky et al., 2008). We include year η_t and 2-digit SIC code industry ξ_j fixed effects by using adequate dummies in all our regressions. In each year, all variables (aside from dummy variables) are winsorized at the 1st and 99th percentiles to avoid the influence of extrema (Chen and Chen, 2012). Finally, we delete observations with negative realizations inter alia R&D, Sales, and Shareholders' Equity (Fauver and McDonald IV, 2014; Xiao, 2013).

⁸ We obtain similar results when not setting missing observations to zero.

⁹ Tests with other proxies for diversification as entropy measure (Chakrabarti et al., 2007; Ravichandran, 2009) Hirschman-Herfindal Index (Berger and Ofek, 1995; Hitt, 1999), and the number of operating segments (Lang and Stulz, 1994; Yermack, 1996) confirm the results robustness.

¹⁰ Similar to R&D we set missing dividend values to zero in order to increase the number of observations and can confirm results robustness for either dividend definition.

4.2 Descriptive statistics

Panel A, B, and C of Table 2 show descriptive statistics for our variables distinguishing between the full sample, positive *IT-Exposure* and negative *IT-Exposure*. For the full sample *Raw Tobin's Q* (*Tobin's Q*) has a mean of 1.91 (0.49) and a median of 1.47 (0.38), which corresponds to a right-skewed distribution and accordingly justifies the use of the natural logarithm to obtain a more symmetric distribution.¹¹ Mean and median of *CapEx (R&D)* are 0.06 (0.05) and 0.04 (0.00) respectively. The low median for *R&D* is due to the generally high number of observations with R&D expenditures of zero (almost 25% of firm-year observations have zero R&D) and is reinforced by setting missing observations to zero.

A comparison between firms with positive (Panel B) and negative (Panel C) *IT-Exposure* reveals that the former ones have on average a higher *Tobin's Q* (0.50 vs. 0.48) and lower *CapEx* (0.05 vs. 0.06) but higher *R&D* expenditures (0.05 vs. 0.04). In addition, firms with positive *IT-Exposure* are smaller (2.06 vs. 2.37), have a lower *Capital Intensity* (0.26 vs. 0.32), are less likely to pay a dividend (0.34 vs. 0.45), have lower *Leverage* (0.84 vs. 0.97), are less profitable (-0.01 vs. 0.00), less diversified (0.29 vs. 0.33), and have a higher *Sales Intensity* (1.05 vs. 1.02), i.e., generate higher sales per \$1 asset.

¹¹ This finding is common in the literature, e.g., Lang and Stulz (1994), Allayannis and Weston (2001), and Jin and Jorion (2006).

4.3 Portfolio sorts

We start off with univariate and multivariate portfolio level analysis to analyze the interrelationship between *IT-Exposure* and *Raw Tobin's Q*.¹² Each year *Raw Tobin's Q* is sorted into quintiles based on the firm's current year estimated *IT-Exposure*. For the multivariate portfolio sorts we control for several variables that could drive our results, e.g., industry affiliation, *R&D*, and *CapEx*.

Table 3 presents yearly average *Raw Tobin's Q* values (aggregated into periods) of quintile portfolios that are formed by sorting on the firms yearly estimated *IT-Exposures*, while partly controlling for several variables. Portfolio Q1 (Q5) is the portfolio with the lowest (highest) *IT-Exposure*. Panel A reports results exclusively sorted by *IT-Exposure*, showing average *Raw Tobin's Qs* from 1.51 to 2.50. The quintile differences for Q5-Q1 are mostly positive and predominantly not statistically significant, indicating no relevant impact difference from low and high *IT-Exposure* on firm value. In contrast, the portfolio differences for Q1-Q3 and Q5-Q3 are uniformly positive and are economically as well as statistically significant at common levels of significance.

These results indicate a u-shaped relationship between *IT-Exposure* and firm value, revealing that extreme *IT-Exposures*, i.e., positive as well as negative deviations from the market average *IT-Exposure*, are on average associated with higher *Raw Tobin's Q*. To ensure the validity of these results, both double (Table IA.1) and triple portfolio sorting is performed, considering common control variables such as industry affiliation, market value, degree of diversification, *R&D*, and *CapEx*. The double portfolio sorting is carried out by first dividing the firms into quintiles based on the selected control variable and then dividing each quintile

¹² For better interpretation, we use *Raw Tobin's Q* over *Tobin's Q*.

again into quintiles based on *IT-Exposure*.¹³ The procedure for triple portfolio sorting is alike, but firms are now presorted twice based on two control variables. Even after controlling for industry affiliation and *R&D (CapEx)* scaled by firm size (Panel B and C), the positive and statistically significant correlation between extreme *IT-Exposure* and higher firm value can be confirmed, therefore indicating a nonlinear relationship.

[Table 3 about here]

4.4 Logit

4.4.1 Empirical design and methodology

We want to examine the positive and nonlinear relationship between *IT-Exposure* and firm value in more detail, thus providing further support for the explanation we offer. Specifically, we estimate equation (2) by a (conditional) logit regression to elaborate *IT-Exposures* influence on the probability of a firm's *Tobin's Q* being in the bottom 20th or top 80th percentile. Furthermore, we want to examine the importance of necessary investments in internal solutions (*R&D*) and external solutions (*CapEx*) on the positive relationship between *IT-Exposure* and firm value. We expect sufficient investments in *R&D* or *CapEx* to provide effective protection against technological change, thereby increasing the probability of high firm value on average. To do so, we create two binary variables D_q that equal 1 if the yearly *Tobin's Q* is very low (below the 20% quantile of the *Tobin's Q* distribution, $q = 20\%$) or very high (above the 80% quantile of the *Tobin's Q* distribution, $q = 80\%$), respectively, and analyze the probability that

¹³ If the control variable is industry affiliation, firms will not be divided into quintiles in the first step but into as many quantiles as there are 2-digit SIC codes. Quintiles will only be used again when sorting is carried out based on *IT-Exposure*.

a yearly *Tobin's Q* lies in the low (high) quantile of the *Tobin's Q* distribution of that year. We run the following logistic regression using industry clustered robust standard errors:

$$\begin{aligned}
 \text{logit} \left(P(D_{q,i,t} = 1) \right) & \quad (2) \\
 & = \alpha + \beta * IT\text{-Exposure}_{i,t} + \sum_k \lambda_k * Interactions_{k,i,t} \\
 & + \gamma_1 CapEx + \gamma_2 R\&D + \gamma_3 Size + \gamma_4 Capital Intensity \\
 & + \gamma_5 Dividend\text{-Dummy} + \gamma_6 Leverage + \gamma_7 ROA \\
 & + \gamma_8 Diversification\text{-Dummy} + \gamma_9 Sales Intensity \\
 & + \eta_t + \xi_j + \varepsilon_{i,t},
 \end{aligned}$$

where the dependent variables $D_{q,i,t}$ are the dummy variables mentioned above and interactions are one of the two interaction terms defined in Section 4.1. For the graphical representation of the results, we calculate the probability of the distribution of *IT-Exposure* in 5% steps from the 5th to the 95th percentile of *IT-Exposure*. All control variables, except *R&D* and *CapEx*, are analyzed at their (unconditional) mean. The dummy component of the interaction term used is set to the values 0 and 1, respectively. In accordance with this, the corresponding continuous variable (*R&D* or *CapEx*) is analyzed at its (conditional) mean, provided that the dummy component has the value 0 or 1.

We also add industry ξ_j and year fixed effects η_t , which leads to an incidental parameter problem and may render the standard maximum likelihood estimator biased. Therefore, the use of a conditional estimator with cluster robust standard errors is proposed (Neyman and Scott, 1948; Chamberlain, 1980; Lancaster, 2000). However, we encounter practical implementation

problems in Stata¹⁴, which force us to use the standard logit estimator with cluster robust standard errors. In the case of sufficient observations per group (here, number of firms' times number of years per industry) the bias of the unconditional fixed effects estimator is not a concern (Katz, 2001; StataCorp LLC, 2017, p. 359). Since we use 2-digit SIC code industry fixed effects, our database includes industries with less than “sufficient” observations per group. Therefore, we define a minimum of 100 observations per industry as sufficient and exclude all industries with less than 100 observations. To ensure the robustness of our results, we re-estimate our regression each time with a different minimum number of observations, set at 50, 30, and 0, respectively, and find quantitatively very similar results. Since we expect a nonlinear relationship between *IT-Exposure* and firm value, model (2) is separately estimated for positive and negative *IT-Exposure*.

4.4.2 Empirical results

Figure 3 and Figure 4 depict our estimated probability results, distinguishing between the interaction term used. In case of positive (negative) *IT-Exposure* a low *IT-Exposure* percentile, e.g., 5th percentile, refers to a small positive (large negative; mathematically small) value, while a high *IT-Exposure* percentile, e.g., 95th percentile, refers to a large positive (small negative; mathematically large) value.¹⁵

Figure 3 shows results for the interaction term (*IT-Exposure* × *CapEx-Dummy*). If a firm has a negative *IT-Exposure* and makes CapEx investments that are below industry median, *CapEx-Dummy* = 0, then the probability of a low [high] firm value increases [decreases] with

¹⁴ Stata 15 reports a numeric overflow problem, why computations cannot proceed.

¹⁵ An example to clarify things. Positive exposure: the 5th (small) percentile corresponds to an exposure of, e.g., 0.05 (small) whereas the 95th (large) percentile corresponds to an exposure of, e.g., 2.5 (large). Negative exposure: the 5th (small) percentile corresponds to an exposure of, e.g., -2.5 (large) whereas the 95th (large) percentile corresponds to an exposure of, e.g., -0.05 (small).

increasing *IT-Exposure*, i.e., decreasing percentile (I-a) [III-a]. However, if a firm makes CapEx investments above industry median, *CapEx-Dummy* = 1, the probability of a low [high] firm value remains stable [increases] with increasing *IT-Exposure*, i.e., decreasing percentile, and only increases for extreme exposures, i.e., low percentile (I-a) [III-a]. If a firm has a positive *IT-Exposure* and conducts CapEx investments below industry median, then the probability of a low [high] firm value increases [decreases] with increasing *IT-Exposure*, i.e., increasing percentile (II-a) [IV-a]. However, if a firm conducts CapEx investments that are above the industry median, the probability of a low [high] firm value remains stable [increases] with increasing *IT-Exposure*, i.e., increasing percentile, and slightly decreases for extreme exposures, i.e., high percentile (II-a) [IV-a]. Given the observed quadratic relationship between *IT-Exposure* and firm value, we can calculate the *Absolute IT-Exposure* and thus estimate model (2) again. This allows us to maximize the number of observations. The results are shown in graphs I-b and II-b and confirm our findings, but with slightly narrower confidence intervals.

[Figure 3 about here]

Figure 4 shows results for the interaction term (*IT-Exposure* × *R&D-Dummy*). Analogous to Figure 3, we find that with increasing *IT-Exposure* and R&D expenditures below industry median, *R&D-Dummy* = 0, the probability of a low [high] firm value increases [decreases] with increasing *IT-Exposure*. In case of R&D expenditures above industry median, *R&D-Dummy* = 1, the probability of a low [high] firm value remains almost constant [increases] with increasing *IT-Exposure* (I-a; II-a) [III-a; IV-a]. Again, the use of the *Absolute IT-Exposure* (I-b; II-b) allows for the same conclusions but is associated with slightly smaller confidence intervals.

[Figure 4 about here]

To summarize: it can be stated that (i) there is both a u-shaped and an inverted u-shaped relationship between *IT-Exposure* and firm value; (ii) the probability of whether a firm has a high or low firm value is independent of the sign of the *IT-Exposure* but depends on the *IT-Exposure's* magnitude; (iii) this probability is significantly influenced by the firm's investment behavior in *R&D* or *CapEx*; and (iv) if a firm invests sufficiently, i.e., above the industry median, then on average the IT-related investments can increase (decrease) the probability of a high (low) firm value and thus successfully protect the firm against challenges induced by technological progress.

4.5 Fixed effects regression

4.5.1 Empirical design and methodology

To investigate the average impact of *IT-Exposure* on *Tobin's Q*, we estimate the following fixed effects panel data regression using industry clustered robust standard errors, conditioning on positive and negative *IT-Exposure*, separately:

$$\begin{aligned}
 \text{Tobin's } Q_{i,t} = & \alpha + \beta * \text{IT-Exposure}_{i,t} + \sum_{k=1}^K \lambda_k * \text{Interactions}_{k,i,t} & (3) \\
 & + \gamma_1 \text{CapEx} + \gamma_2 \text{R\&D} + \gamma_3 \text{Size} + \gamma_4 \text{Capital Intensity} \\
 & + \gamma_5 \text{Dividend-Dummy} + \gamma_6 \text{Leverage} + \gamma_7 \text{ROA} \\
 & + \gamma_8 \text{Diversification-Dummy} + \gamma_9 \text{Sales Intensity} \\
 & + \eta_t + \xi_j + \varepsilon_{i,t} ,
 \end{aligned}$$

where the estimated coefficients for β and λ_k are of special interest for us and interactions are the variables defined in Section 4.1.

However, the estimation of (3) suffers from endogeneity, especially reverse causality, regarding $CapEx_{i,t}$, $R\&D_{i,t}$, and the $Interactions_{k,i,t}$ through the dummy component. For example, a firm could have a high Tobin's Q due to its CapEx (R&D) expenditures. But it could also be that the company invested in CapEx (R&D) only after it became valuable. Accordingly, we apply an instrumental variable approach and exploit existing industry effects to create instruments for $CapEx$ and $R\&D$. We follow the literature (e.g., Faulkender and Petersen, 2006) and calculate for each firm the mean of $CapEx_{i,t}$ ($R\&D_{i,t}$), for that firm's industry in a specific year, while excluding the firm of interest.¹⁶

Since the endogenous component of both interactions, $CapEx-Dummy$ and $R\&D-Dummy$, is binary, equation (3) is a dummy endogenous variable model (Heckman, 1978) which rules out the standard approach. We follow Wooldridge's (2002, p. 623, procedure 18.1) procedure of a generated instrumental variable approach, used extensively in the literature (Chang et al., 2009; An and Chan, 2008; Adams et al., 2009; Faulkender and Petersen, 2006; Lin and Su, 2008). In a first step, this approach estimates a probit model of the following regression to obtain fitted probabilities of having CapEx (R&D) above industry median, i.e., $CapEx-Dummy$ ($R\&D-Dummy$) takes the value 1:

¹⁶ We also use the median to construct the instruments and find quantitatively very similar results, but the majority do not pass Kleibergen and Paap's (2006) weak identification test.

$$\begin{aligned}
& \text{probit} \left(P(Dummy_{i,t} = 1) \right) & (4) \\
& = \alpha + \beta_1 * Instrument_{i,t} + \gamma_1 Size + \gamma_2 Capital Intensity \\
& + \gamma_3 Dividend-Dummy + \gamma_4 Leverage + \gamma_5 ROA \\
& + \gamma_6 Diversification-Dummy + \gamma_7 Sales Intensity + \eta_t + \xi_j + \varepsilon_{i,t},
\end{aligned}$$

where $Dummy_{i,t}$ is one of *CapEx-Dummy* or *R&D-Dummy* and $Instrument_{i,t}$ is one of the corresponding instruments created for the continuous variables *CapEx* and *R&D*. In a second step, equation (3) is estimated via two-stage least squares (2SLS) using the fitted probabilities from the probit model as instruments for the endogenous dummy. Main advantages of this approach are that it (i) takes into account the binary structure of the endogenous dummy, (ii) does not require the binary response model (4) to be correctly specified, and (iii) under fairly general conditions, this procedure provides asymptotically valid standard errors (Adams et al., 2009; Chang et al., 2009; Wooldridge, 2002).

The use of estimated variables as independent variables in a regression setup leads to an errors-in-variables bias and renders the estimated coefficients inconsistent. This so-called “attenuation bias” leads to coefficients that are biased towards zero. In our case, *IT-Exposure* is affected by attenuation bias, which leads to more conservative coefficient estimates (Levi, 1973; Tambe and Hitt, 2014b).

4.5.2 Empirical results – not controlling for endogeneity

Panel A of Table 4 shows fixed effects results, distinguishing between positive and negative *IT-Exposure*, while Panel B uses the *Absolute IT-Exposure*. The use of *Absolute IT-Exposure* is possible due to the observed quadratic relationship in Section 4.4. The sign and statistical

significance of our controls are mostly in line with our expectations. In case of positive *IT-Exposure*, Model (I) shows a positive but non-significant effect on firm value. For negative *IT-Exposure*, the coefficient is -0.001 and statistically insignificant. Considering both, the negativity of the *IT-Exposure* and the negative coefficient, the effect is again positive at 0.001. Models (II), (III), and (IV) apply control variables and interaction effects. For model (II) [(III)], incorporating (*IT-Exposure* × *CapEx-Dummy*) [(*IT-Exposure* × *R&D-Dummy*)], both the positive (-0.044) [-0.033] and the negative (0.064) [0.055] *IT-Exposure* show a negative and mostly statistically significant effect, therefore reducing firm value. However, if a firm invests sufficiently in CapEx [R&D], both the positive (0.087) [0.059] and the negative *IT-Exposure* (-0.079) [-0.069] have a positive effect on firm value, significant at the 1% level. Model (IV) implements both interaction terms and shows a stronger *IT-Exposure* discount for the positive (-0.074) and negative (0.091) *IT-Exposure*, which is overcompensated by sufficient investments in CapEx (0.087; -0.081) and R&D (0.059; -0.071), significant at the 1% level.¹⁷ Applying *Absolute IT-Exposure* in Panel B confirms the presented results.

The observed effects are in line with our previous findings (Section 4.4) and can be summarized as follows: (i) Considering control variables and interaction effects, an *IT-Exposure* value discount can be shown, (ii) this firm value discount can be compensated by sufficient investments in CapEx or R&D. Hence, investments provide an effective protection against technological changes and increase firm value in contrast to idle firms. (iii) As model (IV) shows, there are no substitution effects between the interaction terms as the estimated coefficients are very similar to those in models (II) and (III) and statistical significance remains at the 1% level. This is of relevance, since Brown and Petersen (2015) show that in times of crisis firms focus their liquidity management on keeping R&D investments as constant as

¹⁷ We also estimate 10-year subperiods (Table IA.2) and apply between effects (Table IA.3) as well as Fama-MacBeth (1973) regressions (Table IA.4) to analyze the cross section. We can confirm our results robustness.

possible, whereas investments in CapEx are often significantly reduced. Thus, investments in CapEx and R&D are to be regarded as complementary, which also offer effective protection against technological challenges when viewed separately.

[Table 4 about here]

4.5.3 Empirical results – controlling for endogeneity

Since our previously discussed results are potentially biased due to endogeneity, we re-estimate equation (3) using an instrumental variables approach. Panel A of Table 5 shows results of the probit regression, for which equation (4) is estimated (separately for *CapEx-Dummy* and *R&D-Dummy*) using the economic instruments for the continuously expressed variables *CapEx* and *R&D* described in Section 4.5.1. The results show a negative and statistically significant correlation between the respective regressand and the corresponding instrument demonstrating that the instruments influence the dummy regressands as expected and that the specification does not suffer from “weak instruments”.¹⁸

Panel B and Panel C (*Absolute IT-Exposure*) of Table 5 report our 2SLS results. For each instrumental variables regression, we report validity tests for endogeneity (Durbin, 1954; Wu, 1973; Hausman 1978), underidentification and weak identification (Kleibergen and Paap, 2006). The test statistics indicate that the regressors in question are endogenous and that the instruments are correlated with the endogenous regressors and are not weak instruments.

¹⁸ The observed negative correlation is due to technical reasons. The *CapEx-Dummy* (*R&D-Dummy*) takes the value 1 if *CapEx* (*R&D*) is above the industry (2-digit SIC code) median, otherwise 0. The *CapEx* (*R&D*) instrument is generated excluding the firm under consideration. Therefore, if the *CapEx-Dummy* (*R&D-Dummy*) takes the value 1 [0], then *CapEx* (*R&D*) is above [below] industry median and consequently, compared to many other firms, can be classified as high [low]. However, since this firm is excluded from the calculation of the instruments, the result is a decreasing [increasing] industry median and thus a negative correlation.

Model (II) does not support our interpretation, since the estimated coefficients at focus, *IT-Exposure* and (*IT-Exposure* × *CapEx-Dummy*), are characterized by a shifting of signs as well as a lack of significance. In contrast, model (III) confirms our previous argumentation showing a significant (at the 1% level) negative effect of *IT-Exposure* on firm value (-0.084/0.101), that is overcompensated if R&D investments above industry median are made (0.180/-0.195), significant at least at the 5% level. Model (IV) again considers the possibility of making (IT-related) investments in form of CapEx as well as R&D. As before, the significant (1% level) negative influence of *IT-Exposure* is confirmed (-0.098/0.149) and can be more than compensated by appropriate investments in CapEx (0.022/-0.084; both insignificant) and R&D (0.187/-0.224, significant at 1% level). Using *Absolute IT-Exposure* (Panel C) confirms our results.

[Table 5 about here]

4.5.4 Economic significance

In the following we briefly discuss the economic significance of our results, according to Table 6 and thus calculate two indicators: (i) the indicator “Compensation Factor” is calculated as the sum of the positive effects of the interaction terms divided by the negative influence of *IT-Exposure*; (ii) the indicator “Value Premium” is calculated by multiplying the estimated coefficients for *IT-Exposure* and the interaction terms with the average *IT-Exposure* (distinguishing between positive, negative and absolute exposure), summing them, and finally relating the sum to the average *Tobin’s Q*.

Without controlling for endogeneity, we find for models (II), (III) and (IV) Compensation Factors in the range of 1.2 to 2.0, meaning that the firm value reducing impact of *IT-Exposure*

can be overcompensated by 120% to 200%, resulting in an overall positive, value enhancing, effect. These figures relate to a Value Premium of between 1.7% and 5.7% for Model (II) and (III), and between 7.4% and 9.6% for Model (IV), showing that firms experience an economically significant premium when investing above industry median.

When we control for endogeneity these effects increase strongly. The Compensation Factor now lies (for models (III) and (IV), as they provide plausible results) between 1.9 and 2.1, corresponding to a Value Premium of 11.3% to 12.8% for model (III) and 14.8% to 19.2% for model (IV). This confirms that firms which successfully adapt their business model to the new conditions caused by IT progress are rewarded with a significant premium.

[Table 6 about here]

4.6 Robustness tests

Having established a link between *IT-Exposure* and firm value, we then perform two major tests to evaluate the robustness of our results and discuss them briefly. First, since *IT-Exposure* is our main variable, we control for the robustness of our results by modifying the model used to estimate *IT-Exposure*. Instead of using the underlying 3-factor Fama-French model (1993), we now use the CAPM (Sharpe, 1964) extended by our IT-proxy and perform our entire analysis again. We find very similar results across all our analyses, both quantitatively and qualitatively. Panel A of Table 7 shows 2SLS results confirming the value reducing impact of *IT-Exposure*, that can be overcompensated by sufficient IT related investments via CapEx and R&D.

As a second robustness check, we exclude IT related firms, since those firms could be driving our results. Therefore, we identify the 4-digit SIC codes of our IT-proxy constituents and

exclude afterwards all firms belonging to the respective 2-digit SIC codes. As the definition of “IT related” can be vague, we exclude firms not based on their 4-digit SIC code but on their 2-digit SIC code to ensure we have excluded IT firms in the broadest sense. Panel B of Table 7 shows the respective 2SLS estimates, confirming our results robustness. We find quantitatively similar results when excluding firms based on their 3-digit or 4-digit SIC codes.

[Table 7 about here]

5 Conclusion

We investigate the relationship between a firms’ *IT-Exposure* and its firm value. Compared to previous literature, our methodology allows us to investigate a large dataset with more than 48,000 firm-year observations for firms in the Russell 3000 Index covering the period 1990 to 2018. *IT-Exposure* is defined as the exposure (sensitivity) of a firm’s return to an IT-proxy, estimated using a Fama-French 3-factor model extended by an IT-proxy. The IT Index that is used as a proxy, reflects the average performance of the included firms. Based on the market-efficiency hypothesis (Fama, 1970) that stock prices reflect all available information, it can be concluded that the performance of the firms included in the IT-proxy is determined by the degree of innovation, i.e., the development of new hardware and software, for example. The estimated *IT-Exposure* now indicates how sensitively a firm’s return reacts to changes in the IT sector. We interpret *IT-Exposure* as a measure of how strongly the business model is challenged by advances in IT as well as the need to adapt it.

In a second step we analyze the impact of the interrelationship between *IT-Exposure* and investment behavior on firm value, approximated by *Tobin’s Q*. Firms can choose between

investing in external solutions (*CapEx*) and internal solutions (*R&D*). Using *CapEx* as well as *R&D* is advantageous since there is no need to define IT expenditures in a complete and comprehensive way, which is difficult to measure in practice (Mitra and Chaya, 1996; Brynjolfsson and Hitt, 1996; Brynjolfsson et al., 2002; Tambe and Hitt, 2014b). Furthermore, *CapEx* and *R&D* comprise not only IT expenditures (Tambe and Hitt, 2012; Barua et al., 1995; Brynjolfsson and Hitt, 1996; Mitra and Chaya, 1996), but also expenditures that positively impact the business model adaptation process forced by IT progress, but would not be classified directly as IT-related expenditures (Bardhan et al., 2013).

The *Total IT-Exposure* shows that in principle 89% of firms are affected by IT progress and thus their business models. The use of partial *IT-Exposure* allows the focus to be directed at those firms whose *IT-Exposure* deviates from market average. An analysis of the partial *IT-Exposure* suggests a systematic structure and shows that the level of a firm's *IT-Exposure* is not arbitrary. Applying univariate and multivariate portfolio sorting reveals a u-shaped relationship between *IT-Exposure* and firm value, i.e., the more extreme the *IT-Exposure* (positive as well as negative) the higher the firm value. The impact of *IT-Exposure* on the probability of a high or low firm value is examined by means of (conditional) logit analysis. Our results show that a more extreme (positive as well as negative) *IT-Exposure* increases the probability of a low firm value. However, if firms conduct sufficient investments, the probability of a high firm value increases and the probability of a low firm value decreases. Finally, implementing a 2SLS fixed effects regression, to control for endogeneity, confirms the significant negative influence of *IT-Exposure* on *Tobin's Q* and the positive influence of IT-related investments via *CapEx* and *R&D*. Therefore, the negative IT effect is overcompensated by up to 2.1 times if sufficient investments are made, amounting to a premium for a firm with an average *Tobin's Q* of 14.8% to 19.2%.

Overall, we introduce a new approach to analyze the relationship between IT and firm value. This approach requires no specific IT expenditure data and allows a relative differentiation between firms whose business model is affected by new IT above average compared to those firms that are far less affected. Furthermore, the approach allows a distinction to be made between a fundamentally negative IT impact, which affects all firms, and the positive IT effect that arises if there is sufficient investment activity. Our approach can confirm the overall positive IT effect observed in the literature.

Our findings are important for companies and show the need to embrace technological transformation. There are two options available to companies for a successful transformation. One is to invest in firm internal solutions via R&D and the other in firm external solutions via CapEx.

Appendix

Table A.1: Variable definitions for variables used in second stage analysis

(1) Variable	(2) Definition
Raw Tobin's Q	Defined as book value of assets (WC02999) minus book value of equity (WC03995) plus market value of equity (RDS MV) all divided by total assets (WC02999; Coles et al. 2008; Hong and Kacperczyk, 2009; Doidge et al., 2004).
Tobin's Q	We calculate the natural logarithm of "Raw Tobin's Q" to obtain Tobin's Q (Coles et al. 2008; Hong and Kacperczyk, 2009; Doidge et al., 2004).
IT-Exposure	Estimated IT coefficient from a Fama and French 3-factor model (Fama and French, 1993) extended by an IT-proxy. We expect a negative effect on Tobin's Q.
Absolute IT-Exposure	Defined as the absolute value of "IT-Exposure".
Total IT-Exposure	The market factor is regressed on all other regressors used in equation (1) and the resulting residuals are further on used as an orthogonalized market factor in equation (1) instead of the original market factor itself.
CapEx	Capital expenditures (WC04601) divided by total assets (WC02999; Servaes, 1996; Jin and Jorion, 2006). Positively affects firm value (Allayannis and Weston, 2001; Myers, 1977; Smith and Watts, 1992).
R&D	Defined as R&D (WC01201) divided by total assets (WC02999) and is expected to positively impact firm value. We follow the common practice in previous research and replace missing values with zero. This is because since 1972 the SEC has required all publicly traded firms to report their R&D expenditures when they are material, exceed 1% of sales, or a policy of deferral or amortization of R&D expenses is pursued (Allayannis and Weston, 2001; Lewis and Tan, 2016; Hirschey et al., 2012; Chauvin and Hirschey, 1993; Myers, 1977; Smith and Watts, 1992).
(IT-Exposure x CapEx-Dummy)	Interaction effect between IT-Exposure and CapEx-Dummy, where CapEx-Dummy equals 1 if CapEx of a firm is in year t larger than the industry-specific (2-digit SIC code) median in year t , else 0.
(IT-Exposure x R&D-Dummy)	Interaction effect between IT-Exposure and R&D-Dummy, where R&D-Dummy equals 1 if R&D of a firm is in year t larger than the industry-specific (2-digit SIC code) median in year t , else 0.
Capital Intensity	Gross Property, Plant, and Equipment (WC02501) divided by total assets (WC02999; Konijn et al., 2011; Gulen and Ion, 2015). Can be positively or negatively related to Tobin's Q, since relatively large intangible assets may lead to an underestimation of Tobin's Q's denominator, the replacement costs of capital. On the other hand, agency problems could cause larger problems for firms with lower tangible assets (Konijn et al., 2011; Habib and Ljungqvist, 2005).
Diversification-Dummy	Indicator variable that equals 1 if the firm's number of operating segments which operate in different 2-digit SIC codes is two or higher, else 0 (based on WC19506 to WC19596; Glaser and Müller, 2010; Kuppaswamy and Villalonga, 2016). Empirical literature largely records a negative effect on firm value (Lang and Stulz, 1994; Berger and Ofek, 1995; Lins and Servaes, 1999) even after accounting for endogeneity problems (Campa and Keida, 2002; Graham et al., 2002; Villalonga, 2004).

Dividend-Dummy	Indicator variable that takes the value 1 if the firm paid a dividend (WC05101) in the current year, else 0. Missing values are replaced with 0 (Servaes, 1996; Allayannis and Weston, 2001). A firm's value can remain high even if the firm fails to undertake potential projects due to a lack of funding, as long as only the projects with the highest NPVs are carried out. Thus, a firm is unlikely to be capital constrained if it pays a dividend and could therefore have a lower Tobin's Q, which corresponds to a negative regression coefficient (Lang and Stulz, 1994; Servaes, 1996; Allayannis and Weston, 2001).
Leverage	Total debt divided (WC03255) by shareholders' equity (WC03995). A firm's capital structure may have a positive impact on firm value (Allayannis and Weston, 2001; Fauver and McDonald IV, 2014).
ROA	Net income (WC01551) divided by total assets (WC02999). Profitability makes it more likely for a firm to be traded at a premium, i.e., higher Tobin's Q (Allayannis and Weston, 2001; Jin and Jorion, 2006).
Sales Intensity	Defined as sales (WC01001) divided by total assets (WC02999; Kobbelsky et al. (2008)). We have no expectation regarding the coefficient's sign.
Size	Natural logarithm of total assets (WC02999; Lang and Stulz (1994); Allayannis and Weston, 2001), deflated by the consumer price index to express nominal values in 2015 dollars (Flannery and Rangan, 2006). The yearly consumer price index is obtained via the Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/). Whether firm size has a positive influence on profitability is ambiguous, at least for US firms (Lang and Stulz, 1994; Allayannis and Weston, 2001).

This table shows definitions of variables used in the second part of our analysis as well as the expected relationship between Tobin's Q and our independent variables. Where "RDS" and "WC", indicate "Refinitiv Datastream" and "Worldscope" items used to retrieve the data.

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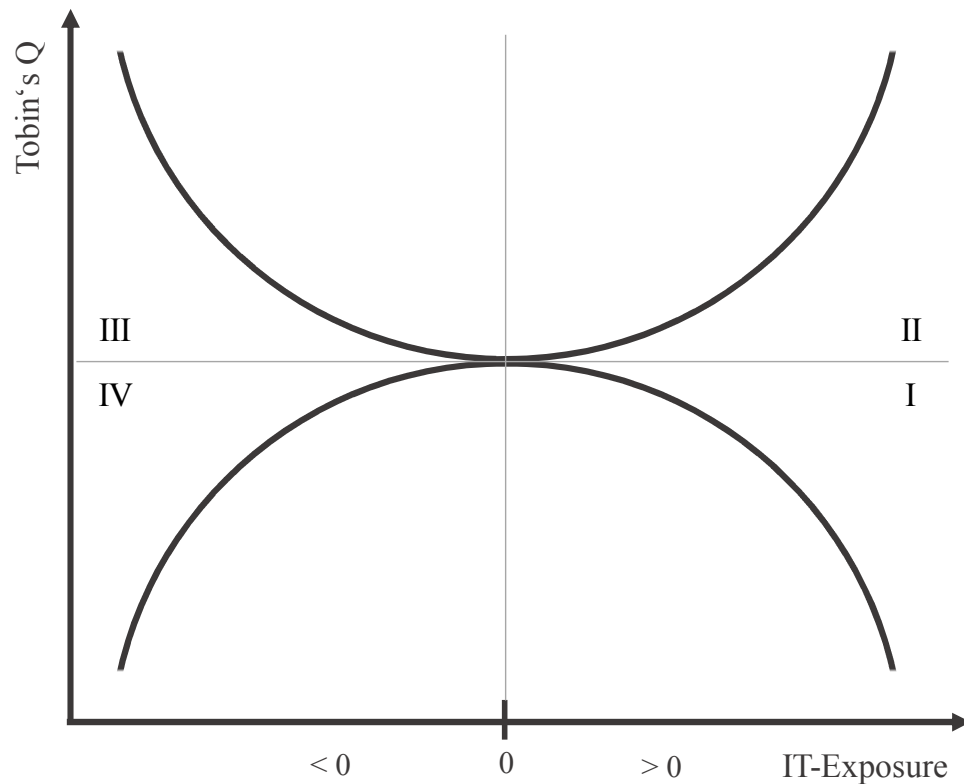
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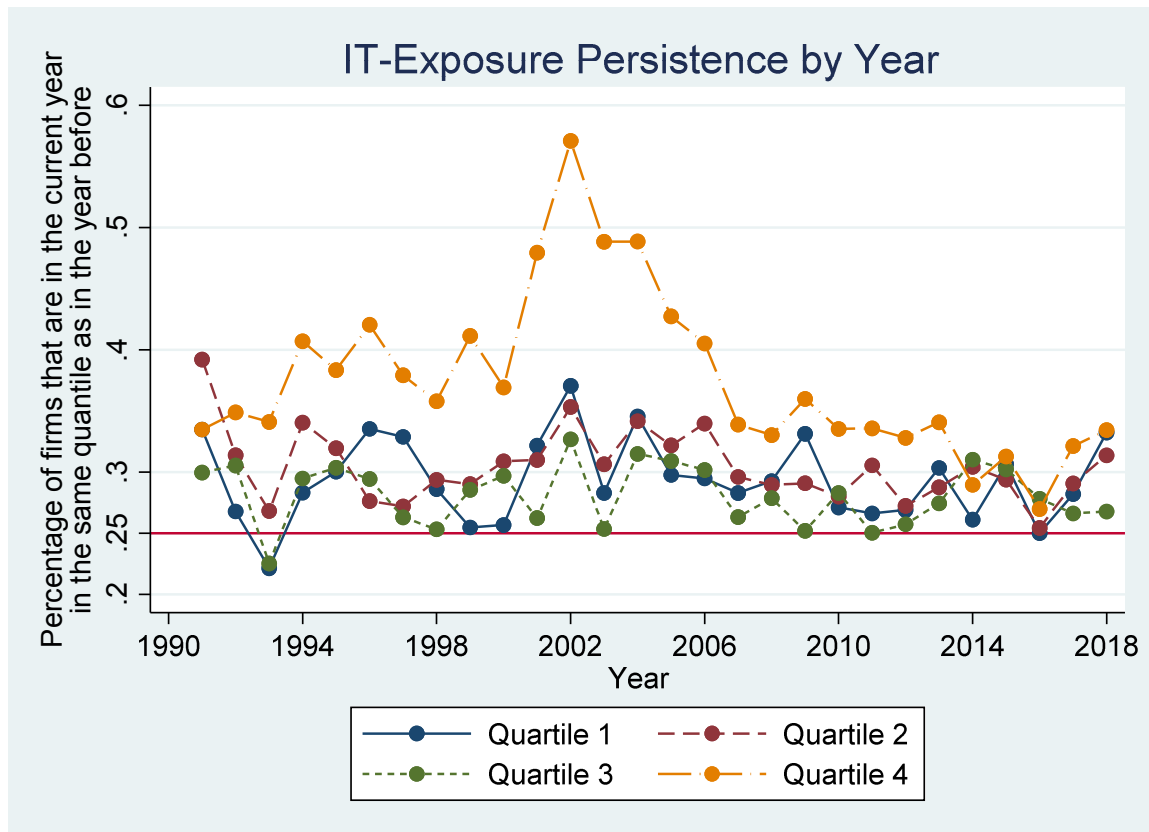
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Figures and Tables

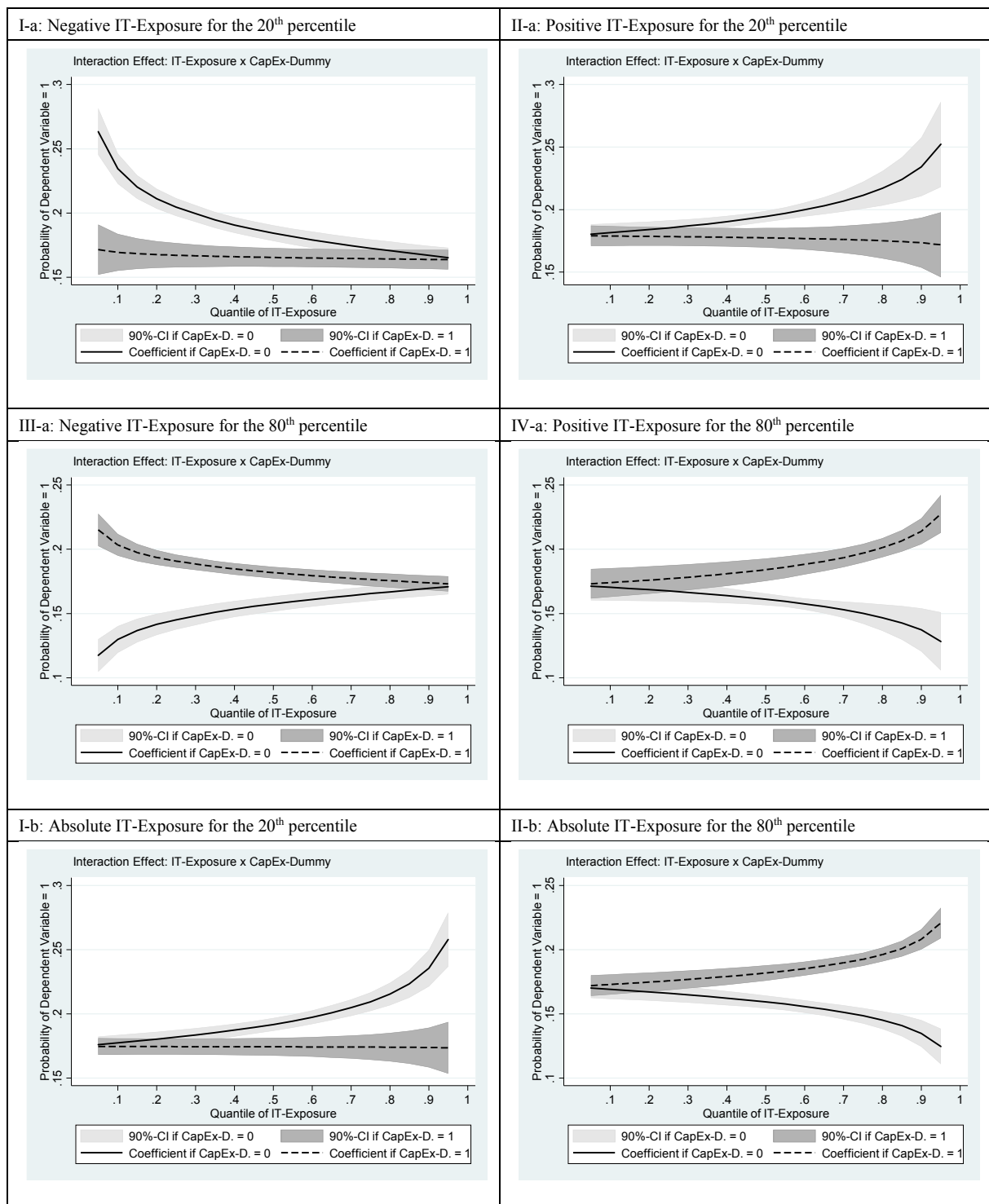
Figure 1: Theoretical relationship between firm value and IT-Exposure



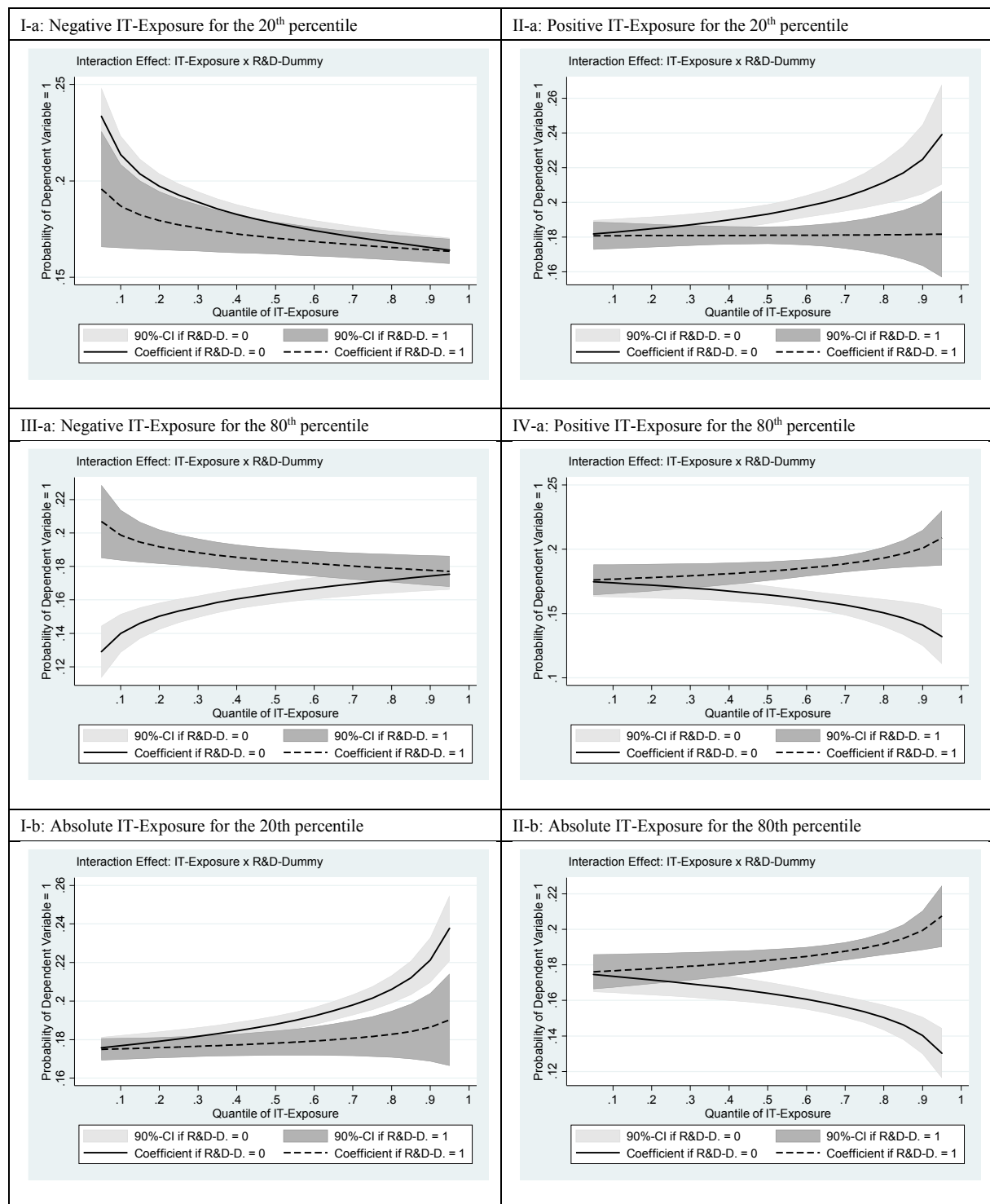
This figure shows our theoretically expected interrelationship between a firm's *IT-Exposure* and its firm value. The business model of firms with a positive *IT-Exposure* is challenged above market average and leads to a reduction in firm value if the firms do not adapt their business model to the new conditions (quadrant I). If, on the other hand, firms adapt their business model to the new challenges, they experience a value premium (quadrant II). The business model of firms with a negative *IT-Exposure* is also challenged, but below market average. The more negative the *IT-Exposure*, the less pressure there is on the business model to adapt, which is why we expect the value of these firms to increase with the degree of *IT-Exposure* (quadrant III). Empirically, we also find a discount in firm value (quadrant IV) and attribute this to a lack of investment behavior.

Figure 2: Yearly IT-Exposure persistence by exposure quartile

Each year firms are divided into quartiles based on their *IT-Exposure* in the respective year. Subsequently, for each year and each quartile, the number of firms divided into the same exposure quartile in the current year and one year before is determined. A random allocation to the quartiles would lead us to expect migration rates of 25% (red horizontal line). Deviations point to a certain IT-Exposure persistence.

Figure 3: Estimated probability via logit for minimum number of observations of 100

This figure reports results from logistic regression according to model (2), distinguishing between partial (positive and negative) and *Absolute IT-Exposure* as well as *Tobin's Q* being below the 20th and above the 80th percentile, respectively. The interaction effect (*IT-Exposure x CapEx-Dummy*) was used. Light (dark) shaded areas represent the 90% confidence interval when the *CapEx-Dummy* is 0 (1). Solid (dashed) lines represent coefficients when the *CapEx-Dummy* is 0 (1). The continuous variable *CapEx* is set at the (conditional) mean of the respective quantile if *CapEx-Dummy* is 1 or 0. All other variables are set at their (unconditional) mean of the entire distribution. 2-digit SIC code industry and year fixed effects were incorporated and industry clustered robust standard errors calculated.

Figure 4: Estimated probability via logit for minimum number of observations of 100

This figure reports results from logistic regression according to model (2), distinguishing between partial (positive and negative) and *Absolute IT-Exposure* as well as *Tobin's Q* being below the 20th and above the 80th percentile, respectively. The interaction effect (*IT-Exposure x R&D-Dummy*) was used. Light (dark) shaded areas represent the 90% confidence interval when the *R&D-Dummy* is 0 (1). Solid (dashed) lines represent coefficients when the *R&D-Dummy* is 0 (1). The continuous variable *R&D* is set at the (conditional) mean of the respective quantile if *R&D-Dummy* is 1 or 0. All other variables are set at their (unconditional) mean of the entire distribution. 2-digit SIC code industry and year fixed effects were incorporated and industry clustered robust standard errors calculated.

Table 1: Correlation structure between market and IT-proxies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>Market Proxy</u>												
Fama-French	100%											
Wilshire 5000	99.89%	100%										
Russell 3000	99.91%	99.98%	100%									
S&P 500	99.54%	99.75%	99.70%	100%								
<u>IT-proxy</u>												
S&P 500 IT	87.30%	87.18%	87.33%	87.84%	100%							
DJ Technology	86.78%	86.53%	86.73%	86.92%	99.59%	100%						
MSCI World IT	88.01%	87.75%	87.98%	88.18%	99.28%	99.26%	100%					
S&P 500 IT ETF	79.95%	79.84%	79.95%	80.40%	91.71%	91.06%	92.52%	100%				
MSCI World IT ETF	80.92%	80.66%	80.86%	80.97%	91.33%	91.14%	93.30%	98.97%	100%			
<u>Other</u>												
SMB	22.54%	20.72%	21.61%	14.58%	13.60%	17.23%	16.02%	10.53%	14.01%	100%		
HML	-6.62%	-6.61%	-7.07%	-7.43%	-35.11%	-36.72%	-35.12%	-30.52%	-30.53%	-8.21%	100%	
RF	-15.38%	-15.24%	-15.16%	-14.07%	-12.26%	-12.25%	-13.72%	-13.60%	-14.53%	-12.51%	-9.15%	100%

This table shows correlation coefficients for market and IT-proxies, Fama and French risk factors SMB and HML and the risk-free rate RF.

Table 2: Descriptive statistics for regression variables and different IT-Exposure definitions

Variables	(1) Obs.	(2) Mean	(3) Std. Dev.	(4) Min	(5) Max	(6) P5	(7) P10	(8) P25	(9) P50	(10) P75	(11) P90	(12) P95
<u>Panel A: Full Sample</u>												
<u>Dependent Variable</u>												
Raw Tobin's Q	48,952	1.91	1.33	0.47	15.25	0.83	0.94	1.13	1.47	2.16	3.41	4.58
Tobin's Q	48,952	0.49	0.52	-0.76	2.72	-0.19	-0.07	0.12	0.38	0.77	1.23	1.52
<u>IT-Exposure</u>												
IT-Exposure	48,952	0.02	2.59	-76.98	464.60	-1.30	-0.91	-0.43	-0.03	0.42	1.04	1.49
IT-Exposure winsorized	48,952	0.01	0.87	-5.26	4.77	-1.30	-0.91	-0.43	-0.03	0.42	1.04	1.49
IT-Exposure abs. & win.	48,952	0.62	0.65	0.00	6.77	0.04	0.07	0.19	0.43	0.84	1.40	1.85
Total IT-Exposure win.	48,952	0.54	0.53	-2.09	3.15	-0.22	-0.03	0.22	0.51	0.82	1.19	1.46
<u>Control Variables</u>												
CapEx	48,952	0.06	0.06	0.00	0.42	0.01	0.01	0.02	0.04	0.07	0.12	0.18
Capital Intensity	48,952	0.29	0.25	0.00	0.95	0.02	0.04	0.09	0.21	0.43	0.70	0.81
Diversification-Dummy	48,952	0.31	0.46	0.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
Dividend-Dummy	48,952	0.40	0.49	0.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
Leverage	48,952	0.91	1.93	0.00	22.43	0.00	0.00	0.06	0.42	0.97	1.88	3.18
R&D	48,952	0.05	0.10	0.00	0.84	0.00	0.00	0.00	0.00	0.05	0.14	0.22
ROA	48,952	0.00	0.19	-1.52	0.33	-0.35	-0.15	0.00	0.04	0.08	0.12	0.16
Sales Intensity	48,952	1.03	0.75	0.00	4.16	0.13	0.26	0.50	0.88	1.37	2.00	2.52
Size	48,952	2.23	1.91	-3.26	7.74	-0.83	-0.16	0.91	2.16	3.50	4.79	5.52
<u>Panel B: Positive IT-Exposure</u>												
Tobin's Q	23,264	0.50	0.53	-0.76	2.72	-0.47	-0.20	-0.08	0.12	0.40	0.79	1.25
IT-Exposure (win.)	23,264	0.66	0.65	0.00	4.77	0.01	0.04	0.07	0.19	0.46	0.93	1.52
CapEx	23,264	0.05	0.06	0.00	0.42	0.00	0.01	0.01	0.02	0.04	0.07	0.12
Capital Intensity	23,264	0.26	0.23	0.00	0.95	0.00	0.02	0.03	0.08	0.18	0.37	0.64
Diversification-Dummy	23,264	0.29	0.45	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
Dividend-Dummy	23,264	0.34	0.47	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
Leverage	23,264	0.84	1.91	0.00	22.43	0.00	0.00	0.00	0.03	0.33	0.86	1.76

R&D	23,264	0.05	0.10	0.00	0.84	0.00	0.00	0.00	0.00	0.01	0.07	0.15
ROA	23,264	-0.01	0.20	-1.52	0.33	-0.96	-0.38	-0.17	-0.01	0.04	0.08	0.13
Sales Intensity	23,264	1.05	0.74	0.00	4.16	0.00	0.14	0.28	0.53	0.89	1.38	2.00
Size	23,264	2.06	1.85	-3.26	7.74	-2.22	-0.90	-0.22	0.80	2.00	3.28	4.50

Panel C: Negative IT-Exposure

Tobin's Q	25,688	0.48	0.51	-0.76	2.72	-0.45	-0.18	-0.06	0.12	0.38	0.75	1.20
IT-Exposure (win.)	25,688	-0.58	0.58	-5.26	0.00	-2.85	-1.70	-1.27	-0.78	-0.41	-0.18	-0.07
CapEx	25,688	0.06	0.06	0.00	0.42	0.00	0.01	0.01	0.02	0.04	0.07	0.13
Capital Intensity	25,688	0.32	0.26	0.00	0.95	0.00	0.02	0.04	0.10	0.24	0.49	0.74
Diversification-Dummy	25,688	0.33	0.47	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
Dividend-Dummy	25,688	0.45	0.50	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
Leverage	25,688	0.97	1.94	0.00	22.43	0.00	0.00	0.00	0.11	0.50	1.05	1.97
R&D	25,688	0.04	0.09	0.00	0.84	0.00	0.00	0.00	0.00	0.00	0.03	0.11
ROA	25,688	0.00	0.18	-1.52	0.33	-0.93	-0.33	-0.13	0.01	0.04	0.08	0.12
Sales Intensity	25,688	1.02	0.75	0.00	4.16	0.00	0.12	0.25	0.46	0.87	1.37	2.00
Size	25,688	2.37	1.94	-3.26	7.74	-2.12	-0.75	-0.10	1.01	2.32	3.71	5.02

This table shows descriptive statistics for our dependent variable, *IT-Exposure* and control variables for the sample period 01/01/1990 – 12/31/2018 (yearly observations), distinguishing between our full sample (Panel A) positive (Panel B) and negative (Panel C) *IT-Exposure*. Variables are defined as in Table A.1. In Panel A, each year, “Dependent Variable” and “Control Variables” (aside from dummy variables) are winsorized at the 1st and 99th percentiles. “*IT-Exposure*” stands for the raw version of the estimated partial exposure in model (1). Winsorized (win.) indicates that the variable was winsorized at the 1st and 99th percentiles and absolute (abs.) indicates that the absolute value was formed. “*Total IT-Exposure*” was estimated using an orthogonalized market proxy in model (1). “*IT-Exposure* winsorized” indicates our main version of *IT-Exposure* used in our analysis. In Panel B and Panel C, each year, all variables (aside from dummy variables) are winsorized at the 1st and 99th percentiles.

Table 3: Portfolio sorts

Quintile / Period	(1) 1990-1993	(2) 1994-1998	(3) 1999-2003	(4) 2004-2008	(5) 2009-2013	(6) 2014-2018
<i>Panel A: No controls</i>						
Q1	1.70	2.01	2.05	2.15	1.77	2.03
Q2	1.55	1.82	1.81	1.93	1.66	2.00
Q3	1.55	1.74	1.75	1.91	1.69	1.99
Q4	1.51	1.77	1.77	1.95	1.65	2.04
Q5	1.68	2.16	2.50	2.16	1.78	2.08
Q5-Q1	-0.02 (-0.30)	0.15** (2.48)	0.45*** (6.49)	0.02 (0.35)	0.02 (0.46)	0.06 (1.20)
Q1-Q3	0.15** (2.23)	0.27*** (5.33)	0.30*** (5.85)	0.24*** (5.88)	0.08** (2.37)	0.04 (0.89)
Q5-Q3	0.13* (1.95)	0.41*** (7.83)	0.75*** (11.68)	0.25*** (6.49)	0.10*** (2.83)	0.09** (2.21)
<i>Panel B: 2-digit SIC Code and R&D scaled by firm size as controls</i>						
Q1	1.71	2.03	2.06	2.17	1.76	2.04
Q2	1.56	1.86	1.86	1.98	1.70	2.04
Q3	1.54	1.77	1.80	1.93	1.71	2.05
Q4	1.56	1.81	1.94	2.00	1.67	2.05
Q5	1.62	2.03	2.22	2.03	1.70	1.95
Q5-Q1	-0.09 (-1.31)	0.00 (-0.06)	0.16** (2.46)	-0.13*** (-3.07)	-0.07* (-1.82)	-0.09** (-1.96)
Q1-Q3	0.16** (2.47)	0.26*** (5.09)	0.26*** (4.95)	0.24*** (5.87)	0.05 (1.64)	-0.01 (0.12)
Q5-Q3	0.07 (1.11)	0.26*** (4.91)	0.42*** (6.89)	0.11*** (2.84)	-0.01 (-0.31)	-0.09** (-2.27)
<i>Panel C: 2-digit SIC Code and CapEx scaled by firm size as controls</i>						
Q1	1.67	2.03	2.03	2.15	1.76	2.02
Q2	1.59	1.81	1.82	1.94	1.67	1.99
Q3	1.52	1.73	1.74	1.91	1.68	2.01
Q4	1.56	1.81	1.81	1.94	1.66	2.04
Q5	1.65	2.14	2.49	2.18	1.78	2.09
Q5-Q1	-0.03 (-0.35)	0.11* (1.91)	0.45*** (6.66)	0.03 (0.72)	0.02 (0.50)	0.07 (1.50)
Q1-Q3	0.15** (2.44)	0.30*** (6.03)	0.30*** (5.89)	0.24*** (5.83)	0.09*** (2.61)	0.02 (0.39)
Q5-Q3	0.13** (2.04)	0.41*** (7.92)	0.75*** (11.83)	0.27*** (6.78)	0.11*** (3.11)	0.09** (2.01)

This table shows average *Raw Tobin's Q* quintiles sorted by yearly *IT-Exposure* (winsorized). Parentheses contain t-statistics. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Fixed effects OLS regressions

Variables / Model	<i>Panel A: Positive and Negative IT-Exposure</i>				<i>Panel B: Absolute IT-Exposure</i>						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
IT-Exposure	0.026 (1.346)	-0.001 (-0.035)	-0.044* (-1.951)	0.064*** (9.132)	-0.033 (-1.566)	0.055*** (6.119)	-0.074*** (-3.095)	0.091*** (6.904)	-0.049*** (-3.504)	-0.042*** (-3.068)	-0.078*** (-5.012)
IT-E. x CapEx-D.			0.087*** (7.015)	-0.079*** (-4.580)			0.087*** (7.056)	-0.081*** (-4.627)	0.080*** (6.432)		0.081*** (6.485)
IT-E. x R&D-D.					0.059*** (4.776)	-0.069*** (-3.857)	0.059*** (5.244)	-0.071*** (-4.075)		0.061*** (5.205)	0.063*** (5.999)
CapEx			1.729*** (5.886)	1.536*** (4.931)	2.029*** (6.468)	1.792*** (5.377)	1.717*** (5.862)	1.532*** (4.953)	1.640*** (5.468)	1.911*** (5.955)	1.632*** (5.481)
R&D			1.871*** (8.092)	1.861*** (6.522)	1.735*** (8.527)	1.708*** (6.316)	1.719*** (8.571)	1.696*** (6.301)	1.879*** (7.400)	1.735*** (7.605)	1.720*** (7.612)
Size			-0.004 (-0.609)	-0.017*** (-3.939)	-0.004 (-0.555)	-0.017*** (-3.926)	-0.006 (-4.102)	-0.018*** (-4.102)	-0.009** (-2.250)	-0.009** (-2.192)	-0.010** (-2.603)
Capital Intensity			-0.593*** (-6.469)	-0.512*** (-6.106)	-0.557*** (-6.268)	-0.481*** (-6.042)	-0.583*** (-6.410)	-0.503*** (-6.068)	-0.553*** (-6.547)	-0.520*** (-6.410)	-0.543*** (-6.498)
Dividend-D.			0.097*** (5.512)	0.115*** (7.094)	0.097*** (5.530)	0.114*** (7.067)	0.097*** (5.681)	0.115*** (7.142)	0.105*** (7.059)	0.105*** (7.016)	0.106*** (7.184)
Leverage			0.004* (1.793)	0.008*** (3.827)	0.005* (1.889)	0.008*** (4.034)	0.005** (2.037)	0.008*** (4.134)	0.006*** (2.997)	0.006*** (3.144)	0.006*** (3.326)
ROA			0.210* (1.724)	0.205 (1.541)	0.200 (1.662)	0.201 (1.471)	0.196 (1.614)	0.196 (1.447)	0.211* (1.736)	0.203 (1.665)	0.199 (1.633)
Diversification-D.			-0.056*** (-3.566)	-0.034* (-1.878)	-0.055*** (-3.457)	-0.034* (-1.873)	-0.055*** (-3.532)	-0.034* (-1.890)	-0.046*** (-2.706)	-0.045*** (-2.669)	-0.045*** (-2.696)
Sales-Intensity			-0.012 (-0.726)	0.020 (1.413)	-0.004 (-0.233)	0.026* (1.890)	-0.009 (-0.540)	0.023 (1.592)	0.003 (0.202)	0.010 (0.675)	0.006 (0.371)
Constant	0.055 (1.187)	0.093** (2.600)	0.267*** (6.750)	0.235*** (3.402)	0.213*** (5.684)	0.197*** (3.083)	0.270*** (6.757)	0.234*** (3.392)	0.250*** (4.677)	0.207*** (4.156)	0.251*** (4.684)
Observations	23,264	25,688	23,264	25,688	23,264	25,688	23,264	25,688	48,952	48,952	48,952
Adj. R-squared	0.17	0.20	0.29	0.32	0.29	0.32	0.29	0.32	0.30	0.30	0.30
IT-Exposure used	+	-	+	-	+	-	+	-	/	/	/

Panel A and Panel B report results from fixed effects OLS regressions according to equation (3) using the *IT-Exposures* estimated from the extended Fama-French model characterized by equation (1), thereby Panel B uses the *Absolute IT-Exposure*. 2-digit SIC code industry and year fixed effects were incorporated. “IT-Exposure used” denotes

if *Absolute IT-Exposures* (“*P*”), only positive (“+”) or only negative (“-”) were used. Industry cluster robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Instrumental variables fixed effects regressions

Variables / Model	<i>Panel A: Probit</i>			<i>Panel B: Positive and Negative IT-Exposure</i>			<i>Panel C: Absolute IT-Exposure</i>				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
IT-Exposure			0.033 (0.564)	0.013 (0.564)	-0.084*** (-3.558)	0.101*** (6.006)	-0.098*** (-2.589)	0.149*** (3.946)	0.012 (0.297)	-0.082*** (-5.636)	-0.115*** (-4.901)
IT-E. x CapEx-D.			-0.051 (-0.768)	0.028 (0.541)			0.022 (0.373)	-0.084 (-1.466)	-0.035 (-0.645)		0.054 (1.091)
IT-E. x R&D-D.					0.180** (2.359)	-0.195*** (-3.467)	0.187*** (2.955)	-0.224*** (-4.779)		0.170*** (2.677)	0.186*** (3.810)
CapEx	-10.837*** (-4.551)		4.056*** (3.175)	4.365** (2.397)	3.803*** (5.373)	3.822*** (3.665)	3.863*** (5.160)	4.025*** (3.429)	4.329*** (3.034)	3.905*** (4.913)	4.041*** (4.734)
R&D		-3.157** (-2.236)	-1.015 (-1.034)	-1.076 (-1.283)	-1.031 (-1.069)	-1.313* (-1.697)	-1.036 (-1.090)	-1.378* (-1.791)	-1.112 (-1.379)	-1.203 (-1.537)	-1.228 (-1.611)
Size	0.006 (0.314)	0.014 (0.509)	-0.012* (-1.668)	-0.024*** (-4.215)	-0.017** (-2.241)	-0.027*** (-5.531)	-0.017** (-2.453)	-0.027*** (-5.471)	-0.017*** (-3.737)	-0.020*** (-4.885)	-0.021*** (-5.131)
Capital Intensity	4.522*** (11.993)	-1.464*** (-6.769)	-1.026*** (-3.673)	-1.012*** (-3.008)	-0.985*** (-5.179)	-0.922*** (-4.589)	-1.013*** (-4.838)	-1.018*** (-3.931)	-1.050*** (-3.578)	-0.977*** (-5.225)	-1.043*** (-4.687)
Dividend-D.	-0.084* (-1.871)	-0.271*** (-2.993)	0.094*** (3.930)	0.128*** (6.156)	0.101*** (4.501)	0.126*** (6.283)	0.103*** (4.723)	0.130*** (6.703)	0.110*** (5.130)	0.113*** (5.407)	0.116*** (5.836)
Leverage	-0.032*** (-3.901)	-0.060*** (-4.650)	-0.002 (-0.533)	0.002 (0.506)	0.001 (0.394)	0.004 (1.304)	0.002 (0.482)	0.005 (1.630)	-0.001 (-0.149)	0.002 (0.740)	0.003 (1.015)
ROA	0.256** (2.278)	-1.051*** (-6.394)	-0.428* (-1.893)	-0.541* (-1.769)	-0.379* (-1.655)	-0.521* (-1.733)	-0.379 (-1.644)	-0.533* (-1.760)	-0.496* (-1.902)	-0.458* (-1.738)	-0.461* (-1.744)
Diversification-D.	-0.009 (-0.200)	-0.147** (-2.167)	-0.088*** (-3.380)	-0.057** (-2.574)	-0.082*** (-3.535)	-0.057*** (-2.659)	-0.081*** (-3.472)	-0.056*** (-2.673)	-0.074*** (-3.136)	-0.071*** (-3.235)	-0.070*** (-3.269)
Sales-Intensity	0.282*** (5.593)	-0.273*** (-3.106)	-0.034 (-1.604)	-0.000 (-0.012)	-0.031 (-1.494)	0.002 (0.110)	-0.033 (-1.600)	-0.002 (-0.094)	-0.020 (-0.972)	-0.018 (-0.933)	-0.021 (-1.058)
Constant	-2.236*** (-10.688)	0.265 (1.196)									
Observations	48,801	45,966	23,201	25,600	21,887	24,079	21,887	24,079	48,801	45,966	45,966
IT-Exposure used			+	-	+	-	+	-	/	/	/
p-value of DWH test			0.03	0.00	0.07	0.00	0.07	0.00	0.00	0.02	0.02
p-value of KP rk LM-statistic			0.03	0.11	0.05	0.06	0.05	0.05	0.03	0.06	0.06

KP rk Wald F-statistic	22.90	2.33	129.01	174.05	85.72	110.41	20.23	198.64	150.97
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Panel A reports results from probit regressions according to equation (4). 2-digit SIC code Industry and year fixed effects were incorporated. The instrumental variable for a firm's *CapEx (R&D)* was calculated using the mean of *CapEx (R&D)* for that firm's industry in a specific year, while excluding the firm of interest. Z-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using industry clustered robust standard errors. Panel B and Panel C report second-stage results from instrumental variables fixed effects regressions according to equation (3) using the *IT-Exposures* estimated from the extended Fama-French model characterized by equation (1), thereby Panel C uses the *Absolute IT-Exposure*. 2-digit SIC code industry and year fixed effects were incorporated. The instrumental variable for a firm's *CapEx (R&D)* was calculated using the mean of *CapEx (R&D)* for that firm's industry in a specific year, while excluding the firm of interest. Need for an instrumental variable regression is tested via a Durbin-Wu-Hausman endogeneity test (Durbin, 1954; Wu, 1973; Hausman, 1978). Validity of the instrumental variables regression is tested via the robust Kleibergen-Paap rk LM-statistic of underidentification and Kleibergen-Paap rk Wald F-statistic of weak identification (Kleibergen and Paap (2006). "IT-Exposure used" denotes if *Absolute IT-Exposures ("I")*, only positive ("+") or only negative ("-") were used. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using industry clustered robust standard errors.

Table 6: Economic significance

	(1)	(2)	(3)	(4)	(5)	(6)
	No Endogeneity Control			Endogeneity Control		
IT-Exposure used	+	-	/	+	-	/
<i>Model (II)</i>						
IT-Exposure	-0.029	-0.037	-0.031	0.022	-0.008	0.007
CapEx	0.057	0.046	0.050	-0.034	-0.016	-0.022
R&D						
CapEx + R&D	0.057	0.046	0.050	-0.034	-0.016	-0.022
Total Effect	0.028	0.009	0.019	-0.012	-0.024	-0.014
Compensation Factor	2.0	1.2	1.6	-1.5	-2.2	-2.9
Value Premium	5.7%	1.8%	4.0%	-2.4%	-4.9%	-2.9%
<i>Model (III)</i>						
IT-Exposure	-0.022	-0.032	-0.026	-0.055	-0.058	-0.051
CapEx						
R&D	0.039	0.040	0.038	0.119	0.113	0.106
CapEx + R&D	0.039	0.040	0.038	0.119	0.113	0.106
Total Effect	0.017	0.008	0.012	0.063	0.054	0.055
Compensation Factor	1.8	1.3	1.5	2.1	1.9	2.1
Value Premium	3.5%	1.7%	2.4%	12.8%	11.3%	11.2%
<i>Model (IV)</i>						
IT-Exposure	-0.049	-0.053	-0.049	-0.065	-0.086	-0.072
CapEx	0.057	0.047	0.050	0.015	0.049	0.034
R&D	0.039	0.041	0.039	0.123	0.129	0.116
CapEx + R&D	0.096	0.088	0.090	0.138	0.178	0.149
Total Effect	0.048	0.035	0.041	0.073	0.092	0.078
Compensation Factor	2.0	1.7	1.8	2.1	2.1	2.1
Value Premium	9.6%	7.4%	8.4%	14.8%	19.2%	16.0%
Average Tobin's Q	0.50	0.48	0.49	0.50	0.48	0.49

This table reports economic significance of our results. “No Endogeneity Control” refers to Table 4, while “Endogeneity Control” refers to Table 5, differentiating between positive (+), negative (-) and *Absolute IT-Exposure* (/). “IT-Exposure”, “CapEx” and “R&D” show results for the multiplication between the respective estimated coefficient (Tables 5 and 6) and the average *IT-Exposure* (Table 2). The “Compensation Factor” is calculated by dividing the sum of “CapEx + R&D” by the absolute value of “IT-Exposure”. “Value Premium” represents the ratio of “Total Effect” (“IT-Exposure” + “CapEx + R&D”) to “Average Tobin's Q” (*Tobin's Q*) (Table 2).

Table 7: Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A: IT-Exposure based on CAPM											
Panel A1: Probit											
Variables / Model	CapEx-D.	R&D-D.	(III)	(III)	(IV)	(IV)	(V)	(V)	(III)	(IV)	(V)
IT-Exposure	0.125*	0.042	0.125**	0.042	-0.073**	0.115***	-0.044	0.162***	0.058	-0.091***	-0.108***
	(1.859)	(1.630)	(1.859)	(1.630)	(-2.261)	(6.964)	(-0.709)	(4.103)	(1.185)	(-6.602)	(-3.893)
IT-E. x CapEx-D.	-0.123*	0.030	-0.123*	0.030	-0.039	-0.039	-0.039	-0.088	-0.101*		0.028
	(-1.941)	(0.463)	(-1.941)	(0.463)			(-0.598)	(-1.495)	(-1.764)		(0.556)
IT-E. x R&D-D.					0.236***	-0.183***	0.221***	-0.210***		0.225***	0.232***
					(2.766)	(-3.895)	(2.703)	(-4.334)		(3.254)	(3.850)
CapEx	-10.837***	4.942***	3.940**	3.940**	4.719***	3.327***	4.612***	3.478***	4.185***	3.797***	3.846***
	(-4.551)	(3.124)	(2.540)	(2.540)	(4.976)	(4.054)	(4.908)	(3.652)	(3.091)	(4.713)	(4.629)
R&D	-3.157**	-1.346	-0.540	-0.540	-1.461	-0.769	-1.439*	-0.832	-1.065	-1.269*	-1.288*
	(-2.236)	(-1.528)	(-0.684)	(-0.684)	(-1.645)	(-0.953)	(-1.659)	(-1.022)	(-1.356)	(-1.646)	(-1.710)
Observations	48,801	45,966	23,459	25,342	22,240	23,726	22,240	23,726	48,801	45,966	45,966
IT-Exposure used			+	-	+	-	+	-	/	/	/
p-value of DWH test			0.02	0.01	0.05	0.00	0.07	0.01	0.01	0.02	0.03
p-value of KP rk LM-statistic			0.01	0.11	0.05	0.05	0.05	0.05	0.02	0.06	0.06
KP rk Wald F-statistic			11.73	2.52	144.68	86.55	117.16	74.67	15.13	181.98	139.66
Panel B: Exclusion of IT firms											
Panel B1: Probit											
Variables / Model	CapEx-D.	R&D-D.	(II)	(II)	(III)	(III)	(IV)	(IV)	(II)	(III)	(IV)
IT-Exposure	-0.053	-0.007	-0.053	-0.007	-0.121***	0.080***	-0.149***	0.085**	-0.019	-0.085***	-0.098***
	(-1.451)	(-0.283)	(-1.451)	(-0.283)	(-10.200)	(5.463)	(-3.672)	(2.044)	(-0.767)	(-8.244)	(-3.207)
IT-E. x CapEx-D.	-0.028	0.086	-0.028	0.086			0.052	-0.008	-0.052		0.026
	(-0.414)	(1.601)	(-0.414)	(1.601)			(0.754)	(-0.118)	(-1.028)		(0.476)
IT-E. x R&D-D.					0.156**	-0.150***	0.175***	-0.153***		0.127**	0.136***
					(2.019)	(-2.829)	(2.787)	(-4.013)		(2.314)	(3.401)
CapEx	-10.815***	3.493**	3.493**	3.699**	3.034***	3.329***	3.192***	3.350***	3.881***	3.384***	3.451***

R&D	(-3.929)	-2.721*	(2.299)	(2.519)	(4.969)	(4.398)	(4.621)	(4.104)	(2.760)	(5.656)	(5.282)
		(-1.925)	(-1.787)	(-0.839)	(-2.818)	(-1.478)	(-2.913)	(-1.365)	(-1.119)	(-1.858)	(-1.779)
Observations	30,399	27,564	12,549	17,850	11,235	16,329	11,235	16,329	30,399	27,564	27,564
IT-Exposure used			+	-	+	-	+	-	/	/	/
p-value of DWH test			0.01	0.00	0.06	0.01	0.06	0.02	0.00	0.02	0.02
p-value of KP rk LM-statistic			0.09	0.13	0.02	0.05	0.01	0.02	0.11	0.05	0.04
KP rk Wald F-statistic			1.99	1.95	29.69	47.31	15.98	48.21	2.00	40.81	36.03

Panel A reports 2SLS results when *IT-Exposure* estimation is based on the CAPM extended by our IT-proxy. Panel B reports 2SLS results when IT firms, identified by their 2-digit SIC code where excluded. Panel A1/B1 shows results from probit regressions according to equation (4). 2-digit SIC code industry and year fixed effects were incorporated. The instrumental variable for a firms *CapEx (R&D)* was calculated using the mean of *CapEx (R&D)* for that firm's industry in a specific year, while excluding the firm of interest. Z-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using industry clustered robust standard errors. Panel A2/B2 and Panel A3/B3 report second-stage results from instrumental variables fixed effects regressions according to equation (3), thereby Panel A3/B3 uses the *Absolute IT-Exposure*. 2-digit SIC code industry and year fixed effects were incorporated. The instrumental variable for a firms *CapEx (R&D)* was calculated using the mean of *CapEx (R&D)* for that firm's industry in a specific year, while excluding the firm of interest. Need for an instrumental variable regression is tested via a Durbin-Wu-Hausman endogeneity test (Durbin, 1954; Wu, 1973; Hausman, 1978). Validity of the instrumental variables regression is tested via the robust Kleibergen-Pappa rk LM-statistic of underidentification and Kleibergen-Pappa rk Wald F-statistic of weak identification (Kleibergen and Paap (2006). "IT-Exposure used" denotes if *Absolute IT-Exposures* ("?"), only positive ("+") or only negative ("-") were used. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using industry clustered robust standard errors.

Internet Appendix:

IT-Exposure and Firm Value

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Table IA.1: Additional portfolio sorts

Period	(1) 1990-1993	(2) 1994-1998	(3) 1999-2003	(4) 2004-2008	(5) 2009-2013	(6) 2014-2018
<i>Panel A: 2-digit SIC Code</i>						
Q1	1.65	1.97	1.93	2.08	1.72	2.03
Q2	1.58	1.83	1.89	2.02	1.70	2.01
Q3	1.51	1.85	1.94	1.96	1.68	2.04
Q4	1.61	1.87	1.96	1.97	1.68	2.01
Q5	1.63	1.98	2.17	2.07	1.76	2.05
Q5-Q1	-0.01 (-0.20)	0.01 (0.25)	0.24*** (3.73)	-0.02 (-0.39)	0.03 (0.89)	0.02 (0.49)
Q1-Q3	0.14** (2.37)	0.12** (2.31)	-0.01 (0.12)	0.12*** (3.15)	0.04 (1.29)	-0.01 (0.34)
Q5-Q3	0.12* (1.87)	0.13** (2.42)	0.23*** (3.48)	0.11*** (2.69)	0.07** (2.14)	0.01 (0.19)
<i>Panel B: Market Value</i>						
Q1	1.78	2.03	2.06	2.13	1.78	2.05
Q2	1.46	1.79	1.77	1.96	1.65	1.94
Q3	1.53	1.73	1.72	1.89	1.65	1.95
Q4	1.52	1.75	1.88	1.95	1.65	2.04
Q5	1.71	2.21	2.45	2.17	1.82	2.16
Q5-Q1	-0.07 (-0.88)	0.18*** (3.07)	0.40*** (5.89)	0.04 (0.98)	0.04 (1.13)	0.11** (2.43)
Q1-Q3	0.25*** (3.72)	0.30*** (5.96)	0.33*** (6.52)	0.24*** (6.07)	0.13*** (3.95)	0.10** (2.30)
Q5-Q3	0.19*** (2.82)	0.48*** (9.02)	0.73*** (11.70)	0.28*** (7.29)	0.17*** (5.12)	0.21*** (5.01)
<i>Panel C: Diversification-Dummy</i>						
Q1	1.71	2.02	2.05	2.13	1.76	2.02
Q2	1.55	1.82	1.84	1.96	1.67	2.00
Q3	1.54	1.74	1.74	1.94	1.70	2.01
Q4	1.55	1.83	1.85	1.94	1.67	2.06
Q5	1.64	2.10	2.41	2.14	1.75	2.06
Q5-Q1	-0.07 (-0.91)	0.09 (1.53)	0.36*** (5.36)	0.02 (0.36)	-0.01 (-0.24)	0.04 (0.94)
Q1-Q3	0.16** (2.47)	0.28*** (5.67)	0.31*** (6.03)	0.19*** (4.73)	0.06* (1.77)	0.01 (0.19)
Q5-Q3	0.10 (1.51)	0.37*** (7.25)	0.67*** (10.76)	0.21*** (5.28)	0.05 (1.51)	0.05 (1.22)
<i>Panel D: R&D scaled by firm size</i>						
Q1	1.69	2.02	2.05	2.16	1.77	2.02
Q2	1.59	1.90	1.94	2.04	1.74	2.10
Q3	1.57	1.82	1.85	1.96	1.70	2.06
Q4	1.55	1.83	1.92	1.94	1.67	2.04
Q5	1.58	1.94	2.12	2.00	1.66	1.93
Q5-Q1	-0.11 (-1.54)	-0.08 (-1.52)	0.06 (1.02)	-0.17*** (-3.98)	-0.11*** (-3.01)	-0.08* (-1.87)
Q1-Q3	0.12* (1.87)	0.20*** (3.84)	0.20*** (3.86)	0.20*** (4.84)	0.07** (2.14)	-0.05 (1.15)
Q5-Q3	0.02 (0.26)	0.12** (2.33)	0.27*** (4.51)	0.03 (0.84)	-0.03 (-1.04)	-0.13*** (-3.18)
<i>Panel E: CapEx scaled by firm size</i>						

Q1	1.69	1.99	2.05	2.15	1.77	2.05
Q2	1.58	1.84	1.80	1.95	1.66	1.99
Q3	1.53	1.74	1.73	1.89	1.67	1.98
Q4	1.53	1.79	1.78	1.94	1.67	2.05
Q5	1.67	2.15	2.51	2.18	1.78	2.09
Q5-Q1	-0.02 (-0.33)	0.15*** (2.64)	0.45*** (6.62)	0.03 (0.58)	0.01 (0.31)	0.04 (0.91)
Q1-Q3	0.16** (2.52)	0.26*** (5.20)	0.32*** (6.30)	0.26*** (6.43)	0.09*** (2.79)	0.06 (1.54)
Q5-Q3	0.14** (2.15)	0.41*** (7.90)	0.77*** (12.10)	0.28*** (7.31)	0.10*** (3.07)	0.11** (2.52)

This table shows average *Raw Tobin's Q* quintiles sorted by yearly *IT-Exposure* (winsorized) and another control variable. Parentheses contain t-statistics. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table IA.2: Fixed effects OLS regressions: 10-year subperiods

Variables / Model	(1) (I)	(2) (I)	(3) (II)	(4) (II)	(5) (III)	(6) (III)	(7) (IV)	(8) (IV)
<u>Panel A: 1990-1998</u>								
IT-Exposure	0.098*** (3.178)	-0.046** (-2.106)	-0.031 (-1.282)	0.045 (1.306)	0.008 (0.174)	0.009 (0.222)	-0.029 (-0.591)	0.071* (1.943)
IT-Exposure x CapEx-Dummy			0.082*** (3.859)	-0.144*** (-3.802)			0.083*** (4.318)	-0.143*** (-3.902)
IT-Exposure x R&D-Dummy					0.003 (0.052)	-0.086* (-1.855)	-0.005 (-0.087)	-0.083* (-1.861)
Observations	4,033	4,495	4,033	4,495	4,033	4,495	4,033	4,495
<u>Panel B: 1999-2008</u>								
IT-Exposure	0.061* (1.833)	-0.033** (-2.593)	-0.013 (-0.399)	0.044*** (2.681)	0.005 (0.159)	0.034** (2.285)	-0.045 (-1.321)	0.075*** (3.639)
IT-Exposure x CapEx-Dummy			0.102*** (7.268)	-0.088*** (-3.265)			0.103*** (7.380)	-0.088*** (-3.241)
IT-Exposure x R&D-Dummy					0.058*** (4.175)	-0.089*** (-3.863)	0.061*** (4.332)	-0.090*** (-4.083)
Observations	9,227	10,225	9,227	10,225	9,227	10,225	9,227	10,225
<u>Panel C: 2009-2018</u>								
IT-Exposure	-0.010 (-0.718)	0.017 (0.853)	-0.072*** (-5.122)	0.068*** (5.966)	-0.066*** (-6.229)	0.065*** (8.184)	-0.101*** (-6.800)	0.095*** (7.320)
IT-Exposure x CapEx-Dummy			0.078*** (4.912)	-0.064*** (-3.926)			0.078*** (4.989)	-0.067*** (-4.164)
IT-Exposure x R&D-Dummy					0.059*** (4.097)	-0.062*** (-3.159)	0.059*** (4.517)	-0.065*** (-3.117)
Observations	10,004	10,968	10,004	10,968	10,004	10,968	10,004	10,968
IT-Exposure used	+	-	+	-	+	-	+	-

This table reports results from fixed effects OLS regressions according to equation (3) using the *IT-Exposures* estimated from the extended Fama-French model characterized by equation (1) for subperiods. 2-digit SIC code industry and year fixed effects were incorporated. “IT-Exposure used” denotes if positive (“+”) or negative (“-”) *IT-Exposure* observations were used. Industry cluster robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table IA.3: Between effects OLS regressions

Variables / Model	Panel A: Positive and Negative IT-Exposure				Panel B: Absolute IT-Exposure						
	(1) (I)	(2) (I)	(3) (II)	(4) (II)	(5) (III)	(6) (III)	(7) (IV)	(8) (IV)	(9) (II)	(10) (III)	(11) (IV)
IT-Exposure	0.064*** (4.234)	-0.085*** (-4.088)	-0.120*** (-9.272)	0.052*** (2.832)	-0.121*** (-7.496)	0.095*** (5.334)	-0.180*** (-15.234)	0.136*** (8.049)	-0.079*** (-2.950)	-0.096*** (-4.229)	-0.150*** (-5.723)
IT-E. x CapEx-D.			0.128*** (7.132)	-0.082*** (-3.514)			0.126*** (5.684)	-0.090*** (-4.251)	0.111*** (5.818)		0.112*** (4.960)
IT-E. x R&D-D.					0.116*** (4.544)	-0.161*** (-5.755)	0.113*** (4.800)	-0.166*** (-6.190)		0.143*** (5.301)	0.144*** (5.546)
CapEx			1.613*** (5.249)	2.219*** (7.901)	2.079*** (7.990)	2.536*** (10.261)	1.595*** (5.328)	2.159*** (8.044)	1.938*** (8.808)	2.413*** (10.335)	1.905*** (8.352)
R&D			2.056*** (18.158)	1.535*** (15.419)	1.761*** (10.960)	1.159*** (10.731)	1.767*** (11.238)	1.156*** (10.124)	1.873*** (11.031)	1.477*** (8.778)	1.485*** (8.788)
Size			-0.028*** (-5.311)	-0.032*** (-5.308)	-0.027*** (-5.141)	-0.032*** (-5.295)	-0.029*** (-5.527)	-0.033*** (-5.463)	-0.029*** (-5.321)	-0.029*** (-5.550)	-0.031*** (-5.871)
Capital Intensity			-0.632*** (-12.151)	-0.709*** (-12.181)	-0.582*** (-12.415)	-0.662*** (-11.862)	-0.611*** (-12.894)	-0.678*** (-12.456)	-0.682*** (-12.009)	-0.641*** (-10.745)	-0.658*** (-11.487)
Dividend-D.			0.112*** (3.790)	0.138*** (13.243)	0.105*** (3.652)	0.130*** (11.693)	0.109*** (3.777)	0.131*** (12.427)	0.132*** (8.129)	0.124*** (7.649)	0.127*** (7.712)
Leverage			0.010*** (3.852)	0.012*** (5.157)	0.012*** (5.209)	0.014*** (6.246)	0.012*** (5.086)	0.015*** (6.532)	0.010*** (2.742)	0.013*** (3.188)	0.013*** (3.344)
ROA			0.271*** (4.735)	0.097 (1.309)	0.239*** (3.748)	0.086 (1.283)	0.236*** (3.619)	0.080 (1.164)	0.230*** (2.722)	0.208*** (2.329)	0.200*** (2.350)
Diversification-D.			-0.057*** (-4.038)	-0.049*** (-2.179)	-0.058*** (-4.233)	-0.052*** (-2.257)	-0.058*** (-4.146)	-0.053*** (-2.295)	-0.059*** (-4.975)	-0.060*** (-5.604)	-0.061*** (-5.410)
Sales-Intensity			-0.010 (-0.929)	-0.000 (-0.037)	0.004 (0.281)	0.011 (0.763)	-0.003 (-0.280)	0.007 (0.529)	-0.014 (-1.082)	0.000 (0.007)	-0.006 (-0.470)
Constant	0.103 (0.874)	0.111** (2.158)	0.425*** (4.885)	0.345*** (4.160)	0.369*** (3.766)	0.327*** (3.513)	0.442*** (4.956)	0.370*** (4.217)	0.387** (2.481)	0.348** (2.021)	0.412** (2.525)
Observations	23,264	25,688	23,264	25,688	23,264	25,688	23,264	25,688	48,952	48,952	48,952
Adj. R-squared	0.25	0.22	0.44	0.37	0.44	0.38	0.44	0.38	0.43	0.43	0.43
IT-Exposure	+	-	+	-	+	-	+	-	/	/	/

Panel A and Panel B report results from fixed effects OLS regressions according to equation (3) using the *IT-Exposures* estimated from the extended Fama-French model characterized by equation (1), thereby Panel B uses the *Absolute IT-Exposure*. 2-digit SIC code industry fixed effects were incorporated. “IT-Exposure used” denotes if

Absolute IT-Exposures (“/”), only positive (“+”) or only negative (“-”) were used. Z-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 100 replications.

Table IA.4: Fama-MacBeth regressions

Variables / Model	Panel A: Positive and Negative IT-Exposure				Panel B: Absolute IT-Exposure						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
IT-Exposure	0.048** (2.058)	-0.025 (-1.474)	-0.053** (-2.742)	0.058*** (6.151)	-0.046** (-2.430)	0.032* (1.716)	-0.084*** (-4.828)	0.085*** (6.070)	-0.052*** (-4.307)	-0.033** (-2.752)	-0.075*** (-9.756)
IT-E. x CapEx-D.			0.078*** (6.873)	-0.108*** (-5.099)			0.073*** (5.208)	-0.112*** (-4.981)	0.087*** (7.362)		0.087*** (7.299)
IT-E. x R&D-D.					0.056*** (4.433)	-0.072*** (-3.350)	0.061*** (3.865)	-0.075*** (-3.518)		0.050*** (3.503)	0.049*** (3.327)
CapEx			1.593*** (9.842)	1.299*** (10.090)	1.880*** (10.687)	1.616*** (11.258)	1.594*** (10.082)	1.295*** (9.738)	1.422*** (10.695)	1.714*** (11.330)	1.418*** (10.773)
R&D			2.020*** (19.045)	2.115*** (13.738)	1.880*** (17.445)	1.980*** (11.258)	1.840*** (15.524)	1.953*** (11.252)	2.126*** (20.775)	2.011*** (18.220)	1.990*** (17.832)
Size			-0.004 (-0.497)	-0.016** (-2.443)	-0.004 (-0.446)	-0.016** (-2.326)	-0.005 (-0.612)	-0.017** (-2.525)	-0.010 (-1.286)	-0.009 (-1.199)	-0.011 (-1.410)
Capital Intensity			-0.536*** (-16.609)	-0.482*** (-14.907)	-0.508*** (-16.277)	-0.453*** (-15.226)	-0.527*** (-16.521)	-0.474*** (-15.152)	-0.500*** (-21.206)	-0.473*** (-23.089)	-0.492*** (-21.774)
Dividend-D.			0.079*** (3.092)	0.104*** (8.817)	0.077*** (2.961)	0.104*** (9.202)	0.079*** (3.052)	0.104*** (9.027)	0.091*** (5.171)	0.090*** (5.113)	0.091*** (5.204)
Leverage			-0.005 (-0.642)	0.003 (0.685)	-0.004 (-0.549)	0.003 (0.668)	-0.004 (-0.563)	0.004 (0.825)	-0.001 (-0.096)	-0.001 (-0.110)	-0.000 (-0.026)
ROA			0.511*** (2.796)	0.418** (2.289)	0.501** (2.753)	0.425** (2.260)	0.495** (2.749)	0.413** (2.207)	0.456** (2.708)	0.452** (2.671)	0.447** (2.632)
Diversification-D.			-0.057*** (-5.822)	-0.039*** (-4.694)	-0.056*** (-5.749)	-0.039*** (-4.361)	-0.056*** (-5.927)	-0.038*** (-4.567)	-0.047*** (-7.238)	-0.047*** (-6.838)	-0.047*** (-7.111)
Sales-Intensity			-0.012 (-1.112)	0.018** (2.064)	-0.005 (-0.427)	0.023** (2.434)	-0.010 (-0.815)	0.019** (2.080)	0.002 (0.183)	0.008 (0.798)	0.003 (0.377)
Constant	0.744*** (5.580)	0.506*** (5.660)	0.653*** (7.880)	0.480*** (3.530)	0.616*** (6.695)	0.489*** (3.998)	0.665*** (7.431)	0.556*** (3.576)	0.492*** (4.585)	0.441*** (3.812)	0.501*** (4.390)
Observations	23,264	25,688	23,264	25,688	23,264	25,688	23,264	25,688	48,952	48,952	48,952
Adj. R-squared	0.207	0.248	0.363	0.386	0.361	0.385	0.366	0.389	0.341	0.340	0.343
IT-Exposure used	+	-	+	-	+	-	+	-	/	/	/

Panel A and Panel B report results from Fama-MacBeth (1973) regressions according to equation (3) using the *IT-Exposures* estimated from the extended Fama-French model characterized by equation (1), thereby Panel B uses the *Absolute IT-Exposure*. 2-digit SIC code industry fixed effects were incorporated. “IT-Exposure used” denotes if

Absolute IT-Exposures (“/”), only positive (“+”) or only negative (“-”) were used. T-statistics are in parentheses. ***, **, *, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using Newey-West (1987) standard errors.

References for Internet Appendix

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2 | **Corporate Social Responsibility, Risk, and Firm Value: An Unconditional Quantile Regression Approach***

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Abstract

This paper examines the impact of corporate social responsibility (CSR) on firm risk, comprising total risk, idiosyncratic risk, and systematic risk, as well as firm value. We focus on analyzing the interrelationships along the entire distribution of the dependent variables, thus estimating an unconditional quantile regression (UQR). The analysis is based on CSR scores from Refinitiv and MSCI, using up to 12,013 firm-year observations over the period 2002 to 2019 for all U.S. companies listed on NYSE, NASDAQ, and AMEX. UQR reveals strongly heterogeneous effects along the unconditional quantiles of the dependent variables, which are reflected in sign changes, magnitude and significance variations. For CSR we find a risk-reducing as well as value-enhancing effect. When applying fixed effects OLS, we can just partly confirm the risk-reducing and value-enhancing effect of CSR shown in the literature.

Keywords: Unconditional Quantile Regression, Corporate Social Responsibility, ESG, Firm Risk, Volatility, Systematic Risk, Idiosyncratic Risk, Firm Value

JEL classification: G30; G32; M14

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1 Introduction

Corporate social responsibility (CSR), the concept of what role a company should play in society, has long been perceived as a relevant factor by both customers and investors worldwide (Albuquerque et al., 2019; Cheng et al., 2014; Oikonomou et al., 2014). Nevertheless, the importance of CSR has risen sharply in recent years (Stellner et al., 2015; Deng et al., 2013; Drempetic et al., 2019), as evidenced, for example, by the high level of spending on sustainability and corporate philanthropy (Di Giuli and Kostovetsky, 2014), or the sharp increase in the number of companies publishing a CSR report or giving the topic extensive space in their annual reports (Deng et al., 2013; Di Giuli and Kostovetsky, 2014; El Ghouli et al., 2011). Currently, investors with more than \$100 trillion in assets have joined an initiative dedicated to integrating environmental, social, and governance (ESG) information into investment decisions (PRI, 2020). Even though there is no universally accepted definition and interpretation of the concept of CSR (Griffin, 2000; van Beurden and Gössling, 2008), CSR can be understood as a process in which companies include ESG (Environmental, Social, and Governance) factors in the corporate decision-making process and account for the quality of their relationship with their various stakeholders (Stellner et al., 2015; Oikonomou et al., 2014; Renneboog et al., 2008). The increasing relevance of CSR topics in recent years reflects in a steadily growing research literature, that analyzes the impact of CSR on firms' key metrics such as firm risk and firm value. The literature shows a risk-reducing (e.g., Sassen et al., 2016; Albuquerque et al., 2019) and value-enhancing (e.g., Albuquerque et al., 2019; Servaes and Tamayo, 2013) effect for CSR.

This study differs from previous literature, firstly, by implementing an unconditional quantile regression (UQR) according to Firpo et al. (2009) to analyze the influence across the entire distribution of firm risk and firm value, respectively. This is motivated by the fact that it

is a priori unclear why a possible influence should be purely constant across the quantiles, estimated via ordinary least squares (OLS), and not also contain non-constant elements. If CSR can be considered as soft information, the question arises whether an increase in CSR is still relevant for firms with high risk levels. It seems more plausible that for high-risk firms, improving other factors, such as leverage (Mishra and Modi, 2013) and liquidity (Brogaard et al., 2017), will be more effective rather than focusing on CSR performance. Likewise, for firms with a low risk level, the question arises as to why increasing CSR should still have a considerable risk-reducing influence. Analog considerations can be applied to the relationship between CSR and firms with low versus high firm value as well. For example, Wang et al. (2015) show a heterogeneous impact of CSR on firm performance using conditional quantile regression. Applying UQR allows for a nuanced analysis regarding the relationship between the entire distribution of the dependent variable and the regressors, as the relationships are estimated at each unconditional quantile of the dependent variable, thus, making it possible to estimate heterogeneous coefficients for each unconditional quantile that may vary in sign, magnitude, and significance. For these reasons, the unconditional quantile regression methodology has been applied extensively in the finance (e.g., Entrop et al., 2017; Cobb-Clark et al., 2016; Kang et al., 2021; Basten et al., 2016; Christelis et al., 2021) and economics (e.g., England et al., 2016; Baltagi and Ghosh, 2017; Haylock, 2022; Fournier and Koske, 2013) literature.

Second, we fully analyze the relationship between CSR and risk by considering total risk, idiosyncratic risk, and systematic risk. To the best of our knowledge, there is no study to date that simultaneously considers all facets of risk for the U.S. capital market; so far, this has only been done for Europe (Sassen et al., 2016). Since firm risk has a direct impact on firm value, we analyze not only firm risk but also firm value in this study. Such a comprehensive analysis has not often been pursued in the literature (e.g., Albuquerque et al., 2019). Third, by using two

acknowledged CSR databases, namely Refinitiv and MSCI, emphasizing the need to use CSR scores from different providers to confirm the results robustness.

For this purpose, we start with estimating three risk variables and calculate the standard deviation of daily stock returns, the volatility of the residuals from the Carhart (1997) model, and the CAPM (Sharpe, 1964) beta. Firm value is approximated using Tobin's Q. At first, we reproduce the previous literature and analyze the average impact of CSR on firm risk and firm value via fixed effects OLS regression, respectively. Subsequently, the relationship for the entire distribution of the risk variables, respectively Tobin's Q and CSR is analyzed via UQR. CSR can have a risk-reducing and value-enhancing effect. However, it is also possible that companies with low risk have a higher firm value and thus more financial resources are available, which could be used for CSR activities (e.g., Albuquerque et al., 2019). To control for this potential endogeneity problem between CSR and firm risk, and firm value, respectively, we apply in the context of standard OLS a two-stage least squares (2SLS) regression procedure as well as lagged CSR scores in the context of UQR.

This study is based on daily discrete stock returns and annual accounting data for all U.S. American headquartered companies, listed on the major exchanges NYSE, NASDAQ, and AMEX covering the period January 2002 to December 2019, and giving us a total of up to 12,013 (Refinitiv) and 11,001 (MSCI) effectively usable firm-year observations for our research.

We summarize our findings as follows: First, using fixed effects OLS regression, we can partly confirm the statistically significant risk-reducing impact of CSR on *Total Risk*, *Idiosyncratic Risk*, and *Systematic Risk* observed in the literature (e.g., Albuquerque et al., 2019, Sassen et al., 2016), when using our database. In line with the literature (e.g., Albuquerque et al., 2019) we find a significant value-enhancing effect of CSR on *Tobin's Q*. When applying 2SLS to our dataset to account for endogeneity, we no longer find a statistically significant risk-

reducing and value-enhancing effect of CSR. This is not implausible if the influence of CSR is highly heterogeneous across the unconditional quantiles and the effects offset each other on average.

Second, analyzing unconditional quantiles via UQR reveals strong heterogeneous effects in terms of coefficients significance, magnitude, and sign, along the entire distribution of the risk variables and *Tobin's Q*, respectively. Significance and magnitude of the coefficients depend on the CSR score provider used.

Indeed, we find a weak risk-reducing influence of CSR on *Total Risk* for companies with a low risk level, that increases continuously up to the 60% quantile before strongly decreasing and eventually disappearing for companies with a high risk level. For *Idiosyncratic Risk*, we find a risk-reducing influence that is more pronounced at the low and medium risk quantiles and loses relevance for firms with very high *Idiosyncratic Risk*. In terms of *Systematic Risk*, CSR exerts a stronger risk mitigating influence in the lower and upper quantiles of the risk distribution compared to firms with medium risk levels.

For *Tobin's Q* we find a value-enhancing influence for almost all quantiles. This effect increases steadily up to the 70th percentile and vanishes for firms with high firm value.

The risk-reducing and value-enhancing effect of CSR can be confirmed when using CSR scores lagged by four periods to mitigate the potential endogeneity problem. The high heterogeneity in the effects, both on firm risk and firm value, confirms the appropriateness of implementing an UQR as opposed to estimating the pure average effect via plain vanilla OLS. It is this approach that reveals the very different degrees to which CSR influences firm risk and firm value. Third, when applying OLS, significant results are found per risk variable for either the CSR score from Refinitiv or the CSR score from MSCI, but never for both scores at the same time, which emphasizes the relevance of the CSR data provider used. A similar but less extreme pattern can be observed when using UQR. Furthermore, in terms of economic

significance, we find throughout our study stronger risk-reducing as well as value-enhancing effects when using Refinitiv's CSR score.

The remainder of the paper is organized as follows. Section 2 starts with a literature review, while Section 3 describes the data and sample. Section 4 then discusses the empirical design and methodology applied, whereas Section 5 presents and discusses our results, distinguishing between the CSR-risk (Section 5.2) and CSR-firm value relationship (Section 5.3). Section 6 concludes.

2 Related literature and theory

The literature to date has examined the relationship between corporate social performance (CSP) and corporate financial performance (CFP) in numerous studies, but has found diverging results, which point to be weakly positive overall (for an extensive literature review see e.g., Margolis and Walsh, 2003; Margolis et al., 2009; Orlitzky et al., 2003). The literature on CSR can be classified into two strands, shareholder theory and stakeholder theory (Deng et al., 2013; Mishra and Modi, 2013). Shareholder theory argues that according to economic theory, firms should not internalize the negative effects they inflict on stakeholders who are not shareholders (see e.g., Pigou, 1920). Friedman (1962, 1970) was amongst the first who argued that the social responsibility of corporations is solely to maximize shareholder value, since the implementation of CSR in corporate decisions at best has no impact on shareholder value and at worst destroys value as CSR increases costs to the firm, creating a competitive disadvantage (Aupperle et al., 1985; Friedman, 1970; McWilliams and Siegel, 1997; Jensen, 2002). On the basis of principal-agent theory (Jensen and Meckling, 1976) it is argued, that the use of corporate resources for CSR results in benefits for management, and not in financial benefits for shareholders

(Brammer and Millington, 2008; Barnea and Rubin, 2010; Kim et al., 2009; Goss and Roberts, 2011; Tirole, 2001; Bénabou and Tirole, 2010; Cheng et al., 2013). However, these days CSR is considered an important factor for investors, customers, and politicians worldwide (Stellner et al., 2015; Deng et al., 2013; Dremptic et al., 2019). This reflects, for example, in the high spending on sustainability projects (Di Giuli and Kostovetsky, 2014) and the commitment of investors with more than \$100 trillion of assets to include ESG criteria in their decision-making processes (PRI, 2020).

In contrast, stakeholder theory (Freeman, 1984) argues that positive (negative) CSR can have a positive (negative) impact on shareholder value (Mishra and Modi, 2013) and companies accordingly invest in CSR for value-enhancing reasons, sometimes referred to as “doing well by doing good”. Managers interact with stakeholders to realize positive net present value (NPV) projects, which is why positive CSR news should have a value-enhancing effect (Krüger, 2015). However, firms need to consider the interests of all stakeholders to gain competitive advantage and increase shareholder wealth (Clarkson, 1995; Donaldson and Preston, 1995; Wood and Jones, 1995). Through positive CSR, companies can gain advantages in access to valuable, non-substitutable, rare, and non-imitable resources and thus positively influence the value of the company (Russo and Fouts, 1997; Srivastava et al., 1998; Cochran and Wood, 1984; Waddock and Graves, 1997).¹

Based on stakeholder theory, it can be argued for the CSR-risk relationship, that a more pronounced CSR level (i) is associated with a lower risk for companies to be sued and having to pay fines (Nofsinger and Varma, 2014), (ii) reduces capital constraints (Cheng et al., 2014), (iii) has a positive impact on firm reputation, brand equity, and workforce quality (Cornell and Shapiro, 1987; Brown and Dacin, 1997; Turban and Greening, 1997; Greening and Turban,

¹ A detailed discussion of the various positive effects of CSR can be found in, e.g., Mishra and Modi (2013), Cheng et al. (2014), Stellner et al. (2015), and El Ghoul et al., (2017).

2000), and (iv) can be interpreted as a signal of superior management skills (Waddock and Graves, 1997). Even in times of crisis, a firm can build positive moral capital with its stakeholders through its CSP that provides “insurance-like” protection (Godfrey, 2005; Godfrey et al., 2009). Overall, the literature suggests that higher CSP is associated with less volatile cash flows, lower financial risk, and thus lower stock market risk, as well as a lower probability of corporate crises (Chang et al., 2014; Oikonomou et al., 2012).

Accordingly, several studies can find a risk mitigating influence of CSR on overall firm risk, systematic risk, and idiosyncratic risk (Sassen et al., 2016; Jo and Na, 2012; Mishra and Modi, 2013; Albuquerque et al., 2019; Aupperle et al., 1985; McGuire et al., 1988; Sharfman and Fernando, 2008; Luo and Bhattacharya, 2009; Bouslah et al., 2013; Jo and Harjoto, 2014; Becchetti et al., 2015; Benlemlih, 2018). Consequently, this risk reduction results in reduced (i) cost of equity (Sharfman and Fernando, 2008; Chava, 2010; El Ghoual et al., 2011; Dhaliwal et al., 2011; Harjoto and Jo, 2015), (ii) credit risk and cost of debt (Chava, 2014; Goss and Roberts, 2011; Stellner et al., 2015; Jiraporn et al., 2014), and (iii) ultimately increases firm value (Albuquerque et al., 2019; Servaes and Tamayo, 2013; Harjoto and Jo, 2015; El Ghoual et al., 2017; Aouadi and Marsat, 2018). Besides the direct impact of CSR on firm risk and firm value, indirect channels have been investigated, such as the moderating effects of (i) the number of analysts following a firm (Jo and Harjoto, 2011), (ii) the influence of customer awareness and customer loyalty (Servaes and Tamayo, 2013; Albuquerque et al., 2019), (iii) deviations from the optimal risk level (Harjoto and Laksmana, 2018), (iv) country-specific institutions (El Ghoual et al., 2017), and (v) firm visibility, reputation, and other intangibles (Surroca et al., 2010; Aouadi and Marsat, 2018).

We extend this literature by examining the impact of CSR along the unconditional quantiles using UQR in addition to the classical analysis at the mean via standard OLS. For this purpose, we regress the risk variables *Total Risk*, *Idiosyncratic Risk* and *Systematic Risk* as well as

Tobin's Q as a proxy for firm value on the CSR score and additional controls. In addition, we also analyze the indirect influence of CSR via customer awareness and customer loyalty (Servaes and Tamayo, 2013; Albuquerque et al., 2019). Overall, our results show that the impact of CSR is not constant across firms and depends on the risk level (value) of the company.

3 Sample selection and data

3.1 Sample selection in general

We start with all common (ordinary) equity stocks of U.S. American headquartered companies, listed at least once on one of the major exchanges NYSE, NASDAQ, and AMEX during 01/01/2002 and 12/31/2019 to avoid survivorship bias and backfilling bias (Landis and Skouras, 2021; Ince and Porter, 2006; Amihud et al., 2015; Griffin et al., 2010). Via Refinitiv Datastream (formerly Thomson Reuters Datastream) we obtain daily stock prices, ask prices, bid prices, and yearly accounting data, where annual observations are defined on the basis of fiscal years instead of calendar years, since companies differ along their fiscal year ends (Flannery and Rangan, 2006). Following the literature, we exclude financial firms (SIC 6000-6999) and utilities (SIC 4900-4999), since their financial statements are not comparable with those of other industries due to regulatory issues (Deng et al., 2013; Flannery and Rangan, 2006).

We use CSR datasets from two different rating agencies, that is (i) Refinitiv's ESG Score database and (ii) MSCI ESG Ratings Time Series database. In addition, we use data from Kenneth French's website, as well as tax data from Tax Foundation, described in more detail below.

3.2 Firm value and firm risk variables

In terms of CSR and firm risk, we follow the literature and determine three risk variables covering total firm risk, idiosyncratic (unsystematic, firm-specific) risk, and systematic risk (Table A.1, Panel A). *Total Risk* is generally represented by stock volatility and is calculated as the standard deviation of daily discrete stock returns over the past 12 months (Jo and Na, 2012; Bouslah et al., 2013; Jo and Harjoto, 2014; Sassen et al., 2016).

Total risk is composed of systematic risk and idiosyncratic risk (Sharpe, 1964; Lintner, 1965; Mossin, 1966). If CSR exerts an influence on total risk, then it can be assumed that idiosyncratic risk in particular is positively influenced and systematic risk to a lesser extent or not at all. This is based on the consideration that CSR is primarily perceived as a form of soft information that significantly improves the information environment of the firm and accordingly has a firm-specific effect. Following traditional portfolio theory, idiosyncratic risk is eliminated by diversification in the context of a well-constructed portfolio, so that only systematic risk is of concern to the investor, for which he is compensated with a risk premium (Sharpe, 1964). However, Bennett and Sias (2010) point out that it is virtually impossible to create perfectly diversified portfolios. In addition, it is known (i) from a theoretical perspective that there is a positive relationship between idiosyncratic risk and expected return in absence of well diversified portfolios (Merton, 1987) as well as (ii) empirically that the majority of private investors hold poorly diversified portfolios (Polkovnichenko, 2005; Benartzi, 2001; Campbell, 2006). Furthermore, recent asset pricing literature shows that idiosyncratic risk is also associated with a risk premium (e.g., Goyal and Santa-Clara, 2003; Ang et al., 2006, 2009; Fu, 2009) and that it accounts for a large portion of total risk (Goyal and Santa-Clara, 2003). Therefore, we analyze the impact of CSR on idiosyncratic risk and, for the sake of completeness, also consider systematic risk.

Idiosyncratic risk is the portion of the variation that cannot be explained by the portfolio returns used, which is represented by the residuals of a regression. Following the literature (e.g., Sassen et al., 2016; Luo and Bhattacharya, 2009; Bouslah et al., 2013; Mishra and Modi, 2013; Ang et al., 2006, 2009), we implement the 4-factor model of Carhart (1997) and estimate it for each firm i and for each year t based on daily discrete return data. *Idiosyncratic Risk* is then calculated for each year t as the standard deviation of the estimated daily residuals in year t . The 4-factor model is estimated based on the following equation:

$$(R_{i,t} - rf_t) = \alpha_i + \beta_{m,i} * (R_{m,t} - rf_t) + \beta_{SMB,i} * R_{SMB,t} + \beta_{HML,i} * R_{HML,t} + \beta_{WML,i} * R_{WML,t} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ denotes a firm's daily return, $R_{m,t}$ is the daily market return, and rf_t is the daily risk-free return on 1-month treasury bills, respectively.² $R_{SMB,t}$, $R_{HML,t}$, and $R_{WML,t}$ are the daily discrete portfolio returns of the small-minus-big, high-minus-low, and winner-minus-loser risk factors (Fama and French, 1993; Carhart, 1997) in year t . The estimate of interest is $\varepsilon_{i,t}$ that indicates the daily error component in year t .

To estimate *Systematic Risk* using the CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966), we run the following regression for each firm i and for each year t using daily discrete return data (Albuquerque et al., 2019; Jo and Na, 2012; Sassen et al., 2016; Oikonomou et al., 2012):

$$(R_{i,t} - rf_t) = \alpha_i + \beta_{m,i} * (R_{m,t} - rf_t) + \varepsilon_{i,t} \quad (2)$$

² Data for the market return and the risk-free return are obtained from Kenneth French's Website (<http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html>). The market consists of all CRSP firms incorporated in the U.S. and listed on the NYSE, AMEX, and NASDAQ.

The coefficient of interest is $\beta_{m,i}$ which captures a firm's systematic risk. All other variables are defined as in equation (1).

In order to analyze the relationship between CSR and firm value, we approximate firm value using Tobin's Q. We follow the literature (e.g., Coles et al., 2008; Hong and Kacperczyk, 2009; Doidge et al., 2004) and calculate *Raw Tobin's Q* as book value of assets minus book value of equity plus market value of equity all divided by book value of assets, measured at fiscal year end t . Since we have no data regarding the replacement cost of assets or market value of debt (Lindenberg and Ross, 1981), this is merely an approximation, which is, however, likely to be strongly correlated with the actual Tobin's Q. Chung and Pruitt (1994) are able to show an R^2 of at least 96.6% for a regression of the Lindenberg and Ross (1981) Tobin's Q on this Tobin's Q approximation. We calculate the natural logarithm of *Raw Tobin's Q* to obtain a more symmetric distribution (*Tobin's Q*). All variables just introduced here as well as in the following are defined in more detail in Table A.1.

3.3 CSR measures

We measure CSR using ESG scores provided by Refinitiv and MSCI. Refinitiv's ESG ratings are available for almost 9,000 companies worldwide from 2002 at the earliest (Refinitiv, 2020b) and have been used in numerous studies, due to its good reputation in terms of data quality (Stellner et al., 2015; Cheng et al., 2014; Hawn and Ioannou, 2016; Ioannou and Serafeim, 2012; Luo et al., 2015).³ Refinitiv collects more than 450 company-related ESG measures, of which the 186 most relevant and comparable measures for each industry are used in the further process. The 186 measures (data points) are divided into 10 categories, which, after being

³ Refinitiv's (formerly Thomson Reuters) ESG Scores were published in 2015 as a successor to the Asset4 database, which was purchased by Thomson Reuters in 2009 and forms the basis of the ESG Scores.

weighted, form the three Pillar Scores (Environmental, Social, and Governance). The calculation of the category scores results in percentile scores, which are robust to outliers as they are based on ranks.⁴ The final ESG Score is then determined via a weighting scheme of the single Pillar Scores (Refinitiv, 2020a). Since the scores are based on a relative ranking within the same industry and the data points used for this were also selected and weighted on an industry-specific basis, a comparison across industries is not possible (Refinitiv, 2020b).

In addition, we obtain the “MSCI ESG Ratings Time Series database” for which ESG scores are available from 2007 and cover more than 8,700 companies worldwide (MSCI, 2020a, 2020b).⁵ MSCI evaluates thousands of data points along 35 so-called industry-specific key issues, which are aggregated into 10 themes and in turn are used to compile the three Pillar Scores (Environmental, Social, and Governance). To obtain the final ESG score (ESG Industry Adjusted Score) the weighted average of the Pillar Scores (Key Issues) is then calculated to arrive at an aggregated ESG score, that is normalized for the specific industry, which means that a cross-industry comparison is not possible and the scores of a company must be compared in relation to its industry-specific peers (MSCI, 2020a). Thus, MSCI’s ESG Industry Adjusted Score (*MSCI Score*) is comparable to Refinitiv’s ESG Score (*Refinitiv Score*).

Motivation for the use of two different ESG databases are recent findings by Berg et al. (2022), which show that the correlation between the ESG scores of Refinitiv (Asset4), KLD (KLD STATs) and the MSCI ESG score, are only between 38% and 53% (Asset4-MSCI: 38%; KLD-Asset4: 42%; KLD-MSCI: 53%). Accordingly, strongly differing assessments regarding

⁴ Another advantage compared to raw scores is that percentile scores do not have a trend component, which could bias the empirical analysis.

⁵ MSCI purchased the rating firm Kinder, Lydenberg & Domini (KLD) in 2010 (Berg et al., 2022) and thus gained access to the “KLD STATs ESG database”, one of the most widely used databases in the CSR literature (e.g., Albuquerque et al., 2019; Kim et al., 2014; El Ghouli et al., 2011; Krüger, 2015; Servaes and Tamayo, 2013; Deng et al. 2013), as well as the underlying methodology. MSCI continued to use this database until 2018, when it was replaced by proprietary ESG scores. As obtaining the KLD STATs database from MSCI is no longer possible, we use the current MSCI ESG scores comprised in the so-called “MSCI ESG Ratings Time Series database”.

the ESG valuation of companies exist (Berg et al., 2022), which in turn can have an impact on empirical findings.

3.4 Control variables

Following previous literature, we implement several control variables known to be associated with firm risk and firm value, respectively. Specifically, we control for firm size, capital expenditures (*CapEx*), research and development expenditures (*R&D*), dividend payments (dummy), capital intensity, leverage, return on assets, return on assets volatility, diversification (dummy), and liquidity. We include the variable *State Tax* to control for the fact that Democratic states have higher corporate tax rates than Republican states (Heider and Ljungqvist, 2015; Albuquerque et al., 2019).⁶ In addition, we follow recent literature and use the variable *Advertising* to consider that CSR via advertising can represent a product differentiation strategy, which is associated with a more loyal customer base resulting in a higher pricing power for the enterprise (Albuquerque et al., 2019; Servaes and Tamayo, 2013). If product differentiation takes place not only through advertising but also through the technology used, this would be absorbed through *R&D* and *CapEx* (Albuquerque et al., 2019). We include in all our regressions year η_t and 2-digit SIC code industry ξ_j fixed effects by using adequate dummies. In each year, all variables (except for dummy variables, CSR, and *State Tax*) are winsorized at the 1st and 99th percentiles to avoid the influence of extrema (Chen and Chen, 2012).⁷ Finally, we delete observations with negative realizations inter alia *R&D* and *Shareholders' Equity* (Fauver and McDonald IV, 2014; Xiao, 2013).

⁶ State corporate income tax rate data are obtained via Tax foundation: <https://taxfoundation.org/>.

⁷ Since the CSR scores are percentiles, winsorization is not meaningful.

4 Empirical design and methodology

In the following, we will now present the methodology and estimated models used. Section 4.1 discusses the classical OLS analysis whereas section 4.2 explains the UQR methodology.

4.1 Baseline fixed effects analysis

We analyze the influence of CSR on *Total Risk*, *Systematic Risk*, *Idiosyncratic Risk* and *Tobin's Q* using the following fixed effects panel data regressions with industry cluster robust standard errors and independent variables being lagged by one period:

$$\begin{aligned}
 Risk_{i,t+1} = & \alpha + \beta * CSR_{i,t} + \lambda * (CSR_{i,t} \times Advertising_{i,t}) \\
 & + \gamma_1 Advertising_{i,t} + \gamma_2 Size_{i,t} + \gamma_3 Liquidity_{i,t} + \gamma_4 CapEx_{i,t} \\
 & + \gamma_5 R\&D_{i,t} + \gamma_6 Dividend-Dummy_{i,t} + \gamma_7 Leverage_{i,t} \\
 & + \gamma_8 ROA_{i,t} + \gamma_9 ROA Volatility_{i,t} \\
 & + \gamma_{10} Diversification-Dummy_{i,t} + \gamma_{11} State Tax_{i,t} \\
 & + \eta_t + \xi_j + \varepsilon_{i,t+1} ,
 \end{aligned} \tag{3}$$

$$\begin{aligned}
 Tobin's Q_{i,t+1} = & \alpha + \beta * CSR_{i,t} + \lambda * (CSR_{i,t} \times Advertising_{i,t}) \\
 & + \gamma_1 Advertising_{i,t} + \gamma_2 Size_{i,t} + \gamma_3 Capital Intensity_{i,t} \\
 & + \gamma_4 CapEx_{i,t} + \gamma_5 R\&D_{i,t} + \gamma_6 Dividend-Dummy_{i,t} + \gamma_7 Leverage_{i,t} \\
 & + \gamma_8 ROA_{i,t} + \gamma_9 Diversification-Dummy_{i,t} + \gamma_{10} State Tax_{i,t} \\
 & + \eta_t + \xi_j + \varepsilon_{i,t+1} ,
 \end{aligned} \tag{4}$$

where $Risk_{i,t+1}$ and $CSR_{i,t}$ is one of our defined firm risk measures as well as CSR measures, respectively, and variables are defined as in Section 3. The estimated coefficients for β and λ are of main interest.

The estimation of (3) and (4) may be affected by endogeneity, in particular by reverse causality, since not only a risk-reducing or firm value-increasing effect of CSR is possible, but it could also be that companies with low risk have a higher firm value and thus more financial resources are available, which could be used for CSR activities (e.g., Albuquerque et al., 2019). Accordingly, we apply an instrumental variable approach (2SLS) and exploit existing industry effects (Cao et al., 2019) to create instruments for CSR. We calculate for each firm the median of our CSR variables for that firm's industry in a specific year, while excluding the firm of interest (El Ghoul et al., 2011, 2017; Kim et al., 2014; Cheng et al., 2014; Harjoto and Laksmana, 2018; Aouadi and Marsat, 2018; Faulkender and Petersen, 2006). Additionally, recent literature argues that democratic-leaning voters tend to take CSR issues more seriously, allowing for instruments based on the party affiliation of the state in which the company is headquartered (Di Giuli and Kostovetsky, 2014; Albuquerque et al., 2019; Cheung, 2016; Deng et al., 2013). However, when implementing this strategy, we encountered the problem of obtaining invalid instruments. We attribute the difference to Di Giuli and Kostovetsky (2014), and Albuquerque et al. (2019) to the use of other CSR databases, which again underlines (i) the relevance of the CSR provider used and (ii) the existing differences regarding the creation of CSR scores (Berg et al., 2022).

Using continuous CSR scores leads to the problem that the validity of the instruments, analyzed via test for underidentification and weak identification (Kleibergen and Paap, 2006), is not given. For that reason, we convert the CSR scores into dummy variables, thus passing the

validity tests. The CSR-Dummy takes the value 1 if the CSR score of the company is greater than the industry-specific (2-digit SIC code) median, otherwise 0.

Since, the CSR-Dummy and the endogenous component of the interaction (CSR-Dummy) is binary, equations (3) and (4) are dummy endogenous variable models (Heckman, 1978) which rules out the standard approach. We follow Wooldridge's (2002, p. 623, procedure 18.1) procedure of a generated instrumental variable approach as well as Chang et al. (2009), An and Chan (2008), Adams et al. (2009), Faulkender and Petersen (2006), and Lin and Su (2008). In a first step, this approach estimates a probit model of the following regression to obtain fitted probabilities of having CSR above industry median, i.e., CSR-Dummy takes the value 1:

$$\begin{aligned} \text{probit} \left(P(\text{CSR-Dummy}_{i,t} = 1) \right) & \quad (5) \\ & = \alpha + \beta_1 * \text{Instrument}_{i,t} + \gamma \text{Controls}_{i,t} + \eta_t + \xi_j + \varepsilon_{i,t} , \end{aligned}$$

where $\text{Instrument}_{i,t}$ is the corresponding instrument defined above and $\text{Controls}_{i,t}$ are the control variables used in equations (3) and (4), respectively. In a second step, equations (3) and (4) are estimated via 2SLS using the fitted probabilities from the probit model as instruments for the endogenous dummy. Main advantages of this approach are that it (i) takes the binary structure of the endogenous dummy into account, (ii) does not require the binary response model (5) to be correctly specified, and (iii) under fairly general conditions, this procedure provides asymptotically valid standard errors (Adams et al., 2009; Chang et al., 2009; Wooldridge, 2002).

4.2 Unconditional quantile regression analysis

In order to analyze the potential non-constant relationship between CSR and firm risk or firm value at the tails of the distribution, i.e., in the quantiles of the dependent variable, we implement the UQR developed by Firpo et al. (2009).⁸ This method shows how an unconditional quantile of the firm risk (firm value) distribution is affected by a marginal change in the distribution of the explanatory variable under consideration (CSR), while controlling for the effects of other regressors (Rios-Avila and Maroto, 2022; Rios-Avila, 2020).⁹ The relationships are mapped by regressor-specific coefficients in equations (3) and (4), estimated for each unconditional quantile of interest (here 5% to 95% in 5% steps) of the dependent variable. Thus, the estimated coefficients along the different unconditional quantiles of the dependent variable (firm risk and firm value, respectively) can differ in sign, magnitude, and significance, allowing heterogeneous relationships between regressand and regressor to be represented at different quantiles (Firpo et al., 2009; Entrop et al., 2017). As before we consider industry and year fixed effects and calculate robust standard errors bootstrapped from 1,000 replications.

UQR methodology is based on the idea of a marginal shift in the distribution of the independent variable to analyze the effect on the unconditional quantile of the dependent variable (Firpo et al., 2009). Our regressor of interest, the respective CSR score, is a percentile

⁸ We are grateful to Nicole Fortin for making the Stata ado-file available on her homepage.

⁹ UQR answers the following question: How much would the observed distribution of firm risk (firm value) change, measured by the change in the τ^{th} quantile of the firm risk (firm value) distribution, if all firms faced, on average, a marginal increase (e.g., 1%) in CSR, holding everything else constant. In contrast, Conditional Quantile Regression (CQR) answers the question how much would the firm risk (firm value) distribution change, measured by changes in the τ^{th} quantile of the firm risk (firm value) distribution, if every firm with the same observed characteristics (realized covariates) faced a marginal increase in CSR (e.g., 1%), holding everything else constant (Rios-Avila and Maroto, 2022; Firpo et al., 2009). Accordingly, CQR estimates the relationship between CSR and firm risk (firm value) at different points of the conditional firm risk (firm value) distribution, thereby estimating variation in the CSR effect among firms with different firm risk (firm value) levels but similar covariate values. Firms at high quantiles of the conditional firm risk (firm value) distribution have higher firm risk (firm value) than we would expect, given their covariates, but are not necessarily high-risk (high-value) in an absolute sense. Therefore, UQR allows for a comparison between the effect of CSR on low risk (value) and high risk (value) firms in an absolute sense (Killewald and Bearak, 2014; England et al., 2016).

score and by definition scaled to the value range 0 to 1. This means that a marginal shift in the (overall) distribution of the CSR score is not possible, as the improvement in the relative ranking of one company is automatically accompanied by the deterioration in the relative ranking of at least one other company. Thus, a meaningful (in an economic sense) interpretation of the UQR results is no longer possible. To circumvent this problem, we create two subsamples. We calculate the change in CSR score from $t - 1$ to t and classify the firm-year observations into those that experienced a CSR score improvement and deterioration, respectively. We then perform separate UQRs for these two subsamples, which is possible because now only the distribution of the CSR score is marginally shifted with respect to one subsample. We present and discuss results only for firm-year observations with positive CSR score change, since they are accompanied by more observations (7,846). Our results for negative CSR score changes are quantitatively similar, but are based on less observations (4,152) resulting in less significance.¹⁰ The UQR results can then be interpreted as what would be the impact of an additional marginal CSR shift on the dependent variable for the companies with positive (negative) CSR change.

As before, the estimation of equations (3) and (4) via UQR may suffer from endogeneity. So far, no instrumental variables approach exists and the current literature still discusses potential approaches to adequately account for endogeneity (Firpo et al., 2009).¹¹ We reduce the potential

¹⁰ We also use first differences of our CSR scores in the estimation procedure, which comes with the advantage of utilizing more observations (10,185) but has the disadvantage of eliminating a lot of variation that results in insignificant results.

¹¹ In the case of binary treatment variables Firpo (2007) proposed a quantile treatment effects (QTE) estimator, assuming exogeneity. “QTE can be considered as a compromise between CQR [conditional quantile regression] and UQR that focuses on analyzing the distributional impact of a single binary variable on the outcome of interest, holding the distribution of other characteristics constant” (Rios-Avila and Maroto, 2022). QTE was extended to include endogeneity by Frölich and Melly (2008, 2013) and implemented in the statistical program Stata through the user-written command `ivqte` (Frölich and Melly, 2010). Here, a variant was implemented which makes it mandatory that the instrument used, as well as the endogenous variable, is binary (Frölich and Melly, 2010). The case of a continuous instrument, which is our situation, was described in the working paper (Frölich and Melly, 2008) but has not been implemented so far.

endogeneity problem by (i) using industry and year fixed effects and (ii) re-estimating equations (3) and (4) using CSR scores lagged by up to four time periods.

5 Empirical results

5.1 Descriptive statistics

Panel A of Table 1 shows that *Raw Tobin's Q* (*Tobin's Q*) has a mean of 2.35 (0.69) which is larger than the median of 1.83 (0.60), indicating a right skewed distribution and thus justifying the use of the natural logarithm to obtain a more symmetric distribution.¹² Both the mean and median are 0.02 for *Total Risk* and *Idiosyncratic Risk*. *Systematic Risk* has a mean of 1.15 and a median of 1.09. Annualization of *Total Risk* ($\sqrt{250} * 0.02 = 0.32$) and *Idiosyncratic Risk* ($\sqrt{250} * 0.02 = 0.32$) shows that the level of risk is lower but comparable to previous studies (Bouslah et al., 2013; Sassen et al., 2016).

For the *Refinitiv Score* and *MSCI Score*, there are 13.778 and 12.223 observations. The mean score is 0.38 for the *Refinitiv Score* and 0.43 for the *MSCI Score* and is slightly larger than the median 0.34 for the *Refinitiv Score* and *MSCI Score* 0.41, respectively. By construction, the CSR scores are restricted to the range of values 0 to 1.

Panel B of Table 1 shows correlation coefficients for the CSR scores, *Tobin's Q* and risk variables. The low correlation of 34.09% between Refinitiv and MSCI is striking and suggests that a consistent definition of CSR is lacking. This leaves room for interpretation by the rating agencies, which is why the ratings address different aspects of CSR and are ultimately poorly correlated. This low correlation is confirmed by Berg et al. (2022), who compare CSR scores

¹² This finding is common in the literature, e.g., Lang and Stulz (1994), Allayannis and Weston (2001), and Jin and Jorion (2006).

from six different providers and find that differences in the scope and measurement of CSR in particular lead to the relatively low correlations. Furthermore, *Tobin's Q* and the three risk variables are negatively correlated with the CSR scores, except for $Cor(Tobin's Q, MSCI Score)$. While a negative correlation between CSR and risk was expected, the likewise negative correlation between the *Refinitiv Score* and *Tobin's Q* is surprising, as well as the positive correlation between *Tobin's Q* and risk that also contradicts with the company valuation literature (see Section 2). However, no control variables have yet been included, so we do not want to overinterpret these univariate results.

[Table 1 about here]

5.2 CSR and firm risk

5.2.1 Fixed effects regression

We start with an analysis of the CSR-firm risk relationship and estimate equation (3) for this purpose. Panel A and B of Table 2 contain the results for *Total Risk*, *Idiosyncratic Risk*, and *Systematic Risk*. The sign and statistical significance of our controls are mostly in line with our expectations. Model (I) confirms the risk-reducing influence of CSR for all three risk types but is significant only in four cases (once (thrice) at the 5% (10%) level). Model (II) tests whether CSR is more negatively related with risk in firms with greater product differentiation by interacting CSR and advertising (Albuquerque et al., 2019; Servaes and Tamayo, 2013). With one exception, the interaction terms have a risk-reducing effect, but are consistently not significant. Overall, we observe that the signs are in line with the literature (e.g., Albuquerque et al., 2019; Luo and Bhattacharya, 2009), however, we find very little significance based on

our dataset and in particular the CSR scores used. More specifically, we find significance for either the Refinitiv score or the MSCI score but never for both scores simultaneously.

[Table 2 about here]

5.2.2 Unconditional Quantile Regression

Figure 1 exemplifies the relations between *Total Risk*, *Refinitiv Score* and the control variables for the unconditional quantiles of *Total Risk* and shows the estimated coefficients and corresponding 90% confidence intervals.¹³ As already mentioned in Section 4.2 the following results are based on firm-year observations that show a positive change in CSR score. With regard to the *Refinitiv Score*, a risk-reducing and significant influence can be confirmed for most of the unconditional quantiles of *Total Risk*. Indeed, we find a weak influence of CSR on *Total Risk* in the lower quantiles, which increases continuously up to the 60th quantile. For high quantiles, the influence of CSR decreases strongly and is insignificant from the 80th percentile onwards. These results support our initial hypothesis that the impact of CSR is not the same for all firms. Moreover, it can be seen that firms with a low risk level benefit little and firms with a high risk level do not benefit at all from improved CSR performance, while other factors play a greater role (e.g., *Liquidity* and *Leverage*).

Regarding the *Interaction Term* (CSR x *Advertising*), significantly negative coefficients are found only up to the 40th quantile. Thereafter, the indirect channel of CSR described by Albuquerque et al. (2019), and Servaes and Tamayo (2013) no longer has any influence on *Total Risk*.

¹³ Figures for *Idiosyncratic Risk* (Figure IA.1) and *Systematic Risk* (Figure IA.2) can be found in the Internet Appendix.

Our controls reveal strong heterogeneous relationships in combination with mostly high statistical significance to *Total Risk*, where magnitude and significance mainly decrease in the top quantiles, reflected in widening confidence intervals.

[Figure 1 about here]

Panel A of Table 3 reports specific estimated coefficients for the 10% to 90% quantile for both CSR scores. Model (I) confirms the negative impact of CSR on *Total Risk*, which is mostly significant at the 1% (5%) level for the *Refinitiv Score* (*MSCI Score*) up to the 70% (60%) percentile. Including the *Interaction Term* in Model (II) essentially does not affect our CSR coefficients and their respective significance levels. The *Interaction Term* itself is mostly negative for the *Refinitiv Score*, but only significant below the median, while the *MSCI Score* shows significant risk increasing effects at the median and 60% quantile.

The results show that the estimated CSR coefficients based on the *Refinitiv Score* are about twice as high compared to the *MSCI Score*, thus directly affecting economic relevance. In comparison to the *MSCI Score*, we find more significant results and higher significance in case of the *Refinitiv Score*.

Panel B of Table 3 shows results for *Idiosyncratic Risk*. The results and their economic interpretation are similar to the explanations for *Total Risk*. Thus, we find a risk-reducing influence of the *Refinitiv Score* in Model (I), that is stronger at the low and medium quantiles and loses relevance at the high quantiles. More precisely, while significance at the 1% level is given up to the 70% quantile, no significance is observed thereafter. The *MSCI Score* exhibits a significant risk-reducing effect only for the 20th to 60th percentiles that is stronger for the medium quantiles. Model (II) allows for similar conclusions regarding the estimated CSR coefficients. The *Interaction Term* itself shows mostly negative coefficients in the case of the

Refinitiv Score, but is significant only for the 10% quantile. In case of the *MSCI Score*, the *Interaction Term* is negative only for the 30% quantile and below, but significant for the 60th percentile. Based on our CSR scores, we find weak evidence for the indirect CSR channel for *Idiosyncratic Risk*.

Again, we find about twice as large CSR coefficients, more significant results, and higher significance for the *Refinitiv Score* in comparison to the *MSCI Score*.

Panel B of Table 3 also shows results for *Systematic Risk*. In model (I), the *Refinitiv Score* exerts a significant risk-reducing effect in the 60%, 70% and 80% percentiles, thus only for high risk firms. For the *MSCI Score* below the 80th quantile, all but one of the coefficients are significantly negative with stronger effects for low-risk and high-risk firms. In model (II), there is an overall risk-reducing effect of CSR for the *Refinitiv Score* (also for the *MSCI Score*) across all quantiles, which is mostly exerted by the interaction effect. The effect of the *Interaction Term* is stronger for low and high quantiles. For the *MSCI Score*, the CSR coefficients in model (II) can only maintain their significance between the 40th and 70th quantiles and the interaction effect has a significant risk-reducing influence only at the 10th quantile.

This time we find more significant results and higher significance when using the *MSCI Score* instead of the *Refinitiv Score*.

[Table 3 about here]

5.2.3 Endogeneity in the CSR-Risk relation

Since our previously discussed results are potentially biased due to endogeneity, we re-estimate equation (3) using an instrumental variables approach. Table 4 reports results for our

instrumented fixed effects regressions.¹⁴ For each regression, we report validity tests for endogeneity (Durbin, 1954; Wu, 1973; Hausman, 1978), underidentification and weak identification (Kleibergen and Paap, 2006). The test statistics imply that the respective CSR scores are not endogenous and that the instruments are correlated with the (endogenous) CSR scores and are not weak instruments. Overall, the results show no significant impact of CSR on the risk variables, although a risk-reducing effect can be confirmed for the *MSCI Score Dummy*. The interaction term is significant at the 5% (10%) level in two (one) cases using the *Refinitiv Score Dummy*, confirming the results of Albuquerque et al. (2019). Using the *MSCI Score Dummy*, the interaction effect shows no impact on risk and emphasizes the relevance of using different CSR score providers to reach meaningful inferences.

[Table 4 about here]

We repeat the analysis using CSR scores lagged by 4 periods ($t = 4$) and find very similar results to 2SLS. The results in Table 5 show that the coefficients retain their sign and continue to indicate a risk-reducing effect (one exception), but the majority of the coefficients loses its significance. Accordingly, we see that the potential endogeneity problem does not change the sign, but the significance of the coefficients is affected.

¹⁴ Table IA.1 shows the results of the probit regression, for which equation (5) was estimated using the economic instruments described in Section 4.1. The results show a negative and statistically significant correlation between the respective dependent variable (*Refinitiv Score Dummy* and *MSCI Score Dummy*) and the corresponding instrument (*Median Refinitiv Score* and *Median MSCI Score*) demonstrating that the instruments influence the dummy regressands as expected and that the specification does not suffer from “weak instruments”. The observed negative correlation is due to technical reasons. The Refinitiv Score Dummy [MSCI Score Dummy] takes the value 1 if Refinitiv Score [MSCI Score] is above the industry (2-digit SIC code) median, otherwise 0. The Refinitiv Score [MSCI Score] instrument is generated excluding the company under consideration. Therefore, if the Refinitiv Score Dummy [MSCI Score Dummy] takes the value 1 (0), then the Refinitiv Score [MSCI Score] is above (below) the industry median and consequently, compared to many other companies, it can be classified as high (low). However, since this company is excluded from the calculation of the instruments, the result is a decreasing (increasing) industry median and thus a negative correlation.

[Table 5 about here]

Finally, we tackle endogeneity in context of UQR. We mitigate the potential endogeneity problem by using CSR scores lagged by four periods ($t = 4$), instead of one period ($t = 1$). Panel A and B of Table 6 show results for *Total Risk*, *Idiosyncratic Risk*, and *Systematic Risk*.

With respect to *Total Risk*, the signs of the coefficients are preserved for both CSR scores and in both models, confirming the risk-reducing influence of CSR. The coefficient magnitude of both CSR scores decreases in model (I) and (II), respectively, especially for the *Refinitiv Score*. Also, the coefficients of the *Refinitiv Score* in particular lose significance, whereas the MSCI score results appear more robust. The interaction term can retain its significance in the context of the *Refinitiv Score*, whereas there is no longer any significance when using the *MSCI Score*.

Regarding *Idiosyncratic Risk*, the interpretation is very similar to *Total Risk*. The estimated CSR coefficients hardly show any sign changes, are somewhat smaller and less significant than the results in Table 3 Panel B. It is striking that in the case of the *Refinitiv Score* in model (II), the risk-reducing influence is particularly due to the increased significance of the *Interaction Term*.

The results for *Systematic Risk* are very similar to those in Table 3 Panel B. For model (I), the *Refinitiv Score* shows almost no significant risk-reducing effect, whereas the *MSCI Score* shows no effect only for high-risk firms. The same can be observed for the CSR score in model (II). Using the *Refinitiv Score*, the *Interaction Term* retains its significance to a large extent, whereas with the *MSCI Score*, as before, a risk-reducing influence can only be detected in the 10% quantile.

Overall, the risk-reducing influence of the CSR score, directly as well as indirectly via the *Interaction Term*, can be confirmed. Compared to Panel A and B of Table 3, most of the

coefficients slightly decreased, but hardly show any changes in sign. The reduced number of quantiles with a significant coefficient is striking. Especially for the *Refinitiv Score*, many coefficients lose their significance, whereas the results for the *MSCI Score* are slightly more robust in terms of significance. This may be due to (i) the high degree of lags used, which negatively affects the dependent and independent variable's strength of correlation, and (ii) due to the significant loss in statistical power, since the number of available observations has been almost halved (3,513 and 4,444).

[Table 6 about here]

5.3 CSR and firm value

Having examined the risk-reducing impact of CSR on Total Risk, Idiosyncratic Risk and Systematic Risk, we now focus on the value of the firm. More specifically, we examine the impact of CSR on Tobin's Q and expect to find a value-enhancing effect.

5.3.1 Fixed effects regression

We estimate equation (4) to analyze the impact of CSR on firm value and present results in Panel A of Table 2. CSR has a significant positive effect on *Tobin's Q* in both models, regardless of the CSR score used. The results for the *Refinitiv Score* (*MSCI Score*) are significant at the 1% (5% and 10%) level. The *Interaction Term* shows a positive but insignificant effect. Based on our dataset this implies that CSR does not exert an additional influence for firms with a larger product differentiation strategy, contrasting the literature

(Albuquerque et al., 2019; Servaes and Tamayo, 2013). The signs and statistical significance for most of our controls are in line with our expectations.

We find more than twice as large CSR coefficients for the *Refinitiv Score* than for the *MSCI Score*, as well as higher statistical significance. This suggests that the results depend on the CSR score used.

5.3.2 Unconditional Quantile Regression

Figure 2 depicts the relation between *Tobin's Q*, *Refinitiv Score* and the control variables for the unconditional quantiles of *Tobin's Q* and shows the estimated coefficients and corresponding 90% confidence intervals for firm-year observations with a positive change in CSR score (see Section 4.2). For the *Refinitiv Score*, we observe a significant value-enhancing effect for most of the unconditional quantiles of *Tobin's Q* that is in line with the literature (e.g., Albuquerque et al., 2019; Servaes and Tamayo, 2013). More specifically, we see that the impact of CSR increases steadily up to the 70th percentile before declining rapidly. This shows that the influence of CSR is particularly important for firms with a medium-high firm value. For firms with a low firm value the effect is almost half as large, whereas the value-enhancing CSR effect is no longer present for firms with a very high *Tobin's Q* as the coefficients are insignificant. As hypothesized, the results show that the impact of CSR is highly heterogeneous and depends on the value of the firm. Firms with a high value benefit little or not at all from improved CSR performance and, based on our results, should focus more on *R&D* and *CapEx*, for example.

The *Interaction Term* (CSR x *Advertising*) displays throughout positive coefficients but explicit significance only at the 60% quantile. This suggests that the indirect channel of CSR (Albuquerque et al., 2019; Servaes and Tamayo, 2013) on *Tobin's Q* is rather weak in our dataset.

As before (Figure 1), the control variables show strong heterogeneous relations to *Tobin's Q* that are highly significant, and where magnitude and significance mainly decrease in the top quantiles, reflected in widening confidence intervals.

[Figure 2 about here]

Panel A of Table 3 shows estimated coefficients for *Tobin's Q*. In model (I), regardless of the CSR score used, all but one of the coefficients are significantly positive. Coefficient's magnitude is lower for the *MSCI Score*, as is the significance in the extreme quantiles. Including the *Interaction Term* leaves the CSR coefficients almost unchanged, as does their statistical significance. The *Interaction Term* shows a significant positive influence on *Tobin's Q* only for the *Refinitiv Score* in the upper quantiles. Overall, a value-enhancing influence of CSR can be observed for both CSR scores, despite partly insignificant negative *MSCI Score* interaction coefficients.

The results show that the estimated CSR coefficients based on the *Refinitiv Score* are more than twice as large compared to the *MSCI Score*, thus directly affecting economic relevance. In comparison to the *MSCI Score*, we find slightly more significant results and higher significance in case of the *Refinitiv Score*.

5.3.3 Endogeneity in the CSR-Firm value relation

We re-estimate equation (4) using an instrumental variables approach.¹⁵ Table 4 reports results for our instrumented CSR-firm value fixed effects regressions. We perform various tests that

¹⁵ Table IA.1 shows the results of the probit regression, for which equation (5) was estimated using the economic instruments described in Section 4.1.

confirm the validity of the instruments, as described in Section 5.2.3. The estimated coefficients no longer exhibit statistical significance and have a value-reducing effect. The *Interaction Terms* are positive but also not significant at any common significance level.

Using CSR scores lagged by four periods ($t = 4$) just partly confirm these results. In Table 5, we find throughout positive coefficients that maintain significance in case of the *Refinitiv Score* but are not significant for the *MSCI Score*. In line with the 2SLS results, the *Interaction Term* is positive but also insignificant.

Panel A of Table 6 presents UQR results for *Tobin's Q*. With regard to the CSR scores, we observe quite heterogeneous effects. In models (I) and (II), the *Refinitiv Score* can keep its effect almost unchanged in terms of significance and coefficient magnitude compared with Panel A of Table 3. Thereby we can confirm the value-enhancing effect of CSR described in the literature, e.g., Albuquerque et al. (2019), Servaes and Tamayo (2013), Harjoto and Jo (2015), El Ghouli et al. (2017), and Aouadi and Marsat (2018). In contrast, the *MSCI Score* coefficients lose all significance and suffer a loss in magnitude but still have positive coefficients. Regardless of the CSR score used, the *Interaction Term* no longer has a significant value-enhancing effect on *Tobin's Q* (two exceptions for the *Refinitiv Score*).

5.4 Discussion of results

With respect to firm risk, our fixed effects OLS results (Table 2) do not completely meet our expectations of a significant negative effect of CSR. Although we find a risk-reducing influence of CSR on all three risk definitions, the results hardly show any significance. Also, the indirect effect of CSR via advertising as a product differentiation strategy does not show any significant influence on firm risk. This is unexpected, since the literature can show a significant negative influence of CSR on the average of the distribution of the three risk variables and via the

interaction effect (Albuquerque et al., 2019; Luo and Bhattacharya, 2009; Mishra and Modi, 2013; Jo and Na, 2012). The loss of significance of the CSR coefficient in model (II) is consistent with the literature, where, in turn, the interaction effect is strongly significant, which is not the case in our setting (Albuquerque et al., 2019). However, while most studies use CSR data from KLD, even Sassen et al. (2016), using CSR data from Refinitiv, partly document unclear patterns in terms of statistical significance for all three risk variables. We also note, that significant results are found per risk variable for either the *Refinitiv Score* or the *MSCI Score*, but never for both scores at the same time, which emphasizes the relevance of the CSR data provider used.

Regarding *Tobin's Q*, we can confirm the value-enhancing effect of CSR, although the lack of significance of the *Interaction Term* is striking and contradicts the literature (Albuquerque et al., 2019; Servaes and Tamayo, 2013; El Ghouli et al., 2017; Jiao, 2010). Again, the loss of significance between the *Refinitiv Score* (1% level) and *MSCI Score* (10% level) is eye-catching and we find more than twice as high coefficients for the *Refinitiv Score* than for the *MSCI Score*.

The application of 2SLS shows that CSR, regardless of the CSR score used, has no direct impact on both firm risk and firm value. For all three risk variables, however, there is now a significant indirect effect via the interaction term when using the *Refinitiv Score*. This finding cannot be confirmed when applying the *MSCI Score*. Also, the use of CSR scores lagged by four periods is largely consistent with the results of the 2SLS.

The implementation of the UQR now confirms both the risk-reducing and value-enhancing influence of CSR, directly as well as indirectly.¹⁶ In addition, the assumption of high heterogeneity, with respect to coefficient magnitude and significance, of CSR along the unconditional quantiles of the respective dependent variable is confirmed. Accordingly, the

¹⁶ These results hold when we restrict our dataset to the same firm-year observations for the Refinitiv Score and MSCI Score, rather than using all available observations per CSR Score.

observed effects along the unconditional quantiles of the distribution deviate significantly from the average effects estimated via fixed effects regression, reinforcing the relevance of analyzing the effects at the unconditional quantiles of the independent variables. Moreover, we find for *Total Risk*, *Idiosyncratic Risk*, and *Tobin's Q* coefficients that are about twice as high for the *Refinitiv Score* than for the *MSCI Score*. Even after using CSR scores lagged by four periods, the effects found can be confirmed, even though the number of significant results has now been reduced, mainly due to the significantly lower number of observations. To support this line of reasoning, we rerun the UQR using the entire data set, thus increasing the number of observations. While this limits the economic interpretation, it does not affect the statistical validity of the results. Overall, we observe (i) nearly identical coefficients and (ii) more as well as higher statistically significant results when the CSR score is lagged by one period (Table IA.2). When using four lags (Table IA.3), this observation can be confirmed, confirming our previous line of reasoning, that the reduced sample size results in a loss of statistical power.

6 Conclusion

We investigate the impact of CSR on both firm risk, represented by total risk, systematic risk, and idiosyncratic risk, and firm value approximated via Tobin's Q. In contrast to previous literature, we do not focus on the average relationship, estimated with standard OLS, but on the relationship along the entire distribution of the dependent variables. Therefore, we analyze the unconditional quantiles of the distribution of the dependent variables, enabling us to identify heterogeneous effects in terms of coefficient magnitude, sign and significance. For this purpose, we implement UQR according to Firpo et al. (2009) in addition to standard fixed effects OLS and instrumental variable regression. We apply a large U.S. panel dataset, which contains all

U.S. American headquartered companies, listed on the NYSE, NASDAQ, and AMEX during the period 01/01/2002 to 12/31/2019. To measure CSR, we use ESG scores from Refinitiv (period: 2002-2019), as well as the MSCI ESG Ratings Time Series from MSCI (period: 2007-2019). We test both, the direct impact of CSR and the indirect impact via CSR as a product differentiation strategy on firm risk and firm value, respectively, thus picking up on a channel of impact only recently discussed in the literature (Albuquerque et al., 2019; Servaes and Tamayo, 2013; Luo and Bhattacharya, 2009).

While the fixed effects regressions partly confirm a (weak) statistically significant risk-reducing and value-enhancing effect of CSR, these results cannot be confirmed when controlling for endogeneity and thus deviate from the literature. The implementation of UQR, a methodology not previously used in this part of the literature, reveals strongly heterogenic effects across the quantiles of the distribution of the dependent variables, which continues to be confirmed even when using CSR scores lagged by four periods to mitigate endogeneity concerns. The results high heterogeneity emphasizes the relevance of analyzing the effects at the unconditional quantiles of the dependent variables.

Our results can be important for companies to assess how the capital market evaluates a stronger CSR compliant engagement. This can help management to prioritize different options efficiently. For instance, high risk companies may want to focus less on CSR performance and more on more pressing issues that increase the likelihood of the company's continued existence. The focus can then be shifted to CSR performance at a later stage. Policy makers may also benefit from our findings in terms of a better understanding of corporate behavior. On the one hand, when companies consciously decide against further improving CSR performance and thus act contrary to the interest of the policy maker. On the other hand, our results can help the policy maker to design new measures more specifically and to better assess their impact. Moreover, our results show that even if no influence of CSR is observable in a mean analysis,

this does not imply that there is fundamentally no influence. Rather that this influence may be primarily observed in the tails of the distribution.

Appendix

Table A.1: Definition of dependent and independent variables

(1) Variable	(2) Definition
<u>Panel A: Dependent Variables</u>	
Raw Tobin's Q	Defined as book value of assets (WC02999) minus book value of equity (WC03995) plus market value of equity (WC08001) all divided by total assets (WC02999; Coles et al. 2008; Hong and Kacperczyk, 2009; Doidge et al., 2004)
Tobin's Q	We calculate the natural logarithm of "Raw Tobin's Q" to obtain Tobin's Q (Coles et al. 2008; Hong and Kacperczyk, 2009; Doidge et al., 2004)
Total Risk	Standard deviation of daily discrete stock returns (based on RDS RI) over the past 12 months for firm i and year t (Jo and Na, 2012; Bouslah et al., 2013; Sassen et al., 2016)
Idiosyncratic Risk	Standard deviation of the residuals from a 4-factor Carhart (1997) model estimated for each firm i and each year t using daily discrete return data (based on RDS RI; Sassen et al., 2016; Luo and Bhattacharya, 2009; Ang et al., 2006, 2009)
Systematic Risk	Estimated CAPM (Sharpe, 1964) beta coefficient for each firm i and each year t using daily discrete return data (based on RDS RI; Albuquerque et al., 2019; Sassen et al., 2016)
<u>Panel B: Independent Variables</u>	
Advertising	Defined as Advertising expenses (RE TR.F.AdExpnSuppl) divided by total assets (WC02999). Advertising data in Datastream has many missing observations (set to zero in our analysis), but that does not imply that those firms did not advertise, rather that firms did not report the data separately from SG&A (selling, general and administrative), likely leading to an attenuation bias (Albuquerque et al., 2019; Servaes and Tamayo, 2013).
CapEx	Capital expenditures (WC04601) divided by total assets (WC02999; Albuquerque et al., 2019; Servaes, 1996; Jin and Jorion, 2006). Positively affects firm value and is expected (as an investment opportunity) to positively affect systematic risk and unsystematic risk (Allayannis and Weston, 2001; Albuquerque et al., 2019; Bouslah et al., 2013; Jo and Na, 2012; Mishra and Modi, 2013).
Capital Intensity	Gross Property, Plant, and Equipment (WC02501) divided by total assets (WC02999; Konijn et al., 2011; Gulen and Ion, 2015). Can be positively or negatively related to Tobin's Q, since relatively large intangible assets may lead to an underestimation of Tobin's Q's denominator, the replacement costs of capital. On the other hand, agency problems could cause larger problems for companies with lower tangible assets (Konijn et al., 2011; Habib and Jungqvist, 2005)
CSR Score	As provided by Refinitiv (Refinitiv Score) and MSCI (MSCI Score). We expect a risk-reducing and value enhancing effect.
CSR-Dummy	Indicator variable that equals 1 if the CSR score of a company in year t is greater than the industry-specific (2-digit SIC code) median in year t , otherwise 0
Diversification-Dummy	Indicator variable that equals 1 if the firm's number of operating segments which operate in different 2-digit SIC codes is two or higher, else 0 (based on WC19506 to WC19596; Glaser and Müller, 2010; Kuppaswamy and Villalonga, 2016). Empirical literature largely records a negative effect on firm value (Campa and Keida, 2002; Graham et al., 2002; Villalonga, 2004). There is also literature showing a relationship

Dividend-Dummy	<p>between diversification and (un)systematic risk (Albuquerque et al., 2019; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007; Melicher and Rush, 1973; Sassen et al., 2016).</p> <p>Indicator variable that takes the value 1 if the company paid a dividend (WC05101) in the current year, else 0. Missing values are replaced with 0 (Servaes, 1996; Allayannis and Weston, 2001). A firm's value can remain high even if the firm fails to undertake potential projects due to a lack of funding, as long as only the projects with the highest NPVs are carried out. Thus, a company is unlikely to be capital constrained if it pays a dividend and could therefore have a lower Tobin's Q, which corresponds to a negative regression coefficient (Lang and Stulz, 1994; Servaes, 1996; Allayannis and Weston, 2001). Idiosyncratic risk may be affected, since shareholders and investors value dividend payments. For systematic and idiosyncratic risk, the literature has shown a negative and positive relationship (Sassen et al., 2016; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007; Mishra and Modi, 2013).</p> <p>Total debt divided (WC03255) by shareholders' equity (WC03995; Allayannis and Weston, 2001; Fauver and McDonald IV, 2014). A firm's capital structure may have a positive impact on firm value (Allayannis and Weston, 2001; Fauver and McDonald IV, 2014) and on systematic and unsystematic risk (Albuquerque et al., 2019; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007; Sassen et al., 2016).</p> <p>Calculated as adjusted ask price (RE.TR.AskPrice) minus adjusted bid price (RE.TR.BidPrice) divided by the spread midpoint. The spread midpoint is calculated as adjusted ask price plus adjusted bid price divided by two. For each year we take the average of daily figures to obtain an annual frequency. We expect a positive relationship towards risk (Chung and Zhang, 2014; Sassen et al., 2016; Bouslah et al., 2013).</p> <p>Defined as R&D (WC01201) divided by total assets (WC02999). We follow the common practice in previous research and replace missing values with zero. This is because since 1972 the SEC has required all publicly traded companies to report their R&D expenditures when they are material, exceed 1% of sales, or a policy of deferral or amortization of R&D expenses is pursued (Allayannis and Weston, 2001; Lewis and Tan, 2016; Hirschey et al., 2012). Positively affects firm value (Allayannis and Weston, 2001), and positively or negatively systematic risk and unsystematic risk (Albuquerque et al., 2019; Becchetti et al., 2015; Bouslah et al., 2013; Jo and Na, 2012; McAlister et al., 2007).</p> <p>Net income (WC01551) divided by total assets (WC02999; Allayannis and Weston, 2001; Jin and Jorion, 2006; Jiang et al., 2018).</p> <p>Profitability makes it more likely for a firm to be traded at a premium (higher Tobin's Q; Allayannis and Weston, 2001; Jin and Jorion, 2006). Profitability also affects risk since it contains information about a firm's future cash flow streams (Luo and Bhattacharya, 2009; Sassen et al., 2016; Jo and Na, 2012).</p>
ROA	<p>Standard deviation of ROA over the previous 5 years (Albuquerque et al., 2019; Luo and Bhattacharya, 2009). Profit volatility can signal the uncertainty of firm future cash flows and therefore affect risk (Albuquerque et al., 2019; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007; Bouslah et al., 2013; Sassen et al., 2016).</p>
ROA Volatility	<p>Natural logarithm of total assets (WC02999; Albuquerque et al., 2019; Allayannis and Weston, 2001), deflated by the consumer price index to express nominal values in 2015 dollars (Flannery and Rangan, 2006). The yearly consumer price index is obtained via the Federal Reserve Bank of St. Louis: https://fred.stlouisfed.org. Whether company size has a positive influence on profitability is ambiguous, at least for US companies (Lang and Stulz, 1994; Allayannis and Weston, 2001). A negative influence of company size on systematic as well as unsystematic risk has already been noted in the literature (Albuquerque et al., 2019; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007; Mishra and Modi, 2013).</p>
State Tax	<p>Defined as the highest-bracket state corporate income tax rate, obtained via Tax foundation (https://taxfoundation.org/). We have no expectations regarding the coefficient's sign (Albuquerque et al., 2019).</p>

This table defines our dependent variables (Panel A) and independent variables and shows signs regarding the expected relationship between dependent and independent variables (Panel B). Where "RDS", "RE", and "WC", indicate "Refinitiv Datastream", "Refinitiv Eikon", and "Worldscope" items used to retrieve the data.

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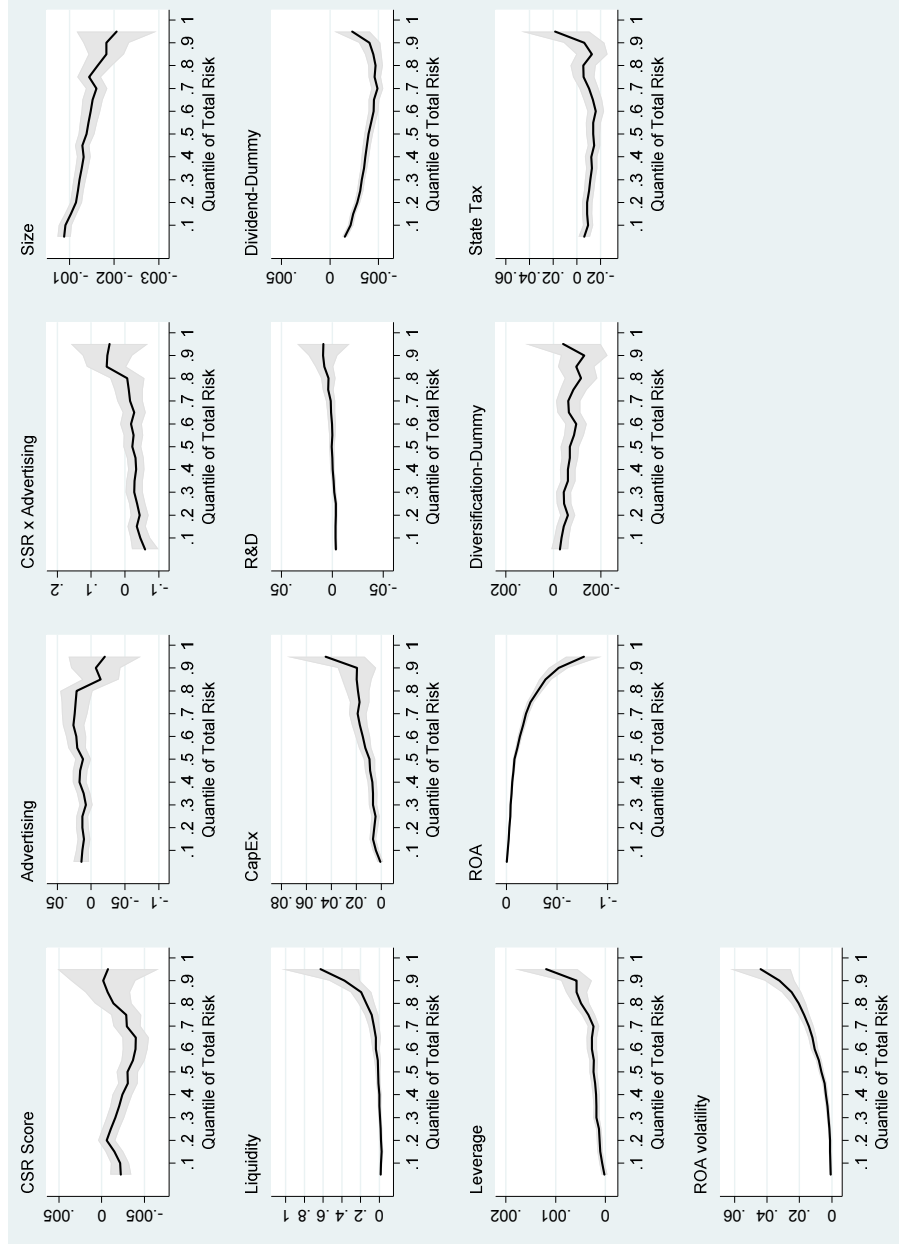
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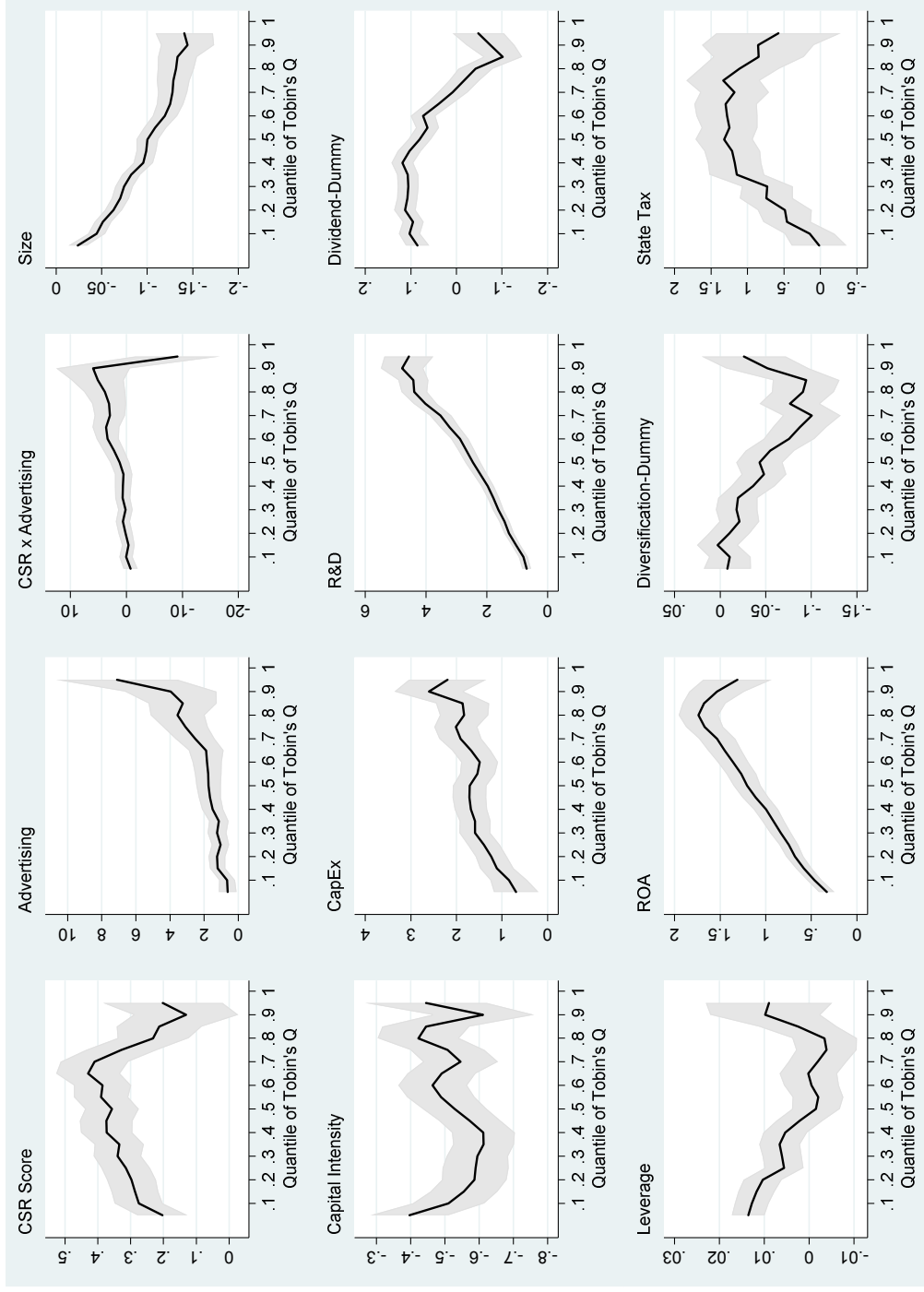
Figures and Tables

Figure 1: Unconditional quantile regression results for *Total Risk* and positive *Refinitiv Score* changes. Regression model (II).



This figure shows coefficients (solid line) and 90% confidence intervals (shaded area, calculated from robust standard errors bootstrapped with 1,000 replications) of the independent variables (lagged by one year) for unconditional quantiles from the 5%- to 95%-quantiles in 5% steps of *Total Risk* (horizontal axis).

Figure 2: Unconditional quantile regression results for *Tobin's Q* and positive *Refinitiv Score* changes. Regression model (II).



This figure shows coefficients (solid line) and 90% confidence intervals (shaded area), calculated from robust standard errors bootstrapped with 1,000 replications) of the independent variables (lagged by one year) for unconditional quantiles from the 5%- to 95%-quantiles in 5% steps of *Tobin's Q* (horizontal axis).

Table 1: Descriptive statistics and correlation coefficients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	Obs.	Mean	Std. Dev.	Min	Max	P5	P10	P25	P50	P75	P90	P95
<u>Panel A: Descriptive Statistics</u>												
<u>Dependent Variables</u>												
Raw Tobin's Q	13,771	2.35	1.62	0.48	13.00	0.97	1.08	1.34	1.83	2.75	13,771	2.35
Tobin's Q	13,771	0.69	0.54	-0.72	2.56	-0.03	0.07	0.29	0.60	1.01	13,771	0.69
Total Risk	13,778	0.02	0.01	0.01	0.20	0.01	0.01	0.02	0.02	0.03	13,778	0.02
Idiosyncratic Risk	13,778	0.02	0.01	0.01	0.19	0.01	0.01	0.01	0.02	0.02	13,778	0.02
Systematic Risk	13,778	1.15	0.43	-0.54	2.92	0.53	0.67	0.86	1.09	1.40	13,778	1.15
<u>CSR Scores</u>												
Refinitiv Score	13,778	0.38	0.19	0.00	0.95	0.13	0.16	0.23	0.34	0.50	13,778	0.38
MSCI Score	12,723	0.43	0.20	0.00	1.00	0.14	0.19	0.29	0.41	0.56	12,723	0.43
<u>Control Variables</u>												
Advertising	13,778	0.01	0.03	0.00	0.18	0.00	0.00	0.00	0.00	0.01	13,778	0.01
CapEx	13,778	0.05	0.05	0.00	0.36	0.01	0.01	0.02	0.03	0.06	13,778	0.05
Capital Intensity	13,752	0.25	0.23	0.00	0.95	0.02	0.04	0.08	0.17	0.35	13,752	0.25
Diversification-Dummy	13,778	0.36	0.48	0.00	1.00	0.00	0.00	0.00	0.00	1.00	13,778	0.36
Dividend-Dummy	13,778	0.54	0.50	0.00	1.00	0.00	0.00	0.00	1.00	1.00	13,778	0.54
Leverage	13,778	1.07	2.11	0.00	19.95	0.00	0.00	0.17	0.53	1.04	13,778	1.07
Liquidity	13,778	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	13,778	0.00
R&D	13,778	0.05	0.09	0.00	1.00	0.00	0.00	0.00	0.01	0.05	13,778	0.05
ROA	13,778	0.02	0.16	-1.90	0.36	-0.25	-0.08	0.01	0.05	0.09	13,778	0.02
ROA Volatility	13,778	0.07	0.12	0.00	1.40	0.01	0.01	0.02	0.03	0.07	13,778	0.07
Size	13,778	3.53	1.59	-3.03	7.50	0.77	1.42	2.56	3.54	4.53	13,778	3.53
State Tax	13,778	0.06	0.03	0.00	0.12	0.00	0.00	0.05	0.07	0.09	13,778	0.06

Panel B: Correlation

Variables	Ref. S.	MSCI S.	Raw TQ	TQ	TR	IR	SR
Refinitiv Score	100%						
MSCI Score	34.09%	100%					
Raw Tobin's Q	-8.03%	5.45%	100%				
Tobin's Q	-4.66%	7.61%	92.43%	100%			
Total Risk	-27.07%	-9.74%	-0.65%	-9.54%	100%		
Idiosyncratic Risk	-29.95%	-8.94%	0.91%	-7.87%	97.85%	100%	
Systematic Risk	-12.97%	-8.15%	8.94%	11.12%	7.30%	-4.74%	100%

Panel A of this table shows descriptive statistics for available firm-year observations for the sample period 01/01/2002 – 12/31/2019. Variables are defined as in Table A.1. In each year, all variables (aside from dummy variables, CSR Scores, and *State Tax*) are winsorized at the 1st and 99th percentiles. Panel B shows pairwise correlation coefficients for CSR, *Tobin's Q*, and risk variables for the sample period 01/01/2002 – 12/31/2019. Where TQ, TR, IR, and SR stand for *Tobin's Q*, *Total Risk*, *Idiosyncratic Risk*, and *Systematic Risk*, respectively. All correlation coefficients are significant at the 1% level except for **Cor(Raw TQ, TR)** (not significant) and **Cor(Raw TQ, IR)** (10% level significant). Variables are defined as in Table A.1. *Tobin's Q* and the risk variables are winsorized at the 1st and 99th percentiles.

Table 2: Fixed effects OLS regressions

Variables / Model	Total Risk				Tobin's Q			
	Refinitiv Score		MSCI Score		Refinitiv Score		MSCI Score	
	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CSR Score	-0.002* (-1.920)	-0.001 (-1.628)	-0.001 (-1.142)	-0.001 (-1.151)	0.268*** (5.061)	0.257*** (5.210)	0.114** (2.107)	0.104* (1.818)
CSR x Advertising		-0.019 (-1.048)		-0.003 (-0.174)		0.778 (0.447)		0.781 (0.430)
Advertising	0.007 (0.716)	0.014 (1.633)	0.004 (0.523)	0.006 (0.637)	2.680*** (4.656)	2.416*** (3.984)	2.027*** (3.132)	1.685 (1.551)
Size	-0.001*** (-11.058)	-0.001*** (-11.082)	-0.002*** (-12.867)	-0.002*** (-12.853)	-0.091*** (-9.341)	-0.091*** (-9.375)	-0.036*** (-4.103)	-0.036*** (-4.106)
Liquidity	0.098*** (3.603)	0.099*** (3.601)	0.143*** (4.592)	0.143*** (4.577)				
Capital Intensity					-0.536*** (-5.744)	-0.537*** (-5.725)	-0.496*** (-4.365)	-0.496*** (-4.372)
CapEx	0.014*** (3.214)	0.014*** (3.226)	0.017*** (3.677)	0.017*** (3.679)	1.579*** (5.310)	1.578*** (5.314)	1.376*** (4.905)	1.375*** (4.908)
R&D	0.002 (0.690)	0.002 (0.702)	0.009* (1.744)	0.009* (1.744)	2.716*** (13.075)	2.714*** (12.962)	2.869*** (10.111)	2.868*** (10.065)
Dividend-Dummy	-0.003*** (-10.478)	-0.003*** (-10.459)	-0.003*** (-14.223)	-0.003*** (-14.443)	0.050* (1.735)	0.050* (1.709)	0.073** (2.356)	0.073** (2.325)
Leverage	0.000*** (3.658)	0.000*** (3.702)	0.000*** (3.779)	0.000*** (3.787)	0.005* (1.721)	0.005* (1.706)	0.003 (0.952)	0.003 (0.920)
ROA	-0.020*** (-7.838)	-0.020*** (-7.829)	-0.020*** (-7.555)	-0.020*** (-7.556)	1.189*** (7.556)	1.188*** (7.542)	1.248*** (4.481)	1.248*** (4.476)
ROA Volatility	0.011***	0.011***	0.009***	0.009***				

Panel A: Total Risk and Tobin's Q

2 | Corporate Social Responsibility, Risk, and Firm Value:
An Unconditional Quantile Regression Approach

Diversification-Dummy	(5.007) -0.001*	(5.007) -0.001*	(3.423) -0.000	(3.428) -0.000	-0.037**	-0.037**	-0.061***
State Tax	(-1.788) -0.008*	(-1.801) -0.008	(-1.372) -0.011**	(-1.370) -0.011**	(-2.406) 0.668***	(-2.407) 0.665***	(-3.528) 0.810***
Constant	(-1.673) 0.028*** (38.535)	(-1.658) 0.028*** (37.687)	(-2.182) 0.046*** (36.661)	(-2.182) 0.046*** (36.855)	(3.024) 0.641*** (11.455)	(3.045) 0.645*** (11.512)	(3.101) 0.060 (0.929)
Observations	12,010	12,010	11,001	11,001	12,013	12,013	10,755
Adj. R-squared	0.54	0.54	0.51	0.51	0.40	0.40	0.37

Panel B: Idiosyncratic Risk and Systematic Risk

Variables / Model	Refinitiv Score		Idiosyncratic Risk		Refinitiv Score		Systematic Risk	
	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
CSR Score	-0.002** (-2.014)	-0.001* (-1.770)	-0.001 (-0.907)	-0.001 (-0.976)	-0.039 (-0.885)	-0.015 (-0.371)	-0.070* (-1.711)	-0.061 (-1.551)
CSR x Advertising		-0.011 (-0.810)		0.003 (0.205)		-1.788 (-1.446)		-0.666 (-1.127)
Advertising	0.011 (1.376)	0.014* (1.913)	0.008 (1.221)	0.006 (0.840)	-0.423 (-0.739)	0.187 (0.489)	-0.340 (-0.743)	-0.047 (-0.129)
Size	-0.001*** (-12.292)	-0.001*** (-12.317)	-0.002*** (-14.634)	-0.002*** (-14.607)	-0.021*** (-4.243)	-0.021*** (-4.278)	-0.019*** (-2.616)	-0.019*** (-2.620)
Liquidity	0.120*** (4.819)	0.120*** (4.804)	0.155*** (5.087)	0.155*** (5.069)	-3.388** (-2.452)	-3.339** (-2.455)	-1.820 (-1.100)	-1.808 (-1.093)
CapEx	0.011** (2.658)	0.011*** (2.666)	0.014*** (3.299)	0.014*** (3.297)	0.500** (2.601)	0.505** (2.601)	0.535** (2.365)	0.535** (2.372)
R&D	0.004 (1.096)	0.004 (1.102)	0.008* (1.725)	0.008* (1.724)	-0.080 (-0.570)	-0.076 (-0.542)	0.186 (1.445)	0.186 (1.449)
Dividend-Dummy	-0.003*** (-10.710)	-0.003*** (-10.731)	-0.003*** (-13.694)	-0.003*** (-13.888)	-0.103*** (-7.973)	-0.102*** (-7.813)	-0.094*** (-11.030)	-0.093*** (-11.029)

2 | Corporate Social Responsibility, Risk, and Firm Value:
An Unconditional Quantile Regression Approach

Leverage	0.000*** (3.493)	0.000*** (3.517)	0.000*** (3.610)	0.000*** (3.600)	0.009*** (3.405)	0.009*** (3.400)	0.011*** (4.300)	0.011*** (4.324)
ROA	-0.018*** (-7.731)	-0.018*** (-7.725)	-0.019*** (-7.910)	-0.019*** (-7.910)	-0.473*** (-5.639)	-0.472*** (-5.616)	-0.417*** (-5.063)	-0.417*** (-5.068)
ROA Volatility	0.010*** (4.645)	0.010*** (4.644)	0.008*** (3.341)	0.008*** (3.344)	0.300*** (5.655)	0.300*** (5.716)	0.256*** (3.739)	0.257*** (3.744)
Diversification-Dummy	-0.001** (-2.573)	-0.001** (-2.584)	-0.001** (-2.023)	-0.001** (-2.025)	-0.008 (-0.407)	-0.008 (-0.409)	0.000 (0.005)	0.000 (0.020)
State Tax	-0.006 (-1.616)	-0.006 (-1.606)	-0.009** (-2.181)	-0.009** (-2.179)	-0.322 (-1.039)	-0.315 (-1.013)	-0.433 (-1.491)	-0.431 (-1.488)
Constant	0.026*** (42.093)	0.026*** (41.402)	0.036*** (42.798)	0.036*** (42.698)	0.889*** (17.114)	0.879*** (16.810)	0.907*** (17.006)	0.903*** (17.256)
Observations	12,010	12,010	11,001	11,001	12,010	12,010	11,001	11,001
Adj. R-squared	0.49	0.49	0.47	0.47	0.32	0.32	0.31	0.31

This table reports results from fixed effects OLS regressions according to equations (3) and (4) using *Total Risk* and *Tobin's Q* in Panel A and *Idiosyncratic Risk* and *Systematic Risk* in Panel B as dependent variables. 2-digit SIC code industry and year fixed effects were incorporated. Industry cluster robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Unconditional quantile regressions

Quantile / Model	Tobin's Q											
	Total Risk				Refinitiv Score				MSCI Score			
	(1) CSR	(2) (II) CSR	(3) (II) Int.	(4) (I) CSR	(5) (II) CSR	(6) (II) Int.	(7) (I) CSR	(8) (II) CSR	(9) (II) Int.	(10) (I) CSR	(11) (II) CSR	(12) (II) Int.
10%	-0.003*** (-4.377)	-0.002*** (-3.242)	-0.045** (-2.544)	-0.001** (-2.273)	-0.001* (-1.724)	-0.015 (-0.987)	0.276*** (6.486)	0.276*** (6.152)	0.060 (0.083)	0.075** (2.135)	0.073* (1.831)	0.130 (0.127)
20%	-0.001** (-2.047)	-0.001 (-0.965)	-0.044*** (-2.723)	-0.001* (-1.659)	-0.001 (-1.186)	-0.016 (-1.120)	0.300*** (6.958)	0.298*** (6.560)	0.159 (0.208)	0.103*** (2.800)	0.107*** (2.750)	-0.300 (-0.318)
30%	-0.002*** (-3.306)	-0.002** (-2.523)	-0.027* (-1.745)	-0.001** (-1.975)	-0.001* (-1.714)	-0.006 (-0.444)	0.342*** (7.960)	0.340*** (7.730)	0.156 (0.198)	0.158*** (4.307)	0.175*** (4.243)	-1.381 (-1.318)
40%	-0.003*** (-4.507)	-0.002*** (-3.448)	-0.033** (-2.269)	-0.002*** (-2.942)	-0.002*** (-2.835)	0.014 (0.802)	0.382*** (8.696)	0.373*** (7.837)	0.609 (0.693)	0.191*** (4.983)	0.196*** (4.704)	-0.396 (-0.357)
50%	-0.003*** (-4.561)	-0.003*** (-3.896)	-0.022 (-1.333)	-0.001** (-2.034)	-0.002*** (-2.849)	0.045** (2.320)	0.373*** (7.883)	0.357*** (7.199)	1.181 (1.130)	0.227*** (5.516)	0.223*** (5.021)	0.357 (0.280)
60%	-0.004*** (-5.181)	-0.004*** (-4.428)	-0.018 (-0.920)	-0.001* (-1.712)	-0.002** (-2.427)	0.041* (1.749)	0.432*** (8.150)	0.386*** (7.279)	3.345*** (2.787)	0.228*** (4.777)	0.214*** (4.117)	1.088 (0.693)
70%	-0.003*** (-3.390)	-0.003*** (-3.060)	-0.015 (-0.656)	-0.001 (-0.946)	-0.001 (-1.442)	0.039 (1.359)	0.451*** (7.305)	0.410*** (6.565)	2.945* (1.785)	0.167*** (3.117)	0.173*** (3.099)	-0.432 (-0.230)
80%	-0.001 (-1.193)	-0.001 (-1.034)	-0.007 (-0.220)	0.000 (0.106)	-0.000 (-0.280)	0.037 (0.863)	0.285*** (4.179)	0.232*** (3.515)	3.865* (1.732)	0.138** (2.296)	0.125** (1.983)	0.999 (0.407)
90%	0.001 (0.245)	-0.000 (-0.074)	0.052 (1.162)	-0.000 (-0.034)	0.000 (0.012)	-0.007 (-0.092)	0.214** (2.285)	0.131 (1.354)	5.968 (1.490)	0.132 (1.560)	0.123 (1.313)	0.767 (0.169)
Observations	7,846	7,846	7,846	6,263	6,263	6,263	7,867	7,867	7,867	6,109	6,109	6,109

Panel B: Idiosyncratic Risk and Systematic Risk

Quantile / Model	Idiosyncratic Risk				Systematic Risk							
	Refinitiv Score		MSCI Score		Refinitiv Score		MSCI Score					
	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.			
10%	-0.003*** (-5.018)	-0.002*** (-3.677)	-0.035** (-2.325)	-0.001 (-1.388)	-0.001 (-1.049)	-0.009 (-0.702)	-0.053 (-1.221)	0.010 (0.215)	-4.495*** (-3.160)	-0.096*** (-2.643)	-0.052 (-1.380)	-3.470** (-2.461)
20%	-0.003*** (-5.551)	-0.002*** (-4.592)	-0.016 (-1.261)	-0.001* (-1.902)	-0.001 (-1.440)	-0.012 (-0.940)	-0.029 (-0.757)	0.037 (0.960)	-4.675*** (-4.705)	-0.067** (-2.186)	-0.046 (-1.437)	-1.647 (-1.568)
30%	-0.003*** (-5.349)	-0.003*** (-5.000)	-0.008 (-0.621)	-0.001* (-1.796)	-0.001 (-1.620)	-0.002 (-0.170)	-0.031 (-0.886)	0.029 (0.780)	-4.311*** (-4.948)	-0.033 (-1.215)	-0.031 (-1.001)	-0.219 (-0.230)
40%	-0.003*** (-5.551)	-0.003*** (-4.903)	-0.016 (-1.173)	-0.002*** (-3.305)	-0.002*** (-3.322)	0.011 (0.730)	-0.028 (-0.793)	0.021 (0.552)	-3.477*** (-4.247)	-0.069*** (-2.607)	-0.066** (-2.210)	-0.247 (-0.271)
50%	-0.003*** (-4.465)	-0.003*** (-3.725)	-0.011 (-1.585)	-0.002*** (-1.919)	-0.002*** (-2.595)	0.011 (1.718)	-0.037 (-1.651)	0.012 (-0.717)	-3.549*** (-2.838)	-0.070** (-2.514)	-0.078** (-2.699)	0.673 (1.505)
60%	-0.002*** (-2.834)	-0.002*** (-1.319)	-0.024 (-1.280)	-0.001 (-1.612)	-0.001* (-1.648)	0.013 (0.480)	-0.113** (-2.490)	-0.093* (-1.902)	-1.405 (-1.533)	-0.077** (-2.238)	-0.093** (-2.548)	1.311 (1.226)
70%	-0.002 (-1.488)	-0.002 (-1.338)	-0.007 (-0.242)	-0.000 (-0.476)	-0.001 (-0.503)	0.006 (0.168)	-0.120** (-2.185)	-0.134** (-2.382)	1.036 (0.925)	-0.061 (-1.421)	-0.059 (-1.264)	-0.218 (-0.176)
80%	-0.002 (-1.011)	-0.003 (-1.338)	0.060 (1.302)	0.002 (1.060)	0.002 (0.976)	0.007 (0.115)	-0.085 (-1.169)	-0.163** (-2.130)	5.581*** (4.218)	-0.063 (-1.076)	-0.081 (-1.225)	1.439 (0.811)
Observations	7,846	7,846	7,846	6,263	6,263	6,263	7,846	7,846	7,846	6,263	6,263	6,263

This table reports results from unconditional quantile regressions on equations (3) and (4) using *Total Risk* and *Tobin's Q* in Panel A and *Idiosyncratic Risk* and *Systematic Risk* in Panel B as dependent variables. Firm-year observations with positive CSR score change were used. 2-digit SIC code industry and year fixed effects were incorporated. "Int." stands for the interaction term. T-statistics are in parentheses. ***, **, *, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

Table 4: Instrumental variables fixed effects regressions

Dep. Variable / Model	(1)	(2)	(3)	(4)
	Refinitiv Score Dummy (I)	Refinitiv Score Dummy (II)	MSCI Score Dummy (I)	MSCI Score Dummy (II)
<i>Total Risk</i>				
CSR Score	0.001 (0.836)	0.001 (0.789)	-0.001 (-0.327)	-0.001 (-0.320)
CSR x Advertising		-0.091** (-2.279)		-0.007 (-0.182)
Observations	11,918	11,918	10,944	10,944
p-value of DWH test	0.31	0.19	0.8	0.95
p-value of KP rk LM-statistic	0.00	0.00	0.00	0.00
KP rk Wald F-statistic	111.68	24.05	52.1	26.73
<i>Idiosyncratic Risk</i>				
CSR Score	0.001 (0.847)	0.001 (0.799)	-0.001 (-0.643)	-0.001 (-0.603)
CSR x Advertising		-0.076** (-2.165)		-0.024 (-0.725)
Observations	11,918	11,918	10,944	10,944
p-value of DWH test	0.29	0.14	0.59	0.76
p-value of KP rk LM-statistic	0.00	0.00	0.00	0.00
KP rk Wald F-statistic	111.68	24.05	52.1	26.73
<i>Systematic Risk</i>				
CSR Score	0.031 (0.549)	0.029 (0.498)	-0.038 (-0.317)	-0.039 (-0.318)
CSR x Advertising		-4.933* (-1.796)		0.327 (0.158)
Observations	11,918	11,918	10,944	10,944
p-value of DWH test	0.51	0.46	0.84	0.73
p-value of KP rk LM-statistic	0.00	0.00	0.00	0.00
KP rk Wald F-statistic	111.68	24.05	52.1	26.73
<i>Tobin's Q</i>				
CSR Score	-0.005 (-0.093)	-0.004 (-0.085)	-0.055 (-0.511)	-0.072 (-0.662)
CSR x Advertising		1.188 (0.221)		9.549 (1.501)
Observations	11,924	11,924	10,700	10,700
p-value of DWH test	0.32	0.67	0.43	0.32
p-value of KP rk LM-statistic	0	0	0.00	0.00
KP rk Wald F-statistic	112.07	24.1	52.86	26.65

This table reports second-stage results from instrumental variables fixed effects regressions according to equations (3) and (4). 2-digit SIC code industry and year fixed effects were incorporated. Need for an instrumental variable regression is tested via a Durbin-Wu-Hausman endogeneity test (Durbin, 1954; Wu, 1973; Hausman, 1978). Validity of the instrumental variables regression is tested via the robust Kleibergen-Papp rk LM-statistic of underidentification and Kleibergen-Paap rk Wald F-statistic of weak identification (Kleibergen and Paap (2006). T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using industry cluster robust standard errors.

Table 5: Fixed effects OLS regressions with CSR lagged by four periods

Dependent Variable / Model	(1)	(2)	(3)	(4)
	Refinitiv Score		MSCI Score	
	(I)	(II)	(I)	(II)
<i>Total Risk</i>				
CSR Score	-0.001 (-1.059)	-0.001 (-0.905)	-0.000 (-0.596)	-0.000 (-0.480)
CSR x Advertising		-0.014 (-0.755)		-0.007 (-0.618)
Observations	6,885	6,885	5,994	5,994
Adj. R-squared	0.50	0.50	0.45	0.45
<i>Idiosyncratic Risk</i>				
CSR Score	-0.001 (-0.697)	-0.000 (-0.483)	-0.000 (-0.029)	0.000 (0.061)
CSR x Advertising		-0.013 (-0.834)		-0.005 (-0.532)
Observations	6,885	6,885	5,994	5,994
Adj. R-squared	0.41	0.41	0.43	0.43
<i>Systematic Risk</i>				
CSR Score	-0.068 (-1.279)	-0.030 (-0.616)	-0.113*** (-2.796)	-0.113*** (-2.688)
CSR x Advertising		-2.520* (-1.867)		-0.056 (-0.077)
Observations	6,885	6,885	5,994	5,994
Adj. R-squared	0.30	0.31	0.34	0.34
<i>Tobin's Q</i>				
CSR Score	0.180** (2.628)	0.151** (2.438)	0.049 (0.814)	0.046 (0.686)
CSR x Advertising		1.928 (0.945)		0.239 (0.113)
Observations	6,768	6,768	5,789	5,789
Adj. R-squared	0.39	0.39	0.32	0.32

This table reports results from fixed effects OLS regressions according to equations (3) and (4). All regressors are lagged by four periods. 2-digit SIC code industry and year fixed effects were incorporated. Industry cluster robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Unconditional quantile regressions for positive CSR changes lagged by four periods

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>Panel A: Total Risk and Tobin's Q</u>												
Quantile / Model	Total Risk						Tobin's Q					
	Refinitiv Score			MSCI Score			Refinitiv Score			MSCI Score		
	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.
10%	-0.002** (-2.374)	-0.001 (-0.993)	-0.058*** (-3.135)	-0.001* (-1.939)	-0.001 (-1.537)	-0.021 (-1.023)	0.121** (2.318)	0.115** (2.133)	0.422 (0.470)	0.015 (0.353)	0.022 (0.455)	-0.550 (-0.420)
20%	-0.000 (-0.670)	0.000 (0.304)	-0.043*** (-2.665)	-0.001 (-1.074)	-0.000 (-0.490)	-0.028 (-1.450)	0.231*** (4.507)	0.235*** (4.261)	-0.254 (-0.255)	0.047 (1.069)	0.039 (0.799)	0.632 (0.442)
30%	-0.000 (-0.035)	0.001 (1.235)	-0.062*** (-4.005)	-0.001 (-1.174)	-0.001 (-0.919)	-0.012 (-0.601)	0.245*** (4.750)	0.240*** (4.351)	0.368 (0.350)	0.041 (0.913)	0.041 (0.853)	-0.016 (-0.012)
40%	-0.001* (-1.723)	-0.001 (-0.791)	-0.045*** (-3.028)	-0.001* (-1.890)	-0.001* (-1.653)	-0.003 (-0.135)	0.292*** (5.275)	0.284*** (5.034)	0.526 (0.472)	0.054 (1.116)	0.047 (0.897)	0.537 (0.343)
50%	-0.001 (-0.889)	-0.000 (-0.216)	-0.038** (-2.282)	-0.001* (-1.931)	-0.001* (-1.958)	0.009 (0.386)	0.304*** (4.821)	0.285*** (4.381)	1.224 (0.921)	0.051 (0.929)	0.042 (0.698)	0.775 (0.394)
60%	-0.001 (-1.112)	-0.001 (-0.766)	-0.019 (-0.861)	-0.001 (-1.563)	-0.001* (-1.646)	0.017 (0.592)	0.348*** (5.090)	0.308*** (4.617)	2.662* (1.815)	0.049 (0.864)	0.030 (0.478)	1.582 (0.696)
70%	-0.003** (-2.132)	-0.002* (-1.842)	-0.017 (-0.631)	-0.001 (-1.109)	-0.001 (-1.189)	0.011 (0.311)	0.285*** (4.024)	0.256*** (3.467)	1.936 (1.092)	0.024 (0.365)	-0.004 (-0.049)	2.233 (0.839)
80%	-0.003 (-1.571)	-0.003 (-1.529)	-0.005 (-0.123)	-0.001 (-0.930)	-0.002 (-1.420)	0.068 (1.452)	0.239*** (2.792)	0.183** (2.117)	3.706 (1.527)	0.016 (0.188)	0.009 (0.101)	0.552 (0.155)
90%	0.001 (0.326)	0.000 (0.178)	0.022 (0.417)	-0.001 (-0.556)	-0.002 (-0.895)	0.082 (1.051)	0.238** (2.178)	0.138 (1.185)	6.631* (1.669)	0.067 (0.728)	0.023 (0.235)	3.584 (0.736)
Observations	4,444	4,444	4,444	3,513	3,513	3,513	4,363	4,363	4,363	3,372	3,372	3,372

Panel B: Idiosyncratic Risk and Systematic Risk

Quantile/ Model	Idiosyncratic Risk				Systematic Risk							
	Refinitiv Score		MSCI Score		Refinitiv Score		MSCI Score					
	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.				
10%	-0.001*** (-2.622)	-0.001 (-1.385)	-0.038*** (-2.715)	-0.000 (-0.655)	-0.000 (-0.164)	-0.021 (-1.336)	-0.134** (-2.259)	-0.030 (-0.466)	-6.989*** (-3.925)	-0.105** (-2.212)	-0.059 (-1.248)	-3.848* (-1.923)
20%	-0.001 (-1.249)	-0.000 (-0.390)	-0.031** (-2.255)	-0.000 (-0.666)	-0.000 (-0.690)	0.003 (0.208)	-0.029 (-0.702)	0.015 (0.339)	-2.924** (-2.488)	-0.096** (-2.504)	-0.098** (-2.557)	0.210 (0.130)
30%	-0.000 (-0.590)	0.000 (0.017)	-0.023* (-1.746)	-0.001* (-1.830)	-0.001* (-1.731)	0.004 (0.214)	-0.068 (-1.583)	-0.021 (-0.458)	-3.180*** (-3.222)	-0.125*** (-3.401)	-0.124*** (-3.344)	-0.156 (-0.119)
40%	-0.001 (-1.449)	-0.001 (-0.961)	-0.020 (-1.457)	-0.001 (-1.500)	-0.001 (-1.569)	0.010 (0.551)	-0.018 (-0.445)	0.020 (0.466)	-2.580*** (-2.809)	-0.103*** (-2.947)	-0.093** (-2.373)	-0.765 (-0.654)
50%	-0.001** (-2.030)	-0.001 (-1.264)	-0.031** (-2.128)	-0.001 (-1.093)	-0.001 (-1.169)	0.008 (0.381)	0.016 (0.372)	0.049 (1.073)	-2.217** (-2.284)	-0.082** (-2.342)	-0.076* (-1.901)	-0.481 (-0.431)
60%	-0.001* (-1.775)	-0.001 (-1.264)	-0.027* (-1.659)	-0.001 (-1.245)	-0.001 (-1.518)	0.025 (1.110)	-0.004 (-0.088)	0.023 (0.424)	-1.807* (-1.822)	-0.101*** (-2.583)	-0.100** (-2.270)	-0.101 (-0.081)
70%	-0.000 (-0.372)	-0.000 (-0.168)	-0.013 (-0.615)	-0.001 (-1.067)	-0.001 (-1.297)	0.030 (0.924)	-0.069 (-1.271)	-0.057 (-0.987)	-0.803 (-0.794)	-0.118*** (-2.614)	-0.109** (-2.111)	-0.694 (-0.481)
80%	0.000 (0.294)	0.001 (0.590)	-0.028 (-0.934)	-0.001 (-0.490)	-0.001 (-0.996)	0.065 (1.250)	-0.122* (-1.722)	-0.130* (-1.708)	0.530 (0.432)	-0.071 (-1.198)	-0.084 (-1.363)	1.094 (0.630)
90%	-0.002 (-1.094)	-0.002 (-0.841)	-0.036 (-0.657)	-0.001 (-0.345)	-0.001 (-0.437)	0.017 (0.220)	-0.126 (-1.482)	-0.172* (-1.854)	3.099** (2.155)	-0.125 (-1.587)	-0.146 (-1.614)	1.739 (0.745)
Observations	4,444	4,444	4,444	3,513	3,513	3,513	4,444	4,444	4,444	3,513	3,513	3,513

This table reports results from unconditional quantile regressions on equations (3) and (4) using *Total Risk* and *Tobin's Q* in Panel A and *Idiosyncratic Risk* and *Systematic Risk* in Panel B as dependent variable. Firm-year observations with positive CSR score change were used. All regressors are lagged by four periods. 2-digit SIC code industry and year fixed effects were incorporated. "Int." stands for the interaction term. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

Internet Appendix:

Corporate Social Responsibility, Risk, and Firm Value: An Unconditional Quantile Regression Approach

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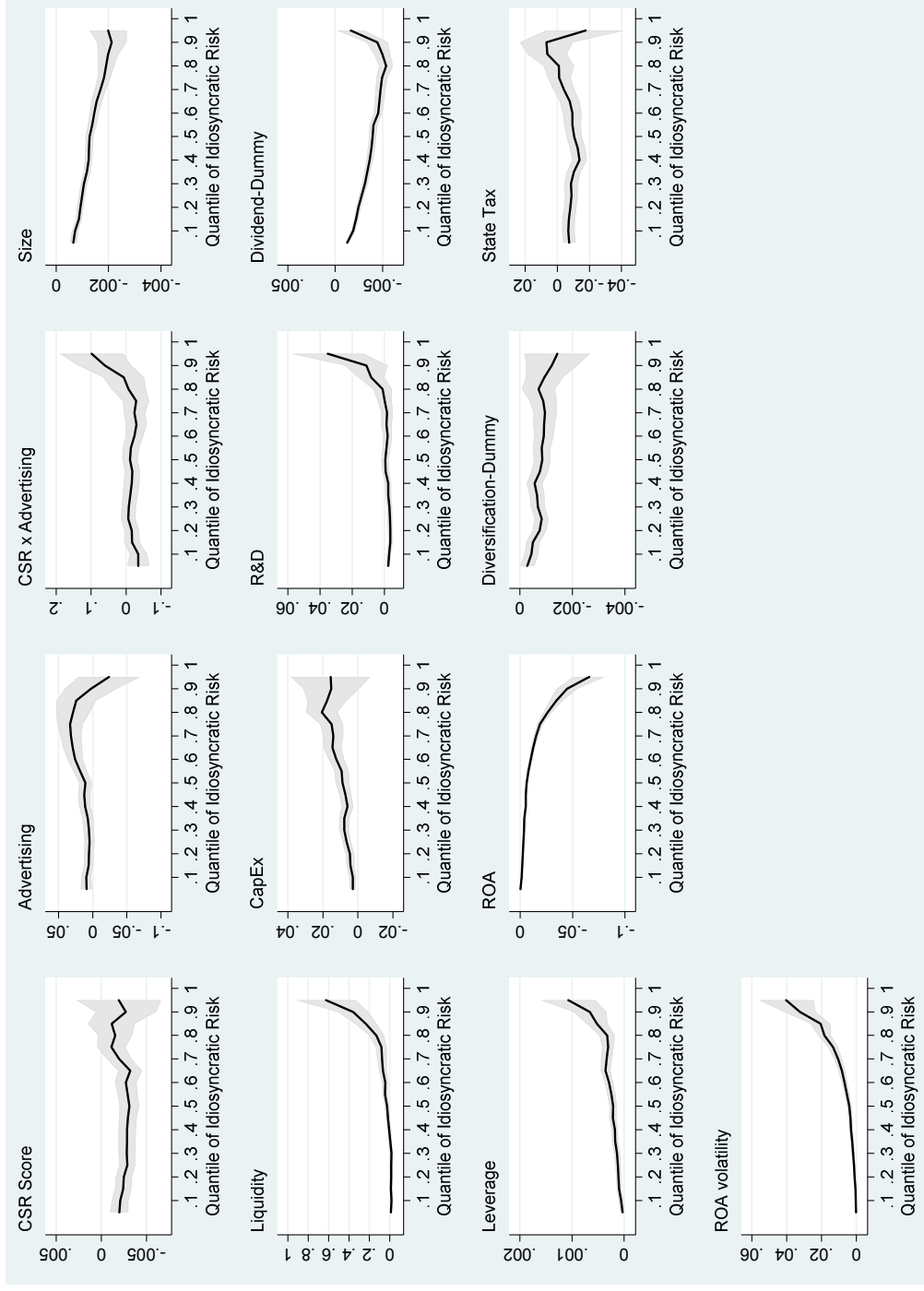
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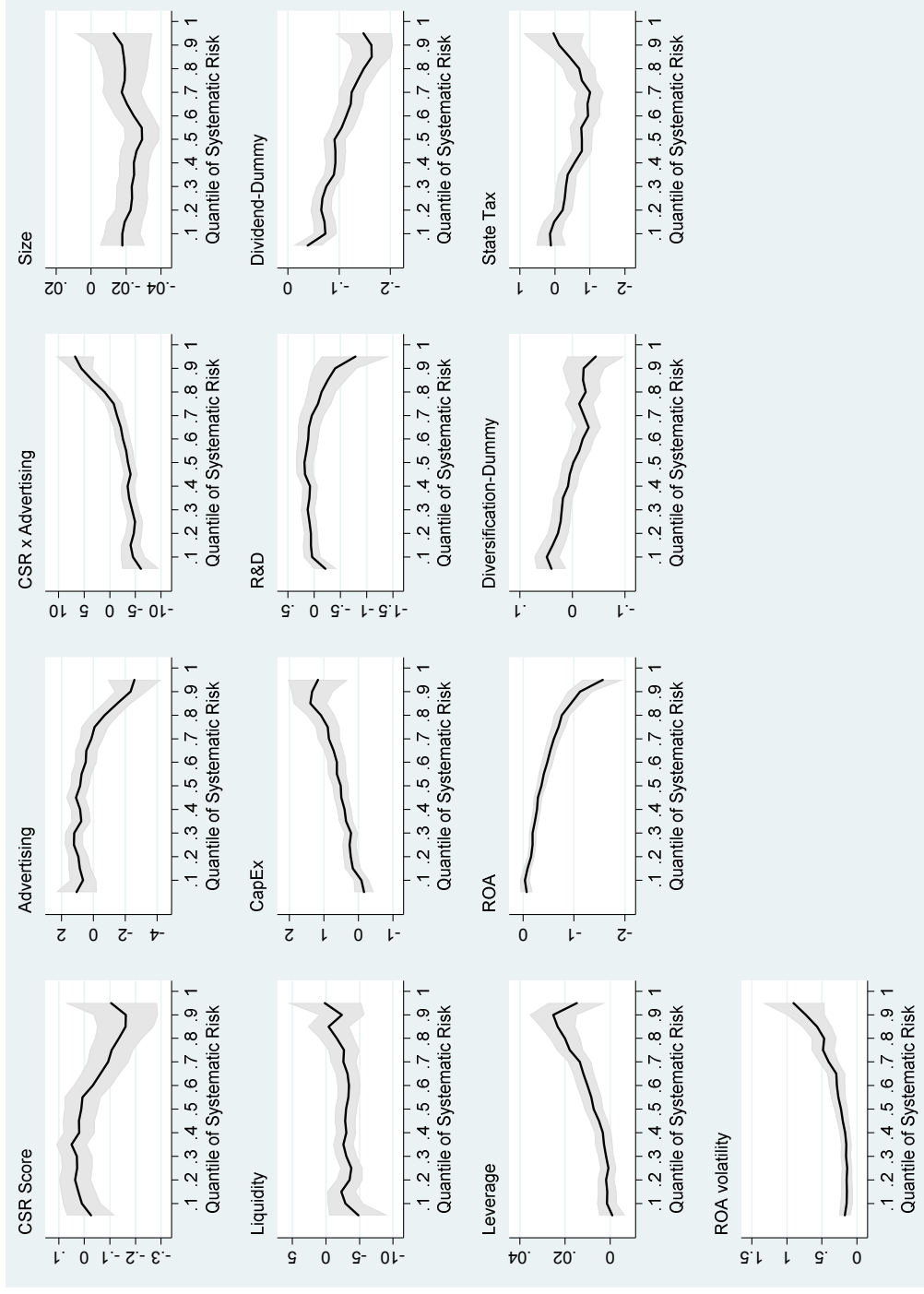
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Figure IA.1: Unconditional quantile regression results for *Idiosyncratic Risk* and positive *Refinitiv Score* changes. Regression model (II).



This figure shows coefficients (solid line) and 90% confidence intervals (shaded area, calculated from robust standard errors bootstrapped with 1,000 replications) of the independent variables (lagged by one year) for unconditional quantiles from the 5%- to 95%-quantiles in 5% steps of *Idiosyncratic Risk* (horizontal axis).

Figure IA.2: Unconditional quantile regression results for *Systematic Risk* and positive *Refinitiv Score* changes. Regression model (II).



This figure shows coefficients (solid line) and 90% confidence intervals (shaded area, calculated from robust standard errors bootstrapped with 1,000 replications) of the independent variables (lagged by one year) for unconditional quantiles from the 5%- to 95%-quantiles in 5% steps of *Systematic Risk* (horizontal axis).

Table IA.1: Probit regressions for *Refinitiv Score Dummy* and *MSCI Score Dummy* in the context of risk and *Tobin's Q*

Variables	Tobin's Q		Risk	
	(1) Refinitiv Score Dummy	(2) MSCI Score Dummy	(3) Refinitiv Score Dummy	(4) MSCI Score Dummy
Median Refinitiv Score	-6.928*** (-8.007)		-6.954*** (-8.060)	
Median MSCI Score		-3.948*** (-6.964)		-3.905*** (-6.861)
Advertising	0.981 (0.682)	1.348 (1.295)	0.974 (0.672)	1.544 (1.399)
Size	0.540*** (12.976)	0.104*** (3.146)	0.535*** (12.779)	0.106*** (3.207)
Capital Intensity	0.197 (1.171)	-0.478* (-1.736)		
Liquidity			-1.285 (-0.416)	1.853 (0.334)
CapEx	-0.956 (-1.592)	1.175** (2.107)	-0.552 (-0.762)	0.028 (0.033)
R&D	2.615*** (4.350)	0.141 (0.287)	2.592*** (4.242)	0.215 (0.435)
Dividend-Dummy	0.348*** (7.674)	0.036 (0.740)	0.331*** (7.731)	0.031 (0.612)
Leverage	-0.011 (-1.007)	0.002 (0.210)	-0.004 (-0.329)	0.003 (0.264)
ROA	0.848*** (2.675)	-0.010 (-0.044)	0.835*** (2.620)	0.046 (0.220)
ROA Volatility			-0.185 (-1.140)	0.218 (1.617)
Diversification-Dummy	0.073* (1.654)	0.141*** (3.730)	0.078* (1.810)	0.141*** (3.783)
State Tax	0.033 (0.032)	0.617 (0.744)	0.091 (0.089)	0.715 (0.842)
Constant	-0.616* (-1.713)	0.715*** (2.976)	-0.526 (-1.498)	0.354 (1.615)
Observations	12,378	11,436	12,003	11,248

This table reports results from probit regressions according to equation (5). 2-digit SIC code industry and year fixed effects were incorporated. The instrumental variable for a firms CSR Score was calculated using the median of the CSR Score for that firm's industry in a specific year, while excluding the firm of interest. Z-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using industry cluster robust standard errors.

Table IA.2: Unconditional quantile regressions for the whole dataset

Quantile / Model	Tobin's Q											
	Total Risk				Refinitiv Score				MSCI Score			
	(1) CSR	(2) (II) CSR	(3) (II) Int.	(4) (I) CSR	(5) (II) CSR	(6) (II) Int.	(7) (I) CSR	(8) (II) CSR	(9) (II) Int.	(10) (I) CSR	(11) (II) CSR	(12) (II) Int.
10%	-0.002***	-0.001**	-0.050***	-0.001**	-0.001	-0.016	0.215***	0.211***	0.260	0.032	0.023	0.657
	(-3.899)	(-2.420)	(-3.537)	(-2.350)	(-1.619)	(-1.578)	(6.445)	(5.619)	(0.410)	(1.267)	(0.848)	(0.957)
20%	-0.001*	-0.000	-0.043***	-0.001***	-0.001	-0.028***	0.267***	0.273***	-0.454	0.057**	0.048*	0.691
	(-1.727)	(-0.334)	(-3.523)	(-2.772)	(-1.557)	(-2.754)	(7.843)	(7.475)	(-0.706)	(2.351)	(1.753)	(1.070)
30%	-0.001***	-0.001**	-0.040***	-0.001***	-0.001***	-0.018*	0.293***	0.297***	-0.353	0.096***	0.100***	-0.264
	(-3.262)	(-2.051)	(-3.631)	(-3.694)	(-2.753)	(-1.844)	(9.046)	(8.498)	(-0.551)	(3.798)	(3.751)	(-0.390)
40%	-0.001***	-0.001*	-0.030***	-0.001***	-0.001***	0.003	0.294***	0.289***	0.362	0.132***	0.130***	0.161
	(-2.929)	(-1.921)	(-2.662)	(-3.210)	(-3.224)	(0.312)	(8.174)	(7.905)	(0.496)	(4.823)	(4.500)	(0.209)
50%	-0.002***	-0.002***	-0.024*	-0.001**	-0.001**	0.009	0.295***	0.278***	1.280	0.168***	0.155***	1.017
	(-3.525)	(-2.700)	(-1.893)	(-2.381)	(-2.487)	(0.712)	(7.987)	(6.932)	(1.545)	(5.861)	(4.727)	(1.163)
60%	-0.003***	-0.003***	-0.032**	-0.001*	-0.001**	0.023	0.357***	0.317***	2.966***	0.201***	0.175***	1.961*
	(-4.764)	(-3.906)	(-2.063)	(-1.928)	(-2.371)	(1.423)	(8.673)	(7.543)	(3.030)	(6.094)	(4.782)	(1.804)
70%	-0.003***	-0.002***	-0.028	-0.000	-0.001	0.019	0.396***	0.357***	2.842**	0.133***	0.113***	1.527
	(-3.412)	(-2.785)	(-1.423)	(-0.751)	(-1.118)	(0.946)	(8.128)	(7.335)	(2.213)	(3.586)	(2.730)	(1.167)
80%	-0.002	-0.001	-0.035	-0.000	-0.000	0.015	0.290***	0.224***	4.791***	0.136***	0.113**	1.746
	(-1.627)	(-1.089)	(-1.373)	(-0.259)	(-0.480)	(0.566)	(5.529)	(4.073)	(2.797)	(3.176)	(2.428)	(1.027)
90%	0.001	0.000	0.027	0.001	0.001	-0.041	0.139*	0.069	5.118*	0.132**	0.119*	1.053
	(0.550)	(0.297)	(0.688)	(0.545)	(0.886)	(-0.910)	(1.880)	(0.905)	(1.708)	(2.100)	(1.766)	(0.328)
Observations	12,010	12,010	12,010	11,001	11,001	11,001	12,013	12,013	12,013	10,755	10,755	10,755

Panel B: Idiosyncratic Risk and Systematic Risk

Quantile/ Model	Idiosyncratic Risk				Systematic Risk							
	Refinitiv Score		MSCI Score		Refinitiv Score		MSCI Score					
	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.			
10%	-0.001*** (-3.898)	-0.001** (-2.407)	-0.036*** (-3.272)	-0.001*** (-3.795)	-0.001*** (-3.136)	-0.008 (-0.853)	-0.034 (-1.019)	0.037 (1.031)	-5.209*** (-4.429)	-0.086*** (-3.270)	-0.050* (-1.903)	-2.782*** (-2.869)
20%	-0.002*** (-5.287)	-0.002*** (-4.208)	-0.025** (-2.513)	-0.001*** (-3.255)	-0.001** (-2.481)	-0.012 (-1.351)	-0.006 (-0.223)	0.054* (1.827)	-4.403*** (-5.601)	-0.054** (-2.360)	-0.032 (-1.356)	-1.697** (-2.307)
30%	-0.002*** (-5.269)	-0.002*** (-4.618)	-0.008 (-0.800)	-0.001*** (-3.520)	-0.001*** (-3.182)	-0.005 (-0.577)	0.006 (0.229)	0.060** (2.074)	-3.947*** (-5.796)	-0.030 (-1.443)	-0.017 (-0.756)	-1.033 (-1.459)
40%	-0.002*** (-5.169)	-0.002*** (-4.335)	-0.018* (-1.710)	-0.002*** (-4.211)	-0.001*** (-3.719)	-0.005 (-0.526)	0.006 (0.232)	0.052* (1.777)	-3.335*** (-5.126)	-0.051** (-2.555)	-0.038* (-1.778)	-0.954 (-1.476)
50%	-0.002*** (-5.039)	-0.002*** (-4.112)	-0.020* (-1.896)	-0.001*** (-2.810)	-0.001** (-2.346)	-0.004 (-0.312)	0.011 (0.378)	0.051* (1.699)	-2.907*** (-4.657)	-0.063*** (-2.924)	-0.054** (-2.391)	-0.696 (-1.062)
60%	-0.002*** (-4.070)	-0.002*** (-3.410)	-0.020 (-1.610)	-0.001** (-2.122)	-0.001** (-2.194)	0.010 (0.707)	-0.029 (-0.887)	0.002 (0.055)	-2.273*** (-3.251)	-0.065*** (-2.867)	-0.064** (-2.484)	-0.096 (-0.136)
70%	-0.002*** (-2.785)	-0.001** (-2.101)	-0.022 (-1.331)	-0.000 (-0.660)	-0.001 (-0.960)	0.014 (0.734)	-0.061* (-1.761)	-0.042 (-1.157)	-1.331* (-1.774)	-0.082*** (-3.188)	-0.087*** (-2.965)	0.382 (0.507)
80%	-0.003*** (-3.101)	-0.002** (-2.419)	-0.029 (-1.338)	0.000 (0.267)	0.000 (0.080)	0.010 (0.380)	-0.078* (-1.728)	-0.090* (-1.891)	0.898 (0.996)	-0.059* (-1.889)	-0.066* (-1.882)	0.584 (0.644)
90%	-0.001 (-0.746)	-0.001 (-0.990)	0.027 (0.810)	0.002 (1.466)	0.002 (1.484)	-0.016 (-0.379)	-0.070 (-1.254)	-0.140** (-2.379)	5.160*** (4.527)	-0.094** (-2.204)	-0.112** (-2.241)	1.391 (1.074)
Observations	12,010	12,010	12,010	11,001	11,001	11,001	12,010	12,010	12,010	11,001	11,001	11,001

This table reports results from unconditional quantile regressions on equations (3) and (4) using *Total Risk* and *Tobin's Q* in Panel A and *Idiosyncratic Risk* and *Systematic Risk* in Panel B as dependent variable. All firm-year observations were used. 2-digit SIC code industry and year fixed effects were incorporated. "Int." stands for the interaction term. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

Table IA.3: Unconditional quantile regressions for the whole dataset with CSR scores lagged by four periods

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Total Risk and Tobin's Q												
	Total Risk						Tobin's Q					
	Refinitiv Score			MSCI Score			Refinitiv Score			MSCI Score		
Quantile / Model	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.
10%	-0.001*	-0.000	-0.054***	-0.002***	-0.001**	-0.023	0.125***	0.120***	0.290	0.011	0.028	-1.324
	(-1.815)	(-0.242)	(-3.510)	(-3.249)	(-2.429)	(-1.501)	(3.119)	(2.847)	(0.405)	(0.321)	(0.790)	(-1.503)
20%	-0.000	0.000	-0.042***	-0.001*	-0.000	-0.025*	0.161***	0.161***	-0.004	0.038	0.046	-0.602
	(-0.290)	(0.949)	(-3.352)	(-1.693)	(-0.846)	(-1.861)	(3.747)	(3.550)	(-0.004)	(1.137)	(1.221)	(-0.680)
30%	0.000	0.001**	-0.056***	-0.001**	-0.001*	-0.021	0.199***	0.195***	0.276	0.055*	0.057	-0.145
	(0.729)	(2.213)	(-4.794)	(-2.405)	(-1.655)	(-1.608)	(4.916)	(4.516)	(0.337)	(1.740)	(1.576)	(-0.153)
40%	-0.001	-0.000	-0.037***	-0.001***	-0.001**	-0.009	0.220***	0.207***	0.860	0.062*	0.058	0.312
	(-1.185)	(-0.220)	(-3.040)	(-2.829)	(-2.323)	(-0.674)	(5.357)	(4.670)	(1.008)	(1.787)	(1.466)	(0.292)
50%	-0.001	-0.000	-0.020	-0.001***	-0.001**	-0.004	0.248***	0.229***	1.290	0.071*	0.061	0.767
	(-1.260)	(-0.738)	(-1.369)	(-3.004)	(-2.569)	(-0.265)	(5.375)	(4.503)	(1.245)	(1.796)	(1.501)	(0.584)
60%	-0.001*	-0.001*	0.002	-0.001**	-0.001	-0.016	0.303***	0.257***	3.018**	0.067	0.045	1.714
	(-1.931)	(-1.824)	(0.136)	(-2.090)	(-1.590)	(-0.839)	(5.999)	(4.837)	(2.554)	(1.573)	(0.990)	(1.195)
70%	-0.003***	-0.003***	-0.013	-0.001	-0.001	0.002	0.248***	0.219***	1.912	0.033	0.019	1.113
	(-3.223)	(-2.762)	(-0.609)	(-0.918)	(-0.866)	(0.106)	(4.554)	(3.705)	(1.328)	(0.717)	(0.375)	(0.615)
80%	-0.003**	-0.003**	0.011	0.001	0.000	0.044	0.227***	0.171**	3.643**	0.051	0.050	0.085
	(-2.408)	(-2.398)	(0.375)	(0.899)	(0.253)	(1.428)	(3.546)	(2.514)	(2.041)	(0.920)	(0.801)	(0.034)
90%	0.001	0.000	0.074	0.002	0.002	-0.004	0.119	0.017	6.741**	0.100	0.076	1.847
	(0.596)	(0.051)	(1.612)	(1.104)	(1.068)	(-0.078)	(1.357)	(0.185)	(2.092)	(1.406)	(0.993)	(0.497)
Observations	6,885	6,885	6,885	5,994	5,994	5,994	6,768	6,768	6,768	5,789	5,789	5,789

Panel B: Idiosyncratic Risk and Systematic Risk

Quantile/ Model	Idiosyncratic Risk				Systematic Risk							
	Refinitiv Score		MSCI Score		Refinitiv Score		MSCI Score					
	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.	(I) CSR	(II) CSR	(II) Int.			
10%	-0.001 (-1.301)	0.000 (0.001)	-0.038*** (-3.349)	-0.000 (-0.966)	-0.000 (-0.538)	-0.012 (-1.099)	-0.129*** (-2.724)	-0.034 (-0.765)	-6.322*** (-4.375)	-0.101*** (-2.888)	-0.066* (-1.906)	-2.717* (-1.813)
20%	-0.000 (-1.173)	-0.000 (-0.359)	-0.022** (-2.296)	-0.001 (-1.447)	-0.001 (-1.424)	0.002 (0.217)	-0.036 (-1.146)	0.010 (0.300)	-3.117*** (-3.260)	-0.114*** (-4.293)	-0.109*** (-3.855)	-0.394 (-0.361)
30%	-0.000 (-0.699)	0.000 (0.029)	-0.020** (-2.114)	-0.001*** (-2.950)	-0.001*** (-2.601)	-0.001 (-0.114)	-0.041 (-1.305)	0.013 (0.371)	-3.601*** (-4.446)	-0.105*** (-3.975)	-0.098*** (-3.488)	-0.515 (-0.539)
40%	-0.000 (-0.970)	-0.000 (-0.650)	-0.009 (-0.824)	-0.001*** (-2.835)	-0.001*** (-2.677)	-0.003 (-0.201)	0.018 (0.556)	0.065* (1.822)	-3.065*** (-4.069)	-0.108*** (-4.049)	-0.107*** (-3.751)	-0.050 (-0.060)
50%	-0.001** (-2.485)	-0.001* (-1.956)	-0.015 (-1.203)	-0.001** (-2.378)	-0.001** (-1.967)	-0.007 (-0.497)	0.022 (0.667)	0.065* (1.827)	-2.860*** (-3.963)	-0.097*** (-3.396)	-0.085*** (-2.841)	-0.959 (-1.169)
60%	-0.002** (-2.500)	-0.001** (-2.075)	-0.010 (-0.760)	-0.001** (-1.971)	-0.001 (-1.557)	-0.011 (-0.693)	0.029 (0.751)	0.064 (1.644)	-2.287*** (-2.838)	-0.114*** (-3.822)	-0.107*** (-3.320)	-0.546 (-0.635)
70%	-0.001 (-1.196)	-0.001 (-1.040)	-0.009 (-0.548)	-0.001 (-0.876)	-0.000 (-0.592)	-0.012 (-0.539)	-0.054 (-1.260)	-0.028 (-0.602)	-1.742** (-2.114)	-0.105*** (-3.268)	-0.107*** (-2.877)	0.176 (0.182)
80%	-0.000 (-0.274)	-0.000 (-0.244)	-0.001 (-0.033)	0.002* (1.823)	0.001 (1.161)	0.038 (1.071)	-0.129** (-2.403)	-0.111* (-1.869)	-1.157 (-1.117)	-0.103** (-2.524)	-0.122** (-2.566)	1.489 (1.221)
90%	-0.001 (-0.616)	-0.001 (-0.805)	0.022 (0.497)	0.002 (1.645)	0.002 (1.460)	0.005 (0.099)	-0.178** (-2.436)	-0.201*** (-2.686)	1.543 (1.227)	-0.113** (-2.030)	-0.142** (-2.155)	2.276 (1.486)
Observations	6,885	6,885	6,885	5,994	5,994	5,994	6,885	6,885	6,885	5,994	5,994	5,994

This table reports results from unconditional quantile regressions on equations (3) and (4) using *Total Risk* and *Tobin's Q* in Panel A and *Idiosyncratic Risk* and *Systematic Risk* in Panel B as dependent variable. All firm-year observations were used and all regressors are lagged by four periods. 2-digit SIC code industry and year fixed effects were incorporated. "Int." stands for the interaction term. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

3 | Heterogenous Effects of Religiosity on Firm Risk and Firm Value: An Unconditional Quantile Regression Approach*

Carl-Friederich Groesbrink[†]

Abstract

This paper examines the impact of religiosity on firm risk, comprising total risk, idiosyncratic risk, and systematic risk, as well as firm value. We focus on analyzing the interrelationships along the entire distribution of the dependent variables, thus estimating an unconditional quantile regression (UQR). The analysis is based on all U.S. companies listed on NYSE, NASDAQ, and AMEX for the period from 1980 through 2020. UQR reveals strongly heterogeneous effects along the unconditional quantiles of the dependent variables, which are reflected in sign changes, magnitude and significance variations. Overall, the risk-reducing effect of religiosity is more pronounced in the higher quantiles of the distribution. We further observe a value-reducing as well as value-enhancing religiosity effect. When applying fixed effects OLS, we can confirm the risk-reducing and non-existing value effect of religiosity shown in the literature. The robustness of our results is underpinned by a battery of additional tests.

Keywords: Religiosity, Unconditional Quantile Regression, Firm Risk, Volatility, Systematic Risk, Idiosyncratic Risk, Firm Value

JEL classification: G30; G32; Z12

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1 Introduction

The economic impact of religiosity is an important issue and has been discussed in the literature for a long time (Iannaccone, 1998). Since Weber's (1905) seminal work on the relationship between religion and the overall economy numerous other studies have appeared at the macroeconomic level, suggesting a positive influence of religion on, e.g., economic growth and per capita income (Barro and McCleary, 2003; Guiso et al., 2003), and foreign direct investments (Guiso et al., 2009). Motivated by the fact that religion does not only shape cultural values but also influences personal decision making, the social finance literature shows that religiosity also affects corporate behavior through the prevailing set of social norms by which a company is surrounded. Accordingly, religiosity can avoid undesirable corporate behavior and managerial opportunism, such as backdating stock options, less aggressive financial reporting, and less financial reporting irregularities, thus resulting in fewer lawsuits (McGuire et al., 2012; Grullon et al., 2010; Dyreng et al., 2012). Moreover, religiosity is primarily associated with higher risk aversion and consequently lower firm risk (Hilary and Hui, 2009; Adhikari and Agrawal, 2016).

Our study aims to extend this stream of literature by reinvestigating the relationship between religiosity and firm risk, as well as firm value. This paper is motivated by the fact that the religiosity-risk relationship has previously been studied only by Hilary and Hui (2009) for non-financials and by Adhikari and Agrawal (2016) for public banks.¹ Both studies find a risk-reducing impact of local religiosity. This was done exclusively by examining the average relationship between religiosity and firm risk, using standard ordinary least squares (OLS) regression. However, Zolotoy et al. (2021) show that the effect of religiosity varies along the conditional quantiles of M&A announcement returns and is more pronounced in the lower

¹ Risk consists of total risk, idiosyncratic risk, and systematic risk. Cantrell and Yust (2018) also analyze the religiosity-risk relationship, but for a sample of private banks, thus using different risk measures.

quantiles, i.e., is non-constant. Therefore, it is a priori unclear why a possible influence of religiosity should be purely constant and does not vary across the distribution of risk, thus containing heterogenous (non-constant) effects. Since religiosity can be considered as soft information, the question arises, especially with regard to idiosyncratic risk, why companies with a very high risk level should still benefit from a more religious environment. Specifically, we would expect to find a weaker influence of religiosity for high-risk firms as other factors, such as leverage (Mishra and Modi, 2013) and liquidity (Brogaard et al., 2017), will be more relevant than focusing on religiosity. A similar argument can be made for companies with very low risk levels, as it is questionable whether a more religious environment still offers a decisive risk-reducing contribution. Analog considerations can be applied to the relationship between religiosity and firms with low versus high firm value as well. To shed more light on the religiosity-risk relationship, we implement an unconditional quantile regression (UQR), developed by Firpo et al. (2009). This approach allows for a detailed analysis regarding the relationship between the entire distribution of the dependent variable and the regressors, as the relationships are estimated at each unconditional quantile of the dependent variable. This enables us to estimate heterogeneous coefficients for religiosity and our controls for each unconditional quantile that may vary in sign, magnitude, and significance. For these reasons, the unconditional quantile regression methodology has been applied extensively in the finance (e.g., Entrop et al., 2017; Cobb-Clark et al., 2016; Kang et al., 2021; Basten et al., 2016; Christelis et al., 2021) and economics (e.g., England et al., 2016; Baltagi and Ghosh, 2017; Haylock, 2022; Fournier and Koske, 2013) literature.

Second, with respect to the influence of religiosity on firm value, approximated using Tobin's Q, previous literature using standard OLS was not able to find a significant relationship (Zolotoy et al., 2019; Amin et al., 2021). This is surprising, since (i) there is anecdotal evidence on the relevance of culture in a business context. For example, 90% of executives surveyed

believe that culture is an important factor and 92% assume that improving culture increases shareholder value (Graham et al., 2016). Furthermore, (ii) several studies show that the risk-reducing effect of religiosity translates into lower cost of capital (El Ghoual et al., 2012; Chen et al., 2016; Jiang et al., 2018), suggesting that religiosity has a value-enhancing effect.

From a theoretical perspective, the relationship is not entirely clear-cut since firm value could rise if corporate misconduct was avoided through increased religiosity. On the other hand, increased risk aversion due to strong local religious norms could lead to refraining from risky investments with a positive net present value, thus having an adverse effect on firm value (Hilary and Hui, 2009; Zolotoy et al., 2019). As no significant relationship could be found at the mean so far, we apply UQR to analyze the relationship in more detail at the unconditional quantiles of firm value.

We start our empirical analysis with a fixed effects OLS regression to reproduce the previous literature. For this purpose, we regress our risk variables (*Total Risk*, *Idiosyncratic Risk*, and *Systematic Risk*) and firm value, approximated by *Tobin's Q*, on *Religiosity* to determine the quantitative influence of local religious norms. Subsequently, we analyze the relationship for the entire distribution of our risk variables, *Tobin's Q*, and our main independent variable *Religiosity* using UQR. To underpin our findings, we perform a battery of robustness tests. Finally, we follow Jiang et al. (2018) and analyze the channel through which local religious norms affect firm risk and firm value by focusing on the role of information asymmetry (IA). We hypothesize that *Religiosity* plays a greater role for firms when the market has limited information about the firm, hence when IA is high. Since this effect may vary across the dependent variables' distribution, we additionally apply UQR.

This study is based on daily stock returns and annual accounting data for all companies listed on the major exchanges NYSE, NASDAQ, and AMEX, covering the period from January 1980 through December 2020, giving us a total of up to 79,886 usable firm-year observations.

We summarize our findings as follows: First, applying standard OLS regression, we can confirm the statistically significant risk-reducing influence of *Religiosity* on *Total Risk* and *Idiosyncratic Risk* observed in the literature (Hilary and Hui, 2009; Adhikari and Agrawal, 2016). For *Systematic Risk* and *Tobin's Q*, we find no effect of *Religiosity*.

Second, analyzing unconditional quantiles reveals strong heterogeneous effects in terms of coefficients significance, magnitude, and sign, respectively, along the entire distribution of the risk variables and *Tobin's Q*.

Indeed, we find a risk-mitigating influence of *Religiosity* on *Total Risk* that increases steadily along the unconditional quantiles up to the 60th percentile before plateauing. The impact of *Religiosity* on *Idiosyncratic Risk* is similar to that for *Total Risk*. The risk-reducing influence increases up to the 70th percentile. With respect to *Systematic Risk*, *Religiosity* shows the strongest risk-reducing influence in the middle quantiles and no influence in the extreme quantiles. The course of the effect is slightly u-shaped.

For *Tobin's Q*, we find a value-reducing influence of *Religiosity* in the extreme quantiles, i.e., for firms with a very low and very high firm value, respectively. Moreover, we find a slightly positive and significant effect at the 40% quantile. For the vast majority of quantiles, no influence of *Religiosity* can be shown. The coefficients' high heterogeneity confirms the appropriateness of applying UQR as opposed to exclusively analyzing the average effect via standard OLS.

Third, our robustness analyses support our baseline results.

Fourth, we find a stronger risk-reducing effect of local religious norms for firms with high IA. Our robustness tests and IA analysis reveal that *Religiosity* can have a positive as well as negative effect on firm value.

The remainder of the paper is organized as follows. Section 2 starts with a literature review, while Section 3 describes the data and sample. Section 4 discusses the empirical design and

methodology applied, whereas Sections 5 and 6 present our results regarding firm risk and firm value, respectively, and Section 7 provides a discussion. Section 8 concludes.

2 Related literature and theory

It is well known that cultural factors, such as the prevailing religion, shape human beliefs and social values through its function as an informal institution, and thus also have a significant influence on individual behavior (Casson et al. 2010; Kennedy and Lawton 1998; Zolotoy et al., 2019; Ma et al., 2019). Hence, the existing literature shows that religiosity, defined as the importance of religion for an individual, is primarily associated with higher ethical standards (Weaver and Agle, 2002; Mazar et al., 2008; Longenecker, 2004), honesty and trust (Arrunada, 2010; Guiso et al., 2003; Amin et al., 2021), as well as significantly more pronounced risk aversion (Diaz, 2000; Miller, 2000; Miller and Hoffman, 1995), compared to non-religious individuals. Furthermore, social norm theory states that individuals adapt to the geographically prevailing values, norms, and group behavior (Cialdini and Trost, 1998). As a result, not only religious adherents but also non-adherents are significantly influenced and shaped by the dominant religious social norms (Zolotoy et al., 2019; He and Hu, 2016; Spicer and Bailey, 2007).

A company's culture is also shaped by the prevailing religious and social norms as the vast majority of employees, including senior executives, reside in the immediate vicinity of the company (Alam et al., 2014; Zolotoy et al., 2019). Thus, the dominant local culture and social norms influence the culture and behavior of the company, i.e., firms that are headquartered in high religiosity areas are more likely to display characteristics of the prevalent religious adherents. In this regard, He and Hu (2016) as well as Cai and Shi (2019) provide evidence that

firms operating in a more religious environment have more religious managers. Accordingly, the literature uses the religiosity of the population in the county where the firm is headquartered as a proxy for the prevailing religious social norms within the company (e.g., Hilary and Hui, 2009; Jiang et al., 2018; Kumar et al., 2011).

At the corporate level, previous literature shows that companies in more religious environments are less likely to engage in ethically questionable practices such as financial misreporting, stock options backdating, aggressive earnings management (McGuire et al., 2012; Cai et al., 2019; Grullon et al., 2010), corporate tax avoidance (Dyreg et al., 2012; Boone et al., 2013), and bad news hoarding (Callen and Fang, 2015). Therefore, investors are expected to have less agency concerns regarding the investment decisions of these firms (Callen and Fang, 2015; Zolotoy et al., 2021). With respect to risk aversion, Hilary and Hui (2009) find that firms in more religious counties tend to have lower risk, measured by the variance in equity returns and in ROA, as well as lower investment activity in CapEx and R&D. In addition, they have a higher ROA, due to a higher required internal rate of return, and lower long-term growth (Hilary and Hui, 2009). Furthermore, they investigate systematic and idiosyncratic risk based on the CAPM, respectively, and again find lower risk for companies in more religious areas. In a subsequent study, Adhikari and Agrawal (2016) also provide evidence for a negative relationship between religiosity and risk for a sample of public banks. Among other indicators, they calculate total risk as the variance of stock returns and idiosyncratic risk based on Carhart's (1997) four-factor model. The risk-reducing influence of religiosity is also confirmed for venture capital investments (Chircop et al., 2020). In contrast to these studies, Cantrell and Yust (2018) find for a sample of private banks that religiosity is associated with higher asset risk-taking, but at the same time with lower ROA volatility, higher ROA, lower insolvency risk, and fewer bankruptcies.

The risk-reducing influence of religiosity reflects in lower cost of equity (El Ghoual et al., 2012) and lower cost of debt (Chen et al., 2016; Jiang et al., 2018). Moreover, decreasing costs of debt are accompanied with better credit ratings (Jiang et al., 2018; Cai and Shi, 2019), less debt financing, and lower bond yields (Cai and Shi, 2019). Also, firms in more religious counties receive better bank loan terms, e.g., lower interest rates, larger loan amounts, and fewer loan covenants (He and Hu, 2016). Overall, the literature finds evidence for a risk-reducing effect of religiosity.

Turning to firm value, traditional corporate finance theory tells us that, *ceteris paribus*, decreasing costs of capital go hand in hand with increasing firm value. Nevertheless, the limited literature on this topic has so far not been able to identify a direct influence of religiosity on firm value (Tobin's Q). Hilary and Huang (2021) expect that an environment caused by religiosity that is beneficial for the company will have a positive effect on the company, reflected, e.g., by a higher Tobin's Q. Moreover, Zolotoy et al. (2021) document that companies with headquarters in more religious counties achieve on average higher M&A announcement returns. Zolotoy et al. (2019) analyze the effect of religiosity and corporate social responsibility (CSR) on firm value (as proxied by Tobin's Q). However, they do not find a stand-alone effect of religiosity, but only a second-order effect (interaction term) of local religious norms that attenuates the effect of CSR. In line with this, Amin et al. (2021) find that religiosity does not have a direct influence on firm value (Tobin's Q), but only an indirect effect via the protection of human capital. Ma et al. (2019) divide their sample into high and low religious firms and find that cost stickiness only has a significant negative influence on Tobin's Q in the low religious sample. Altogether, evidence on the relationship between religiosity and firm value is scarce, while focusing on the average relationship. An analysis of quantiles has not been considered so far and represents our starting point for extending the existing literature, not only with respect to firm value but also regarding firm risk. Therefore, we apply UQR to analyze

both potential heterogenous effects of religiosity and the role of information asymmetry as a possible influence channel. For this purpose, we regress the risk variables *Total Risk*, *Idiosyncratic Risk* and *Systematic Risk* as well as *Tobin's Q* as a proxy for firm value on *Religiosity* and additional controls

3 Sample construction, data sources, and descriptive statistics

3.1 Sample construction in general

We start with all common (ordinary) equity shares of U.S. headquartered companies, listed at least once on one of the major exchanges NYSE, NASDAQ, and AMEX during 01/01/1980 and 12/31/2020 to avoid survivorship bias and backfilling bias (Landis and Skouras, 2021; Ince and Porter, 2006; Amihud et al., 2015; Griffin et al., 2010). From Refinitiv Datastream (formerly Thomson Reuters Datastream) we obtain daily stock prices and yearly accounting data, whereby annual observations are defined on the basis of fiscal years rather than calendar years, since firms differ along their fiscal year ends (Flannery and Rangan, 2006). Moreover, we exclude financial firms (SIC 6000-6999) and utilities (SIC 4900-4999) as their financial statements are not comparable with those of other industries due to regulatory issues (Hilary et al., 2009; Jiang et al., 2018). Data on county religiosity is retrieved from the Association of Religion Data Archive (ARDA), while data on demographic characteristics comes from the U.S. Census Bureau, and is obtained via IPUMS National Historical Geographic Information System (NHGIS). In addition, we use presidential election data from the MIT Election Data and Science Lab and data from Kenneth French's website. These data are described in more detail below.

3.2 Firm value and firm risk variables

We cover different aspects of risk and define three risk variables: total risk, idiosyncratic (unsystematic, firm-specific) risk, and systematic risk (Table A.1, Panel A). *Total Risk* is a stocks volatility, defined as the standard deviation of a firm's daily discrete stock returns over the past twelve months (Adhikari and Agrawal, 2016; Sassen et al., 2016); it is the risk caused by both systematic and firm-specific factors. Given that religiosity can be primarily considered as soft information, it seems plausible that a possible influence of religiosity on total risk is exerted via firm-specific risk, i.e., idiosyncratic risk. This assumption is based on the consideration that religiosity improves the information environment of the firm, thus affecting the firm-specific risk component. Accordingly, we decompose *Total Risk* into *Systematic Risk* and *Idiosyncratic Risk* (Sharpe, 1964; Lintner, 1965; Mossin, 1966).

Traditional portfolio theory states that idiosyncratic risk is eliminated by diversification in the context of a well-diversified portfolio, implying that only systematic risk is of concern to the investor, for which he is compensated with a risk premium (Sharpe, 1964). However, (i) Bennett and Sias (2010) point out that it is virtually impossible to create perfectly diversified portfolios. Moreover, (ii) from a theoretical perspective, Merton (1987) shows that there is a positive relationship between idiosyncratic risk and expected return in absence of well diversified portfolios, and (iii) empirically, it is known that most private investors hold poorly diversified portfolios (Polkovnichenko, 2005; Benartzi, 2001; Campbell, 2006). In addition, current asset pricing literature shows that idiosyncratic risk is also associated with a risk premium (e.g., Goyal and Santa-Clara, 2003; Ang et al., 2006, 2009; Fu, 2009), while, on the other hand, it accounts for a large portion of total risk (Goyal and Santa-Clara, 2003). Hence, we analyze the influence of religiosity on idiosyncratic risk and, for the sake of completeness, also consider systematic risk.

Idiosyncratic risk is the variation component that cannot be explained by the portfolio returns used and is represented by the residuals of a regression. We calculate *Idiosyncratic Risk* as the standard deviation of the daily residuals $\varepsilon_{i,t}$, estimated via the following 4-factor model of Carhart (1997) for each firm i and for each year t , based on daily discrete return data (Adhikari and Agrawal, 2016; Hilary and Hui, 2009; Ang et al., 2006, 2009):

$$(R_{i,t} - rf_t) = \alpha_i + \beta_{m,i} * (R_{m,t} - rf_t) + \beta_{SMB,i} * R_{SMB,t} + \beta_{HML,i} * R_{HML,t} + \beta_{WML,i} * R_{WML,t} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ denotes a company's daily return, $R_{m,t}$ is the daily market return, and rf_t is the daily risk-free return on 1-month treasury bills.² $R_{SMB,t}$, $R_{HML,t}$, and $R_{WML,t}$ are the daily portfolio returns of the small-minus-big, high-minus-low, and winner-minus-loser risk factors (Fama and French, 1993; Carhart, 1997). The estimate of interest is $\varepsilon_{i,t}$ that indicates the daily error component in year t .

We estimate *Systematic Risk* by running the following CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966) regression for each firm i and for each year t , using daily discrete return data (Hilary and Hui, 2009; Sassen et al., 2016):

$$(R_{i,t} - rf_t) = \alpha_i + \beta_{m,i} * (R_{m,t} - rf_t) + \varepsilon_{i,t} \quad (1)$$

The coefficient of interest is $\beta_{m,i}$, which captures a firm's systematic risk. All other variables are defined as in equation (1).

² Data for the market return and the risk-free return are obtained from Kenneth French's Website (<http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html>). The market consists of all CRSP firms incorporated in the U.S. and listed on NYSE, AMEX, and NASDAQ.

We approximate firm value using Tobin's Q , calculated as book value of assets minus book value of equity plus market value of equity, divided by book value of assets, measured at fiscal year-end t (*Raw Tobin's Q* ; Adhikari and Agrawal, 2016; Amin et al., 2021; Coles et al., 2008; Hong and Kacperczyk, 2009). The natural logarithm of *Raw Tobin's Q* is calculated to obtain a more symmetric distribution (*Tobin's Q*). All variables just introduced here as well as in the following are defined in more detail in Table A.1.

3.3 Religiosity

Following the literature (Hilary and Hui, 2009; Jiang et al., 2018; Kumar et al., 2011), we measure local religiosity (*Religiosity*) by the number of religious adherents of all religious denominations in a county in relation to the total population of that county, where a higher level of *Religiosity* indicates stronger local religious norms. To construct *Religiosity*, we obtain data on the religious composition of a county from ARDA for the years 1980 to 2010 at 10-year intervals (1980, 1990, 2000, and 2010).³ Since social norms change slowly over time (Zolotoy et al., 2019), we interpolate the data to obtain observations for the intermediate (non-survey) years (Hilary and Hui, 2009; Jiang et al., 2018). Furthermore, we apply the *Religiosity* ratios in 2010 for the 2011-2020 period, because no survey data for 2020 has been published yet (Shu et al., 2012). We follow the literature (e.g., Hilary and Hui, 2009; Callen and Fang, 2015) and assign a company the *Religiosity* level of the county in which it is headquartered, as a firm's

³ Specifically, we use the "Longitudinal Religious Congregations and Membership" file for the years 1980 to 2010, that covers the adherent and congregation counts of 302 religious groups (Bacon et al., 2018). Data can be obtained via <https://www.thearda.com/Archive/Files/Descriptions/RCMSMGY.asp>.

headquarter is usually geographically close to its core business activities (Pirinsky and Wang, 2006).⁴

3.4 Control variables

To isolate the effect of *Religiosity* on firm risk and firm value, respectively, and to reduce concerns about an omitted variable bias, we control for county and firm specific variables (Adhikari and Agrawal, 2016). Following Hilary and Hui (2009), He and Hu (2016), and Kumar et al. (2011), we use the total population in a county (*Total Population*), the county level education (*Education*), the per capita income of county residents (*Income*), the male-to-female ratio (*MF-Ratio*), the fraction of married people (*Marriage*), and the proportion of non-white persons in a county (*Minority*) as county specific demographic controls.⁵ In further tests we additionally control for the median age of the population (*Age*), the abortion rate (*Abortion*), the per capita alcohol consumption (*Alcoholism*), state gross domestic product (*State GDP*), and the vote share per state received by the Republican candidate for president in the previous election (*President*).⁶

We implement several firm specific controls known to be associated with firm risk and firm value, respectively. Specifically, we control for firm size (*Size*), capital expenditures (*CapEx*),

⁴ Besides *Religiosity*, we construct the variables *Religiosity Catholics* and *Religiosity Protestants* for supplemental robustness tests (Table IA.2). We set the number of Catholics (Protestants) for each county in relation to the total population of that county.

⁵ Data for these variables are available through the U.S. Census Bureau's 10-year surveys (1980, 1990, 2000, and 2010) and were obtained via IPUMS NHGIS (<https://www.nhgis.org/about-ipums-nhgis>; Manson et al., 2021). As with *Religiosity*, we interpolate the data and use the observations in 2010 for the 2011-2020 period.

⁶ We use the following sources to retrieve the data; *Age*: U.S. Census Bureau via IPUMS NHGIS (<https://www.nhgis.org/about-ipums-nhgis>; Manson et al., 2021); *Abortion*: Guttmacher Institute (<https://www.guttmacher.org/public-use-datasets>); *Alcoholism*: National Institute on Alcohol Abuse and Alcoholism (<https://pubs.niaaa.nih.gov/>; Stata dataset via <https://www.openicpsr.org/openicpsr/project/105583/version/V5/view>); *State GDP*: Bureau of Economic Analysis (<https://apps.bea.gov/iTable/iTable.cfm?reqid=70&step=1#reqid=70&step=1>). Data are only available at state level as of 1997.; *President*: MIT Election Data and Science Lab (<https://electionlab.mit.edu/data>).

research and development expenditures (*R&D*), Amihud (2002) illiquidity (*Illiquidity*), leverage (*Leverage*), and return on assets (*ROA*). In supplemental tests we control for dividend payments (*Dividend-Dummy*), diversification (*Diversification-Dummy*), board size (*Board Size*), and board independence (*Board Independence-Dummy*).

In all our regressions, we include year η_t and 2-digit SIC code industry ξ_j fixed effects by using adequate dummies. In each year, all variables (except for dummy variables and *Board Size*) are winsorized at the 1st and 99th percentiles to avoid the influence of extrema (Chen and Chen, 2012). Finally, we delete observations with negative realizations, inter alia R&D and Shareholders' Equity (Fauver and McDonald IV, 2014; Xiao, 2013).

3.5 Descriptive statistics

Panel A of Table 1 shows that *Raw Tobin's Q* (*Tobin's Q*) has a mean of 2.19 (0.57) which is larger than the median of 1.58 (0.46), indicating a right skewed distribution and thus justifying the use of the natural logarithm to obtain a more symmetric distribution.⁷ Both mean and median are 0.03 for *Total Risk* and *Idiosyncratic Risk*, thus very similar to the study by Adhikari and Agrawal (2016). *Systematic Risk* has a mean of 0.93 and a median of 0.90. *Religiosity* has a mean, median, and standard deviation of 0.52, 0.53, and 0.11, respectively, which is comparable to the literature (e.g., Zolotoy et al., 2019; Jiang et al., 2018). Analysis of the quantiles reveals a substantial variation in the strength of local religious norms between counties.⁸ Panel B of

⁷ This finding is common in the literature, e.g., Lang and Stulz (1994), Allayannis and Weston (2001), and Jin and Jorion (2006).

⁸ On average (untabulated), Oregon (0.33), Maine (0.34), and Alaska (0.34) have the lowest *Religiosity*, while Utah (0.72), Oklahoma (0.65), and North Dakota (0.65) have the highest *Religiosity* in our sample (similar to Hilary and Hui, 2009). Our firm-year observations are spread across 423 counties, with Yamhill County, Oregon (0.27; 5 observations) having on average the lowest and Box Elder County, Utah (0.81; 13 observations) having the highest *Religiosity* level. The counties with most firm-year observations are Santa Clara County, California (3,661), Harris County, Texas (3,145), and Middlesex County, Massachusetts (3,069).

Table 1 shows pairwise correlation coefficients for *Religiosity*, (*Raw*) *Tobin's Q*, and our risk variables, thereby revealing a negative correlation between *Religiosity* and our four dependent variables, statistically significant at the 1% level.

[Table 1 about here]

4 Empirical design and methodology of baseline analyses

4.1 Baseline fixed effects OLS analysis

We analyze the influence of *Religiosity* on *Total Risk*, *Idiosyncratic Risk*, *Systematic Risk* and *Tobin's Q* using the following fixed effects OLS regression with firm cluster robust standard errors, where $\text{DepVar}_{i,t}$ is a placeholder for our four dependent variables (*Total Risk*, *Idiosyncratic Risk*, *Systematic Risk*, and *Tobin's Q*) and variables are defined as in Section 3.⁹ The estimated coefficients for β are of main interest.

⁹ Since social norms change slowly over time (Zolotoy et al., 2019), *Religiosity* offers only little within firm variation. Reflecting this point, we calculate the standard deviation of one-year changes of *Religiosity* (*Delta Religiosity*) and compare it with the standard deviation of *Religiosity*. While the standard deviation of *Delta Religiosity* is only 0.007 (untabulated), the standard deviation of *Religiosity* is 0.11 (Table 1), suggesting that most of the variation is cross-sectional (i.e., between-firm variation). Thus, applying firm fixed effects regression is inappropriate in this setting, as, for example, discussed by Zolotoy et al. (2019), Adhikari and Agrawal (2016), and Frijns et al. (2016).

$$\begin{aligned}
 \text{DepVar}_{i,t} = & \alpha + \beta * \text{Religiosity}_{i,t} & (3) \\
 & + \gamma_1 \text{CapEx}_{i,t} + \gamma_2 \text{Leverage}_{i,t} + \gamma_3 \text{Illiquidity}_{i,t} \\
 & + \gamma_4 \text{R\&D}_{i,t} + \gamma_5 \text{ROA}_{i,t} + \gamma_6 \text{Size}_{i,t} \\
 & + \gamma_7 \text{Education}_{i,t} + \gamma_8 \text{Income}_{i,t} + \gamma_9 \text{MF-Ratio}_{i,t} \\
 & + \gamma_{10} \text{Marriage}_{i,t} + \gamma_{11} \text{Minority}_{i,t} + \gamma_{12} \text{Total Population}_{i,t} \\
 & + \eta_t + \xi_j + \varepsilon_{i,t}
 \end{aligned}$$

4.2 Baseline unconditional quantile regression analysis

To analyze the influence of *Religiosity* on firm risk and firm value at the tails of the distribution, i.e., in the quantiles of the dependent variable, we implement an UQR developed by Firpo et al. (2009).¹⁰ This method shows how an unconditional quantile of the firm risk (firm value) distribution is affected by a marginal change in the distribution of the explanatory variable under consideration (*Religiosity*), which is approximated by a change at the mean of that specific explanatory variable, while controlling for the effects of other regressors (Rios-Avila and Maroto, 2022; Rios-Avila, 2020).¹¹ The relationships are mapped by regressor-specific coefficients in equation (3), estimated for each unconditional quantile of interest (here 5% to

¹⁰ We are grateful to Nicole Fortin for making the Stata ado-file available on her homepage.

¹¹ UQR answers the following question: How much would the observed distribution of firm risk (firm value) change, measured by the change in the τ^{th} quantile of the firm risk (firm value) distribution, if all firms faced, on average, a marginal increase (e.g., 1%), holding everything else constant? In contrast, Conditional Quantile Regression (CQR) answers the question how much the firm risk (firm value) distribution would change, measured by changes in the τ^{th} quantile of the firm risk (firm value) distribution, if every firm with the same observed characteristics (realized covariates) faced a marginal increase in *Religiosity* (e.g., 1%), holding everything else constant (Rios-Avila and Maroto, 2022; Firpo et al., 2009). Accordingly, CQR estimates the relationship between *Religiosity* and firm risk (firm value) at different points of the conditional firm risk (firm value) distribution, thereby estimating variation in the *Religiosity* effect among firms with different firm risk (firm value) levels but similar covariate values. Firms at high quantiles of the conditional firm risk (firm value) distribution have higher firm risk (firm value) than we would expect, given their covariates, but are not necessarily high-risk (high-value) in an absolute sense. Therefore, UQR allows for a comparison between the effect of *Religiosity* on low risk (value) and high risk (value) firms in an absolute sense (Killewald and Bearak, 2014; England et al., 2016).

95% in 5% steps) of the dependent variable. Thus, the estimated coefficients along the different unconditional quantiles of the dependent variable (firm risk and firm value, respectively) can differ in sign, magnitude, and significance, allowing heterogeneous relationships between dependent and independent variable to be represented at different quantiles (Firpo et al., 2009; Entrop et al., 2017). As before, we consider industry and year fixed effects and calculate robust standard errors bootstrapped from 1,000 replications.

4.3 Robustness analyses

To confirm the robustness of our results we control for additional variables and analyze geographical aspects.¹² First, following previous literature (Hilary and Hui, 2009; Jiang et al., 2018; He and Hu, 2016), we include further demographic controls as the abortion rate, the natural logarithm of the median age, the alcohol consumption rate, the natural logarithm of state GDP, and the percentage of republican voters during presidential elections as they might be related to *Religiosity* (Model 1). In Model 2, we control for board independence and board size (Jiang et al., 2018) as several articles document an influence of better corporate governance on firm risk (John et al., 2008; Acharya et al., 2011) and firm value (Yermack, 1996; Coles et al., 2008). Finally, in Model 3, we implement further firm-level controls, namely a diversification dummy and a dividend dummy, as they may affect firm risk and firm value (Luo and Bhattacharya, 2009; Allayannis and Weston, 2001).

Second, we run a battery of tests to address concerns that our results may be driven by geographical firm clustering (Panel B of the respective table). Thus, Model 4 excludes the five

¹² The results will be presented in Table 4 (*Total Risk*), Table 5 (*Idiosyncratic Risk*), Table 6 (*Systematic Risk*), and Table 7 (*Tobin's Q*). Furthermore, we perform temporal robustness tests and analyze if the type of *Religiosity* matters (Table IA.2).

largest counties in terms of firm-year observations (Jiang et al., 2018).¹³ Since more conservative states (e.g., Utah) tend to be more religious and less diverse than liberal states (Cai and Shi, 2019), we exclude the five most religious states (Model 5)¹⁴, the five least religious states (Model 6)¹⁵, and the ten most conservative states in Model 7 (Adhikari and Agrawal, 2016; Jiang et al., 2018; Cai and Shi, 2019).¹⁶ In Model 8, we follow Hilary and Hui (2009) and estimate our model in a more homogenous subsample, that is, we only use the seven western states as this subsample has high degrees of both geographical homogeneity and religious heterogeneity.¹⁷ Model 9 addresses the concern that *Religiosity* could be higher in urban areas than in rural ones, meaning that our results would be rather driven by the urban-rural division than the religious adherent rates. Therefore, we re-estimate our model using only firms headquartered in one of the ten largest metropolitan areas (He and Hu, 2016; El Ghouli et al., 2012; Dyreng et al., 2012).¹⁸ Since our observations could be clustered in a limited number of counties, we rerun our regression at the county level (Model 10). To do so, we calculate the yearly average of each variable, thus treating a county-year instead of a firm-year as a base unit (Jiang et al., 2018; Hilary and Hui, 2009; Cantrell and Yust, 2018). Year fixed effects are implemented and standard errors are robust and adjusted for county clustering. Finally, in addition to industry and year fixed effects, we implement state fixed effects to account, e.g., for

¹³ Los Angeles County, California; Harris County, Texas; New York County, New York; Middlesex County, Massachusetts; and Santa Clara County, California.

¹⁴ Most religious states: Utah, Oklahoma, Massachusetts, North Dakota, and Washington DC.

¹⁵ Least religious states: Oregon, Maine, Alaska, Nevada, and Washington.

¹⁶ Cai and Shi (2019) use the results of a 2010 Gallup poll (<https://news.gallup.com/poll/146348/mississippi-rates-conservative-state.aspx/>) which lists the following states as most conservative: Mississippi, Idaho, Alabama, Wyoming, Utah, South Dakota, Louisiana, North Dakota, South Carolina, and Arkansas.

¹⁷ Western states: Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. Utah is the most, Oregon is the least, Nevada the 5th, Washington the 6th, Arizona the 10th, Idaho the 16th, and California the 17th least religious state.

¹⁸ Based on the 2010 Census, estimates for 2019 report the following 10 metropolitan areas to be the largest ones: New York-Newark-Jersey City, NY-NJ-PA; Los Angeles-Long Beach-Anaheim, CA; Chicago-Naperville-Elgin, IL-IN-WI; Dallas-Fort Worth-Arlington, TX; Houston-The Woodlands-Sugar Land, TX; Washington-Arlington-Alexandria, DC-VA-MD-WV; Miami-Fort Lauderdale-West Palm Beach, FL; Philadelphia-Camden-Wilmington, PA-NJ-DE-MD; Atlanta-Sandy Springs-Roswell, GA; Phoenix-Mesa-Scottsdale, AZ (<https://www.census.gov/data/tables/time-series/demo/popest/2010s-total-metro-and-micro-statistical-areas.html>).

differences in the legal, cultural, and economical environment (Model 11; Hilary and Hui, 2009; Cai and Shi, 2019; Zolotoy et al., 2019).

4.4 Causality analysis

We aim to establish a potential causal relationship to ensure that the correlations found in the previous specifications are causally linked and not due to further correlated factors that we have not accounted for so far. As previous research suggests, endogeneity is not a major concern because, e.g., a counties' cultural composition, including local religious norms, is highly stable over time and thus usually predates the existence of a company in a county. Moreover, it seems unlikely that a county's cultural composition could be influenced by a firm's activities. However, it can be argued (i) that firms endogenously self-select their locations according to their business models and risk preferences, and (ii) that the demographic composition of a county could be influenced by the policies of local firms. For instance, companies might locate in counties with more risk-tolerant residents if they can take advantage of the risk preferences of local investors or executives. It is also conceivable that people move for professional reasons, such as job hunting, to regions that match their cultural preferences, including risk preferences (Adhikari and Agrawal, 2016; Cantrell and Yust, 2018). Still, we address these issues via various tests.

First, we re-estimate equation (3) using firms in the manufacturing, mining, and agricultural sectors (SIC codes 100-3999) as these companies are more likely to choose their firm headquarters location based on proximity to customers, suppliers, and production inputs rather than on local religiosity levels (Panel C, Model 12; Cai and Shi, 2019; Loughran and Schultz, 2005; John et al., 2011).

Second, we implement a two-stage least squares (2SLS) regression (Model 13) using *Religiosity* and *Total Population* (in case of *Total Risk* and *Idiosyncratic Risk* we additionally use *Income*), lagged by three periods as instruments (e.g., Hilary and Hui, 2009; Jiang et al., 2018; Zolotoy et al., 2019). For each regression, we report validity tests for endogeneity (Durbin, 1954; Wu, 1973; Hausman, 1978), overidentifying restrictions (Hansen, 1982; Sargan, 1958), underidentification and weak identification (Kleibergen and Paap, 2006). While this works for our OLS analysis, there is, so far, no solution for this problem in the context of UQR, and the current literature still discusses potential approaches to adequately account for endogeneity (Firpo et al., 2009). In absence of available methods, we reduce the endogeneity problem by (i) using industry and year fixed effects and (ii) re-estimating equation (3) using *Religiosity*, lagged by three periods.

Third, we implement a placebo test strategy to further ensure that the documented effect of *Religiosity* is not an artifact of spurious correlations in the data or peculiarities of the data distribution (Zolotoy et al., 2019; Ma et al., 2021). Accordingly, we create the variable *Pseudo-Religiosity* by replacing a county's "true" *Religiosity* level with a randomly assigned "false" *Religiosity* level from another county in our sample. If county-level omitted factors are influencing our results, their effects would still be present, and we would continue to observe significant negative coefficients in case of firm risk and firm value. This means that t-values of *Pseudo-Religiosity* would be significantly smaller than zero, since this test does not alter the distribution of *Religiosity*. Generating *Pseudo-Religiosity* and using it as a regressor for firm risk and firm value is repeated 500 times. We then compare our "true" estimated t-value (baseline model) with the distribution of "false" estimated t-values based on *Pseudo-Religiosity* (Zolotoy et al., 2019; Ma et al., 2021), and conduct two t-tests to test if (H0) the average pseudo t-value is equal to zero (Model 14 (i)), and if (H0) the average pseudo t-value is equal to the

“true” t-value of the *Religiosity* coefficient (Model 14 (ii)). We do not wish to reject H0 for Model 14 (i), but we want to reject H0 for Model 14 (ii).

Finally, we follow the literature (Jiang et al., 2018; Cai et al., 2019) and implement entropy balancing (Model 15) that offers certain advantages over the propensity-score-matching method (Hainmueller, 2012; Hainmueller and Xu, 2013; Chapman et al., 2019). Therefore, we construct a *High-Religiosity-Dummy* that equals 1 if a firm’s *Religiosity* level is above the 75th percentile (treatment group), and 0 if it is below the 25th percentile (control group). Based on the first moment of our control variables in equation (3), the treatment and control group are matched via a maximum entropy reweighting scheme. This reweighting scheme calculates weights for our control group observations so that the distributional properties (in our case the first moment) of the treatment group and the post-weighting control group are virtually identical, without losing observations (Hainmueller, 2012; Hainmueller and Xu, 2013; Jiang et al., 2018; Cai et al., 2019). Afterwards, we re-run equation (3) using *High-Religiosity-Dummy* and the reweighted sample.

4.5 Information asymmetry and the relevance of religiosity

Finally, we would like to shed some light on the channel through which local religious norms affect firm risk and firm value by analyzing the role of information asymmetry (IA) in Panel D. We hypothesize that *Religiosity* plays a greater role for firms when the market has limited information about the firm, hence when IA is high. Firms with low IA, as large firms and firms with high analyst coverage, for example, are less likely to keep unpopular news and unacceptable behavior from the public. Also, their risk profiles are better known and allow investors to act accordingly. Therefore, soft information, such as a company’s culture, including religious norms, is less important in identifying trustworthy companies. In contrast, *Religiosity*

can play a more important role in identifying trustworthy companies when IA is high, for example when corporate activities are opaque, thus affecting the risk profile (Jiang et al., 2018).

We define three proxies to measure IA and divide our sample in low and high IA companies based on these proxies.¹⁹ We then estimate equation (3) for both samples separately to provide a more detailed picture of the relationship (Jiang et al., 2018; Amin et al., 2021; Callen and Fang, 2015). We use analyst coverage (Model 16) as our first proxy for IA, since financial analysts (i) aggregate complex information, thus making it more easily understandable for less sophisticated investors, and (ii) provide information that is not commonly known to market participants (Chang et al., 2006). Such an enhanced information environment goes along with lower IA levels; hence we define a firm as one with high IA if the number of analysts following the firm is zero (Jiang et al., 2018; Amin et al., 2021). Based on our second proxy, a firm has high IA if it is not a constituent of the S&P 500 index (Model 17), as firms receiving low investor attention tend to have more IA problems (Jiang et al., 2018; Chen et al., 2004). We use total assets as our third proxy (Model 18) and define a firm as one with high IA if its asset value is below the sample median (Jiang et al., 2018; Chae, 2005).²⁰

5 Empirical results for the religiosity and firm risk relationship

5.1 Baseline results for firm risk

We start our analysis by estimating our baseline regression in equation (3) using fixed effects OLS and show the results in Table 2. Consistent with the literature (Hilary and Hui, 2009; Adhikari and Agrawal, 2016), we find a statistically significant risk-reducing influence of

¹⁹ We make this classification annually.

²⁰ We make this classification annually and per 2-digit SIC Code industry.

Religiosity on *Total Risk* (-0.004) and *Idiosyncratic Risk* (-0.004) at the 1% level. For *Systematic Risk*, a negative but insignificant relationship can be observed, which contrasts with the significant influence found by Hilary and Hui (2009).

Turning our focus to UQR, Figure 1 exemplifies the relationship between *Total Risk*, *Religiosity*, and the control variables for the unconditional quantiles of *Total Risk* and shows the estimated coefficients and corresponding 90% confidence intervals.²¹ Regarding *Religiosity*, a risk-reducing and statistically significant influence can be confirmed for all the unconditional quantiles of *Total Risk*. In fact, we find a weak risk-mitigating influence of *Religiosity* on *Total Risk* in the low quantiles of the *Total Risk* distribution. This influence increases steadily and more than doubles up to the 60% quantile before plateauing. Contrary to our assumption, the influence grows strongly for the 95th percentile and is strongest there overall. Nevertheless, these results support our initial hypothesis that the influence of *Religiosity* is not constant across firms. Furthermore, it can be seen that all firms benefit from a more pronounced religious environment, especially those with a high firm risk.

Our controls reveal strong heterogenous relationships in combination with mostly high statistical significance to *Total Risk*, where magnitude and significance mainly decrease in the top quantiles, reflected in widening confidence intervals.

[Figure 1 about here]

We present specific estimated coefficients for the 10% to 90% quantile for *Religiosity* in Table 3. In terms of *Total Risk* a significant (mostly at the 1% level) negative influence of

²¹ Figures for *Idiosyncratic Risk* (Figure IA.1) and *Systematic Risk* (Figure IA.2) can be found in the Internet Appendix.

Religiosity can be found for each quantile of the dependent variable. The coefficients range from -0.001 to -0.005 for *Total Risk* with a more risk-reducing influence of *Religiosity* in the upper than in the lower quantiles, i.e., the risk-reducing influence of *Religiosity* is stronger for firms with higher risk.

Regarding *Idiosyncratic Risk*, we find very similar results. All coefficients are significant, mostly at the 1% level and range from -0.001 to -0.005. The risk-mitigating effect of *Religiosity* is the strongest for the 60% and 70% quantiles, but otherwise very similar to *Total Risk*.

For the 30% to 80% quantiles, a significant risk reducing influence of *Religiosity* can now be confirmed for *Systematic Risk*. The coefficients show a high heterogeneity (-0.068 to -0.101) and a slightly u-shaped course.

[Table 3 about here]

5.2 Robustness tests for firm risk

In this section, we present several analyses to confirm the robustness of our results, controlling for additional variables (Panel A) and analyzing geographical aspects (Panel B).²² In the following, we refer to Tables 4 to 6 for *Total Risk*, *Idiosyncratic Risk*, and *Systematic Risk*, respectively. Applying UQR to Model 1 to 3 (Panel A), we can confirm the results' robustness for *Total Risk* and *Idiosyncratic Risk*, although the coefficients are no longer significant for every single quantile. For *Systematic Risk*, we fail to show robustness in Model 1 as almost all coefficients turn insignificant. In Model 2 and 3 *Religiosity* remains significant (mostly at the

²² For the sake of brevity, we focus here on the robustness and causality analysis for the UQR. The OLS results overall confirm the robustness and causality of the baseline OLS analysis and can be found in Table IA.1 of the Internet Appendix, including a commentary.

1% level) mainly for the lower and middle quantiles but loses any significance in the upper part of the distribution.

Panel B (geographic aspects) confirms the robustness of the significant (mainly at the 1% level) risk-reducing *Religiosity* effect for *Total Risk* and *Idiosyncratic Risk* across almost every quantile in each model specification. With respect to *Systematic Risk*, we can draw similar conclusions, since the models confirm the robustness of our baseline regression, except for Model 9, as it does not show a significant negative effect of *Religiosity*.

[Table 4 about here]

[Table 5 about here]

[Table 6 about here]

5.3 Causality analysis for firm risk

Model 12 and 13 confirm the significant risk-reducing influence of *Religiosity* on all three risk variables. Turning to our placebo test strategy, Model 14 (i) shows for all our risk variables that the average pseudo t-value is not significantly different from zero, while Model 14 (ii) confirms that our “true” t-values are significantly (1% level; insignificant in one case for Systematic Risk) different from the average pseudo t-values. Thus, suggesting that our results are not driven by county-level omitted factors.²³

Finally, Model 15 shows results for entropy balancing. UQR analyzes how a marginal change in the independent variable changes the distribution of the dependent variable and is therefore inappropriate for binary variables, as *High-Religiosity-Dummy*, resulting in biased

²³ Figure IA.3 exemplifies the approach in case of OLS using *Total Risk* as dependent variable.

estimates (Firpo et al., 2009; Rios-Avila and Maroto, 2022; Rios-Avila, 2020).²⁴ Nevertheless, we implement entropy balancing to give an idea of the relationship and find significantly negative coefficients in the upper half of the distribution for *Total Risk* and *Idiosyncratic Risk*. For *Systematic Risk*, only a significant positive relation can be observed in the 90th percentile, which contradicts the previous results.

5.4 Information asymmetry analysis for firm risk

We analyze the influence of IA on firm risk in Panel D. In case of *Total Risk* and *Idiosyncratic Risk*, we find stronger relevance of *Religiosity* in our high IA groups, leading to highly significant and heterogenous negative coefficients along almost all quantiles considered. Furthermore, we observe significant coefficients in the low IA groups that are considerably smaller than in the high IA groups, particularly in Models 16 and 18. A Wald test reveals that the coefficient differences are statistically significant mainly in the lower and middle parts of the distribution, implying that *Religiosity* is able to mitigate IA problems only when firms have rather low to medium risk levels, but not in case of firms with high risk levels. With regard to *Systematic Risk*, our results are mixed. We find significantly negative coefficients in the high IA group when using S&P 500 and firm size as proxies, but no significant coefficient

²⁴ In the case of binary treatment variables, Firpo (2007) proposed a quantile treatment effects (QTE) estimator. “QTE can be considered as a compromise between CQR [conditional quantile regression] and UQR that focuses on analyzing the distributional impact of a single binary variable on the outcome of interest, holding the distribution of other characteristics constant” (Rios-Avila and Maroto, 2022, p. 5). QTE was implemented in the statistical program Stata through the user-written command *ivqte* (Frölich and Melly, 2010) but cannot be combined with entropy balancing. In fact, UQR can only be combined with entropy balancing because the UQR methodology is a two-step process where first the dependent variable is transformed (independent of the regressors used) into the recentered influence function (RIF) for a quantile and second the RIF is regressed on the regressors used using OLS (Firpo et al., 2009; Rios-Avila and Maroto, 2022). Weighting of observations during an OLS regression in Stata is technically possible, whereas this is not possible in a QTE regression.

differences of the low versus high IA groups. When firms are classified based on analyst coverage, *Religiosity* has a mostly risk-reducing effect only for firms with low IA.

6 Empirical results for the religiosity and firm value relationship

6.1 Baseline results for firm value

In the following sections, we discuss our results regarding firm value. We estimate equation (3) again, this time using *Tobin's Q* as our dependent variable to analyze the effect of *Religiosity* on firm value and present the results in Table 2. The coefficient on *Religiosity* has a negative but non-significant influence, which is in line with Zolotoy et al. (2019). Accordingly, it currently appears that religiosity has no effect on firm value, although we were able to demonstrate a significant risk-reducing effect of religiosity in Section 5.

Next, we apply UQR to equation (3). Figure 2 depicts the relation between *Tobin's Q*, *Religiosity* and the control variables for the unconditional quantiles of *Tobin's Q* and shows the estimated coefficients and corresponding 90% confidence intervals. We find a significant value-reducing influence of *Religiosity* in the 5th percentile and in the top quantiles. Hence, firms with very low and high firm value experience a value discount if they are headquartered in more religious counties. We also find some evidence that firms with medium firm value benefit from a more religious environment, as we find a significant (10% level) value-enhancing effect at the 40% quantile.

As before (Figure 1), the control variables have highly significant coefficients that show strong heterogenous relations to *Tobin's Q*, and where magnitude and significance mainly decrease in the top quantiles, reflected in widening confidence intervals.

[Figure 2 about here]

The specific estimates (Table 3) at the 40%, 80%, and 90% quantiles are 0.034, -0.069, and -0.149, respectively. Thus, we are able to demonstrate a general influence of *Religiosity* on firm value. The heterogeneity in the signs offers a potential explanation why no influence could be found so far when analyzing the average relationship via OLS (Zolotoy et al., 2019; Amin et al., 2021). Furthermore, it appears that the main effects are in the tails of the Tobin's *Q* distribution and not at the mean.

6.2 Robustness tests for firm value

In the following, we refer to Table 7 for *Tobin's Q*. Adding additional controls (Model 1 to 3), we successfully demonstrate robustness for the upper quantiles (mainly significant at the 1% level). In addition, we find a significant value-reducing effect at the 10th percentile in Model 3 and, as in our baseline regression, a significant (10% level) positive effect at the 40% quantile. Almost all insignificant coefficients are positive.

With regard to geographic aspects (Panel B), we can confirm the robustness of our baseline results, i.e., we observe a value-reducing effect of *Religiosity* in the extreme quantiles and a value-increasing effect at the 40th percentile. The use of state fixed effects in Model 11 is particularly striking as we observe a significant negative effect of *Religiosity* at the 1% level for the 10% to 80% quantile that becomes stronger in higher quantiles. When using state fixed effects, the explanatory power of *Religiosity* on *Tobin's Q* stems solely from the *Religiosity* differences between counties within the same state. Thus, only the deviation of the county *Religiosity* from the average state *Religiosity* is decisive instead of the *Religiosity* level of the county in which the company is headquartered. To test this, we additionally re-estimate

equation (3) using *Delta State Religiosity*, defined as the difference between a county's *Religiosity* and the average state *Religiosity* in which the county is located. Model 11-II shows significant negative coefficients for the 40% quantile and higher, with the magnitude of the coefficients increasing along the quantiles, thereby confirming our hypothesis.²⁵

[Table 7 about here]

6.3 Causality analysis for firm value

Focusing on the agricultural, manufacturing, and mining sectors in Model 12 confirms our significant value-reducing relationship for *Religiosity* in the 70th and 80th percentiles of the *Tobin's Q* distribution. Using *Religiosity*, lagged by three periods in Model 13, we find a significant negative effect of *Religiosity* in the 90% quantile and a significant positive effect in the 40th percentile. Our placebo test strategy in Model 14 (i) shows that the average pseudo t-value is not significantly different from zero, while Model 14 (ii) confirms that our "true" t-values are significantly different from the average pseudo t-values at the 1% level. Overall, the placebo test suggests that our findings are unlikely to stem from spurious correlations in the data. Finally, entropy balancing (Model 15) provides further evidence for the significant negative correlation for the 10%, 70%, and 80% quantiles of the *Tobin's Q* distribution.

²⁵ When applying OLS to Model 11-II (untabulated), we now also find a significant (10% level) negative influence of *Delta State Religiosity* (Coeff.: -0.135; t-value: -1.68).

6.4 Information asymmetry analysis for firm value

Last but not least, we present results regarding the influence of information asymmetry on the religiosity-firm value relationship. We find a significant value-decreasing effect for *Religiosity* in the tails of the *Tobin's Q* distribution for our samples with high IA. Furthermore, the relationship is more pronounced at the tails of the *Tobin's Q* distribution than in the middle part. Contrasting with this, we find a value-enhancing effect of *Religiosity* in the lower and middle quantiles for our samples with low IA, especially when we distinguish by firm size. Despite the largely opposite signs, the coefficient differences are mostly not statistically significant.

7 Discussion of results

7.1 Religiosity and firm risk

With respect to our OLS baseline analysis (Table 2), we find a significant risk-reducing effect of *Religiosity* on *Total Risk* and *Idiosyncratic Risk*, which is consistent with the literature (Hilary and Hui, 2009; Adhikari and Agrawal, 2016). Regarding *Systematic Risk*, we find an insignificant negative effect that is not in line with the literature, as a significant risk-mitigating effect is observed (Hilary and Hui, 2009). We can confirm the results' robustness in numerous additional tests (Table IA.1). Implementing UQR reveals strongly heterogeneous effects along the unconditional quantiles of the distribution of our three risk variables. In addition to *Total Risk* and *Idiosyncratic Risk*, we now also find a significant risk-reducing influence of *Religiosity* on *Systematic Risk*. These results hold in our robustness section. Overall, our results suggest that the risk-reducing influence of religiosity is particularly stronger for medium- and high-risk

firms than for low-risk firms (lower part of the distribution) and contributes to a reduction in information asymmetry.

7.2 Religiosity and firm value

Consistent with the literature (Zolotoy et al., 2019; Amin et al., 2021), we find no significant relationship between *Religiosity* and *Tobin's Q* when estimating our baseline analysis via fixed effects OLS. Several robustness tests confirm this result (Table IA.1). Applying UQR, we consistently find a significant value-reducing influence of *Religiosity* in the upper quantiles and often in the 10% quantile and a value-enhancing influence in the 40% quantile in both our baseline analysis and robustness tests. Considering state fixed effects leads to interesting results, since a value-reducing relationship that is mostly significant at the 1% level emerges for almost every quantile. In case of state fixed effects, the effect is exerted by a county's *Religiosity* deviation from the average *Religiosity* level of the corresponding state. This is confirmed by using *Delta State Religiosity* in an additional test. Moreover, in our IA analysis, we observe numerous significant positive coefficients in the low IA groups, especially when we use firm size as a discriminating factor (Model 18).²⁶ Overall, these results are hard to

²⁶ Since all of our IA proxies depend on firm size, our results could be subject to a size bias. Therefore, we use two additional IA proxies that are less dependent on firm size, namely *Institutional Ownership* and *Blockholder* (defined in Table A.1; Boone and White, 2015). We define a firm to have high IA if *Institutional Ownership* (*Blockholder*) is smaller than the annual median (is zero), else low IA. Regarding *Institutional Ownership*, we find (untabulated) a significant value-decreasing effect in the 10% and 70% quantile for the high IA group and a significant value-enhancing effect from the 20% to 70% quantile for the low IA group. Using *Blockholder*, we find no effect in the high IA group and a significant value-enhancing (value-reducing) effect in the 30% and 40% (90%) quantile. These additional results are not absolutely clear; however, using *Institutional Ownership* confirms the value-enhancing influence of *Religiosity* in the low IA group. In the context of firm risk, our previous results are confirmed when we use these two proxies. Finally, we again use the low and high IA groups based on analyst coverage and subdivide both IA groups based on total assets as in Model 18. For this purpose, we calculate the median firm size of our entire sample and divide the companies in the low (high) IA group into covered (uncovered) and smaller than the median and covered (uncovered) and larger than the median. We find (untabulated) a significant value-enhancing effect of *Religiosity* in most quantiles for firms larger than the median, regardless of whether the firm has high or low IA, and no effect in the groups below the median, with two exceptions. These results again tend to indicate a size bias.

interpret but suggest that there is a relationship between *Religiosity* and firm value and that it can be both negative as well as positive.

Regarding the influence channel of *Religiosity* on firm value, the following two mechanisms might be conceivable. Theoretically, one can imagine that idiosyncratic risk consists of a “normal” component and an IA component. Religion reduces risk by eliminating or at least reducing the IA component. The IA component will be positively priced, i.e., it will be accompanied by a risk premium that, via a higher discount factor, will lead to a stronger discounting of a company’s cash flows and thus (*ceteris paribus*) to a lower firm value. In contrast, an increase in firm value should be observable if this risk component is reduced by *Religiosity*. Another influence channel could be that *Religiosity* leads to lower cash flows. This would not automatically be accompanied by a lower firm value, as the discount factor could decrease proportionally, making the changes overall value-neutral. However, increased *Religiosity* could lead to a restriction in investment opportunities, as management deliberately refrains from morally dubious projects and investments. As a result, the firm’s cash flows would decrease compared with competitors who are not subject to such restrictions, and thus firm value.²⁷ It remains unclear which of the effects dominates or whether the results are not due to a size bias. We leave this research question to be answered.

8 Conclusion

We investigate the influence of local religious norms on both firm risk, represented by *Total Risk*, *Systematic Risk*, and *Idiosyncratic Risk*, and firm value, approximated via *Tobin’s Q*. In

²⁷ This would be in line with Zolotoy et al. (2019). They presume that on the one hand, firm value could increase if corporate misconduct was avoided through increased religiosity. On the other hand, increased risk aversion due to strong local religious norms could lead to refraining from risky investments with positive net present value, thus having an adverse effect on firm value (Hilary and Hui, 2009; Zolotoy et al., 2019).

contrast to previous literature, we focus on the relationship along the entire distribution of the dependent variables instead of the average relationship, estimated via standard OLS. For this purpose, we implement UQR according to Firpo et al. (2009) in addition to fixed effects OLS. UQR allows us to analyze the unconditional quantiles of the distribution of the dependent variable, enabling us to identify heterogeneous effects in terms of coefficient magnitude, sign and significance. We apply a large U.S. panel dataset that contains all U.S. companies listed on the NYSE, NASDAQ, and AMEX during the period 01/01/1980 to 12/31/2020. We measure local religious norms by the number of religious adherents of all religious denominations in a county relative to the total population of that county. Subsequently, a company is assigned the local religious norms of the county it is headquartered in.

In our baseline regression, we find a significant risk-reducing relationship for *Total Risk* and *Idiosyncratic Risk* using OLS and no influence of *Religiosity* for *Systematic Risk* and *Tobin's Q*. The first-time application of UQR in this strand of the literature reveals strongly heterogeneous effects along the unconditional quantiles of the distribution of the dependent variable. Risk-reducing effects are confirmed for *Total Risk*, *Idiosyncratic Risk*, and *Systematic Risk*, while we find a value-reducing effect in the 5th percentile and in the upper quantiles, and a value-increasing effect at the 40% quantile for *Tobin's Q*. Thereby, the risk-reducing influence of *Religiosity* is more pronounced in the higher quantiles of the distribution. For *Tobin's Q* a value-decreasing effect exists in the extreme quantiles and a value-enhancing effect for rather medium value firms. In line with the literature, we perform a battery of additional tests to confirm the robustness of our results.

Finally, we analyze IA as a possible channel of *Religiosity* and find a stronger influence of local religious norms for firms with high IA. Overall, our results reveal that *Religiosity* can have a positive and negative effect on *Tobin's Q*. These heterogenous results emphasize the

advantage of additionally analyzing the relationship at the unconditional quantiles of the dependent variables, compared to purely analyzing the average relationship with OLS.

Overall, our results should be of interest to investors in order to make more informed investment decisions on the one hand and to better understand which companies are positively or negatively influenced by a religious environment on the other hand. It may also be possible for policy makers to draw conclusions about the degree of risk and the need for regulation based on the location of the company and the resulting religious environment.

Appendix

Table A.1: Definition of dependent and independent variables

(1) Variable	(2) Definition
<i>Panel A: Dependent Variables</i>	
Raw Tobin's Q	Defined as book value of assets (WC02999) minus book value of equity (WC03995) plus market value of equity (WC08001), divided by total assets (WC02999; Coles et al. 2008; Hong and Kacperczyk, 2009; Doidge et al., 2004). Since we have no data regarding the replacement cost of assets or market value of debt (Lindenbergh and Ross, 1981), this is merely an approximation, which is, however, likely to be strongly correlated with the actual Tobin's Q. Chung and Pruitt (1994) are able to show an R^2 of at least 96.6% for a regression of the Lindenbergh and Ross (1981) Tobin's Q on this Tobin's Q approximation.
Tobin's Q	We calculate the natural logarithm of "Raw Tobin's Q" to obtain Tobin's Q (Adhikari and Agrawal, 2016; Amin et al., 2021; Coles et al. 2008; Hong and Kacperczyk, 2009).
Total Risk	Standard deviation of daily discrete stock returns (based on RDS RI) over the past 12 months for firm i and year t (Adhikari and Agrawal, 2016; Sassen et al., 2016).
Systematic Risk	Estimated CAPM (Sharpe, 1964) beta coefficient for each firm i and each year t using daily discrete return data (based on RDS RI; Hilary and Hui, 2009; Sassen et al., 2016).
Idiosyncratic Risk	Standard deviation of the residuals from a 4-factor Carhart (1997) model estimated for each firm i and each year t using daily discrete return data (based on RDS RI; Adhikari and Agrawal, 2016; Hilary and Hui, 2009; Ang et al., 2006, 2009).
<i>Panel B: Religiosity Variables</i>	
Religiosity	Main variable of interest. Defined as the number of religious adherents in a county divided by the county population in a year (ARDA). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Jiang et al., 2018; Kumar et al., 2011).
Delta Religiosity	Defined as the difference of Religiosity between year $t-1$ and t .
Delta State Religiosity	Defined as the difference between the Religiosity of a county and the average Religiosity of the state the county is located in.
High-Religiosity-Dummy	Indicator variable that equals 1 if a firm's Religiosity level is above the 75 th percentile (treatment group), and 0 if it is below the 25 th percentile (control group) (Jiang et al., 2018).
Pseudo-Religiosity	Created by replacing a county's "true" Religiosity level with a randomly assigned "false" Religiosity level from another county in our sample, i.e., county A receives, for example, county B's Religiosity level, and county B receives county C's Religiosity level, and so forth (Zolotoy et al., 2019; Ma et al., 2021).
Religiosity Catholics	Number of Catholic adherents in a county divided by the county population in a year (ARDA). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Jiang et al., 2018).

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Religiosity Protestants	Number of Protestant adherents in a county divided by the county population in a year (ARDA). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Jiang et al., 2018).
Panel C: Control Variables	
<i>Firm Characteristics</i>	
Analyst Coverage	Number of analysts forecasting earnings per share for the following year (RDS_EPSINE; Jiang et al., 2018).
Blockholder	Number of institutions that have at least 5% ownership of the target's shares outstanding (Fich et al., 2015). The calculation is based on the variable Institutional Ownership.
Board Independence-Dummy	Indicator variable that equals 1 if the company has a policy regarding the independence of its board, else 0 (RDS_CGBSDP0012; Jiang et al., 2018). Can affect firm risk negatively (John et al., 2008; Acharya et al., 2011) and thus firm value.
Board Size	Number of board members at the end of the fiscal year (RDS_CGBSDP060; Jiang et al., 2018). Can affect firm risk and firm value (Yermack, 1996; Coles et al., 2008).
CapEx	Capital expenditures (WC04601) divided by total assets (WC02999; Servaes, 1996; Jin and Jorion, 2006). Positively affects firm value (Allayannis and Weston, 2001), and is expected (as an investment opportunity) to positively affect systematic risk and unsystematic risk (Albuquerque et al., 2019; Jo and Na, 2012; Bouslah et al., 2013).
Diversification-Dummy	Indicator variable that equals 1 if the firm's number of operating segments which operate in different 2-digit SIC codes is two or higher, else 0 (based on WC19506 to WC19596; Glaser and Müller, 2010; Kuppuswamy and Villalonga, 2016). Empirical literature largely records a negative effect on firm value (Campa and Keida, 2002; Graham et al., 2002; Villalonga, 2004). There is also literature showing a relationship between diversification and (un)systematic risk (Albuquerque et al., 2019; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007; Sassen et al., 2016).
Dividend-Dummy	Indicator variable that takes the value 1 if the company paid a dividend (WC05101) in the current year, else 0. Missing values are replaced with 0 (Servaes, 1996; Allayannis and Weston, 2001). A firm's value can remain high even if the firm fails to undertake potential projects due to a lack of funding, as long as only the projects with the highest NPVs are carried out. Thus, a company is unlikely to be capital constrained if it pays a dividend and could therefore have a lower Tobin's Q, which corresponds to a negative regression coefficient (Lang and Stulz, 1994; Servaes, 1996; Allayannis and Weston, 2001). Idiosyncratic risk may be affected, since shareholders and investors value dividend payments. For systematic and idiosyncratic risk, the literature has shown a negative and positive relationship (Sassen et al., 2016; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007).
Institutional Ownership	The average percentage of shares outstanding held (RE_TR_PctOfSharesOutHeld) by 13-F institutions (RE_TR_FilingType) over the year (e.g., Baghdadli, 2018). All observations greater than 100% are set to 100% analogous to the literature (Lewellen, 2011).
Leverage	Total debt divided (WC03255) by shareholders' equity (WC03995; Allayannis and Weston, 2001; Fauver and McDonald IV, 2014; Jiang et al., 2018). A firm's capital structure may have a positive impact on firm value (Allayannis and Weston, 2001; Fauver and McDonald IV, 2014) and on systematic and unsystematic risk (Albuquerque et al., 2019; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007; Sassen et al., 2016).
Illiquidity	Calculated as the absolute daily discrete return (based on RDS RI) divided by the daily dollar volume (calculated as RDS VO times RDS P) and multiplied with 1,000,000. Since the raw measure is highly skewed, we use the square root version of the raw version. Based on our daily figures, the yearly average is calculated (Amihud, 2002; Gopalan et al., 2012; Hilary and Hui, 2009). Positively

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	affects firm performance (Fang et al., 2009) and is shown to influence firm risk positively and negatively (Sassen et al., 2016, Bouslah et al., 2013).
R&D	Defined as R&D (WC01201) divided by total assets (WC02999). We follow the common practice in previous research and replace missing values with zero. This is because since 1972, the SEC has required all publicly traded companies to report their R&D expenditures when they are material, exceed 1% of sales, or a policy of deferral or amortization of R&D expenses is pursued (Allayannis and Weston, 2001; Lewis and Tan, 2016; Hirschey et al., 2012; Zolotoy et al., 2019). Positively affects firm value (Allayannis and Weston, 2001), and positively or negatively systematic risk and unsystematic risk (Albuquerque et al., 2019; Becchetti et al., 2015; Bouslah et al., 2013; Jo and Na, 2012).
ROA	Net income (WC01551) divided by total assets (WC02999; Allayannis and Weston, 2001; Jin and Jorion, 2006; Jiang et al., 2018). Profitability makes it more likely for a firm to be traded at a premium (higher Tobin's Q) (Allayannis and Weston, 2001; Jin and Jorion, 2006). Profitability also affects risk since it contains information about a firm's future cash flow streams (Luo and Bhattacharya, 2009; Sassen et al., 2016; Jo and Na, 2012).
Size	Natural logarithm of total assets (WC02999; Allayannis and Weston, 2001; Jiang et al., 2018). Whether company size has a positive influence on profitability is ambiguous, at least for US companies (Lang and Stulz, 1994; Allayannis and Weston, 2001). A negative influence of company size on systematic as well as unsystematic risk has already been noted in the literature (Albuquerque et al., 2019; Luo and Bhattacharya, 2009; Ferreira and Laux, 2007).
S&P 500 Constituent	Indicator variable that equals 1 in year t if a firm is a S&P 500 constituent in year t , else 0 (RDS LS&PCOMP"MMYY", e.g., LS&PCOMP1289 for December 1989). We obtain data for the period 1989 to 2020.
<i>County Characteristics</i>	
Abortion Rate	Abortion rate for women aged 15 to 44 (Guttmacher Institute; Hilary and Hui, 2009; Jiang et al., 2018).
Age	Natural logarithm of the median age of the population in a county (U.S. Census Bureau). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Kumar et al., 2011; Adhikari and Agrawal, 2016).
Alcoholism	Defined as the per capita alcohol consumption rate (National Institute on Alcohol Abuse and Alcoholism; Hilary and Hui, 2009; Jiang et al., 2018).
Education	Defined as the percentage of county population above age 25 that has completed a bachelor's, postgraduate, or professional degree (U.S. Census Bureau). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Kumar et al., 2011; He and Hu, 2016).
Income	Natural logarithm of median per capita income of county residents (U.S. Census Bureau). This variable is linearly interpolated between the survey years (Kumar et al., 2011; He and Hu, 2016; Jiang et al., 2018).
MF-Ratio	Measured as the male population to the female population of a county (U.S. Census Bureau). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Kumar et al., 2011; Jiang et al., 2018).
Marriage	Percentage of married people in a county (U.S. Census Bureau). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Kumar et al., 2011; Jiang et al., 2018).
Minority	Percentage of non-white persons in a county (U.S. Census Bureau). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Kumar et al., 2011; Adhikari and Agrawal, 2016).
President	Vote share per state received by the Republican candidate for president in the previous election (MIT Election Data and Science Lab; Hilary and Hui, 2009; Di Giuli and Kostovetsky, 2014; Adhikari and Agrawal, 2016).

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State GDP Natural logarithm of a state's gross domestic product (Bureau of Economic Analysis; He and Hu, 2016; Chen et al., 2016).

Total Population Defined as natural logarithm of the total population in a county (U.S. Census Bureau). This variable is linearly interpolated between the survey years (Hilary and Hui, 2009; Kumar et al., 2011; Adhikari and Agrawal, 2016).

This table shows definitions of our dependent variables (Panel A), religiosity variables (Panel B) and independent variables (Panel C). Religiosity is expected to have a risk-reducing effect and a positive or negative impact on firm value. We have no expectations regarding the direction of the effects on the dependent variables for our county characteristics. Where "RDS" and "WC" indicate "Refinitiv Datastream" and "Worldscope" which were used to retrieve the data.

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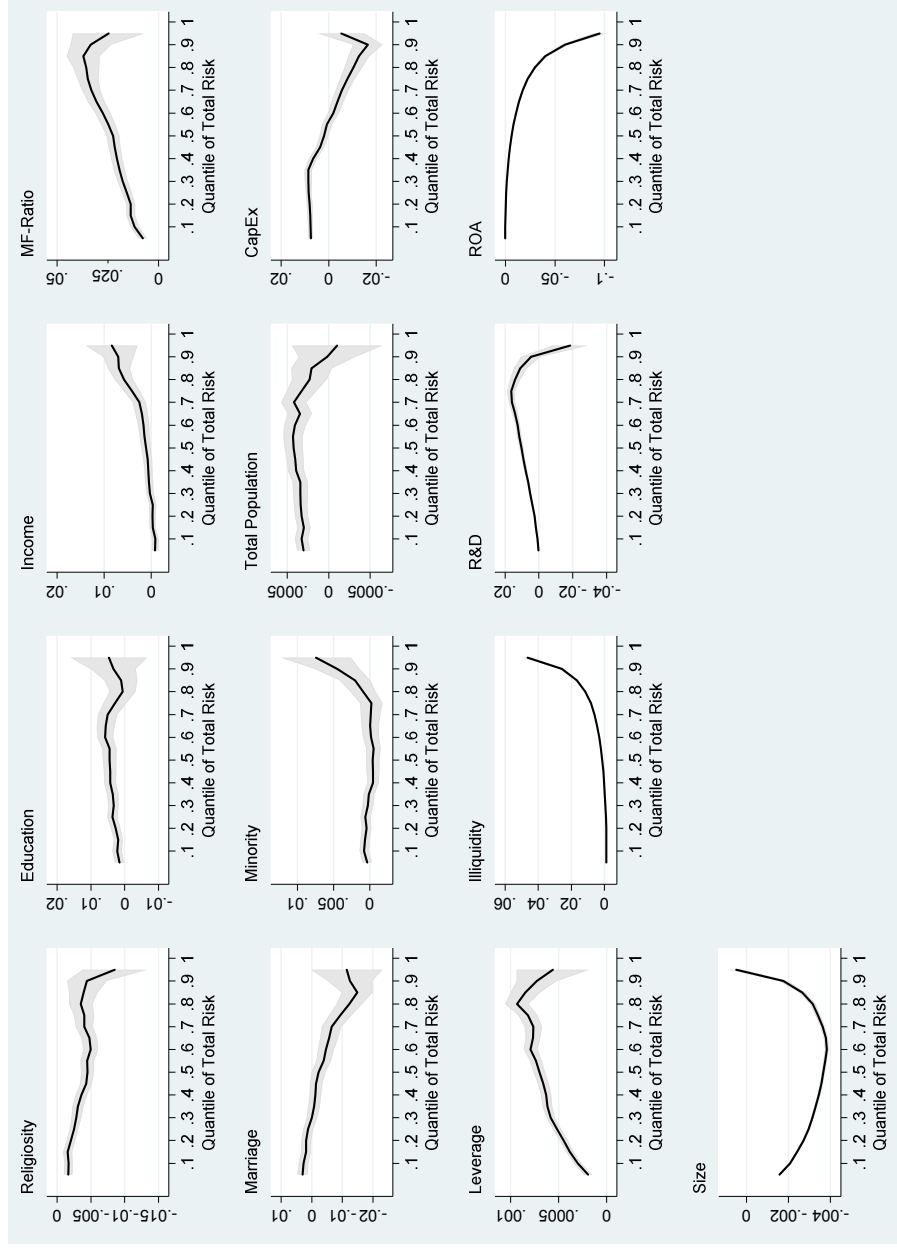
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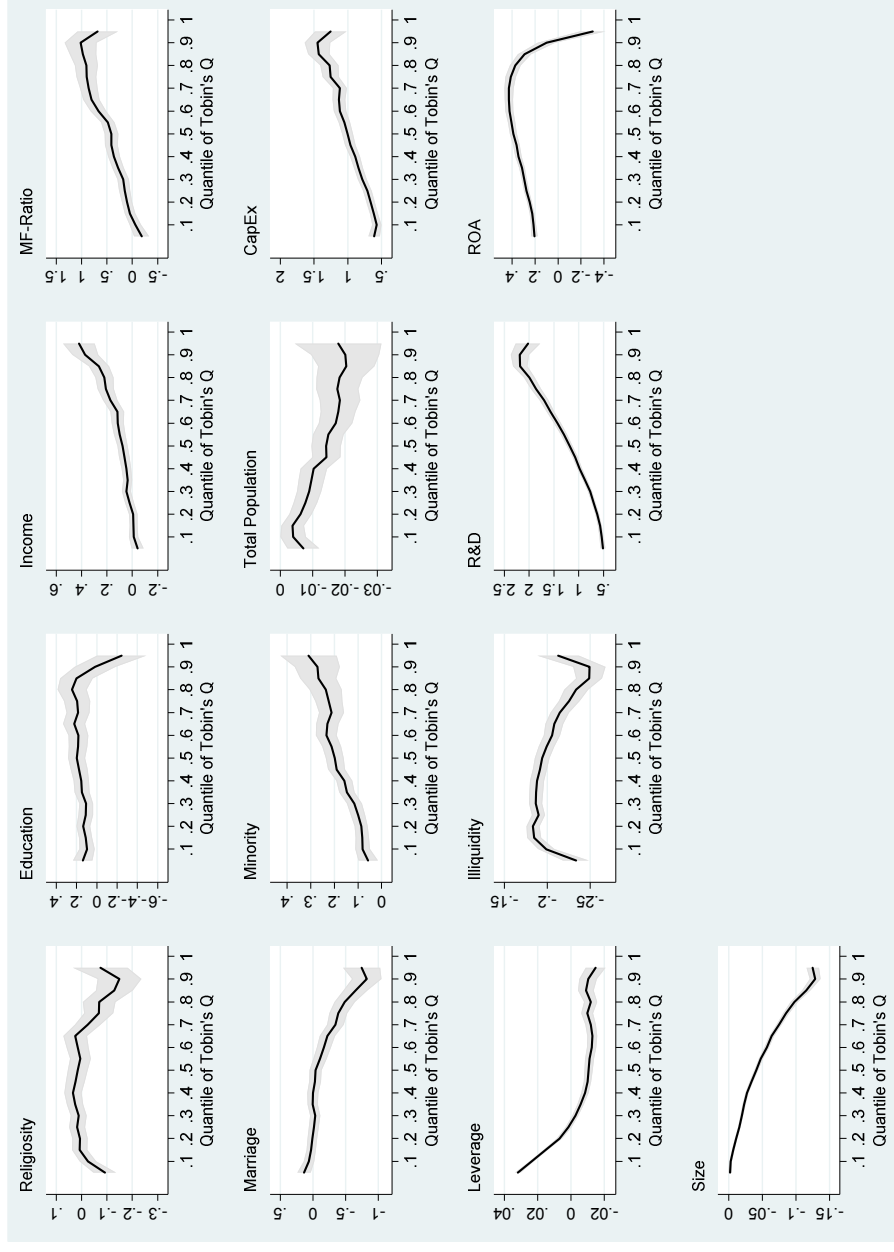
Figures and Tables

Figure 1: Unconditional quantile regression results for *Total Risk*.



This figure shows coefficients (solid line) and 90% confidence intervals (shaded area, calculated from robust standard errors bootstrapped with 1,000 replications) of the independent variables for unconditional quantiles from the 5%- to 95%-quantiles in 5% steps of *Total Risk* (horizontal axis).

Figure 2: Unconditional quantile regression results for *Tobin's Q*.



This figure shows coefficients (solid line) and 90% confidence intervals (shaded area), calculated from robust standard errors bootstrapped with 1,000 replications) of the independent variables for unconditional quantiles from the 5%- to 95%-quantiles in 5% steps of *Tobin's Q* (horizontal axis).

Table 1: Descriptive statistics and correlation coefficients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	Obs.	Mean	Std. Dev.	Min	Max	P5	P10	P25	P50	P75	P90	P95
<u>Dependent Variables</u>												
Raw Tobin's Q	79,886	2.19	1.95	0.41	35.24	0.82	0.93	1.15	1.58	2.45	4.07	5.72
Tobin's Q	79,886	0.57	0.60	-0.90	3.56	-0.19	-0.07	0.14	0.46	0.89	1.40	1.74
Total Risk	79,886	0.03	0.02	0.00	0.24	0.01	0.02	0.02	0.03	0.04	0.06	0.07
Idiosyncratic Risk	79,886	0.03	0.02	0.00	0.25	0.01	0.01	0.02	0.03	0.04	0.06	0.07
Systematic Risk	79,886	0.93	0.59	-1.16	3.21	0.05	0.20	0.51	0.90	1.28	1.68	1.95
<u>Religiosity Variables</u>												
Religiosity	79,886	0.52	0.11	0.27	0.86	0.35	0.38	0.44	0.53	0.60	0.67	0.72
Religiosity Catholics	79,886	0.25	0.14	0.01	0.64	0.06	0.08	0.15	0.23	0.36	0.46	0.51
Religiosity Protestants	79,886	0.21	0.13	0.05	0.70	0.08	0.09	0.11	0.17	0.30	0.40	0.48
<u>Control Variables</u>												
<u>Firm Characteristics</u>												
Board Indep.-D.	16,012	0.89	0.31	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
Board Size	15,991	9.37	2.24	1.00	26.00	6.00	7.00	8.00	9.00	11.00	12.00	13.00
CapEx	79,886	0.06	0.06	0.00	0.42	0.00	0.01	0.02	0.04	0.07	0.12	0.17
Diversification-D.	68,710	0.29	0.45	0.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
Dividend-D.	79,886	0.37	0.48	0.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00
Illiquidity	79,886	0.37	0.71	0.00	8.78	0.01	0.02	0.04	0.12	0.37	0.95	1.57
Leverage	79,886	0.77	1.70	0.00	19.95	0.00	0.00	0.02	0.31	0.79	1.66	2.77
R&D	79,886	0.06	0.12	0.00	1.71	0.00	0.00	0.00	0.01	0.07	0.16	0.25
ROA	79,886	-0.02	0.26	-5.30	0.39	-0.45	-0.22	-0.02	0.04	0.08	0.13	0.16
Size	79,886	5.92	2.01	-1.14	12.42	2.86	3.44	4.47	5.78	7.28	8.63	9.45
<u>County Characteristics</u>												
Education	79,886	0.34	0.10	0.09	0.59	0.18	0.21	0.26	0.32	0.41	0.48	0.52
Abortion	74,255	20.66	8.59	5.40	44.90	9.30	10.30	14.50	18.63	26.50	33.07	37.30
Age	79,886	3.55	0.08	3.25	3.84	3.42	3.45	3.50	3.55	3.61	3.67	3.69
Alcoholism	79,884	2.32	0.32	1.63	5.42	1.88	1.95	2.15	2.27	2.47	2.71	2.86
Income	79,886	10.82	0.36	9.38	11.60	10.15	10.34	10.61	10.84	11.07	11.28	11.38
Marriage	79,886	0.49	0.09	0.24	0.75	0.29	0.38	0.45	0.50	0.55	0.60	0.63

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An Unconditional Quantile Regression Approach

MF-Ratio	79,886	0.96	0.04	0.83	1.05	0.89	0.91	0.93	0.96	0.99	1.01	1.02
Minority	79,886	0.29	0.15	0.01	0.68	0.06	0.10	0.17	0.28	0.42	0.50	0.53
President	79,886	0.45	0.09	0.27	0.71	0.31	0.32	0.37	0.44	0.51	0.58	0.60
State GDP	59,410	13.20	0.92	10.33	14.93	11.68	12.05	12.57	13.15	13.97	14.44	14.66
Total Population	79,886	13.70	1.06	10.15	16.10	11.73	12.32	13.15	13.73	14.28	14.95	15.46

Panel B: Correlation

Variables	Rel	Raw TQ	TQ	TR	IR	SR
Religiosity	100%					
Raw Tobin's Q	-5.87%	100%				
Tobin's Q	-6.24%	87.94%	100%			
Total Risk	-6.64%	11.21%	1.48%	100%		
Idiosyncratic Risk	-5.67%	10.49%	0.67%	98.56%	100%	
Systematic Risk	-8.23%	16.22%	20.39%	6.21%	-4.03%	100%

Panel A shows descriptive statistics for available firm-year observations for the sample period 01/01/1980-12/31/2020. Variables are defined as in Table A.1. In each year, all variables (aside from dummy variables) are winsorized at the 1st and 99th percentiles. Panel B shows pairwise correlation coefficients for *Religiosity*, *Tobin's Q*, and risk variables for the sample period 01/01/1980-12/31/2020. Where TQ, TR, IR, and SR stand for *Tobin's Q*, *Total Risk*, *Idiosyncratic Risk*, and *Systematic Risk*, respectively. All correlation coefficients are significant at the 1% level except for **Cor(TQ, IR)** (10% level significant). Variables are defined as in Table A.1. (*Raw*) *Tobin's Q* and the risk variables are winsorized at the 1st and 99th percentiles.

Table 2: Baseline Fixed effects OLS regression results

Variables	(1) TR	(2) IR	(3) SR	(4) TQ
Religiosity	-0.004*** (-3.919)	-0.004*** (-4.121)	-0.057 (-1.397)	-0.025 (-0.470)
CapEx	0.002 (1.397)	0.000 (0.218)	0.548*** (8.624)	0.964*** (11.647)
Leverage	0.001*** (10.291)	0.001*** (10.957)	0.000 (0.141)	-0.003 (-1.407)
Illiquidity	0.010*** (34.445)	0.011*** (37.653)	-0.218*** (-26.231)	-0.207*** (-22.120)
R&D	0.006*** (3.986)	0.005*** (3.616)	0.485*** (11.388)	1.239*** (18.402)
ROA	-0.020*** (-29.228)	-0.020*** (-28.806)	-0.078*** (-4.685)	0.256*** (7.996)
Size	-0.002*** (-33.565)	-0.003*** (-40.296)	0.052*** (17.862)	-0.051*** (-13.676)
Education	0.005** (1.969)	0.006** (2.350)	-0.162* (-1.787)	0.121 (1.043)
Income	0.002 (1.301)	0.001 (0.955)	0.192*** (4.249)	0.119** (2.027)
MF-Ratio	0.021*** (5.519)	0.018*** (4.794)	1.048*** (7.516)	0.472*** (2.594)
Marriage	-0.003 (-1.050)	-0.002 (-0.659)	-0.351*** (-3.389)	-0.200 (-1.550)
Minority	0.001 (1.040)	0.001 (1.151)	0.000 (0.005)	0.182*** (3.404)
Total Population	0.000** (2.366)	0.000** (2.163)	0.010** (2.154)	-0.013** (-2.040)
Constant	0.004 (0.306)	0.011 (1.001)	-2.326*** (-5.413)	-0.703 (-1.263)
Observations	79,886	79,886	79,886	79,886
Adj. R-squared	0.45	0.50	0.17	0.12

This table reports results from fixed effects OLS regressions according to equation (3) using *Total Risk* (TR), *Idiosyncratic Risk* (IR), *Systematic Risk* (SR), and *Tobin's Q* (TQ) as dependent variables. 2-digit SIC code industry and year fixed effects were incorporated. Firm cluster robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Baseline unconditional quantile regression results

Quantile	(1) TR	(2) IR	(3) SR	(4) TQ
10%	-0.002*** (-4.447)	-0.001*** (-3.273)	0.003 (0.114)	-0.025 (-1.244)
20%	-0.002*** (-5.334)	-0.001*** (-3.618)	-0.043 (-1.637)	0.007 (0.360)
30%	-0.003*** (-6.310)	-0.003*** (-6.267)	-0.068*** (-2.720)	0.012 (0.619)
40%	-0.004*** (-7.026)	-0.003*** (-7.408)	-0.090*** (-3.733)	0.034* (1.667)
50%	-0.004*** (-7.849)	-0.004*** (-7.456)	-0.101*** (-4.283)	0.015 (0.630)
60%	-0.005*** (-7.566)	-0.005*** (-7.130)	-0.101*** (-4.415)	0.016 (0.592)
70%	-0.004*** (-5.197)	-0.005*** (-6.301)	-0.081*** (-3.056)	-0.024 (-0.789)
80%	-0.003*** (-3.257)	-0.004*** (-3.555)	-0.078** (-2.515)	-0.069* (-1.762)
90%	-0.004** (-2.446)	-0.004** (-2.180)	-0.057 (-1.310)	-0.149*** (-2.842)
Observations	79,886	79,886	79,886	79,886

This table reports results from UQR according to equation (3) using *Total Risk*, *Idiosyncratic Risk*, *Systematic Risk*, and *Tobin's Q* as dependent variables. 2-digit SIC code industry and year fixed effects were incorporated. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

Table 4: Further unconditional quantile regression results for *Total Risk*: robustness, causality, and information asymmetry

Models / Quantiles	(1) 10%	(2) 20%	(3) 30%	(4) 40%	(5) 50%	(6) 60%	(7) 70%	(8) 80%	(9) 90%	(10) Obs.
Panel A: Additional Controls										
Model 1: Demographic	-0.001 (-1.637)	-0.001** (-2.018)	-0.002*** (-2.678)	-0.003*** (-5.371)	-0.004*** (-4.903)	-0.004*** (-5.053)	-0.003*** (-2.985)	-0.003*** (-2.646)	-0.003 (-1.186)	59,408
Model 2: Board Indep.-D., Board Size	-0.003*** (-4.991)	-0.002*** (-3.197)	-0.002*** (-2.810)	-0.002*** (-3.103)	-0.002* (-1.661)	-0.002** (-2.069)	-0.003* (-1.914)	-0.005*** (-2.626)	-0.004 (-1.263)	15,991
Model 3: Diversification-D., Dividend-D.	-0.000 (-0.888)	-0.001 (-1.301)	-0.001 (-1.631)	-0.002*** (-3.448)	-0.003*** (-4.843)	-0.004*** (-5.175)	-0.003*** (-3.265)	-0.002* (-1.844)	-0.002 (-0.856)	68,710
Panel B: Geographic Aspects										
Model 4: Ex 5 largest countries	-0.002*** (-5.812)	-0.003*** (-6.562)	-0.004*** (-7.984)	-0.004*** (-8.170)	-0.006*** (-9.252)	-0.006*** (-8.336)	-0.006*** (-6.959)	-0.007*** (-6.451)	-0.007*** (-3.898)	64,695
Model 5: Ex 5 most religious states	-0.003*** (-6.957)	-0.004*** (-8.528)	-0.005*** (-9.795)	-0.006*** (-11.013)	-0.007*** (-11.242)	-0.007*** (-9.960)	-0.007*** (-8.674)	-0.007*** (-6.215)	-0.008*** (-4.226)	73,391
Model 6: Ex 5 least religious states	-0.001*** (-3.474)	-0.001*** (-3.395)	-0.002*** (-4.561)	-0.003*** (-5.705)	-0.004*** (-7.224)	-0.005*** (-6.289)	-0.004*** (-4.433)	-0.003*** (-2.611)	-0.004* (-1.953)	76,685
Model 7: Ex 10 most conservative states	-0.002*** (-4.529)	-0.002*** (-5.448)	-0.003*** (-6.417)	-0.004*** (-6.996)	-0.005*** (-7.130)	-0.005*** (-9.115)	-0.004*** (-4.823)	-0.003*** (-3.465)	-0.004** (-2.273)	77,279
Model 8: Western States	0.001 (0.711)	0.001 (0.745)	-0.001 (-0.489)	-0.002 (-1.149)	-0.005*** (-2.870)	-0.006*** (-3.025)	-0.009*** (-3.545)	-0.007** (-2.217)	-0.008 (-1.456)	18,877
Model 9: Metropolitan companies	-0.002*** (-2.701)	-0.003*** (-4.107)	-0.004*** (-4.807)	-0.005*** (-5.785)	-0.006*** (-6.084)	-0.006*** (-4.868)	-0.004** (-2.472)	-0.000 (-0.156)	0.001 (0.202)	31,100
Model 10: County level estimation	0.004*** (4.830)	0.003*** (3.407)	0.002*** (2.717)	0.002* (1.936)	0.002* (1.708)	0.001 (1.113)	-0.001 (-0.427)	-0.004** (-2.026)	-0.011*** (-4.382)	13,651
Model 11: State fixed effects	-0.000 (-0.568)	-0.001 (-1.214)	-0.002** (-2.379)	-0.002*** (-3.240)	-0.003*** (-4.114)	-0.003*** (-2.785)	-0.002 (-1.435)	-0.002 (-1.024)	-0.003 (-0.958)	79,886
Panel C: Endogeneity										
Model 12: Agri., Manufac., Mining Sectors	-0.001** (-2.063)	-0.001*** (-2.750)	-0.003*** (-4.825)	-0.004*** (-5.920)	-0.006*** (-6.939)	-0.006*** (-6.806)	-0.006*** (-5.981)	-0.007*** (-5.157)	-0.007*** (-3.171)	47,425
Model 13: 2SLS	-0.002*** (-3.868)	-0.002*** (-4.065)	-0.002*** (-4.924)	-0.002*** (-4.479)	-0.003*** (-5.547)	-0.004*** (-5.663)	-0.004*** (-4.784)	-0.004*** (-3.305)	-0.005*** (-2.643)	61,366
Model 14: Placebo Test										500
(i) H0: Pseudo t-values = 0 t-value	0.06	0.57	0.85	0.75	0.56	0.70	0.99	1.15	0.18	

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p-value	0.96	0.57	0.39	0.45	0.57	0.48	0.32	0.25	0.86	
(ii) H0: Pseudo t-values = True t-value										500
t-value	30.13	31.33	25.76	28.01	36.68	41.76	48.92	49.91	81.39	
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Model 15: Entropy Balancing	-0.000 (-1.471)	-0.000 (-0.979)	-0.000 (-1.486)	-0.000 (-0.779)	-0.001** (-2.514)	-0.001** (-2.304)	-0.001** (-2.313)	-0.001* (-1.836)	-0.002** (-2.476)	40,015
Panel D: Information Asymmetry										
Model 16: Analyst Coverage										
Not covered	-0.006** (-2.213)	-0.011*** (-3.822)	-0.017*** (-5.174)	-0.013*** (-3.553)	-0.017*** (-4.249)	-0.019*** (-4.100)	-0.015*** (-2.726)	-0.004 (-0.602)	-0.008 (-0.762)	4,028
Covered	-0.002*** (-4.185)	-0.002*** (-4.461)	-0.003*** (-5.657)	-0.003*** (-6.269)	-0.004*** (-6.974)	-0.004*** (-6.443)	-0.004*** (-5.026)	-0.003*** (-3.129)	-0.003 (-1.508)	75,858
Differences in Coefficients (p-value)	0.287	0.0711	0.00978	0.0906	0.0262	0.0255	0.128	0.926	0.689	
Model 17: S&P 500										
Non-S&P 500 firm	-0.001** (-2.126)	-0.002*** (-4.231)	-0.003*** (-5.336)	-0.005*** (-7.367)	-0.006*** (-8.522)	-0.005*** (-6.903)	-0.005*** (-5.598)	-0.005*** (-3.929)	-0.005** (-2.246)	63,273
S&P 500 firm	-0.001 (-0.732)	-0.001 (-0.889)	-0.001 (-1.262)	-0.000 (-0.200)	0.000 (0.164)	-0.001 (-0.566)	-0.001 (-0.424)	-0.001 (-0.749)	0.001 (0.297)	9,850
Differences in Coefficients (p-value)	0.747	0.335	0.183	0.0132	0.00357	0.0325	0.0840	0.262	0.252	
Model 18: Size										
Below Median	-0.004*** (-4.959)	-0.005*** (-5.899)	-0.005*** (-6.246)	-0.005*** (-6.045)	-0.005*** (-4.961)	-0.004*** (-3.717)	-0.003*** (-2.586)	-0.003** (-2.033)	-0.012*** (-4.074)	39,951
Above Median	-0.001** (-2.260)	-0.001 (-1.516)	-0.001** (-1.968)	-0.001** (-2.429)	-0.001*** (-2.584)	-0.002*** (-2.652)	-0.002*** (-2.982)	-0.004*** (-3.298)	-0.005*** (-2.879)	39,935
Differences in Coefficients (p-value)	0.102	0.0315	0.0147	0.0408	0.112	0.332	0.755	0.974	0.206	

This table shows UQR regression results based on equation (3) for *Total Risk* as dependent variable. All models are estimated with year and 2-digit SIC code industry fixed effects, except for Model 10 and Model 11. In the “Differences in Coefficients (p-value)” columns, we test the null hypothesis of the reported coefficients equality across subsamples (Model 16 to 18). In absence of available methods, no instrumental variables regression is performed in Model 13, but *Religiosity* is lagged by three time periods. “D.” stands for “Dummy”, and “Obs.” abbreviates “Observations”. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

Table 5: Further unconditional quantile regression results for *Idiosyncratic Risk*: robustness, causality, and information asymmetry

Models / Quantiles	(1) 10%	(2) 20%	(3) 30%	(4) 40%	(5) 50%	(6) 60%	(7) 70%	(8) 80%	(9) 90%	(10) Obs.
Panel A: Additional Controls										
Model 1: Demographic	-0.000 (-1.114)	-0.001** (-2.376)	-0.002*** (-3.579)	-0.003*** (-4.013)	-0.004*** (-4.782)	-0.004*** (-5.526)	-0.004*** (-3.870)	-0.004** (-2.549)	-0.003 (-1.157)	59,408
Model 2: Board Indep.-D., Board Size	-0.003*** (-4.472)	-0.002*** (-4.436)	-0.002*** (-3.612)	-0.002*** (-2.935)	-0.003*** (-2.701)	-0.002** (-2.410)	-0.002 (-1.463)	-0.004** (-2.533)	-0.002 (-0.573)	15,991
Model 3: Diversification-D., Dividend-D.	-0.000 (-0.372)	-0.000 (-0.305)	-0.001* (-1.876)	-0.002*** (-3.450)	-0.003*** (-5.994)	-0.004*** (-5.699)	-0.004*** (-4.375)	-0.003** (-2.484)	-0.002 (-1.456)	68,710
Panel B: Geographic Aspects										
Model 4: Ex 5 largest counties	-0.002*** (-4.596)	-0.002*** (-5.586)	-0.003*** (-7.635)	-0.004*** (-8.417)	-0.005*** (-8.207)	-0.006*** (-8.103)	-0.006*** (-7.514)	-0.006*** (-5.641)	-0.006*** (-3.375)	64,695
Model 5: Ex 5 most religious states	-0.002*** (-5.722)	-0.003*** (-7.489)	-0.004*** (-10.242)	-0.005*** (-11.792)	-0.006*** (-10.840)	-0.007*** (-10.273)	-0.008*** (-9.462)	-0.007*** (-5.964)	-0.008*** (-3.892)	73,391
Model 6: Ex 5 least religious states	-0.001** (-2.161)	-0.001*** (-2.755)	-0.002*** (-5.053)	-0.003*** (-6.147)	-0.004*** (-6.390)	-0.005*** (-6.806)	-0.005*** (-6.230)	-0.004*** (-3.227)	-0.004* (-1.864)	76,685
Model 7: Ex 10 most conservative states	-0.002*** (-3.985)	-0.002*** (-4.552)	-0.003*** (-5.666)	-0.004*** (-7.655)	-0.004*** (-8.006)	-0.005*** (-7.469)	-0.005*** (-7.896)	-0.003*** (-2.715)	-0.004* (-1.886)	77,279
Model 8: Western States	0.003*** (2.655)	0.004*** (2.950)	0.003* (1.824)	0.001 (0.619)	-0.002 (-1.017)	-0.005** (-2.418)	-0.009*** (-3.722)	-0.008** (-2.570)	-0.007 (-1.449)	18,877
Model 9: Metropolitan companies	-0.002*** (-3.156)	-0.003*** (-4.817)	-0.004*** (-6.595)	-0.005*** (-6.227)	-0.006*** (-6.640)	-0.006*** (-5.531)	-0.006*** (-4.364)	-0.001 (-0.583)	0.001 (0.260)	31,100
Model 10: County level estimation	0.004*** (5.073)	0.003*** (4.867)	0.002** (2.213)	0.002* (1.927)	0.002** (2.388)	0.001 (1.249)	-0.001 (-0.430)	-0.004** (-2.453)	-0.012*** (-4.576)	13,651
Model 11: State fixed effects	0.000 (0.666)	0.000 (0.053)	-0.002*** (-3.393)	-0.003*** (-4.430)	-0.003*** (-3.577)	-0.003*** (-3.365)	-0.003*** (-2.645)	-0.002 (-1.572)	-0.004 (-1.499)	79,886
Panel C: Endogeneity										
Model 12: Agri., Manufac., Mining Sectors	-0.000 (-0.783)	-0.001* (-1.901)	-0.002*** (-4.090)	-0.004*** (-6.164)	-0.005*** (-7.079)	-0.006*** (-7.194)	-0.007*** (-6.389)	-0.008*** (-5.700)	-0.008*** (-3.322)	47,425
Model 13: 2SLS	-0.001*** (-2.661)	-0.001*** (-3.696)	-0.002*** (-4.314)	-0.003*** (-5.314)	-0.003*** (-4.941)	-0.003*** (-5.002)	-0.004*** (-5.088)	-0.004*** (-3.557)	-0.005** (-2.507)	61,366
Model 14: Placebo Test										500
(i) H0: Pseudo t-values = 0										

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t-value	0.07	0.48	0.61	0.98	0.83	0.76	0.97	1.53	0.35	
p-value	0.94	0.63	0.54	0.33	0.41	0.45	0.33	0.13	0.73	
(ii) H0: Pseudo t-values = True t-value									500	
t-value	25.90	26.13	28.75	22.81	43.30	45.80	47.12	69.22	83.28	
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Model 15: Entropy Balancing	0.000 (0.692)	-0.001 (-1.045)	-0.001 (-1.331)	-0.001 (-0.967)	-0.001 (-0.889)	-0.002** (-2.149)	-0.002* (-1.915)	-0.003 (-1.597)	-0.005* (-1.709)	40,015

Panel D: Information Asymmetry

Model 16: Analyst Coverage											
Not covered	-0.008*** (-2.845)	-0.011*** (-3.827)	-0.018*** (-5.672)	-0.015*** (-4.133)	-0.017*** (-4.196)	-0.017*** (-3.770)	-0.016*** (-2.931)	-0.003 (-0.437)	-0.005 (-0.469)	4,028	
Covered	-0.001*** (-2.594)	-0.001*** (-3.044)	-0.002*** (-5.329)	-0.003*** (-7.135)	-0.004*** (-6.870)	-0.004*** (-6.608)	-0.005*** (-6.195)	-0.004*** (-3.445)	-0.003* (-1.712)	75,858	
Differences in Coefficients (p-value)	0.115	0.0431	0.00506	0.0352	0.0260	0.0445	0.118	0.969	0.872		
Model 17: S&P 500											
Non-S&P 500 firm	-0.001 (-1.142)	-0.002*** (-3.476)	-0.003*** (-6.207)	-0.004*** (-7.400)	-0.005*** (-7.458)	-0.006*** (-7.807)	-0.006*** (-6.180)	-0.005*** (-3.781)	-0.005** (-2.241)	63,273	
S&P 500 firm	-0.001 (-1.391)	-0.001 (-1.117)	-0.001 (-1.287)	-0.001** (-2.044)	-0.001* (-1.681)	-0.001 (-1.475)	-0.001 (-0.558)	-0.001 (-1.103)	-0.002 (-0.972)	9,850	
Differences in Coefficients (p-value)	0.825	0.502	0.121	0.0710	0.0313	0.0199	0.0257	0.271	0.550		
Model 18: Size											
Below Median	-0.004** (-5.216)	-0.005*** (-5.919)	-0.005*** (-6.438)	-0.005*** (-5.775)	-0.004*** (-4.998)	-0.004*** (-4.392)	-0.003** (-2.301)	-0.005*** (-2.713)	-0.010*** (-3.523)	39,951	
Above Median	-0.001** (-2.218)	-0.001** (-2.261)	-0.001 (-1.349)	-0.001* (-1.878)	-0.001*** (-2.875)	-0.002*** (-4.128)	-0.002*** (-3.217)	-0.003*** (-3.339)	-0.005*** (-2.817)	39,935	
Differences in Coefficients (p-value)	0.0696	0.0235	0.0115	0.0292	0.128	0.321	0.861	0.639	0.310		

This table shows UQR regression results based on equation (3) for *Idiosyncratic Risk* as dependent variable. All models are estimated with year and 2-digit SIC code industry fixed effects, except for Model 10 and Model 11. In the “Differences in Coefficients (p-value)” columns, we test the null hypothesis of the reported coefficients equality across subsamples (Model 16 to 18). In absence of available methods, no instrumental variables regression is performed in Model 13, but *Religiosity* is lagged by three time periods. “D.” stands for “Dummy”, and “Obs.” abbreviates “Observations”. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

Table 6: Further unconditional quantile regression results for *Systematic Risk*: robustness, causality, and information asymmetry

Models / Quantiles	(1) 10%	(2) 20%	(3) 30%	(4) 40%	(5) 50%	(6) 60%	(7) 70%	(8) 80%	(9) 90%	(10) Obs.
Panel A: Additional Controls										
Model 1: Demographic	-0.013 (-0.460)	-0.018 (-0.518)	-0.015 (-0.568)	-0.020 (-0.648)	-0.041 (-1.324)	-0.024 (-0.919)	0.007 (0.194)	0.047 (1.206)	0.080* (1.671)	59,408
Model 2: Board Indep.-D., Board Size	-0.034 (-0.649)	-0.106** (-2.276)	-0.156*** (-3.943)	-0.109*** (-3.200)	-0.117*** (-3.234)	-0.055 (-1.575)	-0.054 (-0.945)	-0.078 (-1.513)	0.006 (0.080)	15,991
Model 3: Diversification-D., Dividend-D.	0.009 (0.369)	-0.023 (-0.735)	-0.055* (-1.927)	-0.074*** (-2.585)	-0.082*** (-3.398)	-0.065** (-2.232)	-0.036 (-1.210)	-0.010 (-0.288)	0.019 (0.400)	68,710
Panel B: Geographic Aspects										
Model 4: Ex 5 largest counties	-0.035 (-1.243)	-0.113*** (-4.168)	-0.146*** (-5.846)	-0.171*** (-6.677)	-0.199*** (-8.033)	-0.222*** (-8.775)	-0.231*** (-8.282)	-0.233*** (-7.170)	-0.216*** (-4.786)	64,695
Model 5: Ex 5 most religious states	-0.024 (-0.802)	-0.090*** (-3.448)	-0.160*** (-5.961)	-0.193*** (-7.540)	-0.222*** (-9.067)	-0.229*** (-8.763)	-0.228*** (-8.138)	-0.235*** (-7.123)	-0.244*** (-5.376)	73,391
Model 6: Ex 5 least religious states	0.024 (0.849)	-0.030 (-1.160)	-0.034 (-1.287)	-0.049* (-1.898)	-0.065*** (-2.640)	-0.061** (-2.433)	-0.048* (-1.746)	-0.036 (-1.117)	-0.026 (-0.599)	76,685
Model 7: Ex 10 most conservative states	0.019 (0.795)	-0.029 (-1.213)	-0.070** (-2.400)	-0.089*** (-3.417)	-0.110*** (-5.083)	-0.104*** (-4.197)	-0.091*** (-3.513)	-0.093*** (-3.064)	-0.064 (-1.178)	77,279
Model 8: Western States	-0.473*** (-4.645)	-0.342*** (-3.549)	-0.334*** (-3.946)	-0.228*** (-2.959)	-0.190*** (-2.749)	-0.179** (-2.440)	-0.159** (-2.090)	-0.027 (-0.306)	-0.089 (-0.765)	18,877
Model 9: Metropolitan companies	0.055 (1.170)	0.023 (0.535)	-0.002 (-0.050)	0.008 (0.202)	0.021 (0.515)	0.021 (0.480)	0.035 (0.741)	0.042 (0.756)	0.061 (0.799)	31,100
Model 10: County level estimation	0.202*** (3.607)	0.178*** (3.959)	0.109*** (2.806)	0.085** (2.421)	0.009 (0.264)	-0.044 (-1.304)	-0.074** (-1.996)	-0.116** (-2.508)	-0.156** (-2.354)	13,651
Model 11: State fixed effects	0.089** (2.263)	0.080** (2.051)	0.045 (1.190)	0.038 (1.076)	0.045 (1.338)	0.069** (2.084)	0.080** (2.200)	0.112** (2.560)	0.154** (2.564)	79,886
Panel C: Endogeneity										
Model 12: Agri., Manufac., Mining Sectors	0.018 (0.504)	-0.035 (-1.035)	-0.078** (-2.357)	-0.091*** (-2.948)	-0.117*** (-3.493)	-0.110*** (-3.199)	-0.076** (-2.137)	-0.113*** (-2.750)	-0.071 (-1.285)	47,425
Model 13: 2SLS	-0.018 (-0.602)	-0.091*** (-3.018)	-0.116*** (-4.038)	-0.118*** (-4.470)	-0.137*** (-5.444)	-0.127*** (-4.800)	-0.088*** (-3.036)	-0.094*** (-2.732)	-0.067 (-1.396)	61,366
Model 14: Placebo Test										500

(i) H0: Pseudo t-values = 0

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t-value	0.25	0.58	0.57	0.51	0.39	0.53	0.56	0.35	0.09	
p-value	0.81	0.56	0.57	0.61	0.70	0.59	0.58	0.73	0.93	
(ii) H0: Pseudo t-values = True t-value										500
t-value	-9.36	-0.35	6.08	9.14	9.08	10.90	15.13	16.77	17.38	
p-value	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Model 15: Entropy Balancing	0.059 (1.217)	-0.032 (-0.759)	-0.068 (-1.556)	-0.033 (-0.893)	-0.023 (-0.658)	-0.022 (-0.649)	0.009 (0.229)	0.005 (0.107)	0.093* (1.757)	40,015
Panel D: Information Asymmetry										
Model 16: Analyst Coverage										
Not covered	-0.017 (-0.188)	-0.108 (-1.444)	-0.079 (-1.036)	-0.107 (-1.271)	-0.113 (-1.247)	0.007 (0.073)	0.074 (0.609)	0.142 (0.816)	0.204 (0.878)	4,028
Covered	0.045* (1.678)	-0.021 (-0.805)	-0.065** (-2.548)	-0.091*** (-3.564)	-0.094*** (-4.087)	-0.091*** (-3.709)	-0.076*** (-2.918)	-0.074** (-2.223)	-0.039 (-0.900)	75,858
Differences in Coefficients (p-value)	0.531	0.339	0.885	0.881	0.883	0.489	0.379	0.393	0.456	
Model 17: S&P 500										
Non-S&P 500 firm	0.027 (0.932)	-0.022 (-0.789)	-0.061** (-2.053)	-0.077*** (-2.694)	-0.096*** (-3.457)	-0.088*** (-2.875)	-0.067** (-2.165)	-0.062* (-1.716)	-0.038 (-0.778)	63,273
S&P 500 firm	0.071 (1.089)	-0.016 (-0.329)	-0.008 (-0.163)	-0.031 (-0.662)	0.016 (0.328)	0.009 (0.181)	0.071 (1.250)	0.104 (1.504)	0.067 (0.668)	9,850
Differences in Coefficients (p-value)	0.677	0.951	0.613	0.669	0.295	0.374	0.254	0.245	0.553	
Model 18: Size										
Below Median	-0.010 (-0.308)	0.009 (0.285)	-0.051 (-1.488)	-0.048 (-1.286)	-0.055 (-1.395)	-0.094** (-2.371)	-0.136*** (-3.216)	-0.126*** (-2.762)	-0.100* (-1.654)	39,951
Above Median	0.040 (1.138)	-0.036 (-1.090)	-0.061** (-2.223)	-0.044 (-1.527)	-0.030 (-1.063)	-0.007 (-0.237)	0.025 (0.727)	0.013 (0.303)	0.085 (1.392)	39,935
Differences in Coefficients (p-value)	0.445	0.534	0.896	0.956	0.776	0.316	0.0783	0.177	0.153	

This table shows UQR regression results based on equation (3) for *Systematic Risk* as dependent variable. All models are estimated with year and 2-digit SIC code industry fixed effects, except for Model 10 and Model 11. In the “Differences in Coefficients (p-value)” columns, we test the null hypothesis of the reported coefficients equality and across subsamples (Model 16 to 18). In absence of available methods, no instrumental variables regression is performed in Model 13, but *Religiosity* is lagged by three time periods. “D.” stands for “Dummy”, and “Obs.” abbreviates “Observations”. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

Table 7: Further unconditional quantile regression results for *Tobin's Q*: robustness, causality, and information asymmetry

Models / Quantiles	(1) 10%	(2) 20%	(3) 30%	(4) 40%	(5) 50%	(6) 60%	(7) 70%	(8) 80%	(9) 90%	(10) Obs.
Panel A: Additional Controls										
Model 1: Demographic	-0.041 (-1.457)	0.007 (0.300)	0.025 (1.005)	0.033 (1.304)	0.039 (1.152)	0.061* (1.801)	-0.010 (-0.259)	-0.045 (-0.948)	-0.155*** (-2.658)	59,408
Model 2: Board Indep.-D., Board Size	0.024 (0.496)	0.055 (1.110)	0.056 (1.142)	0.027 (0.558)	-0.015 (-0.240)	-0.092* (-1.683)	-0.229*** (-3.164)	-0.297*** (-3.297)	-0.506*** (-4.477)	15,991
Model 3: Diversification-D., Dividend-D.	-0.044** (-2.143)	-0.002 (-0.079)	0.016 (0.759)	0.032* (1.649)	0.020 (0.782)	0.009 (0.291)	-0.050 (-1.638)	-0.076* (-1.791)	-0.149** (-2.493)	68,710
Panel B: Geographic Aspects										
Model 4: Ex 5 largest counties	-0.036* (-1.658)	0.003 (0.187)	0.012 (0.583)	0.038* (1.738)	0.015 (0.582)	0.000 (0.008)	-0.021 (-0.645)	-0.106*** (-2.636)	-0.146** (-2.543)	64,695
Model 5: Ex 5 most religious states	-0.047** (-2.156)	-0.017 (-0.828)	-0.016 (-0.749)	-0.006 (-0.286)	-0.044* (-1.781)	-0.067** (-2.471)	-0.105*** (-3.190)	-0.210*** (-5.232)	-0.268*** (-4.732)	73,391
Model 6: Ex 5 least religious states	-0.025 (-1.181)	0.012 (0.602)	0.018 (0.835)	0.043** (1.982)	0.020 (0.809)	0.016 (0.616)	-0.036 (-1.090)	-0.073* (-1.775)	-0.144** (-2.547)	76,685
Model 7: Ex 10 most conservative states	-0.038* (-1.794)	-0.000 (-0.019)	0.013 (0.617)	0.036* (1.723)	0.009 (0.432)	-0.000 (-0.017)	-0.055* (-1.893)	-0.125*** (-3.422)	-0.210*** (-3.912)	77,279
Model 8: Western States	0.053 (0.802)	-0.011 (-0.162)	-0.056 (-0.826)	-0.073 (-0.962)	0.018 (0.206)	0.141 (1.414)	0.286*** (2.585)	0.307** (2.350)	0.367** (2.494)	18,877
Model 9: Metropolitan companies	-0.066* (-1.832)	0.049 (1.598)	0.053* (1.651)	0.070* (1.943)	0.056 (1.456)	0.030 (0.654)	-0.027 (-0.523)	-0.084 (-1.274)	-0.141 (-1.460)	31,100
Model 10: County level estimation	-0.087** (-1.973)	-0.016 (-0.418)	0.018 (0.494)	0.002 (0.077)	-0.005 (-0.162)	-0.033 (-0.985)	-0.085** (-2.134)	-0.220*** (-4.624)	-0.457*** (-5.307)	13,651
Model 11: State fixed effects	-0.114*** (-3.866)	-0.102*** (-3.747)	-0.104*** (-3.612)	-0.096*** (-2.983)	-0.132*** (-3.766)	-0.135*** (-3.422)	-0.159*** (-3.766)	-0.152*** (-2.838)	-0.103 (-1.444)	79,886
Model 11-II: Delta State Religiosity	-0.000 (-0.105)	0.000 (0.417)	-0.001 (-0.849)	-0.002** (-2.446)	-0.004*** (-4.044)	-0.004*** (-3.633)	-0.004*** (-3.069)	-0.006*** (-3.643)	-0.010*** (-3.679)	79,886
Panel C: Endogeneity										
Model 12: Agri., Manufac., Mining Sectors	-0.010 (-0.356)	-0.001 (-0.027)	-0.000 (-0.004)	0.015 (0.559)	-0.006 (-0.231)	-0.029 (-0.861)	-0.099** (-2.453)	-0.121** (-2.388)	-0.116 (-1.594)	47,425
Model 13: 2SLS	-0.019 (-0.812)	0.022 (1.024)	0.033 (1.502)	0.061** (2.571)	0.031 (1.244)	0.033 (1.136)	0.023 (0.724)	-0.061 (-1.523)	-0.097* (-1.751)	61,366

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Model 14: Placebo Test										500
(i) H0: Pseudo t-values = 0										
t-value	-0.38	-0.71	-0.15	-0.21	-0.51	-0.62	-0.88	-0.73	-0.29	
p-value	0.70	0.48	0.88	0.83	0.61	0.54	0.38	0.46	0.77	
(ii) H0: Pseudo t-values = True t-value										500
t-value	36.90	10.95	-3.48	-3.05	-7.59	-4.90	-10.00	-13.12	-9.33	
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Model 15: Entropy Balancing										40,015
t-value	-0.048*	-0.019	-0.011	-0.016	-0.045	-0.063	-0.119**	-0.176***	-0.147	
p-value	(-1.663)	(-0.672)	(-0.365)	(-0.446)	(-1.239)	(-1.324)	(-2.210)	(-2.754)	(-1.526)	
Panel D: Information Asymmetry										
Model 16: Analyst Coverage										
Not covered										
t-value	-0.093	-0.002	-0.025	-0.100	-0.046	-0.063	-0.156	-0.130	-1.089***	4,028
p-value	(-1.140)	(-0.023)	(-0.363)	(-1.357)	(-0.548)	(-0.626)	(-1.140)	(-0.687)	(-3.625)	
Covered										
t-value	-0.001	0.030	0.040**	0.059***	0.035	0.033	0.000	-0.019	-0.087	75,858
p-value	(-0.041)	(1.553)	(2.048)	(2.810)	(1.478)	(1.218)	(0.005)	(-0.472)	(-1.546)	
Differences in Coefficients (p-value)										
t-value	0.430	0.764	0.563	0.195	0.570	0.597	0.491	0.709	0.0217	
p-value										
Model 17: S&P 500										
Non-S&P 500 firm										
t-value	-0.070***	-0.015	-0.019	0.002	-0.023	-0.027	-0.068*	-0.111**	-0.167***	63,273
p-value	(-2.895)	(-0.731)	(-0.837)	(0.089)	(-0.897)	(-0.909)	(-1.894)	(-2.545)	(-2.633)	
S&P 500 firm										
t-value	0.105*	0.110**	0.120**	0.119**	0.110*	0.118*	0.017	-0.075	-0.193	9,850
p-value	(1.800)	(2.056)	(2.337)	(2.248)	(1.892)	(1.759)	(0.219)	(-0.826)	(-1.367)	
Differences in Coefficients (p-value)										
t-value	0.145	0.306	0.250	0.376	0.391	0.414	0.673	0.874	0.932	
p-value										
Model 18: Size										
Below Median										
t-value	-0.055*	-0.016	-0.029	-0.012	-0.007	-0.006	-0.072	-0.141**	-0.088	39,951
p-value	(-1.762)	(-0.544)	(-0.927)	(-0.337)	(-0.184)	(-0.128)	(-1.431)	(-2.302)	(-1.169)	
Above Median										
t-value	0.063***	0.093***	0.103***	0.125***	0.091***	0.089***	0.114***	0.015	-0.008	39,935
p-value	(2.813)	(4.354)	(4.490)	(5.188)	(3.462)	(2.891)	(3.340)	(0.340)	(-0.128)	
Differences in Coefficients (p-value)										
t-value	0.0967	0.124	0.0952	0.122	0.332	0.417	0.151	0.306	0.663	
p-value										

This table shows UQR regression results based on equation (3) for *Tobin's Q* as dependent variable. All models are estimated with year and 2-digit SIC code industry fixed effects, except for Model 10 and Model 11. In the "Differences in Coefficients (p-value)" columns, we test the null hypothesis of the reported coefficients equality across subsamples (Model 16 to 18). In absence of available methods, no instrumental variables regression is performed in Model 13, but *Religiosity* is lagged by three time periods. "D." stands for "Dummy", and "Obs." abbreviates "Observations". T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively, using robust standard errors bootstrapped from 1,000 replications.

Internet Appendix:

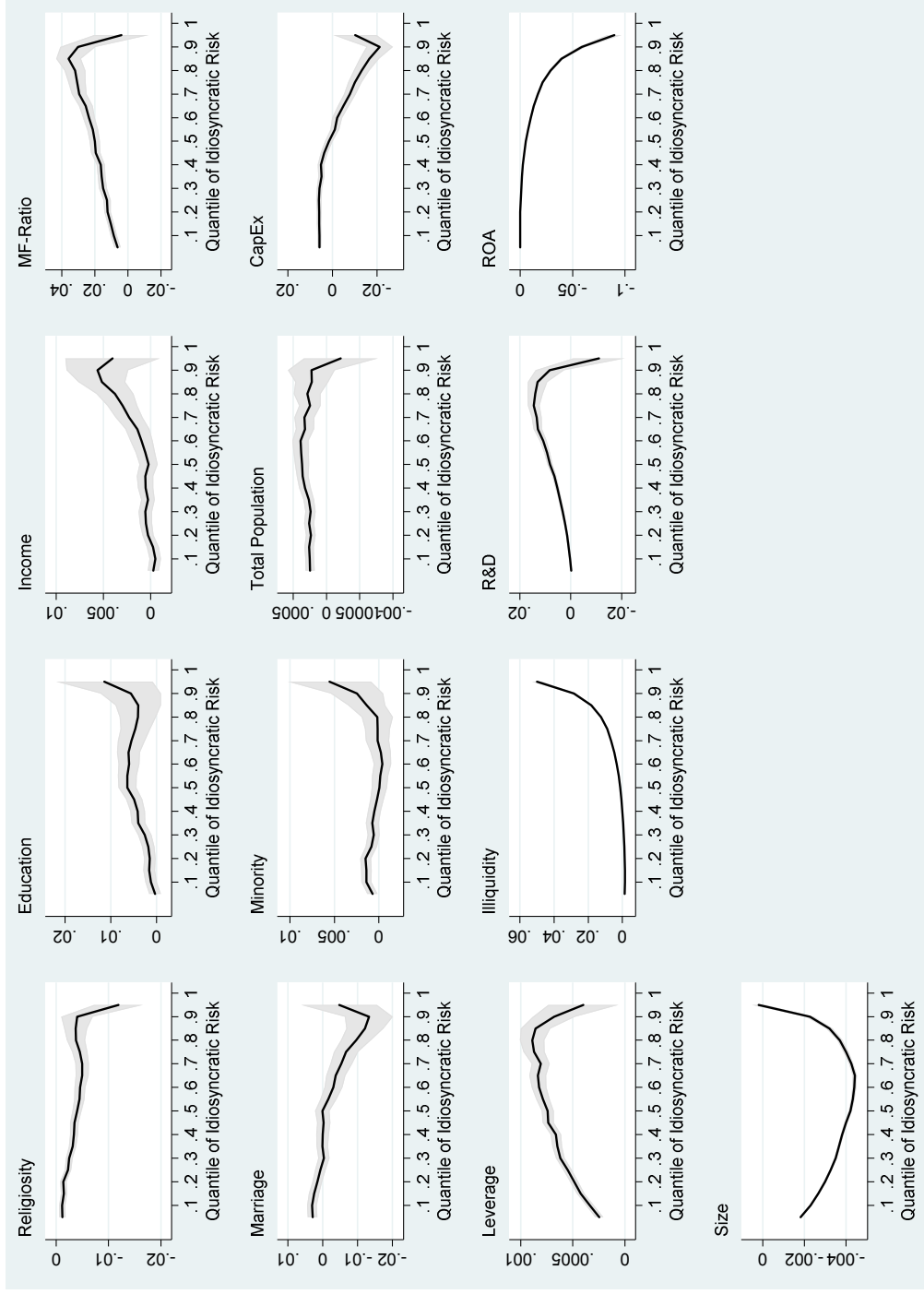
Religiosity, Risk, and Firm Value: An Unconditional Quantile Regression Approach

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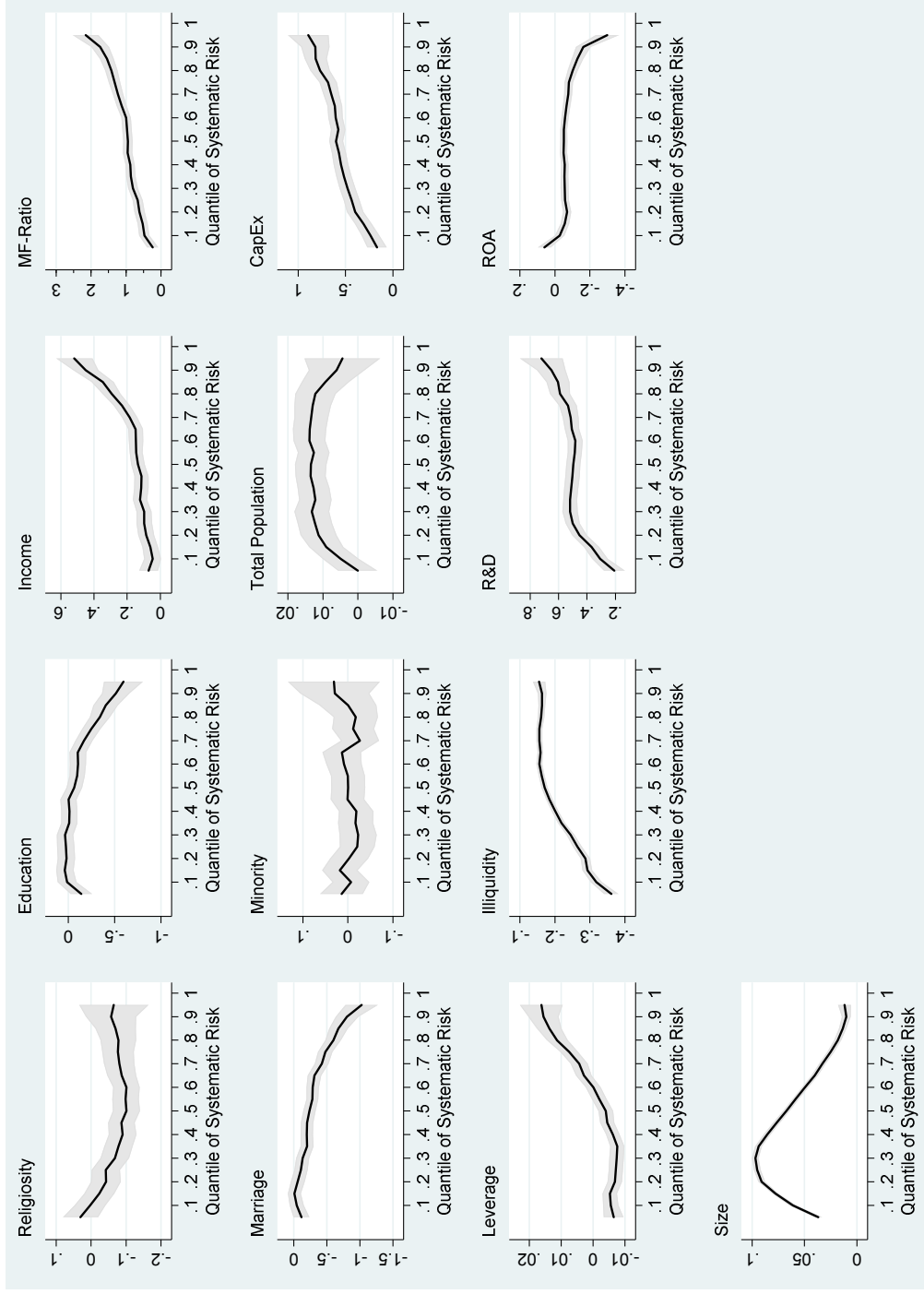
[†] Carl-Friederich Groesbrink, University of Passau, Chair of Finance and Banking, Innstraße 27, 94032 Passau, Germany, phone: +49 851 509 2464, E-mail: carl.groesbrink@uni-passau.de

Figure IA.1: Unconditional quantile regression results for *Idiosyncratic Risk*



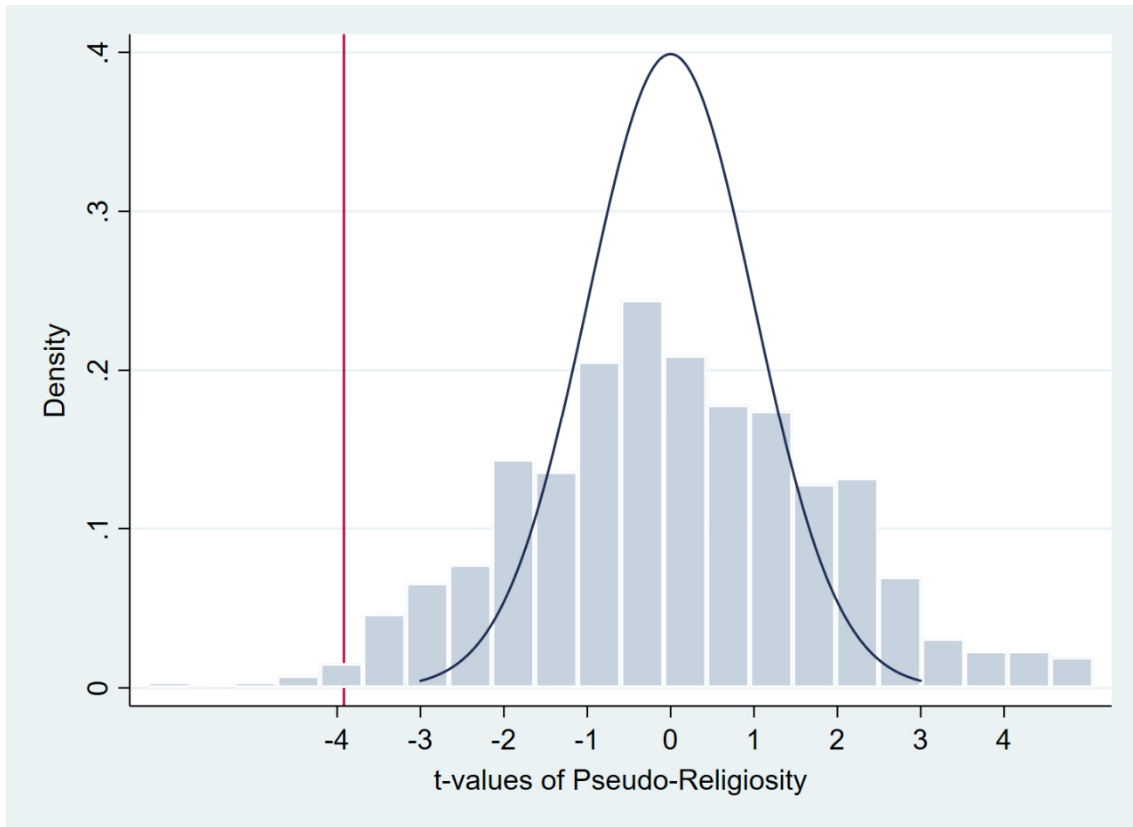
This figure shows coefficients (solid line) and 90% confidence intervals (shaded area, calculated from robust standard errors bootstrapped with 1,000 replications) of the independent variables for unconditional quantiles from the 5%- to 95%-quantiles in 5% steps of *Idiosyncratic Risk* (horizontal axis).

Figure IA.2: Unconditional quantile regression results for *Systematic Risk*



This figure shows coefficients (solid line) and 90% confidence intervals (shaded area), calculated from robust standard errors bootstrapped with 1,000 replications) of the independent variables for unconditional quantiles from the 5%- to 95%-quantiles in 5% steps of *Systematic Risk* (horizontal axis).

Figure IA.3: Placebo test results for *Total Risk* and *Religiosity*.



This figure shows (pseudo) t-values from 500 OLS regressions of equation (3) for *Total Risk* where we replace *Religiosity* with *Pseudo-Religiosity*. The solid vertical red line represents the “true” t-value of *Religiosity* from our baseline regression in Table 2, Column (I). The solid curve overlaying the distribution of pseudo t-values represents the normal density curve.

Table IA.1: Robustness, causality, and information asymmetry tests for OLS analysis

Models / Variables	(1) TR	(2) IR	(2) SR	(4) TQ	(5) Obs.
<i>Panel A: Additional Controls</i>					
Model 1: Demographic	-0.004*** (-2.890)	-0.004*** (-3.261)	0.007 (0.150)	-0.016 (-0.253)	59,408
Model 2: Board Indep.-D., Board Size	-0.003* (-1.928)	-0.003** (-1.998)	-0.068 (-1.056)	-0.119 (-1.305)	15,991
Model 3: Diversification-D., Dividend-D.	-0.003*** (-2.755)	-0.003*** (-2.983)	-0.025 (-0.603)	-0.033 (-0.596)	68,708
<i>Panel B: Geographic Aspects</i>					
Model 4: Ex 5 largest counties	-0.006*** (-4.955)	-0.006*** (-4.802)	-0.165*** (-3.778)	-0.030 (-0.529)	64,695
Model 5: Ex 5 most religious states	-0.007*** (-5.809)	-0.007*** (-5.853)	-0.170*** (-3.874)	-0.086 (-1.520)	73,391
Model 6: Ex 5 least religious states	-0.004*** (-3.357)	-0.004*** (-3.639)	-0.026 (-0.610)	-0.028 (-0.524)	76,685
Model 7: Ex 10 most conservative states	-0.005*** (-4.093)	-0.005*** (-4.358)	-0.060 (-1.391)	-0.046 (-0.843)	77,279
Model 8: Western States	-0.003 (-0.928)	-0.002 (-0.765)	-0.181 (-1.501)	0.109 (0.679)	18,877
Model 9: Metropolitan companies	-0.005** (-2.524)	-0.005*** (-2.926)	0.030 (0.431)	-0.031 (-0.346)	31,100
Model 10: County level estimation	-0.002 (-0.969)	-0.002 (-1.027)	0.024 (0.304)	-0.112 (-1.122)	13,651
Model 11: State fixed effects	-0.003 (-1.604)	-0.003** (-2.096)	0.082 (1.411)	-0.110 (-1.539)	79,886
<i>Panel C: Endogeneity</i>					
Model 12: Agri., Manufac., Mining Sectors	-0.005*** (-3.207)	-0.005*** (-3.389)	-0.072 (-1.286)	-0.053 (-0.764)	47,425
Model 13: 2SLS					
Religiosity (2nd stage)	-0.004*** (-3.712)	-0.004*** (-3.766)	-0.092** (-1.969)	0.012 (0.208)	61,366
p-value of DWH test	0.00	0.06	0.00	0.39	
p-value Hansen J-statistic	0.10	0.05	0.76	0.22	
p-value of KP rk LM-statistic	0.00	0.00	0.00	0.00	
KP rk Wald F-statistic	130,107	130,107	188,876	188,876	
Model 14: Placebo Test					
(i) H0: Pseudo t-values = 0					500
t-value	0.48	0.52	0.42	-0.58	
p-value	0.63	0.61	0.68	0.56	
(ii) H0: Pseudo t-values = True t-value					500
t-value	48.01	56.77	11.87	7.66	
p-value	0.00	0.00	0.00	0.00	
Model 15: Entropy Balancing	-0.001** (-2.092)	-0.001** (-2.235)	-0.004 (-0.229)	-0.023 (-1.047)	40,014
<i>Panel D: Information Asymmetry</i>					
Model 16: Analyst Coverage					
Not covered	-0.010** (-2.026)	-0.010** (-2.134)	-0.033 (-0.270)	-0.205 (-1.414)	4,025
Covered	-0.004*** (-3.566)	-0.004*** (-3.770)	-0.048 (-1.154)	0.004 (0.080)	75,858

Differences in Coefficients (p-value)	0.22	0.19	0.91	0.15	
Model 17: S&P 500					
Non-S&P 500 firm	-0.005*** (-3.848)	-0.005*** (-4.096)	-0.048 (-1.091)	-0.060 (-1.112)	63,273
S&P 500 firm	-0.001 (-0.581)	-0.001 (-0.931)	0.041 (0.454)	0.064 (0.556)	9,850
Differences in Coefficients (p-value)	0.04	0.03	0.37	0.31	
Model 18: Size					
Below Median	-0.006*** (-3.363)	-0.006*** (-3.453)	-0.063 (-1.293)	-0.044 (-0.676)	39,951
Above Median	-0.002 (-1.450)	-0.002* (-1.915)	0.004 (0.069)	0.061 (1.029)	39,934
Differences in Coefficients (p-value)	0.03	0.04	0.32	0.21	

This table shows OLS regression results based on equation (3). All models are estimated with year and 2-digit SIC code industry fixed effects, except for Model 10 and Model 11. In the “Differences in Coefficients (p-value)” columns, we test the null hypothesis of the reported coefficients equality across subsamples (Model 16 to 18). In Model 13, need for an instrumental variable regression is tested via a Durbin-Wu-Hausman endogeneity test (Durbin, 1954; Wu, 1973; Hausman, 1978). Validity of the instrumental variables regression is tested via Hansen’s J-test of overidentifying restrictions (Hansen, 1982; Sargan, 1958), the robust Kleibergen-Papp rk LM-statistic of underidentification, and Kleibergen-Paap rk Wald F-statistic of weak identification (Kleibergen and Paap (2006). Where TR, IR, SR, and TQ stand for *Total Risk*, *Idiosyncratic Risk*, *Systematic Risk*, and *Tobin’s Q*, respectively. “D.” stands for “Dummy”, and “Obs.” abbreviates “Observations”. Firm (except for Model 10) cluster robust t-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Commentary on OLS results shown in Table IA.1 and Figure IA.3

Robustness

Our results hold for *Total Risk* and *Idiosyncratic Risk* when applying additional controls (Model 1 to 3). Regarding *Systematic Risk* and *Tobin's Q*, we continue to observe an insignificant (mostly) negative relationship (Panel A). Focusing on geographical aspects (Panel B), we can confirm the results' robustness for *Total Risk* and *Idiosyncratic Risk* in most of the tests. In case of *Systematic Risk*, we now find a significant risk-reducing effect of *Religiosity* in Model 4 and Model 5, that cannot be confirmed in the other models. The results for *Tobin's Q* are consistent with the baseline regression, i.e., show no significance and mostly have a negative coefficient.

Causality

Model 12 and Model 15 confirm the significant negative coefficient on *Religiosity* for *Total Risk* and *Idiosyncratic Risk*; we find no significance for *Systematic Risk* and *Tobin's Q*. In Model 13, *Religiosity* continues to have a significant risk-reducing influence under all three risk definitions and an insignificant influence on *Tobin's Q*. The test statistics conducted imply that *Religiosity* is endogenous (except for *Tobin's Q*), that the instruments are valid (does not hold for *Idiosyncratic Risk* and even *Total Risk* is questionable), are correlated with the (endogenous) *Religiosity* variable, and are not weak instruments. Turning to our placebo test strategy (Model 14), Figure IA.3 exemplifies the results for *Total Risk*, showing the distribution of pseudo t-values. Most of the pseudo t-values are between -1.65 and +1.65, indicating that the coefficients on *Religiosity* are not significant, while our "true" t-value (Table 2, Column (I): -3.919) is in the far left of the distribution, where almost no pseudo t-value distribution mass is found. Further t-tests suggest that the average pseudo t-value is not significantly different from zero (Model 14 (i)), but that the average pseudo t-value is significantly larger than the "true" t-value of the *Religiosity* coefficient (Model 14 (ii)). Overall, the placebo test for *Total Risk* suggests that our findings are unlikely to stem from spurious correlations in the data. We can conclude

the same for *Idiosyncratic Risk*. Although we did not find significant coefficients for *Systematic Risk* and *Tobin's Q* in the baseline regression (Table 2), we can apply the reasoning just made for *Total Risk* to these two dependent variables.

Information Asymmetry

Regarding *Total Risk* and *Idiosyncratic Risk* (Panel D), we find mostly significant negative coefficients in the high as well as low IA samples. In each model, the *Religiosity* coefficient is larger in the high IA sample compared to the low one, resulting in mostly statistically significant coefficient differences. In case of *Systematic Risk* and *Tobin's Q*, we neither find evidence for a significant relationship across our three IA proxies, nor significant coefficient differences. Overall, the majority of our results is consistent with the literature (Jiang et al., 2018), and suggests that especially firms with high IA benefit from strong local religious norms.

Table IA.2: Supplemental robustness tests for OLS and UQR

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<u>Panel A: OLS</u>										
Models / Variables	TR	IR	SR	TQ	Obs.					
<i>Panel A.1: Temporal Aspects</i>										
Model 1: Survey Years	-0.003* (-1.669)	-0.003 (-1.582)	-0.051 (-0.781)	0.021 (0.304)	6,872					
Model 2: Year 1980	-0.007** (-1.985)	-0.006* (-1.954)	-0.200 (-1.116)	-0.125 (-0.900)	452					
Model 3: Year 1990	-0.003 (-1.013)	-0.003 (-0.957)	-0.061 (-0.568)	0.005 (0.044)	1,217					
Model 4: Year 2000	-0.006* (-1.703)	-0.005 (-1.463)	-0.202* (-1.871)	0.071 (0.565)	2,839					
Model 5: Year 2010	-0.005** (-1.985)	-0.005** (-2.074)	0.003 (0.028)	0.051 (0.480)	2,341					
<i>Panel A.2: Religious Aspects</i>										
Model 6: Religious Subgroups					79,886					
Catholics	-0.005*** (-3.708)	-0.005*** (-4.010)	-0.021 (-0.484)	-0.027 (-0.471)						
Protestants	-0.006*** (-4.267)	-0.006*** (-4.467)	-0.119** (-2.392)	-0.158** (-2.410)						
Differences in Coefficients (p-value)	0.30	0.42	0.01	0.56						
Models / Quantiles	10%	20%	30%	40%	50%	60%	70%	80%	90%	Obs.
<u>Panel B: UQR – Total Risk</u>										
<i>Panel B.1: Temporal Aspects</i>										
Model 1: Survey Years	-0.004*** (-2.918)	-0.003** (-2.220)	-0.003 (-1.622)	-0.004** (-2.092)	-0.005** (-2.422)	-0.005* (-1.881)	-0.001 (-0.233)	0.006 (1.031)	-0.001 (-0.185)	6,874
Model 2: Year 1980	-0.003 (-0.751)	-0.004 (-1.161)	-0.013*** (-3.136)	-0.008* (-1.813)	-0.010** (-2.022)	-0.006 (-1.076)	-0.005 (-0.944)	-0.006 (-0.858)	-0.017 (-1.591)	463

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Model 3: Year 1990	-0.001 (-0.465)	-0.001 (-0.246)	-0.004 (-1.403)	-0.003 (-0.849)	-0.000 (-0.130)	-0.001 (-0.239)	-0.005 (-1.056)	-0.004 (-0.678)	0.009 (0.858)	1,224
Model 4: Year 2000	0.000 (0.043)	-0.004 (-1.067)	-0.008* (-1.734)	-0.007 (-1.206)	-0.004 (-0.611)	-0.006 (-0.834)	-0.006 (-0.949)	-0.007 (-1.003)	-0.005 (-0.599)	2,843
Model 5: Year 2010	-0.003 (-1.238)	-0.002 (-1.347)	-0.001 (-0.580)	-0.000 (-0.063)	-0.004 (-1.560)	-0.005* (-1.717)	-0.003 (-0.878)	-0.004 (-0.866)	-0.005 (-0.586)	2,330

Panel B.2: Religious Aspects

Model 6: Religious Subgroups	-0.002*** (-4.529)	-0.002*** (-5.277)	-0.003*** (-6.501)	-0.004*** (-6.433)	-0.004*** (-7.004)	-0.005*** (-6.646)	-0.004*** (-4.010)	-0.003*** (-2.975)	-0.004** (-2.024)	79,886
Catholics	-0.002*** (-3.609)	-0.003*** (-5.129)	-0.004*** (-7.150)	-0.005*** (-8.441)	-0.007*** (-9.114)	-0.007*** (-7.845)	-0.007*** (-6.809)	-0.006*** (-5.074)	-0.006*** (-2.663)	
Protestants	0.85	0.70	0.23	0.03	0.02	0.12	0.01	0.07	0.55	
Differences in Coefficients (p-value)										

Panel C: UOR – Idiosyncratic Risk

Panel C.1: Temporal Aspects

Model 1: Survey Years	-0.003* (-1.744)	-0.003** (-2.193)	-0.003* (-1.714)	-0.003* (-1.852)	-0.006*** (-2.919)	-0.004 (-1.604)	-0.002 (-0.489)	0.007 (1.298)	-0.002 (-0.372)	6,874
Model 2: Year 1980	-0.005 (-1.391)	-0.003 (-0.786)	-0.006* (-1.811)	-0.006 (-1.517)	-0.003 (-0.901)	-0.005 (-1.044)	-0.008 (-1.568)	-0.016** (-2.282)	-0.018* (-1.827)	463
Model 3: Year 1990	-0.002 (-0.717)	-0.003 (-0.959)	-0.003 (-0.889)	-0.001 (-0.272)	0.002 (0.656)	-0.000 (-0.062)	-0.004 (-0.735)	-0.006 (-0.941)	0.016 (1.395)	1,224
Model 4: Year 2000	-0.000 (-0.137)	-0.001 (-0.365)	-0.006 (-1.471)	-0.004 (-0.705)	-0.001 (-0.107)	-0.000 (-0.038)	-0.003 (-0.530)	-0.009 (-1.403)	-0.005 (-0.585)	2,843
Model 5: Year 2010	-0.005*** (-2.871)	-0.001 (-0.637)	0.001 (0.314)	-0.000 (-0.203)	-0.001 (-0.544)	-0.003 (-1.188)	-0.007** (-2.237)	-0.006 (-1.170)	-0.012 (-1.418)	2,344

Panel C.2: Religious Aspects

Model 6: Religious Subgroups	-0.001*** (-3.583)	-0.002*** (-4.572)	-0.003*** (-5.582)	-0.003*** (-6.625)	-0.004*** (-6.970)	-0.004*** (-6.315)	-0.005*** (-5.351)	-0.004*** (-3.341)	-0.003 (-1.574)	79,886
Catholics	-0.002*** (-4.169)	-0.003*** (-5.430)	-0.004*** (-7.628)	-0.005*** (-9.210)	-0.006*** (-9.345)	-0.007*** (-8.205)	-0.007*** (-7.115)	-0.006*** (-4.923)	-0.006*** (-3.023)	
Protestants	0.45	0.28	0.05	0.01	0.01	0.04	0.06	0.21	0.29	
Differences in Coefficients (p-value)										

Panel D: UOR – Systematic Risk

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Panel D.1: Temporal Aspects

Model 1: Survey Years	-0.029 (-0.419)	-0.051 (-0.736)	-0.012 (-0.156)	0.028 (0.320)	-0.009 (-0.095)	-0.076 (-0.779)	-0.055 (-0.538)	-0.099 (-0.900)	-0.049 (-0.326)	6,874
Model 2: Year 1980	-0.273 (-0.895)	-0.088 (-0.315)	-0.017 (-0.073)	-0.375 (-1.405)	-0.444 (-1.512)	-0.114 (-0.337)	-0.021 (-0.055)	-0.331 (-0.909)	-0.009 (-0.021)	463
Model 3: Year 1990	-0.047 (-0.293)	-0.147 (-0.904)	-0.137 (-0.828)	-0.137 (-0.755)	0.054 (0.322)	0.149 (0.842)	0.124 (0.656)	-0.119 (-0.547)	-0.394 (-1.452)	1,224
Model 4: Year 2000	-0.157 (-1.634)	-0.219** (-2.325)	-0.169* (-1.760)	-0.173* (-1.685)	-0.089 (-0.727)	-0.011 (-0.072)	-0.365 (-1.376)	-0.564* (-1.862)	-0.174 (-0.417)	2,843
Model 5: Year 2010	0.112 (0.577)	0.053 (0.294)	-0.043 (-0.288)	-0.089 (-0.678)	-0.072 (-0.537)	-0.019 (-0.141)	0.051 (0.371)	0.193 (1.351)	0.094 (0.498)	2,344

Panel D.2: Religious Aspects

Model 6: Religious Subgroups	0.028 (0.962)	-0.032 (-1.109)	-0.050* (-1.906)	-0.070*** (-2.740)	-0.083*** (-3.198)	-0.068*** (-2.614)	-0.060** (-2.120)	-0.038 (-1.118)	0.028 (0.615)	79,886
Catholics	0.030 (0.891)	-0.068** (-2.153)	-0.123*** (-3.940)	-0.125*** (-4.348)	-0.161*** (-5.727)	-0.154*** (-5.402)	-0.143*** (-4.435)	-0.144*** (-3.665)	-0.203*** (-3.869)	
Protestants	0.96 (0.891)	0.39 (0.294)	0.07 (0.185)	0.15 (1.167)	0.04 (1.056)	0.03 (0.736)	0.06 (0.121)	0.04 (-1.180)	0.00 (0.146)	
Differences in Coefficients (p-value)										

Panel E: UOR – Tobin's Q

Model 1: Survey Years	-0.039 (-0.549)	0.022 (0.363)	0.029 (0.445)	-0.092 (-1.354)	-0.000 (-0.001)	0.031 (0.340)	-0.020 (-0.191)	-0.118 (-0.873)	0.135 (0.759)	6,874
Model 2: Year 1980	0.011 (0.068)	0.072 (0.421)	0.034 (0.183)	0.012 (0.059)	-0.073 (-0.348)	0.031 (0.122)	-0.248 (-0.832)	-0.289 (-0.883)	-0.323 (-0.733)	463
Model 3: Year 1990	-0.018 (-0.136)	0.016 (0.165)	0.090 (0.903)	0.105 (0.926)	-0.064 (-0.470)	-0.110 (-0.749)	-0.130 (-0.732)	-0.153 (-0.678)	-0.147 (-0.345)	1,224
Model 4: Year 2000	-0.078 (-0.556)	-0.060 (-0.519)	0.059 (0.482)	-0.071 (-0.535)	-0.028 (-0.174)	0.006 (0.035)	0.032 (0.145)	0.111 (0.439)	0.397 (1.028)	2,843
Model 5: Year 2010	0.018 (0.137)	-0.015 (-0.135)	0.021 (0.185)	0.138 (1.167)	0.149 (1.056)	-0.116 (-0.736)	-0.020 (-0.121)	-0.264 (-1.180)	0.041 (0.146)	2,344

Panel E.2: Religious Aspects

Model 6: Religious Subgroups	-0.036* (-1.699)	0.003 (0.155)	0.019 (0.919)	0.041* (1.766)	0.040 (1.534)	0.031 (1.062)	-0.012 (-0.373)	-0.105** (-2.401)	-0.170*** (-2.912)	79,886
Catholics										

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Protestants	0.007 (0.280)	-0.044* (-1.813)	-0.074*** (-3.037)	-0.094*** (-3.595)	-0.136*** (-4.566)	-0.171*** (-5.118)	-0.251*** (-6.860)	-0.366*** (-7.481)	-0.407*** (-6.292)
Differences in Coefficients (p-value)	0.20	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.01

This table shows supplemental robustness tests for OLS and UQR based on equation (3). All models are estimated with year and 2-digit SIC code industry fixed effects. In the “Differences in Coefficients (p-value)” columns, we test the null hypothesis of the reported coefficients equality within the same subsample. “Obs.” abbreviates “Observations” and TR, IR, SR, and TQ stand for *Total Risk*, *Idiosyncratic Risk*, *Systematic Risk*, and *Tobin's Q*, respectively. T-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. In case of UQR robust standard errors bootstrapped from 1,000 replications are used, while firm cluster robust standard errors are calculated in case of OLS.

Commentary on supplemental OLS and UQR results shown in Table IA.2

We additionally test our results' temporal robustness (Hilary and Hui, 2009; Jiang et al., 2018) and explicitly restrict our sample (i) to the four survey years (1980, 1990, 2000, and 2010; Model 1) and (ii) additionally estimate equation (3) for the individual years separately (Models 2 to 5). This allows us to address the concern that linear interpolation might create systematic noise in our *Religiosity* measure. Furthermore, to deepen our understanding of the effect of *Religiosity*, we analyze if the type of *Religiosity* matters, focusing on Catholics and Protestants (Hilary and Hui, 2009; Jiang et al., 2018). Therefore, we replace *Religiosity* with *Religiosity Catholics* and *Religiosity Protestants* (Model 6).

In all Panels and for all four dependent variables, we hardly find any evidence for our results' robustness towards temporal aspects (Model 1 to 5). This could be due to the greatly reduced sample size. Overall, the analyses of the individual survey years as well as their ensemble raise doubts about the robustness of the effects found. However, while we follow Hilary and Hui (2009) and Jiang et al. (2018), there are also several papers that forego this type of analysis (e.g., Adhikari and Agrawal, 2016; Callen and Fang, 2015; He and Hu, 2016; Zolotoy et al., 2019).

Regarding the question whether the type of *Religiosity* matters (Model 6), we find evidence for a stronger impact of *Religiosity Protestants* versus *Religiosity Catholics*. A Wald test is applied to test if the coefficients are significantly different from each other. For the majority of our results, we find a statistically significant difference between the coefficients for *Religiosity Catholics* and *Religiosity Protestants*.

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