Environmental Policies, National Culture, and Stock Price Crash Risk: Evidence from Renewable Energy Firms

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Abstract

This study investigates the impact of country-level environmental performance and national culture on the stock price crash risk of renewable energy firms. Employing a large sample of 626 renewable energy firms across 31 countries, we find a significant non-linear relationship between country-level environmental performance and crash risk. National culture dimensions are found to strongly predict the crash risk of renewable energy firms, particularly after the global financial crisis. On the contrary, national culture dimensions and environmental policies are observed to not exert any significance in explaining the crash risk of fossil fuel firms. Our results are robust with respect to alternative measures of stock price crash risk and the endogeneity of national culture dimensions. Overall, the findings of this paper contribute to the environmental economics literature by providing new evidence regarding the role of societal and environmental factors in explaining the stock price crash risk of energy firms.

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1. INTRODUCTION

In recent years, there has been a surge in the number of studies dedicated to environmental issues and renewable energy investment. This is mainly due to increasing public concerns about climate change, which in turn have shifted consumer preferences towards green corporate practices. Increasing awareness about climate change has also led countries to increase investment in renewable energy sources. Globally, new investments in renewable energy in 2017 exceeded 270 billion dollars, accounting for a cumulative 2.9 trillion dollars' worth of investment from 2004[1]. In terms of electricity generation, renewable sources represented 12.1% of the total electricity production in 2017, which is far above the figure in 2007 (approximately 5.2%).

[1] Global Trends in Renewable Energy Investments (2017).

Despite the growing volume of investment and increasing government and public support, renewable energy firms still face significant challenges in mitigating their inherent operational and financial risks. According to a survey of Economist Intelligence Unit (2011) [2], 69% of the managers in renewable energy firms stated that they faced significant economic and financial risks. It must be noted that 53% of the survey respondents said that they had experienced significant political/regulatory risks such as changing environmental policies, which adversely affected their operations and performance.

Several studies in the literature have investigated how environmental policies and regulations affect the performance of energy firms. For example, Ye et al. (2013) find that energy-saving efforts such as carbon emission rights trading scheme (CERTS) significantly increase the value of energy-related firms in China. Similarly, Kong et al. (2014) find that environmental protection efforts enhance the firm value in environmental-friendly industries. Ramiah et al. (2013) contribute to the discussion by investigating the green policy announcements on stock returns in Australia. They find that new policies fail to penalize the biggest polluters in the energy industry. Interestingly, they find that environmental policies have a significant negative impact on the alternative energy stock prices in the short term. In a similar vein, Sam and Zhang (2020) investigate how the stock market reacts to the new environmental enforcements in China. Different from the results of Ramiah et al. (2013), they find that the new enforcement regime spurred a significant decrease in the value of the polluting firms due to the greater expected regulatory costs for these companies. Quan et al. (2018) investigate the role of government initiatives in generating corporate financial benefits. Their results suggest that governments play a key role in transforming environmental performance into economic gains. The main reason is that firms with higher environmental performance have easy access to government-controlled capital markets and receive preferential tax treatment. Overall, it is acknowledged in the prior literature that environmental policies and enforcements have a significant impact on renewable energy firms. However, it is evident that the value relevance of environmental policies and regulations to firm valuation is quite mixed and inconclusive. More importantly, there are significant cross-country differences in the value relevance of environmental policies.

Although environmental policies have a significant impact on the stock prices of renewable energy firms, there are some other dynamics, which are expected to have an impact on the stock

[2] https://www.swissre.com/dam/jcr:0bb55d9a-68ba-4997-aefb-5ade2c07dc4f/EIU_SwissRe_ManagingRiskRenewableEnergy_Nov11.pdf

prices of these firms. It is argued that societal factors such as social norms, perceptions, and public apathy shape the attitudes of individuals towards green investments (Sovacool, 2009). Besides, the behavioral traits of individuals within a country play an important role in explaining the renewable energy investment decision-making and implementation process (Batel et al., 2013; Masini and Menichetti, 2012; West et al., 2010; Wüstenhagen et al., 2007). Devine-Wright (2005) discuss the importance of social awareness, local engagement, and public belief in promoting green practices in the UK. Local energy beliefs and attitudes are found to be largely explained by the socio-demographic status of the members of the society. Closely related to the current study, Gupta (2017) find that in addition to the macroeconomic and policy-related issues, cultural factors have a strong influence on the market performance of renewable energy firms. Overall, the prior literature on renewable energy documents the importance of environmental policies as well as of cultural and behavioral factors in determining the investment decisions and performance of renewable energy firms.

Building on prior evidence, we argue that environmental policies and national culture contribute to the value creation process through the framework of “stock price crash risk” in renewable energy firms. Stock price crash risk (hereafter referred to as “crash risk”) indicates the probability of a sudden and dramatic decline in stock prices. The recent literature identifies several firm- and country-specific factors as the determinants of crash risk (An et al. 2018; Hutton et al., 2009; Kim et al., 2016). However, the sources of crash risk in renewable energy firms still require further attention due to the riskier nature of the industry, greater downside risk with respect to renewable energy stock prices, and different societal and environmental dynamics of the countries involved. There is ample evidence in the literature that highlights dramatic declines of renewable energy stock prices, especially in the aftermath of stock market bubbles (Bohl et al., 2013; Henriques and Sadorsky, 2008). Moreover, renewable energy stocks have a greater probability of experiencing large stock price declines—particularly when the economic conditions worsen—mainly because of their higher sensitivity to market conditions, which is evidenced by the greater stock betas of these firms. Although renewable energy firms are more likely to experience stock price crashes due to common risk factors, the underlying reasons for stock price crashes in renewable energy firms are often neglected in the literature.

In this study, we try to fill the gap in the literature by investigating the impact of environmental policies and national culture dimensions, as proposed by Hofstede (1980) and Schwartz (1994), on the crash risk of renewable energy firms. The phenomenon of crash risk is usually explained on the basis of corporate behavior and financial market mechanisms. From the agency-based perspective, withholding bad news for an extended period leads to a sudden decline in stock prices when the accumulated bad news is released all at once (Hutton et al., 2009; Kothari et al., 2009). There are two main channels of bad news hoarding by managers. First, opaque accounting reports and the earnings management practices of managers increase crash risk, resulting from the accumulation of unfavorable information for a long period (Jin and Myers, 2006). Second, suboptimal corporate investment behavior may lead to stock price crashes. The managers of the firm, particularly in the historical cost accounting regime, may withhold poorly performed investments within the firm for an extended period (Bleck and Liu, 2007). Under the historical cost regime, shareholders cannot distinguish good investments from bad ones in the early stages of the project, which leads to stock price crashes when poor performance surfaces.

Another strand of the literature provides explanations for the sources of crash risk from a financial-markets perspective. Other than the intentional accumulation of bad news within the firm, financial market mechanisms may lead to stock price crashes. For example, prior studies document that higher stock momentum, trading volume, and heterogeneous beliefs of investors lead to stock price crashes (Barroso and Santa-Clara, 2015; Doyne Farmer 5 et al., 2004; Hong and Stein, 2003; Shieh et al., 2012; Yildiz and Karan, 2019).

We empirically test the impact of environmental policies and national culture on crash risk using a sample of 626 renewable energy firms across 31 countries. Using both OLS and two-stage instrumental variable regressions and controlling for several firm- and country-specific factors, we find that the environmental performance of the country has a strong impact on the crash risk of renewable energy firms, but the relationship is non-linear. Crash risk increases with an increase in the national environmental performance, but it tends to fall after tipping a threshold, which indicates an inverse, U-shaped relationship between country-level environmental performance and crash risk. In addition, cultural factors have a strong influence on the crash risk of renewable energy firms. Firms in countries with a higher score in individualism and mastery dimensions of national culture are exposed to greater crash risk. Long-term orientation, uncertainty avoidance and embeddedness dimensions of the national culture exert negative influences on the crash risk of renewable energy firms. Moreover, we find that the impact of country-level factors on crash risk is more pronounced after the global financial crisis. Noteworthily, we do not find any significance of environmental policies and national culture in explaining the crash risk of fossil fuel firms.

Our study contributes to the environmental economics literature in several distinct ways. First, by virtue of the comprehensively large sample spanning several countries, the findings of this study enhance our understanding of the common risk factors in renewable energy firms. To the best of our knowledge, this is the first study that investigates the determinants of crash risk in the energy industry. Second, we reveal the direct impact of environmental policies on crash risk. While prior studies highlight the relevance of several country-level factors to crash risk, the influence of country-level environmental policies on crash risk is often neglected. Third, by employing a comparative assessment, the findings of this study reveal how renewable energy firms differ from fossil fuel firms in terms of stock price dynamics and downside risk. Finally, the results of this study complement the findings of Gupta (2017), which postulate the significant impact of societal factors on the performance of renewable energy firms. Different from Gupta (2017), however, the current paper shows that environmental policy is as important as the national culture in explaining the financial outcomes of renewable energy firms. In addition, the current paper differs from the prior literature by providing evidence regarding the determinants of crash risk that are unique to renewable energy firms. Overall, this study helps to understand how countries differ in rewarding renewable energy firms through the context of crash risk.

Following the introduction, we discuss how national culture and country-level environmental performance affect crash risk and formulate our hypotheses in Section 2. Section 3 presents the data and methodological approaches. We discuss the findings of the study in Section 4. Section 5 presents the concluding remarks.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1 Stock price crash risk and country-level environmental performance

There is a vast amount of research on the impact of corporate environmental policies on competition, firm performance, and firm risk (Al-Najjar and Anfimiadou, 2011; Brouwers et al., 2018; Gallego-Alvarez et al., 2014; Klassen and McLaughlin, 1996; Lee et al., 2014: Nakao et al., 2007; Sariannidis et al., 2012; Yadav et al., 2017; Xu et al., 2018). The main motivation of these studies is to reveal how corporate environmental performance influences firm-level financial outcomes. However, a limited number of studies focus on how country-level (other than corporate) environmental policies affect firm performance and investor welfare.

The theoretical background on how the external environment shapes business strategies is quite effective. Resource-based theory suggests that the external environment where a firm operates has a significant impact on managerial decisions and in turn financial outcomes (Dess and Beard, 1984; Garcia-Sanchez and Martinez-Ferrero, 2018). Recent literature shows that environmental policies and regulations have a considerable impact on corporate financial decisions and firm performance (Huang et al., 2018; Rassier and Earnheart, 2015). For example, Xiao et al. (2018) argue that the reward of environmental practices largely depends on country-level environmental sustainability. Similarly, Garcia-Sanchez and Martinez-Ferrero (2018) find that the CEO's ability to determine responsible practices is largely dependent on environmental capacity.

With respect to energy firms, their financial outcomes such as profitability, stock returns, and crash risk are direct consequences of the country's environmental capacity and munificence. Prior literature provides strong evidence on the impact of environmental incentives and regulations on the corporate strategies and firm performance of energy firms. For example, Rassier and Earnherat (2015) study the relationship between environmental regulations and the firm profitability of chemical manufacturing firms and find that strict environmental regulations increase the firms' actual profitability—measured by the return on sales—but have a negative impact on the investors' expectations about the firm profitability, which is proxied by Tobin's q ratio. Hassan (2019) investigates the effect of renewable energy incentives on the performance of energy firms in OECD countries and documents an improvement in their accounting-based performance with the implementation of the incentives. Oberndorfer and Ziegler (2006) reveal the impact of environmental regulations on German energy firms. They find that strict environmental policies have a negative impact on the performance of conventional utility firms. On the other hand, the impact is positive for renewable energy firms, particularly in the short run. In a recent study, Huang et al. (2018) investigate the impact of climate risk on firm performance and corporate financial policies. They find that extreme environmental risks have a significant influence on the volatility of cash flows and corporate decisions such as cash holdings and capital structure.

Regarding the sources of crash risk in an international context, several studies have investigated the role of country-level factors in explaining crash risk. For example, Callen and Fang (2015) and Li and Cai (2016) find that a higher level of religiosity lowers stock price crash risk. They argue that managers in religious countries tend to avoid hoarding bad news since the cost of deviating from the social norms is higher than the personal gains arising from the manipulation of the firms' true performance. Therefore, religiosity reduces the managers' incentives for hiding bad news from the public and lowers the risk of future stock price crashes. In a recent paper, Luo and Zhang (2020) examine the impact of economic policy uncertainty on crash risk. They find that firms are more likely to experience stock price crashes when economic policy uncertainty is higher as investors require a greater premium for holding stocks during uncertain periods.

Despite the ample evidence on the impact of several country-level factors on crash risk, the influence of environmental policies on crash risk is yet to be investigated. In this context, we argue that country-level environmental performance is related to the crash risk of renewable energy firms for several reasons. First, given that crash risk is a consequence of bad news hoarding by the managers, a higher level of environmental performance would help discipline managers in "green firms" in terms of corporate disclosures. Similar to the discussion on religion, breaking such environmental norms is costly for the managers. To maintain the same ethical and environmental standards as the country, managers in sustainable countries are expected to be more transparent in case of firm-specific information disclosure, which reduces crash risk. Supporting this view, Staw and Szwajkowski (1975) find that managers working in countries with a higher level of environmental capacity and munificence exhibit less unethical behavior, which implies a negative relationship between national environmental performance and crash risk.

Patten (1991) suggests that other than profitability concerns, disclosure policies are largely determined by social pressure. Therefore, social pressure in countries with high environmental performance may lead to more timely disclosure of bad news and lowers stock price crash risk. To this end, Dowell et al. (2000) discuss the impact of environmental standards on firm value. They find that strict environmental standards increase the firm value, which is proxied by Tobin's q. Sound environmental practices within the country raise public awareness and discipline the firms into exercising ethical corporate behavior. Managers in these countries are aware of the potential negative impact of hiding bad news from the public, since it may be translated into a loss of consumer trust and bad public image in the long term. Moreover, this negative effect is expected to be more severe in industries such as renewable energy, since their performance is sensitive to public perception and social trust. As a result, a high level of environmental performance within the country is expected to diminish managers' tendency to suppress bad news in renewable energy firms, which leads to a lower risk of stock price crash.

The opposing argument outlines that less strict and lax country-level environmental practices may increase bad news disclosure and may reduce crash risk. Evidence suggests that the cost of doing business in countries with lax environmental regulations is cheaper than in countries with strict environmental standards (Stewart, 1993). In such conditions, firms are able to extend the life cycle of their products, which increases the revenues generated from the utilization of old resources (Vernon, 1992) Therefore, shareholders in these countries may require less premium in their stock investments, which in turn reduces the crash risk. In addition, given the less pressure on firms operating in countries with lax environmental policies, managers in these countries may tend to release bad news more quickly due to fewer concerns of loss of social trust and public image.

Overall, we expect that crash risk will be lower at the two extremes of country-level environmental performance, which implies an inverse, U-shaped relationship between environmental performance and crash risk. Hence, we formulate our first hypothesis as follows:

H1: There is an inverted U-shaped relationship between country-level environmental performance and the stock price crash risk of renewable energy firms.

2.2 Stock price crash risk and national culture

Sociological research argues that individual behaviors and group attitudes are shaped by the national culture. Stoner (1986) claims that individual decisions are affected by group norms, and individuals exhibit social behaviors similar to that of their surroundings. Importantly, cultural values are likely to explain the differences in several individual and corporate actions across countries. For example, Griffin et al. (2017) find that national culture explains 90% of the variation in governance policies across firms. Similarly, Stulz and Williamson (2003) argue that the cultural dimensions of the country, as proxied by language and religion, are helpful in explaining the cross-sectional variation in investor protection. Kwok and Tadese (2006) suggest that financial systems are shaped by the national culture. Specifically, they find that bank-based financial systems are more common in countries with high uncertainty avoidance. Recent literature shows that national culture plays an important role in explaining accounting systems (Gray, 1988), corporate risk-taking (Li et al., 2013), and corporate disclosures (Gray and Vint, 1995; Vitolla et al., 2019).

Different from fossil fuel firms, the performance of renewable energy firms depends on the public perceptions and social acceptance of the technology within the residence country (Masini and Menichetti, 2012; Swofford and Slattery, 2010; Vachon and Menz, 2006). Supporting this argument, Gupta (2017) find that national culture has a strong influence on the performance of renewable energy firms and that the natural culture dimensions proposed by

Hofstede (1980) are as important as the firm-specific and macroeconomic factors. Pelau and Pop (2018) investigate the impact of national culture on the demand for renewable energy sources and find that culture has a significant impact on the stock prices of renewable energy firms. Motivated by prior evidence, we examine the impacts of Hofstede's (1980) cultural dimensions of individualism, uncertainty avoidance, and long-term orientation on the crash risk of renewable energy firms. We also present evidence on the impact of the embeddedness and mastery dimensions of national culture, as proposed by Schwartz (1994), to provide additional insights on how social norms play a role in explaining crash risk in renewable energy firms.

Hofstede (1980) defines individualism as "a preference for a loosely-knit social framework in which individuals are expected to take care of only themselves and their immediate families." Individualism has an influence on bad news accumulation and crash risk in different channels. First, firms in individualistic cultures generally use performance-based compensation plans (Schuler and Ragovsky, 1998). Therefore, managers in individualistic cultures have incentives to hide bad news from the public, as their equity wealth decreases if they are not able to sustain stock prices (An et al., 2018; Dang et al., 2018). Second, managers in individualistic cultures tend to be optimistic about the future performance of the company, and they wait for an improvement in the bad news before releasing it to the public (Fischer and Chalmers, 2008). Supporting this idea, Li et al. (2013) and Kim et al. (2016) find that managers take greater risks in individualistic cultures since they are optimistic and overconfident about their skills and abilities, which leads to bad news hoarding and stock price crashes.

With respect to renewable energy firms, we predict a positive relationship between individualism and crash risk for two reasons. First, managers in renewable energy firms are expected to hide bad news due to social pressure if their wealth is based on performance-based compensation policies that are common across individualistic cultures. Second, renewable energy investments are regarded as risky due to greater uncertainty about the company's long-term success (Sadorsky, 2012). Given that managers in individualistic cultures take greater risks in their investment decisions, the probability of experiencing large negative stock price changes increases in renewable energy firms. Hence, we formulate our second hypothesis as follows:

H2: Renewable energy firms in individualistic cultures have higher stock price crash risk.

Hofstede defines uncertainty avoidance as a society's degree of discomfort with uncertainty. Thus, the unpredictability of future and potential losses is avoided in countries with high uncertainty avoidance (Gupta, 2017). Given that hiding bad news for an extended period leads to greater uncertainty in the future stock prices, managers in renewable energy firms tend to release bad news more quickly to alleviate unpredictability in firm value. Due to the risky nature of renewable energy firms, managers are expected to be more cautious and anxious about the negative consequences of hiding bad news in countries with higher level of uncertainty avoidance (An et al., 2018). In addition, managers in countries with high uncertainty avoidance take less risk, which eliminates the need for bad news accumulation (An et al., 2018). Therefore, we formulate our third hypothesis as follows:

H3: Renewable energy firms in countries with higher uncertainty avoidance have lower stock price crash risk.

Long-term orientation is defined by Hofstede as a preference for efforts to change society to be prepared for the future. On the other hand, countries with a short-term orientation tend to maintain the current norms and traditions and approach societal changes with suspicion. Long-term orientation affects the crash risk of renewable energy firms through the social acceptance and trust channels. Li et al. (2017) find that firms in regions with high social trust tend to experience less stock price crashes. The higher inherent risk in the operations of renewable energy firms is denounced as a result of bad news accumulation and may lead to much intense negative reaction from the society when they are released all at once to the public, which will lead to a loss of social trust and in turn increase the risk of failure. As the success of renewable energy firms depends on the social norms, managers in countries with long-term orientation are expected to be more conservative in financial reporting, have a long-term focus in terms of value creation, and, hence, release bad news without any delay. In other words, they care about the long-term health of the company rather than benefiting from temporary success. Therefore, we formulate our fourth hypothesis as follows:

H4: Renewable energy firms in countries with higher long-term orientation have lower stock price crash risk.

Embeddedness puts emphasis on social relationships, group identification, and shared goals (Schwartz, 2006). Managers in high-embeddedness countries tend to focus on long-term and harmonious relationships with the society, which in turn decreases the probability of managerial expropriation and agency costs (Chiu et al., 2016). Similar to the arguments for individualism (versus collectivism), we expect that renewable energy firms in countries with a higher level of embeddedness experience lower stock price crash risk. Therefore, we formulate our fifth hypothesis as follows:

H5: Renewable energy firms in countries with higher embeddedness have lower stock price crash risk.

Our final hypothesis is related to the mastery dimension of national culture proposed by Schwartz (1994). Values such as independence, success, ambition, and self-assertion are very important in countries with a high level of mastery. Individuals in these cultures tend to take more risks and put more emphasis on new achievements. From the corporate perspective, shareholders in mastery cultures trust corporate managers and respect their independence in the decision-making process, which mitigates agency conflicts between shareholders and managers (Shao et al., 2010). However, a high level of independence and weaker monitoring from external entities may lead to opportunistic behavior in managers such as withholding bad news at the expense of shareholders. Moreover, higher risk-taking and optimism encourage managers to keep bad investments for an extended period with an expectation that they will recover historical costs in the future. Therefore, we formulate the sixth hypothesis as follows:

H6: Renewable energy firms in countries with higher mastery have higher stock price crash risk.

3. DATA AND METHODOLOGY

3.1 Stock price crash risk measures

We use two measures of stock price crash risk computed through the following extended market model (Jin and Myers, 2006):

$$\begin{aligned} r_{ijt} = \; & \alpha_i + \beta_1 r_{jmt} + \beta_2 (r_{USt} + EX_{jt}) + \beta_3 r_{jmt-1} + \beta_4 (r_{USt-1} + EX_{jt-1}) \\ & + \beta_5 r_{jmt-2} + \beta_6 (r_{USt-2} + EX_{jt-2}) + \beta_7 r_{jmt+1} + \beta_8 (r_{USt+1} + EX_{jt+1}) \\ & + \beta_9 r_{jmt+2} + \beta_{10} (r_{USt+2} + EX_{jt+2}) + \varepsilon_{ijt} \end{aligned} \quad (1)$$

In Equation (1) r_{ijt} denotes the weekly stock return of firm *i* in county *j* and week *t*, r_{jmt} denotes the weekly market return of country j in week t, r_{USt} denotes the US stock market return in week *t*, and EX_{jt} is the exchange rate of country *j* versus the US dollar in week *t,* which is included in the model to represent the global stock market movements. To capture the nonsynchronous trading, we also included up to two lags and leads of local market and global market returns (Jin and Myers, 2006). ε_{ijt} represents the residual stock return of firm i in country j in week t, which is not explained by the market movements. Since residual returns from the market model have a positive skewness, we transform this idiosyncratic weekly return (W_{ijt}) as the natural logarithm of 1 plus ε_{ijt}.

Our first measure of crash risk (NCSKEW) is the negative skewness of the firm-specific stock returns, which is calculated as dividing the third moment of the firm-specific weekly stock returns by the standard deviation of the stock returns raised to the third power, as in the following equation (Chen et al., 2001):

$$NCSKEW_{i,t} = -\left[n(n-1)^{\frac{3}{2}}\sum W_{it}^{3}\right] \Big/ \left[(n-1)(n-2)\left(\sum W_{it}^{2}\right)^{3/2}\right] \quad (2)$$

In Equation (2), W_{ijt} denotes the firm-specific weekly return of firm i in week t, and n is the number of weeks in a given year. Higher values of NCSKEW indicate higher crash risk.

Our second measure of crash risk (DUVOL) is the down-to-up volatility, which is calculated as the natural logarithm of the ratio of the standard deviation of the weekly returns in down weeks to the standard deviation of the weekly returns in up weeks as follows (Chen et al., 2001):

$$DUVOL_{i,t} = ln\left[\frac{(n_u - 1)\sum_{DOWN}(W_{idt}^2)}{(n_d - 1)\sum_{UP}(W_{iut}^2)}\right] \quad (3)$$

In Equation (3), n_u and n_d correspond to the number of up and down weeks, and W_{idt} and W_{iut} denote the firm-specific stock returns in down and up weeks, respectively. Higher levels of DUVOL indicate a more left skewed distribution and higher crash risk.

3.2 National culture and country-level environmental performance measures

Following Gupta (2017), we use the national culture dimensions proposed by Hofstede (1980)[3]. Specifically, we incorporated the Individualism (IND), Uncertainty Avoidance (UA), and Long-term Orientation (LTO) dimensions of national culture into our analysis. Additionally, we employ estimations regarding the impact of Embeddedness (EMBED) and Mastery (MASTER), which had been first proposed by Schwartz (1994), as another framework for national culture.

As our proxy for the country-level environmental policy, we use the annual Environmental Performance Index (EPI) published jointly by Yale University, Columbia University, and the World Economic Forum[4]. The EPI shows how countries manage environmental problems and how much effort they put into maintaining a green policy and a sustainable environment (Hsu and Zomer, 2014). To end up with a composite EPI score, countries are evaluated using 24 environmental indicators such as the air quality, forests, climate and energy, and water resources to encompass the environmental health and ecosystem vitality, which are the main dimensions of the environmental performance score. The aggregate EPI score indicates how close countries are to the environmental goals. In other words, the EPI shows which countries are doing better in terms of environment protection and policy effectiveness. Raw values of the EPI range from 0 (worst performance) to 100 (best performance). We use the annual decile rankings of EPI scores, instead of the raw values, to ensure the comparability of EPI scores in different years. Thus, our final measure of EPI ranges from 0.1 to 1.

3.3 Control variables

We include several control variables into our model to account for the firm- and country-specific factors that are expected to have an impact on crash risk (An et al. 2018; Kim et al. 2016). First, we include the lag of NCSKEW ($NCSKEW_{t-1}$) into our model to account for the persistence of negative skewness. We control for the mean and the standard deviation of weekly firm-specific stock returns (RET and SIGMA, respectively), detrended stock turnover (DTURN), leverage (LEV), return-on-assets (ROA), market-to-book ratio (MB), firm size (SIZE), and net working capital (NWC) as firm-specific determinants of crash risk. We obtain firm-specific data from Datastream. We also control for the several country-specific factors

[3] The data is available from https://www.hofstede-insights.com/
[4] We obtained the data of the EPI score of each country from https://sedac.ciesin.columbia.edu/data/collection/epi/sets/browse

such as GDP per capita (GDP) to account for the national wealth, anti-self-dealing index (ANTISELF) to control for the investor protection level and finally disclosure quality (DISC) to control for the quality of disclosures at the country level. Variable definitions and data sources are explained in Table 1.

Please insert Table 1 here

3.4 Sample

Our sample includes 626 (5262) renewable energy firms (observations) from 31 countries from 2002 to 2016. The exact number of observations depends on the variables included in the regression models due to the presence of missing observations for some of the firms and countries. We include all renewable energy firms with a complete set of data in Datastream during the sample period. Not surprisingly, the United States has the largest number of observations (1176). China, Australia, and Germany have 539, 378, and 344 total observations, respectively. The smallest number of observations is observed in Belgium and Austria, with 14 and 16 total observations, respectively. Information regarding the distribution of the sample is given in Appendix A.

We use a broad definition to identify a firm as a renewable energy firm based on the sector classification of the Industry Classification Benchmark (ICB). Specifically, we include all firms operating in Alternative Electricity (160 firms), Alternative Fuels (96 firms), Renewable Energy Equipment (165 firms), Waste and Disposal Savings (157 firms), and Water (62 firms) sectors.

3.5 Regression Model

We estimate the following regression model to investigate the impact of national culture and national environmental performance on the crash risk of renewable energy firms.

$$Crash\ risk_{i,t} = \beta_0 + \beta_1 Culture_j + \beta_2 EPI_{j,t-1} + \beta_3 EPI_{j,t-1} x EPI_{j,t-1} + \beta_4 X_{i,t-1} + \beta_5 Y_{j,t-1} + Year\ dummies + \varepsilon_{i,t} \quad (4)$$

In Equation (4) $Crash\ risk_{i,t}$ corresponds to two crash risk measures (NCSKEW and DUVOL) for firm i in year t. $Culture_j$ refers to one of the three cultural dimensions of Hofstede (1980) namely Individualism, Uncertainty Avoidance and Long-term Orientation or to the Embeddedness and Mastery cultural dimensions proposed by Schwartz (1994). $EPI_{j,t-1}$ is the annual decile rank of the country-level environmental performance index of country j in time t-1. We include the square of $EPI_{j,t-1}$ to test the nonlinear impact of national environmental performance on crash risk. $X_{i,t-1}$ and $Y_{j,t-1}$are the firm-specific and macroeconomic control variables. We also include year dummies into our model to control for the year fixed effects. All firm-specific variables are winsorized at the 1% level. We employ weighted least square estimations due to the unbalanced sample size across countries. Specifically, we weighed the standard errors by the inverse of the number of firms within the country. Finally, we use robust standard errors clustered at the firm level to avoid heterogeneity and serial correlation.

4. EMPIRICAL ANALYSIS

In Table 2, we present the descriptive statistics of the variables used in this study. The mean values of NCSKEW and DUVOL are -0.054 and -0.094, respectively. Considering the national culture dimensions of Hofstede (1980), the mean values of IND, UA, and LTO are 60.329, 51.395, and 50.404, respectively. In addition, Embeddedness (EMBED) and Mastery (MASTER) cultural dimensions of Schwartz have 3.719 and 3.892 mean values. Finally, the mean value of the National Environmental Performance Index (EPI) is 67.797.

Please insert Table 2 here

In Table 3 and 4, we present the correlation coefficients used in this study. Regarding the firm-specific variables (Table 3), the highest correlation coefficient is observed between RET and SIGMA (0.795). Regarding the country-level variables (Table 4), the correlation coefficient between UA and ANITSELF is the largest in absolute terms (-0.757).

Please insert Table 3 here

Please insert Table 4 here

4.1 Regression Results

Table 5 presents the results of our main estimations using NCSKEW as the dependent variable. In Panel A of Table 5, we exclude national culture dimensions to observe the relationship between the EPI and crash risk without controlling for the national culture dimensions. First, a nonlinear relationship is observed between country-level environmental performance and the crash risk of renewable energy firms. The positive coefficient of the EPI suggests that crash risk increases with an increase in environmental performance. However, the negative coefficient of EPIxEPI indicates an inverse U-shaped relationship between the EPI and crash risk, which leads us to support H1. In other words, crash risk is lower at the two tails of country-level environmental performance. A non-linear relationship between the EPI and crash risk implies that a lower level of environmental performance may motivate managers to release bad news quickly due to less social pressure and fewer concerns about personal wealth and reputation loss. On the other hand, managers in countries with an extreme level of environmental performance also experience less crash risk due to the quick release of bad news. One possible reason is that a high level of environmental performance may alleviate the expropriation of the insiders/managers and motivate them to avoid any delay in releasing firm-specific information. In addition, the consequences of hiding negative information from the public in sustainable countries will be more severe due to high social awareness; this leads to a quick release of bad news and lower crash risk.

Please insert Table 5 here

When it came to the firm-level control variables, $NCSKEW_{t-1}$, MB, and SIZE show a positive impact on the crash risk of renewable energy firms, and NWC shows a negative impact. Considering the country-level control variables, we do not find any significant impact of these variables on crash risk.

In Table 5, Panels 2-4, we include the national culture dimensions into our baseline model. First, Individualism (IND) is found to significantly increase the crash risk of renewable energy firms, which supports H2. Given that the personal wealth of the managers in individualistic cultures is a function of their performance, they may tend to hide bad news from the public and wait for any improvement before releasing the news, which increases the crash risk. Moreover, managers in individualistic cultures tend to be optimistic and overconfident about their decisions, which also motivates them to pursue bad investments for an extended period and thereby increases the probability of stock price crashes. The coefficient of UA is found to be negative and significant at the 5 percent level. This result suggests that renewable energy firms in countries with higher uncertainty avoidance tend to experience less crash risk, which supports H3. Since the accumulation of bad news increases the uncertainty in future stock prices, managers in countries with high uncertainty avoidance are prompt in bad news disclosure to avoid unpredictability in stock prices and firm value. The coefficient of LTO is negative and not significant at the conventional levels, which lead us to reject H4. Regarding the national culture dimensions of Schwartz (1994), EMBED (MASTER) is found to have a negative (positive) impact on crash risk, which validates H5 and H6. Overall, the findings suggest that both national culture and national environmental performance have a significant influence on the crash risk of renewable energy firms.

4.2 Instrumental variable regressions

Although our models include several firm-specific and country-level control variables, it would be misleading to rule out the possibility of national culture dimensions being endogenous, since certain unobservable factors may have an impact on both national culture and crash risk. To avoid these concerns, we use the instrumental variable approach and employ a two-stages least square estimations. Following prior literature, we construct two sets of instruments for national culture dimensions; we expect to find a significant relationship between national culture dimensions that are not related to crash risk. Our first instrument is the *Ethnic heterogeneity* within the country, which is the probability that two randomly selected individuals belong to the same ethnic group (Alesina et al., 2003). The *Ethnic heterogeneity* of a country is expected to be closely related to the national culture dimensions, and it captures the effect of demography (Li et al. 2013). As another instrument for national culture, we used *Pronoun-drop,* which is a dummy variable equal to 1 if the grammatical rule of the major language spoken in the country licensed pronoun drop, and 0 otherwise (Kashima and Kashima, 1998). Kashima and Kashima (1998) argue that the omission of the first-person singular pronoun is linked to the degree of psychological differentiation between the speaker and the social context of speech, and it is significantly correlated to the national culture. Indeed, pronoun-drop is extensively used in the literature as an instrument for national culture (Ho et al., 2012; Li et al., 2013; An et al., 2018). To assess the validity of the instruments, we employ LM[5] and Hansen tests[6], which assess whether national culture dimensions are correctly identified. We include all instruments simultaneously into our estimation. Table 6 presents the results of our two-stage instrumental variable regression.

Please insert Table 6 here

Corroborating with the earlier estimates, the results of the instrumental variable regression suggest a positive (negative) relationship between IND (UA) and crash risk. However, different from our earlier results, the coefficient of LTO is also found to be negative and significant at the 1 percent level, thereby supporting H4. Specifically, managers in countries with high LTO

[5] The Kleibergen-Paap rk LM statistic tests whether excluded instruments are not correlated with the endogenous regressor with a null hypothesis of "there is no correlation."
[6] The Hansen statistic tests the validity of the over-identification restrictions with a null hypothesis of "over-identification instruments are valid."

tend to release bad news more quickly to avoid crashes and sustain the firm value in the long term. Moreover, a non-linear relationship still exists between the EPI and crash risk, with a positive coefficient of EPI and a negative coefficient of EPIxEPI. Regarding the culture dimensions of Schwartz (1994), EMBED shows a negative and MASTER a positive impact on crash risk. Overall, the national culture dimensions of both Hofstede and Schwartz are found to have a strong influence on the crash risk of renewable energy firms even after accounting for the endogeneity. Finally, significant LM statistics and insignificant Hansen statistics indicate that national culture dimensions are correctly identified by the instruments.

4.3 Alternative measure of stock price crash risk

As another robustness test, we use DUVOL as an alternative stock price crash risk measure. DUVOL represents the down-to-up volatility in the stock prices and is a widely used proxy for the crash risk (An et al., 2018; Hutton et al., 2009). Regression results in Table 7 suggest that our main findings are not sensitive to the different measures of crash risk.

Please insert Table 7 here

4.4 Impact of global financial crisis

The period of the global financial crisis provides us a natural experiment to test how the effects of environmental policies and natural culture dimensions differ in pre- and post-crisis periods. To fulfill this aim, we divide our sample period into the pre-crisis (2001–2007) and post-crisis (2009–2016) periods and retest our predictions. Panel A in Table 5 provides the instrumental variable regression results for the pre-crisis period. First, similar to the estimations regarding the whole sample period, we observed a non-linear relationship between the EPI and crash risk. However, none of the natural cultural dimensions is found to be significant in explaining crash risk during the pre-crisis period. Regarding the results presented in Panel B of Table 8, we observe that the impact of national culture on crash risk became significant after the global financial crisis. Overall, we can conclude that the global financial crisis has a strong impact on cultural tendencies and managerial behavior such as bad news hoarding.

Please insert Table 8 here

4.5 The role of investor protection

There is an ongoing debate on whether country-level governance substitutes or complements other such mechanisms in determining managerial behavior. For example, Callen and Fang

(2015) find that external governance mechanisms significantly moderate the relationship between religion and crash risk, which implies that governance substitutes religion in determining crash risk. One may argue that high level of governance within the country may substitute national culture and environmental policies in determining managerial behavior and crash risk. To examine the extent to which country-level governance mechanisms moderate the impact of environmental performance and national culture on crash risk, we divide our sample into two subsets using the sample median of the anti-self-dealing index as a proxy for investor protection. The anti-self-dealing index is used as a measure for the legal protection of shareholders against the expropriation of insiders (Djankov et al., 2008). According to the results presented in Table 9, the EPI and national culture dimensions are only significant for firms in the context of low investor protection. Therefore, we can argue that the investor protection level within the country substitutes mechanisms such as national culture and environmental policies.

Please insert Table 9 here

4.6 Determinants of stock price crash risk in fossil-fuel firms

Although prior evidence suggests that renewable energy firms are very sensitive to environmental policies and social norms, we cannot argue that these factors are important only for firms in the renewable energy industry. For example, An et al. (2018) argue that the impact of the individualism dimension of natural culture on crash risk is common to all firms. To provide robust evidence on how the impact of country-level factors differs in explaining the crash risk, we estimate crash risk for fossil-fuel firms. This approach is useful for identifying whether the factors are unique to renewable energy firms. We identify 7685 firm-year observations from 2002 to 2016 from the same set of countries. The results presented in Table 10 suggest that environmental policies do not exert any significant influence in explaining the crash risk of fossil-fuel firms. Similarly, the national culture dimensions of Hofstede are not found to be among the significant determinants of crash risk in these firms. On the other hand, the embeddedness and mastery dimensions of Schwartz are found to be positive and significant in explaining the crash risk only after the global financial crisis. Overall, we can conclude that the determinants of stock price crash significantly differ in renewable energy firms and fossil fuel firms. The latter are less sensitive to environmental policies in terms of crash risk.

Please insert Table 10 here

5. CONCLUSION AND DISCUSSION

Despite the growing interest in the sources of renewable energy and environmental sustainability, empirical research on the business strategies of renewable energy firms is still limited. Particularly, renewable energy firms are considered risky and have a greater probability of experiencing large stock price changes. However, little is known about the factors that lead to stock price crashes in these firms. In this study, we try to fill this gap by investigating the impact of national culture and country-level environmental performance on the crash risk of renewable energy firms. Employing data from 626 firms in 31 countries, we find that national culture and country-level environmental performance have a significant impact on the crash risk of renewable energy firms.

First, the country-level environmental performance is found to be significant in explaining the crash risk of renewable energy firms. We find an inverted U-shaped relationship between country-level environmental performance and crash risk. Specifically, the crash risk of renewable energy firms is observed to be lower in the two tails of environmental performance and higher in countries with a moderate level of environmental performance. This finding implies that investors should be aware of the environmental conditions within the country when making decisions about investing in renewable energy firms. As another important implication, sluggish and weak improvements in national environmental sustainability do not help eliminate managers' expropriation but increase it. From the academic perspective, the national environmental performance should be considered an important factor in explaining crash risk to avoid omitted variable bias.

Second, we find that renewable energy firms located in countries with higher uncertainty avoidance, long-term orientation, and embeddedness have lower crash risk. Moreover, the crash risk is found to be significantly higher in countries with high individualism and mastery score. These results have several implications for investors, firms, and governments. Due to managerial expropriation and higher agency costs in these countries, the firms are more likely to experience a loss in equity value, especially if the target firms are in industries with a high level of uncertainty. In addition, governmental bodies in these countries should be more rigid in terms of disclosure policies and environmental regulations to avoid expropriation of managers and enhance information transparency. Otherwise, the shareholders will incur severe costs in the long-term in the form of stock price crashes.

Further analysis reveals that the impact of country-level factors on crash risk is more pronounced after the global financial crisis and in case of the countries with low investor protection. Another important conclusion of the study is that country-level factors do not help explain the crash risk of fossil fuel firms. It is evident that the dynamics of crash risk are significantly different in these firms. Our results are robust to alternative measures of crash risk and different methods of estimations. Overall, the findings of this paper help us better understand the role of national culture and environmental policies in explaining crash risk in the energy industry. In this context, future research testing the impact of environmental policies on the corporate strategies and firm-level financial outcomes would be of much interest.

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TABLES

Table 1
Variable definitions

Variable	Definition
NCSKEW	Negative conditional skewness which is the negative of the third central moment of firm-specific weekly return scaled by the sample variance of firm-specific weekly return raised to 3/2. [Equation 2]
DUVOL	Down-to-up volatility. [Equation 3]
RET	The mean of the firm-specific weekly returns
SIGMA	The standard deviation of weekly stock returns
DTURN	The difference between the average monthly stock turnover over the current year and that over the previous year
LEV	Total debt divided by total assets
ROA	The ratio of net income to total assets
MB	The ratio of book value of assets minus the book value of equity plus the market value of equity to total assets
SIZE	Natural logarithm of total assets
NWC	Current assets minus cash and equivalents minus current liabilities divided by total assets
GDP	Natural logarithm of the gross domestic product per capita in dollar terms
IND	Country-specific individualism index (Hofstede 1980)
UA	Country-specific uncertainty avoidance index (Hofstede 1980)
LTO	Country-specific long-term orientation index (Hofstede 1980)
EMBED	Country-specific embeddedness index (Schwartz 1994)
MASTER	Country-specific mastery index (Schwartz 1994)
EPI	Country-specific environmental performance index (Yale Center for Environmental Law & Policy)
ANTISELF	Anti-self-dealing index of the country
DISC	Disclosure quality of the country

This table presents the definitions of the variables used in this study.

Table 2
Descriptive statistics

	# of obs.	Mean	Median	Std. dev.
NCSKEW	5335	-0.054	-0.055	0.858
DUVOL	5335	-0.094	-0.099	0.372
RET	5335	0.005	0.002	0.024
SIGMA	5335	0.106	0.074	0.134
DTURN	5335	0.005	0.000	0.178
LEV	5335	0.299	0.261	0.268
ROA	5335	-0.211	0.008	0.571
MB	5335	2.408	1.288	3.156
SIZE	5335	11.689	11.960	2.786
NWC	5335	-0.282	0.067	2.285
GDP	5335	10.052	10.559	1.066
IND	5335	60.329	69.000	29.039
UA	5335	51.395	46.000	20.177
LTO	5335	50.404	44.000	24.103
EMBED	5142	3.719	3.771	0.288
MASTER	5142	3.892	3.876	0.217
EPI	5335	67.797	68.910	12.940
ANTISELF	5335	0.629	0.650	0.222
DISC	5262	87.249	87.320	14.204

Table 3

Correlation coefficients between firm-specific variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)NCSKE	1									
(2)DUVOL	0.946*	1								
(3)RET	0.030	0.011	1							
(4)SIGMA	0.041*	-0.017	0.795*	1						
(5)DTURN	0.012	0.017	0.117*	0.076*	1					
(6)LEV	0.052*	0.029	0.063*	0.140*	0.000	1				
(7)ROA	-0.055*	0.008	-0.148*	-0.379*	-0.006	-0.300*	1			
(8)MB	0.071*	0.018	0.278*	0.349*	0.053*	0.316*	-0.732*	1		
(9)SIZE	-0.007	0.066*	-0.210*	-0.435*	-0.016	-0.016	0.636*	-0.606*	1	
(10)NWC	-0.080*	-0.035*	-0.172*	-0.298*	-0.017	-0.450*	0.565*	-0.623*	0.418	1

This table presents the coefficient coefficients between the firm-specific variables. * denote significance level at 1%.

Table 4

Correlation coefficients between country-level variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)GDP	1								
(2)IND	0.673*	1							
(3)UA	0.046*	0.046*	1						
(4)LTO	-0.347*	-0.664*	0.033	1					
(5)EMBED	-0.348*	-0.387*	-0.304*	-0.220*	1				
(6)MASTER	-0.554*	-0.327*	-0.448*	0.313*	0.131*	1			
(7)EPI	0.393*	0.319*	0.376*	-0.054*	-0.440*	-0.625*	1		
(8)ANTISELF	0.025	-0.069*	-0.757*	-0.114*	0.408*	0.294*	-0.295*	1	
(9)DISC	0.497*	0.527*	-0.233*	-0.138*	-0.407*	-0.368*	0.379*	0.248*	1

This table presents the coefficient coefficients between the country-level variables. * denote significance level at

Table 5
Main estimation results

	(1)	Hofstede (1980) (2) (IND)	(3) (UA)	(4) (LTO)	Schwartz (1994) (5) (EMBED)	(6) (MASTER)
$NCSKEW_{t-1}$	0.064***	0.064***	0.062***	0.064***	0.070***	0.071***
	(0.020)	(0.020)	(0.021)	(0.020)	(0.021)	(0.021)
RET	-0.523	-0.374	-0.442	-0.522	-0.361	-0.295
	(1.244)	(1.239)	(1.258)	(1.245)	(1.215)	(1.215)
SIGMA	0.290	0.240	0.253	0.286	0.313	0.285
	(0.250)	(0.250)	(0.250)	(0.250)	(0.257)	(0.256)
DTURN	-0.023	-0.022	-0.021	-0.022	0.035	0.031
	(0.074)	(0.074)	(0.074)	(0.074)	(0.072)	(0.072)
LEV	-0.034	-0.040	-0.037	-0.033	-0.052	-0.049
	(0.069)	(0.068)	(0.069)	(0.069)	(0.073)	(0.073)
ROA	-0.030	-0.020	-0.030	-0.028	-0.055	-0.054
	(0.044)	(0.045)	(0.045)	(0.045)	(0.039)	(0.039)
MB	0.023***	0.022***	0.021***	0.023***	0.019**	0.019**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
SIZE	0.040***	0.041***	0.039***	0.040***	0.039***	0.040***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
NWC	-0.028***	-0.029***	-0.029***	-0.028***	-0.028***	-0.027***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
GDP	0.004	-0.008	0.007	0.005	-0.020	0.010
	(0.016)	(0.017)	(0.016)	(0.016)	(0.017)	(0.018)
EPI	0.667***	0.626***	0.822***	0.648***	0.920***	0.782***
	(0.190)	(0.190)	(0.200)	(0.202)	(0.223)	(0.209)
EPIxEPI	-0.620***	-0.592***	-0.744***	-0.605***	-0.833***	-0.673***
	(0.172)	(0.172)	(0.176)	(0.182)	(0.194)	(0.179)
CULTURE		0.001**	-0.002**	-0.000	-0.169**	0.192*
		(0.001)	(0.001)	(0.001)	(0.072)	(0.099)
ANTISELF	-0.049	-0.018	-0.166**	-0.052	0.105	-0.074
	(0.067)	(0.069)	(0.084)	(0.068)	(0.100)	(0.073)
DISC	0.001	0.000	0.001	0.001	-0.000	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.868***	-0.751***	-0.661***	-0.851***	0.025	-1.717***
	(0.195)	(0.206)	(0.202)	(0.209)	(0.394)	(0.547)
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.029	0.030	0.030	0.029	0.033	0.033
# of obs.	5262	5262	5262	5262	5069	5069

Dependent variable is $NCSKEW_t$ in all of the estimations. ***, **, and * denote the significance level at 1%, 5%, and 10%, respectively. *CULTURE* variable represents the corresponding cultural dimension in each estimation.

Table 6
Instrumental variable regression

	Hofstede (1980)			Schwartz (1994)	
	(1)	(2)	(3)	(4)	(5)
	IND	UA	LTO	EMBED	MASTER
$NCSKEW_{t-1}$	0.056**	0.052**	0.053**	0.055**	0.059***
	(0.022)	(0.024)	(0.023)	(0.022)	(0.022)
RET	-0.136	0.033	-0.337	-0.402	-0.079
	(1.233)	(1.206)	(1.233)	(1.246)	(1.267)
SIGMA	0.255	0.202	0.275	0.380	0.261
	(0.262)	(0.264)	(0.262)	(0.267)	(0.271)
DTURN	0.040	0.056	0.037	0.041	0.038
	(0.078)	(0.080)	(0.078)	(0.077)	(0.079)
LEV	-0.066	-0.094	-0.044	-0.057	-0.054
	(0.075)	(0.085)	(0.075)	(0.079)	(0.082)
ROA	-0.028	-0.058	-0.013	-0.053	-0.047
	(0.041)	(0.041)	(0.043)	(0.041)	(0.040)
MB	0.019**	0.016**	0.018**	0.019**	0.021**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
SIZE	0.046***	0.045***	0.040***	0.041***	0.048***
	(0.008)	(0.009)	(0.008)	(0.008)	(0.009)
NWC	-0.030***	-0.031***	-0.028***	-0.029***	-0.028***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
GDP	-0.002	0.029	0.040**	-0.052	0.046**
	(0.020)	(0.018)	(0.017)	(0.035)	(0.020)
EPI	0.828***	1.265***	0.649***	1.437***	0.869***
	(0.207)	(0.245)	(0.230)	(0.269)	(0.231)
EPIxEPI	-0.736***	-1.076***	-0.549***	-1.330***	-0.710***
	(0.180)	(0.200)	(0.205)	(0.244)	(0.206)
CULTURE	0.003***	-0.009***	-0.005***	-0.541***	0.761**
	(0.001)	(0.003)	(0.002)	(0.185)	(0.312)
ANTISELF	0.027	-0.527***	-0.115	0.417**	-0.173*
	(0.079)	(0.183)	(0.072)	(0.181)	(0.089)
DISC	-0.001	-0.001	0.001	-0.003*	0.004**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Constant	-0.930***	-0.346	-0.933***	1.675*	-4.462***
	(0.237)	(0.406)	(0.236)	(0.996)	(1.346)
Year fixed	Yes	Yes	Yes	Yes	Yes
Centered R^2	0.036	0.023	0.033	0.026	0.026
# of obs.	4530	4530	4530	4530	4530
LM (p-value)	0.000	0.000	0.000	0.000	0.000
Hansen J (p-value)	0.9971	0.1877	0.1693	0.2020	0.0702

Dependent variable is $NCSKEW_t$ in all of the estimations. *CULTURE* variable represents the corresponding cultural dimension in each estimation. All culture dimensions are instrumented with the *PRONOUN DROP* and *ETHNIC*. LM is the under identification test for the instruments with a null hypothesis instruments under identify the culture dimensions. Hansen J is an over identification test with a null hypothesis of instruments correctly identify the culture dimensions. ***, **, and * denote the significance level at 1%, 5%, and 10%, respectively.

Table 7
Alternative measure of stock price crash risk (DUVOL)

	Hofstede (1980)			Schwartz (1994)	
	(1)	(2)	(3)	(4)	(5)
	IND	UA	LTO	EMBED	MASTER
$NCSKEW_{t-1}$	0.023**	0.022**	0.022**	0.023**	0.024***
	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)
RET	0.418	0.469	0.339	0.319	0.424
	(0.555)	(0.546)	(0.553)	(0.558)	(0.569)
SIGMA	-0.061	-0.076	-0.051	-0.013	-0.054
	(0.110)	(0.111)	(0.110)	(0.113)	(0.114)
DTURN	0.017	0.022	0.016	0.017	0.016
	(0.034)	(0.035)	(0.034)	(0.034)	(0.035)
LEV	-0.050	-0.059*	-0.041	-0.046	-0.045
	(0.033)	(0.036)	(0.033)	(0.035)	(0.036)
ROA	-0.001	-0.012	0.004	-0.010	-0.008
	(0.018)	(0.017)	(0.018)	(0.017)	(0.017)
MB	0.009**	0.008**	0.009**	0.009**	0.009***
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)
SIZE	0.025***	0.025***	0.023***	0.023***	0.026***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
NWC	-0.013***	-0.013***	-0.012***	-0.013***	-0.012***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
GDP	0.006	0.017**	0.021***	-0.015	0.023***
	(0.009)	(0.008)	(0.008)	(0.016)	(0.009)
EPI	0.325***	0.481***	0.264**	0.567***	0.343***
	(0.101)	(0.111)	(0.113)	(0.122)	(0.109)
EPIxEPI	-0.271***	-0.392***	-0.207**	-0.507***	-0.265***
	(0.089)	(0.091)	(0.101)	(0.110)	(0.098)
CULTURE	0.001**	-0.003**	-0.002**	-0.216***	0.257*
	(0.001)	(0.002)	(0.001)	(0.083)	(0.142)
ANTISELF	-0.007	-0.203**	-0.059*	0.151*	-0.077*
	(0.036)	(0.083)	(0.032)	(0.082)	(0.040)
DISC	-0.000	0.000	0.001	-0.001	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.587***	-0.388**	-0.594***	0.460	-1.787***
	(0.110)	(0.185)	(0.110)	(0.450)	(0.610)
Year fixed	Yes	Yes	Yes	Yes	Yes
R^2	0.043	0.035	0.042	0.035	0.035
# of obs.	4530	4530	4530	4530	4530
LM (p-value)	0.000	0.000	0.000	0.000	0.000
Hansen J (p-value)	0.6531	0.1353	0.1207	0.5257	0.0621

Dependent variable is $NCSKEW_t$ in all of the estimations. *CULTURE* variable represents the corresponding cultural dimension in each estimation. All culture dimensions are instrumented with the *PRONOUN DROP* and *ETHNIC*. LM is the under identification test for the instruments with a null hypothesis instruments under identify the culture dimensions. Hansen J is an over identification test with a null hypothesis of instruments correctly identify the culture dimensions. ***, **, and * denote the significance level at 1%, 5%, and 10%, respectively.

Table 8
Estimations for sub-periods

	Hofstede (1980)			Schwartz (1994)	
	(1) IND	(2) UA	(3) LTO	(4) EMBED	(5) MASTER
Panel A. Pre-crisis period (2002-2007)					
EPI	0.853*	0.954*	0.649	1.401**	0.861*
	(0.467)	(0.515)	(0.533)	(0.576)	(0.511)
EPIxEPI	-0.902**	-0.999**	-0.671	-1.435***	-0.878*
	(0.403)	(0.431)	(0.483)	(0.512)	(0.454)
CULTURE	0.003	-0.007	-0.004	-0.487	0.496
	(0.002)	(0.006)	(0.003)	(0.394)	(0.610)
Controls	Yes	Yes	Yes	Yes	Yes
Centered R^2	0.039	0.025	0.040	0.038	0.035
# of obs.	1160	1160	1160	1160	1160
LM (p-value)	0.000	0.015	0.000	0.000	0.001
Hansen J (p-value)	0.935	0.826	0.900	0.564	0.257
Panel B. Post-crisis period (2009-2016)					
EPI	0.654**	1.459***	0.481*	1.441***	0.711**
	(0.258)	(0.338)	(0.287)	(0.344)	(0.283)
EPIxEPI	-0.532**	-1.157***	-0.353	-1.290***	-0.494**
	(0.224)	(0.272)	(0.252)	(0.308)	(0.252)
CULTURE	0.005***	-0.012***	-0.006***	-0.668***	1.079***
	(0.001)	(0.004)	(0.002)	(0.210)	(0.371)
Controls	Yes	Yes	Yes	Yes	Yes
Centered R^2	0.037	0.010	0.031	0.019	0.019
# of obs.	3076	3076	3076	3076	3076
LM (p-value)	0.000	0.000	0.000	0.000	0.000
Hansen J (p-value)	0.989	0.118	0.079	0.149	0.134

Dependent variable is $NCSKEW_t$ in all of the estimations. *CULTURE* variable represents the corresponding cultural dimension in each estimation. All culture dimensions are instrumented with the *PRONOUN DROP* and *ETHNIC*. LM is the under identification test for the instruments with a null hypothesis instruments under identify the culture dimensions. Hansen J is an over identification test with a null hypothesis of instruments correctly identify the culture dimensions. ***, **, and * denote the significance level at 1%, 5%, and 10%, respectively.

Table 9
Estimations for sub-samples of countries

	Hofstede (1980)			Schwartz (1994)	
	(1) IND	(2) UA	(3) LTO	(4) EMBED	(5) MASTER
Panel A. Low anti-self-dealing index					
EPI	0.771**	0.789*	0.478	1.348***	0.578
	(0.383)	(0.423)	(0.416)	(0.474)	(0.436)
EPIxEPI	-0.916***	-0.878***	-0.630**	-1.338***	-0.657**
	(0.269)	(0.284)	(0.284)	(0.346)	(0.313)
CULTURE	0.008**	-0.006***	-0.005*	-0.721***	0.387
	(0.003)	(0.002)	(0.003)	(0.265)	(0.338)
Controls	Yes	Yes	Yes	Yes	Yes
Centered R^2	0.046	0.051	0.042	0.036	0.048
# of obs.	2060	2060	2060	2060	2060
LM (p-value)	0.000	0.000	0.000	0.000	0.000
Hansen J (p-value)	0.120	0.823	0.023	0.373	0.008
Panel B. High anti-self-dealing index					
EPI	-0.201	-0.145	-0.125	-0.203	-0.154
	(0.649)	(0.642)	(0.640)	(0.650)	(0.642)
EPIxEPI	0.165	0.130	0.120	0.168	0.131
	(0.523)	(0.521)	(0.522)	(0.523)	(0.521)
CULTURE	0.001	0.002	-0.002	-0.082	0.213
	(0.002)	(0.004)	(0.006)	(0.132)	(0.427)
Controls	Yes	Yes	Yes	Yes	Yes
Centered R^2	0.061	0.062	0.062	0.062	0.061
# of obs.	1294	1294	1294	1294	1294
LM (p-value)	0.000	0.000	0.000	0.000	0.000
Hansen J (p-value)	0.650	0.516	0.469	0.549	0.645

Dependent variable is $NCSKEW_t$ in all of the estimations. *CULTURE* variable denotes to corresponding cultural dimension in each estimation. All culture dimensions are instrumented with the *PRONOUN DROP* and *ETHNIC*. LM is the under identification test for the instruments with a null hypothesis instruments under identify the culture dimensions. Hansen J is an over identification test with a null hypothesis of instruments correctly identify the culture dimensions. ***, **, and * denote the significance level at 1%, 5%, and 10%, respectively.

Table 10
Estimations for fossil-fuel firms

	Hofstede (1980)			Schwartz (1994)	
	(1) IND	(2) UA	(3) LTO	(4) EMBED	(5) MASTER
Panel A. Full period (2002-2016)					
EPI	0.362	0.540	0.334	0.516	0.562
	(0.327)	(0.451)	(0.323)	(0.337)	(0.350)
EPIxEPI	-0.361	-0.536	-0.345	-0.483*	-0.523*
	(0.252)	(0.397)	(0.249)	(0.265)	(0.277)
CULTURE	-0.000	-0.002	-0.001	0.044	0.055
	(0.002)	(0.003)	(0.001)	(0.037)	(0.042)
Controls	Yes	Yes	Yes	Yes	Yes
Centered R^2	0.046	0.046	0.048	0.049	0.049
# of obs.	7685	7685	7685	7685	7685
LM (p-value)	0.000	0.004	0.000	0.000	0.000
Hansen J (p-value)	0.068	0.116	0.123	0.186	0.270
Panel B. Pre-crisis period (2002-2007)					
EPI	0.697	0.549	0.351	-0.037	-0.014
	(0.682)	(0.684)	(0.695)	(0.840)	(0.793)
EPIxEPI	-0.896*	-0.815	-0.617	-0.361	-0.362
	(0.526)	(0.549)	(0.558)	(0.644)	(0.612)
CULTURE	0.003	-0.002	-0.002	-0.097	-0.094
	(0.004)	(0.004)	(0.003)	(0.077)	(0.071)
Controls	Yes	Yes	Yes	Yes	Yes
Centered R^2	0.109	0.106	0.111	0.088	0.097
# of obs.	1342	134	1342	1342	1342
LM (p-value)	0.000	0.000	0.000	0.002	0.008
Hansen J (p-value)	0.165	0.136	0.150	0.970	0.800
Panel C. Post-crisis period (2009-2016)					
EPI	0.386	0.645	0.359	0.630	0.702
	(0.450)	(0.632)	(0.456)	(0.449)	(0.452)
EPIxEPI	-0.316	-0.572	-0.308	-0.524	-0.591
	(0.331)	(0.546)	(0.333)	(0.334)	(0.340)
CULTURE	-0.001	-0.002	-0.001	0.079**	0.101**
	(0.002)	(0.005)	(0.001)	(0.040)	(0.049)
Controls	Yes	Yes	Yes	Yes	Yes
Centered R^2	0.043	0.042	0.045	0.047	0.046
# of obs.	5854	5854	5854	5854	5854
LM (p-value)	0.000	0.029	0.000	0.000	0.000
Hansen J (p-value)	0.022	0.034	0.031	0.148	0.240

Dependent variable is $NCSKEW_t$ in all of the estimations. *CULTURE* variable denotes to corresponding cultural dimension in each estimation. All culture dimensions are instrumented with the *PRONOUN DROP* and *ETHNIC*. LM is the under identification test for the instruments with a null hypothesis instruments under identify the culture dimensions. Hansen J is an over identification test with a null hypothesis of instruments correctly identify the culture dimensions. ***, **, and * denote the significance level at 1%, 5%, and 10%, respectively.

Appendix A.
Distribution of observations across countries and summary statistics

Country	# of obs.	EPI	IND	UA	LTO	MASTER	EMBED	ANTISELF
Australia	378	73.620	90	51	21	3.748	3.847	0.76
Austria	16	78.459	55	70	60	3.721	3.186	0.21
Belgium	14	73.709	75	94	82	N/A	N/A	0.54
Brazil	317	61.132	38	76	44	3.838	4.026	0.27
Canada	360	73.287	80	48	36	3.930	3.521	0.64
Chile	74	66.127	23	86	31	3.540	3.902	0.63
China	539	46.555	20	30	87	4.407	3.738	0.76
Denmark	32	75.386	74	23	35	3.740	3.289	0.46
France	201	78.372	71	86	63	3.574	3.097	0.38
Germany	344	77.875	67	65	83	3.752	3.183	0.28
Greece	38	73.180	35	100	45	4.126	3.469	0.22
Hong Kong	252	46.649	25	29	61	3.935	3.872	0.96
India	120	37.028	48	40	51	4.162	3.913	0.58
Italy	122	78.291	76	75	61	3.600	3.611	0.42
Japan	62	74.146	46	92	88	3.973	3.547	0.5
Malaysia	153	68.176	26	36	41	3.830	4.332	0.95
New Zealand	53	76.881	79	49	33	3.856	3.471	0.95
Norway	55	80.186	69	50	35	3.619	3.550	0.42
Philippines	40	56.971	32	44	27	3.727	4.071	0.22
Poland	53	73.210	60	93	38	3.638	4.051	0.29
Russia	20	59.408	39	95	81	3.657	4.043	0.44
Singapore	167	87.040	20	8	72	3.619	4.213	1
South Korea	95	67.271	18	85	100	N/A	N/A	0.47
Spain	53	75.759	51	86	48	3.681	3.363	0.37
Sweden	37	81.473	71	29	53	3.610	3.234	0.33
Switzerland	26	84.114	68	58	74	3.740	3.043	0.27
Taiwan	130	70.821	17	69	93	3.873	4.048	0.56
Thailand	84	62.402	20	64	32	N/A	N/A	0.81
Turkey	33	54.316	37	85	46	3.777	4.026	0.43
United Kingdom	291	79.030	89	35	51	3.876	3.552	0.95
United States	1176	69.813	91	46	26	3.924	3.771	0.65

This table presents the distribution of the observations across countries and the mean values of the variables of interest per country.