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Corporate Environmental Responsibility and the Cost of Capital: International Evidence

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Abstract We examine how corporate environmental responsibility (CER) affects the cost of equity capital for manufacturing firms in 30 countries. Using several approaches to estimate firms' *ex ante* equity financing costs, we find in regressions that control for firm-level characteristics as well as industry, year, and country effects that the cost of equity capital is lower when firms have higher CER. This finding is robust to addressing endogeneity through instrumental variables, to using alternative specifications and proxies for the cost of equity capital, and to accounting for noise in analyst forecasts. We conclude that investment in CER reduces firms' equity financing costs worldwide.

Keywords Corporate environmental responsibility · Environmental liability risk · Environmental risk management · Cost of equity capital · Firm risk

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Introduction

Environmental liability risk is increasingly significant to corporations around the world. For instance, in 2011 an Ecuadorean court ordered US oil company Chevron

> to pay $19 billion—later reduced to $9.5 billion—to clean up environmental damage in the Lago Agrio oilfield in the Amazon region. This was allegedly done, more than 20 years ago, by an arm of Texaco, a smaller firm Chevron bought in 2001.[1]

In another high-profile case, the Deepwater Horizon oil spill of 2010 resulted in major financial consequences for British oil and gas company BP and its shareholders, as

> its share price fell by half. The company froze dividends and had to sell assets worth $38 billion, including half of all its offshore platforms and refineries, to help meet a $42 billion charge for the clean-up, compensation and other costs. Litigation is likely to go on for many years and the payouts could rise well beyond that total.[2]

More recently, Volkswagen's emissions scandal resulted in the carmaker losing one-third of its market capitalization since the scandal erupted in addition to facing "billions of dollars in fines and other financial penalties."[3] On top of the costs associated with repairing the 11 million affected vehicles worldwide, "for which the firm has set aside €6.5

[1] Economist, 5 March 2014.

[2] Economist, 8 February 2014.

[3] Economist, 26 September 2015.

billion ($7.3 billion), VW may be fined billions of dollars in America and suffer a grave blow to its business there. Lawyers are preparing class-action suits. Some executives may face prosecution."[4] Against this backdrop of costly litigation and increasing attention from the media, policy makers, investors, and social and environmental activists, many companies are seeking to improve their environmental performance through strategic environmental investments.[5]

To what extent do firms benefit from investment in corporate environmental responsibility (CER)? Prior research on the benefits of CER focuses largely on the relationship between environmental and corporate performance as captured by accounting- or market-based measures of firm performance. This research generally documents a strong, positive relationship between environmental and financial performance (see Sharfman and Fernando 2008, and references therein), and indicates that the financial benefits associated with investment in CER exceed the costs. The literature has less to say, however, about whether investors reward CER investments, that is, about investors' *ex ante* perceptions of corporate environmental performance, worldwide. Using a sample of 267 US firms, Sharfman and Fernando (2008) find that the cost of equity capital estimated using the capital asset pricing model (CAPM) is significantly lower for firms with superior environmental performance.[6] The authors call for additional investigation to learn whether their US-based results extend to "markets where the pressure for firms to improve their environmental risk management is potentially stronger (e.g., Europe and Australia) both from regulation and from societal pressure" (p. 589).[7]

In this paper, we answer this call by examining the link between CER and equity pricing for manufacturing firms in 30 countries. We focus on the cost of equity capital because it is the required rate of return given equity investors' perception of a firm's risk. We build on El Ghoul et al. (2011) and argue that the perceived risk of firms with high CER (i.e., low environmental costs–total assets) is lower than that of firms with low CER (i.e., high environmental costs–total assets) because CER [and corporate social responsibility (CSR) more generally] helps decrease firm risk by reducing the probability and impact of adverse events (e.g., environmental scandals).[8] In addition, firms with low CER have a narrower investor base, leading to higher equity financing costs (Heinkel et al. 2001).

To test our prediction on the link between CER and equity pricing, we employ the Trucost database, which provides a firm-level assessment of environmental costs to society for firms from 30 countries.[9] Unlike other CSR databases, which provide an environmental rating (e.g., KLD, ASSET4, EIRIS), Trucost specifies the dollar value associated with each environmental event in its database. To estimate firms' cost of equity capital, we follow recent research (e.g., Hail and Leuz 2006; El Ghoul et al. 2011) and employ four models to infer the *ex ante* cost of capital implied by analysts' earnings forecasts and stock prices obtained from I/B/E/S.[10] Specifically, we use the residual income valuation models of Claus and Thomas (2001) and Gebhardt et al. (2001), and the abnormal growth models of Ohlson and Juettner-Nauroth (2005) and Easton (2004).[11]

[4] Economist, 3 October 2015.

[5] A 2013 survey by KPMG reveals that 82 % of Fortune Global 250 firms release corporate responsibility information (either in standalone reports or as part of annual financial reports), as opposed to 78 % in 2011. As the report further indicates, "Most G250 CR reports (87 percent) identify at least some social and environmental changes (or 'megaforces') that affect the business. Climate change, material resource scarcity and energy and fuel are the most commonly mentioned" (p. 13). Consistent with the strategic importance of CER, the report stresses that

> Many companies no longer see corporate responsibility as a moral issue, but as core business risks and opportunities. More and more investors accept that environmental and social factors put company value at stake. This leads to the question of what the potential financial impacts of those risks and opportunities could be and what the company is doing to mitigate or maximize them (p. 14).

[6] Sharfman and Fernando (2008) find a positive relation between environmental performance and the cost of debt, which contradicts their evidence for equity pricing. Given that the risk channels through which CER affects the cost of equity are inherently different from those that affect the cost of debt (Sharfman and Fernando 2008), in this paper we focus on shareholders' perception of CER.

[7] Consistent with potential cross-country differences, the 2013 KPMG survey of corporate responsibility indicates that among the world's largest 250 companies, those from Europe

> are the most likely to discuss in detail the environmental and social impacts of their products and services. Almost three quarters (73 percent) of reporting companies in Europe do so with a further 23 percent providing limited information. In the Americas, less than half (49 percent) provide detailed information on downstream impacts and the figure drops to less than one third (32 percent) in Asia Pacific (p. 17).

[8] Prior research finds that CSR engagement is inversely related to firm risk (Boutin-Dufresne and Savaria 2004; Lee and Faff 2009; Jo and Na 2012; Kim et al. 2014).

[9] We emphasize that the environmental costs we analyze are *external* costs, that is, costs that affect a party (in our context, society) that did not choose to incur them (Buchanan and Stubblebine 1962). Thus, the environmental costs that we study in this paper are not accounting costs (Jo et al. 2015b). Jo et al. (2015b) find an insignificant negative correlation between external environmental costs and accounting costs for the manufacturing industry.

[10] Below, we check the robustness of our main evidence to alternative models of the cost of equity.

[11] See El Ghoul et al. (2011) for a discussion of the advantages of the implied cost of capital approach.

Our sample consists of 7122 firm-year observations representing 2107 firms from 30 countries over the 2002–2011 period. Using a multivariate regression framework that controls for firm-level characteristics as well as industry, year, and country effects, we find that the cost of equity capital is lower for firms with a high level of CER. This finding suggests that shareholders perceive firms with improved environmental risk management (i.e., higher CER) as less risky, and thus reduce the risk premium they require. This finding is robust to using alternative specifications and proxies for the cost of equity capital, to accounting for noise in analyst forecasts, to using alternative samples, and to specifying alternative and additional independent variables. Importantly, our results continue to hold when we address potential endogeneity using instrumental variables and generalized methods of moment (GMM) estimation. In additional analyses, we find that the relation between environmental costs and equity financing costs holds across different legal, economic, and geographic settings. Taken together, the results provide consistent support for investment in CER reducing a firm's perceived risk and in turn its equity financing costs worldwide.

This paper contributes to the literature in several ways. First, previous research focuses primarily on outcomes of CSR as measured by indices that rate firms according to dimensions such as community and employee relations, product quality, environment, human rights, and diversity. For example, El Ghoul et al. (2011) find for a sample of US firms that a firm's overall CSR score is associated with a lower *implied* cost of equity capital. In this paper, we study the outcomes of CER—arguably one of the more important dimensions of CSR—using a more accurate proxy (i.e., dollar value of environmental costs). Second, prior studies on the CER–financial performance relation focus on accounting- or market-based measures of performance but have less to say about investors' perceptions of CER performance, although recent surveys and responses to environmental scandals suggest that investors are increasingly sensitive to CER. Our evidence that CER reduces a firm's cost of equity financing highlights one channel through which environmental responsibility influences firm performance. This result extends Sharfman and Fernando (2008), who also examine investors' perceptions of CER but estimate the cost of equity capital using the CAPM instead of the implied (*ex ante*) cost of equity capital approach. Third, while previous research has focused largely on CSR outcomes in a single country, namely, the US (e.g., Sharfman and Fernando 2008), in this paper we employ a cross-country sample over the 2002–2011 period. In doing so we respond to Sharfman and Fernando's (2008) call for research examining whether the negative relationship between CER and equity financing costs holds outside the US.

The remainder of this paper is organized as follows. In "Literature Review and Channels Linking CER and Equity Pricing" section, we discuss related research and outline the channels through which CER affects the cost of equity capital. In "Research Design" section, we describe our sample and empirical methodology. In "Empirical Results" section, we present the empirical results. "Conclusion" section, we conclude.

Literature Review and Channels Linking CER and Equity Pricing

Related Literature

While there is extensive evidence on the link between CSR and firm performance,[12] existing literature on the relation between CER—a component of CSR—and firm performance is limited and tends to focus on specific industries, particular aspects of CER (e.g., pollution), or a single country (e.g., the US). In an early study later questioned by Chen and Metcalf (1980), Spicer (1978) finds for a sample of firms from the pulp and paper industry that those with better pollution-control records are associated with higher profitability. Similarly, based on a sample of 50 bleached paper pulp firms in eight countries, Nehrt (1996) argues that early investment in pollution-reducing technologies can increase long-term financial performance by reducing unit production costs and enhancing sales.

Using ratings on environmental compliance and prevention efforts, Russo and Fouts (1997) test the relation between environmental and economic performance for a sample of 243 firms. They find that firms with environment-friendly policies are associated with higher economic performance. Similarly, Guenster et al. (2011) document a positive relation between environmental performance and both accounting- and market-based measures of performance for a panel of US firms from 1997 to 2004. Using data drawn from the corporate environmental profile of the Investor Responsibility Research Center (IRRC), Hart and Ahuja (1996) study the association between emissions reduction and firm performance. They find that reducing emissions increases efficiency and reduces expenses, resulting in a cost advantage for firms. Similarly, using the IRRC corporate environmental profile of US multinational firms, Dowell et al. (2000) document that the adoption of a single stringent environmental standard has a positive market valuation (Tobin's q) effect. Kim and Statman (2012) suggest that US companies appear to act in shareholders' interest, increasing or decreasing CER investment as necessary to improve firm performance.

[12] For an overview of this literature, see Orlitzky et al. (2003), Margolis et al. (2007), and Baron et al. (2011).

Evidence on the effect of environmental costs on firm performance is scarcer. Thomas et al. (2007) are among the first to use Trucost environmental cost data. They, however, examine only 33 US electric power companies for the year 2004. They find that value-added becomes negative after environmental costs are taken into account, although most firms have a positive EVA. In contrast, using Trucost data for S&P 500 companies, Dawkins and Fraas (2011) find a positive relation between environmental performance and voluntary climate change disclosure.

In sum, prior literature documents a largely positive relationship between CER and firm performance. The literature has little to say, however, about investors' reactions to CER investment, and thus the extent to which a firm's environmental risk management affects its cost of capital remains an open question (Sharfman and Fernando 2008).[13,14] Further, to the best of our knowledge, no cross-country study investigates the effect of a firm's environmental performance on its equity financing costs. In this paper we fill these gaps in the literature by examining the effect of environmental performance on the cost of equity capital for manufacturing firms from 30 countries.

How Does CER Affect Equity Pricing?

The premise in this paper is that CER—as an important component of CSR—is negatively related to firms' cost of equity capital. Building on El Ghoul et al. (2011), we argue that this relationship is driven by environmentally irresponsible firms having (1) higher risk and (2) a narrower investor base.

Risk Channel

CSR can be viewed as a hedging device that reduces equity costs by reducing firm risk. In a perfect Modigliani and Miller world, corporate hedging is irrelevant because shareholders can reduce risk on their own. However, in the presence of financial market frictions such as financial distress and bankruptcy costs, hedging can increase firm value (Smith and Stulz 1985). In particular, CSR can serve as a hedging tool by reducing both the *probability* and the *costs* of adverse events. First, socially responsible firms seek to reduce conflicts with stakeholders, and thus suffer fewer adverse events such as strikes, product recalls, environmental scandals, etc. For example, Chatterji et al. (2009) find that firms with poor CSR scores produce significantly more pollution and commit more regulatory compliance violations than other firms, Hong and Kacperczyk (2009) argue that "sin" stocks (e.g., tobacco, alcohol, and gaming firms) face higher litigation risk than other firms, and Shane and Spicer (1983) show that disclosure of socially oriented information affects a firm's perceived level of compliance.

Second, socially responsible firms benefit from moral capital among stakeholders that can moderate the impact to relational wealth if an adverse event occurs (Godfrey 2005). The idea is that stakeholders do not penalize socially responsible firms facing an adverse event to the same degree as socially irresponsible firms facing an adverse event. In line with this view, Williams and Barrett (2000) provide evidence that corporate philanthropy can reduce the reputation losses due to regulatory violations. Koh et al. (2014) find that the insurance effect of CSR is more valuable for firms with higher litigation risks. Godfrey et al. (2009) find that abnormal stock returns around announcements of negative legal/regulatory actions against firms are higher for socially responsible firms compared to other firms. Minor and Morgan (2011) report similar results for S&P 500 firms around announcements of product recalls. Lins et al. (2015) document that, during the 2008–2009 financial crisis, high-CSR firms exhibit higher stock returns than low-CSR firms.

A related stream of research explores the link between CSR and firm risk. For instance, Boutin-Dufresne and Savaria (2004) and Lee and Faff (2009) document that low-CSR firms exhibit significantly higher idiosyncratic risk, while Albuquerque et al. (2013) document that low-CSR firms have higher systematic risk. Feldman et al. (1997, p. 89) show that firms that adopt an "environmentally proactive posture" significantly reduce their perceived risk. Attig et al. (2013) further show that high-CSR firms exhibit higher credit ratings, consistent with the idea that these firms have lower risk.

[13] A notable exception is Brammer et al. (2006), who investigate the relationship between corporate social performance and stock returns of UK firms. They observe that firms with higher environmental performance realize lower stock returns. We present cross-country evidence on the relation between CER and the cost of equity capital for an institutionally diverse sample of 30 countries from 2002 to 2011.

[14] A handful of studies examine the effects of CER on debt financing costs. Focusing on the most polluting US industries—chemical and pulp and paper—Schneider (2011) argues that toxic emissions increase firm's bankruptcy risks and thus lead to more expensive bond prices. Graham et al. (2001) investigate new bond issues over the 1990–1992 period and find environmental liability information negatively influences bond ratings. Similarly, Bauer and Hann (2010) demonstrate that environmental incidents constitute meaningful risks for investors in the non-secured publicly traded debt market. They find that CER is generally associated with a lower cost of debt and higher credit ratings. Chava (2014) provides evidence that bank lenders charge a significantly higher interest rate on loans to firms with environmental concerns (such as hazardous chemical, substantial emissions, and climate change concerns).

Investor Base Channel

In addition to the risk channel, we argue that firms with higher environmental costs observe higher equity financing costs due to a narrower investor base. In a model in which "neutral" investors hold shares of polluting and clean firms, while "green" investors only hold shares of clean firms, Heinkel et al. (2001) show that the exclusionary investing by green investors leads to fewer investors willing to hold polluting firms' shares. This lack of risk sharing (Merton 1987) leads in turn to lower share prices and a higher cost of capital for firms with higher environmental costs.

Empirically, Chava (2014) provides supporting evidence that investor preferences explain the higher financing costs of environmentally irresponsible firms. He documents that firms with hazardous waste and climate change concerns attract fewer institutional investors. He also finds that that loan syndicates of borrowers with environmental concerns comprise fewer banks. Hong and Kacperczyk (2009) examine sin stocks and find that norm-constrained institutional investors (e.g., pension plans) include fewer sin stocks in their portfolios compared to arbitrageurs (e.g., mutual or hedge funds). Consistent with Hong and Kacperczyk (2009), El Ghoul et al. (2011) show that among sin stocks in the US, firms related to the tobacco and nuclear power industries have a significantly higher cost of equity capital.

Research Design

Sample Construction

To investigate the relation between CER and the cost of equity financing, we employ the following databases: (a) Trucost, which provides information on environmental costs for listed firms from 30 countries, (b) I/B/E/S, which we use to obtain consensus analyst earnings forecasts and stock prices, and (c) Compustat,[15] which we use to collect financial data such as dividends and book value. Since we are interested in estimating firms' implied cost of equity capital, we follow prior research and exclude firm-year observations that do not show positive 1- and 2-year-ahead earnings forecasts or positive 3-year-ahead or long-term growth (LTG) forecasts. These restrictions allow us to calculate all four individual cost of equity estimates outlined in the next section. The unbalanced panel data used in our paper consist of 7122 firm-year observations over the 2002–2011 period.

Cost of Equity Estimates

Following Hail and Leuz (2006), Dhaliwal et al. (2006), and El Ghoul et al. (2011), we estimate the cost of equity capital implied by analysts' earnings forecasts and stock prices using the four models developed by Claus and Thomas (2001, K_{CT}), Gebhardt et al. (2001, K_{GLS}), Ohlson and Juettner-Nauroth (2005, K_{OJ}), and Easton (2004, K_{ES}). In our main analysis, we use our dependent variable as the average estimate obtained from the four individual models (K_{AVG}). These models constitute an appealing alternative to the failure of traditional asset pricing models to capture the cost of equity (Elton 1999; Fama and French 1997; Pástor et al. 2008; El Ghoul et al. 2015). "Appendix 1" section summarizes these four models.

Environmental Costs

We employ environmental cost data from Trucost to capture firms' CER, which analyzes the environmental performance of more than 4000 companies around the world. Trucost provides dollar values of firms' environmental costs worldwide. The database applies a uniform methodology to calculate firms' environmental costs, which is based on an input–output model that assesses firms' environmental impact across operations, supply chains, and investment portfolios.[16] Trucost's advanced environmental profiling model tracks over 100 environmental events for over 464 industries worldwide, examining the interactions and cash flows between sectors to map each sector's supply chain. It then converts quantity-based information into financial values. The value applied to each event captures the event's cost to society and is derived from prior environmental economics literature (Trucost 2008).[17]

A firm's environmental costs are based on six areas of direct and indirect emissions: greenhouse gases (GHGs), water, waste, land and water pollutants, air pollutants, and natural resource use.[18] A reduction in these costs indicates how efficiently the company manages its resources in terms of environmental performance. Jo et al. (2015a) argue that

[15] Canadian and US firms' financial statement data are from the Compustat North America file, while data for firms from the rest of the world are from the Compustat Global file.

[16] Input–output modeling shows the amount of resources required to produce a unit of output, and where this output is sold. Trucost uses a global input–output model based on detailed government census and survey data on resource use and pollutant releases, industry data and statistics, and national economic accounts for over 700 environmental resources (Trucost 2008).

[17] For more details on Trucost methodology, we refer the reader to http://www.trucost.com/methodology.

[18] See "Appendix 2" section for a detailed explanation of the Trucost data.

a reduction in environmental costs is achieved at the expense of CER investment, for example, clean technology and environmental research and development (R&D). The environmental cost data therefore reflect the outcome of firms' investment in CER.[19]

As pointed out by Jo et al. (2015a), the extant corporate finance literature (e.g., Kim and Statman 2012; Deng et al. 2013) mostly relies on the KLD Research and Analytics database to calculate CSR (or CER) scores. However, the KLD database has two limitations. First, it examines CSR (or CER) characteristics of firms qualitatively, only reporting binary figures. Second, since KLD has been adding and eliminating evaluation items over time, the CSR (or CER) scores cannot easily be compared between different time periods. In contrast, the Trucost environmental cost data more accurately estimate CER by specifying the dollar value of environmental costs. Thus, unlike environmental performance data used in prior studies, our data can provide more insight into firms' environmental responsibility.

Empirical Model and Variables

To examine the relation between CER and the cost of equity financing, we estimate the following model:

$$\begin{aligned} K_{\mathrm{AVG}_{it}} = {} & \beta_0 + \beta_1 \mathrm{ENVCOST}_{it-1} + \beta_2 \mathrm{RVAR}_{it-1} \\ & + \beta_3 \mathrm{BTM}_{it-1} + \beta_4 \mathrm{LEV}_{it-1} + \beta_5 \mathrm{INFL}_{it+1} \\ & + \beta_6 \mathrm{SIZE}_{it-1} + \beta_7 \mathrm{FBIAS}_{it-1} + \beta_8 \mathrm{DISP}_{it-1} \\ & + \beta_9 \mathrm{LGDPC}_{it-1} \\ & + \text{year, industry, and country fixed effects} + \varepsilon_{it}, \end{aligned} \tag{1}$$

where i indexes firms, t indexes time, K_{AVG} is the cost of equity capital implied from contemporaneous stock prices and consensus analyst forecasts based on the four models discussed above. ENVCOST is the ratio of (external) environmental costs–total assets.[20] Our prediction of a negative relation between CER and the cost of equity capital implies a positive relation between ENVCOST and the cost of equity, that is, a positive β_1. Following prior research, we include in Eq. (1) the following control variables. RVAR is the volatility of stock returns over the previous 12 months (Hail and Leuz 2006, 2009).[21] BTM is the ratio of the book value to the market value of equity. Fama and French (1992) argue that firms with higher book-to-market are expected to earn higher *ex post* returns, which implies that higher book-to-market firms tend to have higher costs of equity capital. LEV is the leverage ratio defined as the ratio of long-term debt–total assets. Consistent with Modigliani and Miller's (1958) model, empirical studies find a positive relation between leverage and the implied cost of equity (e.g., Gode and Mohanram 2003; Botosan and Plumlee 2005). INFL is the realized inflation rate over the next year. We control for INFL because analyst earnings forecasts are expressed in nominal terms and local currencies implying that the cost of equity capital reflects countries' expected inflation rates (Hail and Leuz 2009). SIZE is the natural logarithm of total assets. Fama and French (1992) argue that larger firms are expected to earn higher *ex post* returns. FBIAS is the signed forecast error defined as the difference between the 1-year-ahead consensus earnings forecast and realized earnings deflated by beginning-of-period assets per share. Easton and Sommers (2007) find that analysts' upward forecast bias would inflate the implied cost of equity capital estimates. Thus, we use the signed forecast error to control for analysts' optimism bias. DISP is the dispersion in analyst forecasts defined as the coefficient of variation of 1-year-ahead analyst forecasts of earnings per share. A higher dispersion means wider disagreement among analysts, which implies greater uncertainty about the forecasted earnings (Guedhami and Mishra 2009). LGDPC is the natural logarithm of real GDP per capita, which is widely used in cross-country analysis to control for the countries' economic development. Finally, we control for year, industry, and country fixed effects with robust standard errors clustered at the firm level following Hail and Leuz (2006).[22]

Table 1 provides descriptive statistics for the variables used in our empirical tests. Panel A reports information on sample composition by country, as well as the country-level mean for each variable. Panel B presents summary statistics based on the full sample.

[19] In other words, the environmental costs of high CER firms should be lower.

[20] Firm-level environmental costs are directly related to firm size. For example, large firms have generally higher absolute environmental costs than small firms. Thus, we measure environmental costs relative to firm size, i.e., we normalize environmental costs by total assets to control for size effects (Kim et al. 2015). As a test of robustness, we re-estimate our baseline regression using environmental costs–sales and the logarithm of environmental costs as alternative proxies of environmental costs. Our results are robust to using these alternative proxies of environmental costs. We discuss these tests in more detail later in the paper.

[21] We proxy for firm risk using the volatility of stock returns instead of beta following Hail and Leuz (2006, 2009). This design choice allows us to avoid taking a position on whether international equity markets are integrated. Specifically, if equity markets are segmented, one should use a local equity index to estimate a firm's beta. However, if equity markets are integrated, one would use a world equity index. Nonetheless, we find that our evidence remains when we control for beta instead of the volatility of stock returns.

[22] Since firm fixed effects would be perfectly correlated with industry and country fixed effects, we do not include firm fixed effects in our equity pricing regressions (Khurana and Raman 2004; Lawrence et al. 2011).

Table 1 Descriptive statistics for firm characteristics

Countries	Obs.	K_{AVG}	K_{CT}	K_{GLS}	K_{OJ}	K_{ES}	ENVCOST	RVAR	BTM	LEV	INFL	SIZE	FBIAS	DISP	LGDPC
Panel A: mean by country															
Australia	337	14.992	11.503	13.063	16.894	19.478	0.031	2.559	0.416	0.662	0.166	7.192	0.855	0.215	10.500
Austria	51	11.264	10.256	10.968	11.795	12.523	0.022	2.322	0.318	0.843	0.173	8.503	0.177	0.177	10.574
Belgium	34	11.618	9.890	12.271	12.936	12.529	0.007	2.436	0.234	0.557	0.277	9.060	−0.212	0.110	10.510
Canada	253	12.364	9.470	9.678	13.034	15.544	0.028	1.709	0.336	0.598	0.180	8.460	0.680	0.195	10.478
Chile	181	15.230	12.244	17.155	14.750	14.615	0.046	3.249	0.397	1.633	0.125	8.896	0.339	0.173	8.075
Denmark	44	13.058	11.636	11.669	13.443	14.061	0.026	2.011	0.357	0.969	0.162	8.475	0.258	0.206	10.747
Finland	88	11.713	10.943	9.488	13.643	14.093	0.017	2.352	0.344	0.643	0.162	8.164	−0.052	0.146	10.551
France	226	12.009	10.853	10.530	12.992	13.427	0.014	1.677	0.309	0.738	0.204	9.606	0.008	0.153	10.446
Germany	211	11.937	10.251	9.854	13.466	14.319	0.012	1.748	0.343	0.638	0.159	8.758	0.212	0.193	10.498
Hong Kong	112	12.610	11.105	12.945	13.545	13.056	0.064	3.662	0.315	0.721	0.190	9.117	0.112	0.114	10.357
India	295	13.531	14.285	10.756	15.743	12.740	0.049	9.169	0.410	0.447	0.176	7.874	−0.033	0.129	6.928
Italy	106	12.238	10.856	10.050	13.464	14.467	0.021	2.158	0.301	0.883	0.251	9.487	0.246	0.208	10.279
Japan	861	10.121	9.056	6.021	12.754	13.675	0.012	0.438	0.308	0.886	0.153	9.069	0.250	0.179	10.502
Malaysia	115	9.748	9.061	7.582	11.473	11.219	0.055	2.332	0.215	0.591	0.209	7.872	0.083	0.122	8.748
Mexico	64	13.147	12.453	12.227	12.920	12.507	0.015	4.173	0.311	0.808	0.212	8.582	0.549	0.167	9.014
Netherlands	75	12.451	11.654	10.420	13.737	14.857	0.006	2.131	0.326	0.674	0.213	8.927	0.462	0.180	10.616
Norway	62	14.081	10.473	13.472	14.905	16.426	0.022	1.744	0.391	0.647	0.166	8.465	0.086	0.233	11.035
Philippines	52	12.518	11.585	10.846	14.277	13.912	0.045	3.757	0.340	0.693	0.234	7.636	0.253	0.111	7.236
Poland	75	13.793	11.731	12.619	16.045	15.043	0.067	2.993	0.366	0.864	0.109	7.795	0.200	0.254	9.222
Russia	41	17.497	15.262	16.768	20.340	20.948	0.045	6.187	0.346	0.875	0.164	9.960	0.958	0.272	8.808
Singapore	73	11.740	10.639	10.869	12.889	12.352	0.057	3.660	0.328	0.575	0.125	8.172	−0.156	0.099	10.239
South Korea	301	13.731	13.631	10.425	15.662	16.537	0.015	2.213	0.384	0.735	0.124	8.389	1.149	0.142	9.941
Spain	106	11.772	10.362	12.476	11.749	11.948	0.012	2.417	0.302	0.670	0.253	9.421	0.249	0.175	10.151
Sweden	114	12.132	10.693	11.510	13.260	13.700	0.011	1.306	0.310	0.699	0.200	8.741	−0.102	0.123	10.661
Switzerland	90	10.282	9.190	8.892	11.432	12.007	0.008	0.790	0.296	0.546	0.153	8.716	0.151	0.139	10.905
Taiwan	411	11.682	11.019	9.418	13.022	13.592	0.016	1.507	0.341	0.626	0.105	7.737	0.537	0.123	9.861
Thailand	72	12.285	11.463	10.771	13.929	13.184	0.072	3.238	0.322	0.632	0.242	8.187	0.537	0.120	8.040
Turkey	51	14.896	14.453	11.674	17.215	16.329	0.016	9.205	0.366	0.758	0.185	8.312	−0.003	0.232	8.984
UK	865	13.167	11.997	11.612	13.975	14.267	0.015	3.108	0.357	0.640	0.157	7.264	0.154	0.131	10.546
US	1756	11.629	9.666	9.735	11.467	13.209	0.022	2.150	0.335	0.517	0.232	8.834	−0.028	0.089	10.690
All countries	7122	12.234	10.769	10.225	13.266	14.050	0.023	2.460	0.341	0.676	0.181	8.440	0.236	0.142	10.159

Table 1 continued

	Mean	Median	SD	Min.	P25	P75	Max.
Panel B: full-sample summary statistics							
K_{AVG}	12.234	11.146	4.761	5.310	9.286	13.822	35.444
K_{CT}	10.769	10.039	4.060	3.859	8.203	12.437	28.516
K_{GLS}	10.225	9.634	4.049	3.242	7.470	12.180	25.177
K_{OJ}	13.266	12.329	4.807	4.876	10.024	15.482	31.464
K_{ES}	13.942	12.430	6.464	3.907	9.740	16.559	40.964
ENVCOST	0.023	0.003	0.056	0.000	0.001	0.016	0.375
RVAR	2.460	2.076	2.004	0.009	1.478	3.141	41.920
BTM	0.341	0.310	0.165	0.096	0.225	0.416	0.998
LEV	0.676	0.559	0.523	−0.012	0.344	0.860	3.625
INFL	0.181	0.163	0.144	0.000	0.061	0.268	0.627
SIZE	8.440	8.437	1.531	2.171	7.506	9.428	12.877
FBIAS	0.236	0.000	1.807	−5.069	−0.424	0.535	10.108
DISP	0.142	0.071	0.271	0.000	0.034	0.140	2.333
LGDPC	10.159	10.517	0.946	6.472	10.253	10.674	11.334

Panel A reports the number of observations and means of the regression variables by country. Panel B reports descriptive statistics of the regression variables for our full sample of 7122 firm-year observations from 30 countries over the period 2002–2011. K_{AVG} (%), our dependent variable, is the average cost of equity obtained from four models developed by Claus and Thomas (2001), Gebhardt et al. (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004). K_{CT} (%) is the implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end. K_{GLS} (%) is the implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end. K_{OJ} (%) is the implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end. K_{ES} (%) is the implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). RVAR (%) is the volatility of stock returns over the previous 12 months. BTM is book value to the market value of equity. LEV is leverage ratio defined as the ratio of long-term debt–total assets. SIZE is defined as natural logarithm of total assets recorded in millions of dollars. FBIAS is signed forecast error defined as the difference between the 1-year-ahead consensus earnings forecast and realized earnings deflated by beginning of period assets per share. DISP is dispersion of analyst forecasts defined as the coefficient of variation of 1-year-ahead analyst forecasts of earnings per share. LGDPC is natural logarithm of real GDP per capita. "Appendix 3" section outlines definitions and data sources for all variables

Table 2 Pearson correlation coefficients

	K_{AVG}	K_{CT}	K_{GLS}	K_{OJ}	K_{ES}	ENV.	RVAR	BTM	LEV	INFL	SIZE	FBIAS	DISP
K_{CT}	**0.792**												
K_{GLS}	**0.690**	**0.482**											
K_{OJ}	**0.894**	**0.653**	**0.428**										
K_{ES}	**0.873**	**0.468**	**0.416**	**0.805**									
ENVCOST	**0.079**	**0.061**	**0.133**	**0.078**	**0.049**								
RVAR	**0.396**	**0.251**	**0.335**	**0.313**	**0.372**	0.007							
BTM	**0.229**	**0.070**	**0.378**	**0.188**	**0.214**	**0.054**	**0.177**						
LEV	**0.039**	0.026	0.020	−0.018	0.015	**0.083**	**−0.041**	−0.015					
INFL	**0.137**	**0.261**	**0.225**	**0.148**	**−0.026**	**0.122**	**0.089**	**−0.081**	0.020				
SIZE	**−0.140**	**−0.098**	−0.016	**−0.127**	**−0.129**	**0.052**	**−0.248**	**0.142**	**0.284**	**−0.132**			
FBIAS	**0.203**	**0.157**	**0.152**	**0.190**	**0.202**	0.023	**0.109**	−0.024	**−0.042**	**−0.048**	**−0.101**		
DISP	**0.258**	**0.063**	**0.109**	**0.256**	**0.358**	**0.041**	**0.205**	**0.189**	**0.054**	−0.011	−0.020	**0.116**	
LGDPC	**−0.103**	**−0.217**	**−0.157**	**−0.156**	0.017	**−0.158**	**−0.074**	**−0.079**	**0.052**	**−0.641**	**0.087**	−0.010	−0.014

This table reports the Pearson correlation between the regression variables. K_{AVG} (%), our dependent variable, is the average cost of equity obtained from four models developed by Claus and Thomas (2001), Gebhardt et al. (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004). K_{CT} (%) is the implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end. K_{GLS} (%) is the implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end. K_{OJ} (%) is the implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end. K_{ES} (%) is the implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). Correlation coefficients reported in bold are significant at the 1 % level. "Appendix 3" section outlines definitions and data sources for all variables

Table 2 reports Pearson correlations between the *ex ante* cost of equity capital estimates and the independent variables in Eq. (2). In line with our expectations, the correlation coefficients between our proxies for the cost of equity capital (K_{AVG}) and environmental costs (ENVCOST), and its four individual costs of equity estimates (i.e., K_{CT}, K_{GLS}, K_{OJ}, and K_{ES}) and ENVCOST are positive and statistically significant at the 1 % level. We also find low pairwise correlation coefficients among the control variables, reducing concerns that multicollinearity could be driving our regression results below.

Empirical Results

In this section we empirically examine the relation between CER and the cost of equity capital. In "Univariate Tests" section we perform univariate tests that compare the equity financing costs of firms with low environmental costs and firms with high environmental costs. In "Multivariate Regression Analysis" section, we perform multivariate regression analysis to examine the effect of CER on the cost of equity financing while controlling for other factors previously shown to affect firms' cost of equity. We perform robustness tests in "Robustness Tests" section. Finally, we explore the relation between CER and the cost of equity across subsamples in "Additional Analyses: Evidence Across Subsamples" section.

Univariate Tests

To provide initial evidence on the CER–equity pricing relationship, in Table 3 we compare the mean and median cost of equity capital (K_{AVG}) of firms with low ENVCOST and firms with high ENVCOST, where high and low ENVCOST firms are those with above- and below-median ENVCOST, respectively. We find that the mean equity financing cost of firms with low ENVCOST is 12.16 %, while it is 12.55 % for firms with high ENVCOST. This suggests that the mean equity financing cost of firms with low ENVCOST (i.e., high CER) is 39 basis points lower than that of firms with high ENVCOST (i.e., low CER). The difference is statistically significant at the 5 % level, and supports our prediction that, worldwide, firms with a high level of CER enjoy a lower cost of equity capital. For robustness, we examine differences in means using the four individual costs of equity estimates. The results again show that equity financing costs are significantly higher for firms with high ENVCOST. When we examine the differences in medians, we continue to find supportive results.

Table 3 also shows the differences in mean and median values of control variables across low ENVCOST firms and high ENVCOST firms. The results show that, on average, high ENVCOST firms are safer, have higher book-to-market and leverage ratios, are larger, and have higher analyst forecast bias and dispersion. These differences are broadly consistent with a growth versus value dichotomy

Table 3 Univariate tests

	Means			Medians		
	(1) Low-ENVCOST (Obs. = 3561)	(2) High-ENVCOST (Obs. = 3561)	(1) − (2) Difference *t*-test	(3) Low-ENVCOST (Obs. = 3561)	(4) High-ENVCOST (Obs. = 3561)	(3) − (4) Difference *z*-test
K_{AVG}	12.159	12.547	−0.388**	10.982	11.348	−0.366***
K_{CT}	10.775	11.064	−0.289***	10.058	10.016	0.042
K_{GLS}	9.791	10.774	−0.983***	9.278	10.064	−0.786***
K_{OJ}	12.885	13.886	−1.001***	12.078	12.643	−0.565***
K_{ES}	13.626	14.500	−0.874***	12.152	12.736	−0.584***
RVAR	0.344	0.338	0.006***	0.313	0.307	0.006**
BTM	0.637	0.715	−0.078***	0.511	0.603	−0.092***
LEV	0.170	0.191	−0.021***	0.145	0.181	−0.036***
INFL	2.326	2.594	−0.268***	2.076	2.076	0.000
SIZE	8.324	8.557	−0.233***	8.314	8.570	−0.256***
FBIAS	0.174	0.298	−0.124***	−0.026	0.006	−0.032***
DISP	0.133	0.152	−0.019***	0.064	0.078	−0.014***
LGDPC	10.237	10.080	0.157***	10.524	10.504	0.020***

This table reports mean and median difference tests of the regression variables across the low-ENVCOST (below median ENVCOST) and high-ENVCOST (above median ENVCOST) subsamples. K_{AVG} (%), our dependent variable, is the average cost of equity obtained from four models developed by Claus and Thomas (2001), Gebhardt et al. (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004). K_{CT} (%) is the implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end. K_{GLS} (%) is the implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end. K_{OJ} (%) is the implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end. K_{ES} (%) is the implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). The superscript asterisks *** and ** denote two-tailed statistical significance at the 1 and 5 % levels, respectively. "Appendix 3" section outlines definitions and data sources for all variables

whereby growth (value) stocks exhibit higher (lower) volatility, lower (higher) book-to-market ratios, and smaller (larger) size. On the one hand, low ENVCOST firms are more likely to belong to nonpolluting industries such as high tech industries, which usually comprise growth stocks. On the other hand, high ENVCOST firms are more likely to belong to polluting industries such as utility and basic resource industries, which typically comprise value stocks. The results also show that high ENVCOST firms are located in countries with lower incomes per capita and higher inflation rates, which are characteristics of developing countries.

Multivariate Regression Analysis

To further examine the association between the cost of equity capital and CER, we regress equity financing costs (K_{AVG}) on the ratio of environmental costs–total assets (ENVCOST) and varying sets of control variables.[23] We use a panel structure from our dataset and employ year, industry, and country fixed effects in all regressions with robust standard errors clustered at the firm level. In column 1 of Table 4, we examine the impact of CER on equity financing costs while controlling for year, industry, and country fixed effects. We find that the coefficient on ENVCOST is positive and statistically significant at the 1 % level, indicating that firms with better environmental responsibility have a significantly lower cost of equity capital. This finding continues to hold when we control in column 2 for additional firm- and country-specific variables—namely, RVAR, BTM, LEV, INFL, SIZE, FBIAS, DISP, and LGDPC as discussed in "Empirical Model and Variables" section—we find that the coefficient on ENVCOST is positive and statistically significant at the 1 % level. Together with the univariate results, these findings suggest that firms with high environmental costs (i.e., low CER) have higher perceived risk, and are consistent with CER investment decreasing firm risk by reducing the probability and impact of adverse events, and enhancing the firm's investor base.

In columns 3–6 of Table 4, we examine whether the documented relation between CER and equity financing costs continues to hold when we separately investigate the

[23] Recall that our main independent variable of interest, ENVCOST, reflects the level of CER because increasing CER investment lowers (external) environmental costs.

Table 4 Environmental costs and the cost of equity capital

	Full sample		Pre-crisis (2002–2006)	Crisis (2007–2008)	Post-crisis (2009–2011)
	(1)	(2)	(3)	(4)	(5)
ENVCOST	5.507***	3.971***	4.970**	2.870	3.791***
	(3.43)	(3.28)	(2.04)	(1.38)	(2.74)
RVAR		8.042***	5.748***	5.989***	10.380***
		(13.33)	(3.86)	(6.28)	(12.35)
BTM		1.753***	0.961*	1.061***	2.185***
		(10.22)	(1.96)	(3.92)	(10.78)
LEV		3.622***	4.353***	2.006**	4.097***
		(6.38)	(3.31)	(2.07)	(6.19)
INFL		−0.006	−0.100	−0.488*	−0.084
		(−0.10)	(−0.95)	(−1.70)	(−0.76)
SIZE		−0.186***	−0.437***	0.070	−0.209***
		(−3.11)	(−3.75)	(0.66)	(−3.04)
FBIAS		0.301***	0.122	0.294***	0.344***
		(6.56)	(1.40)	(2.80)	(5.77)
DISP		2.470***	2.734***	1.768***	2.569***
		(9.07)	(3.96)	(3.95)	(6.39)
LGDPC		−0.255	0.241	−0.852*	0.008
		(−0.75)	(0.31)	(−1.90)	(0.02)
INTERCEPT	14.877***	11.780***	9.776	22.971***	10.012**
	(23.01)	(3.29)	(1.18)	(4.79)	(2.23)
Year effects	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm
Obs.	7122	7122	984	1467	4671
Adj. R^2	0.155	0.334	0.271	0.357	0.383

This table presents estimation results from regressing the implied cost of equity capital (K_{AVG}) on external environmental costs–total assets (ENVCOST) and controls for the full sample of 7122 firm-years from 30 countries. K_{AVG} (%), our dependent variable, is the average cost of equity obtained from four models developed by Claus and Thomas (2001), Gebhardt et al. (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004). K_{CT} (%) is the implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end. K_{GLS} (%) is the implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end. K_{OJ} (%) is the implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end. K_{ES} (%) is the implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). All regressions include (unreported) year, industry, and country fixed effects. Beneath each coefficient estimate is reported the *t*-statistic based on robust standard errors adjusted for clustering by firm. The superscript asterisks ***, **, and * denote two-tailed statistical significance at the 1, 5, and 10 % levels, respectively. "Appendix 3" section outlines definitions and data sources for the regression variables

recent global financial crisis period and the pre- and post-global financial crisis periods. To do so, we re-estimate the regressions above after partitioning the full sample period into three sub-sample periods as follows: pre-crisis (2002–2006), crisis (2007–2008), and post-crisis (2009–2011). In the pre- and post-crisis periods, we find a significant positive relation between ENVCOST and equity financing costs (K_{AVG}). In contrast, we find that the coefficient on ENVCOST is positive but statistically insignificant during the crisis period. These results imply that during non-crisis periods, CER can help reduce the probability and costs of adverse events such as environmental scandals, while in times of crisis, coping with financial distress and bankruptcy costs become more important than decreasing the probability of adverse environmental events. In addition, the results are consistent with investor short-termism increasing during crisis periods, leading them to prefer firms with short-term financial performance to firms with long-term higher CER performance.

Robustness Tests

In this section, we examine whether our primary results are robust to using the individual cost of equity capital estimates as well as alternative cost of equity estimates, applying alternative model specifications, addressing noise in analyst forecasts, mitigating endogeneity concerns, and modifying the sample composition. Overall, these tests, which are summarized in Tables 5, 6, 7, 8, and 9, reinforce our finding that CER lowers the cost of equity capital.

Individual and Alternative Cost of Equity Capital Estimates

In Table 5, columns 1–4, we examine whether our main evidence is robust to using the individual cost of equity capital estimates (K_{CT}, K_{GLS}, K_{OJ}, and K_{ES}) as the dependent variable. Further, as detailed in "Appendix 1" section, the implied cost of equity models apply various assumptions about earnings growth rates and forecast horizons, and thus in columns 5–7 we re-estimate our baseline regression model using three alternative cost of equity capital estimates to ensure the assumptions underlying the four cost of equity models are not driving our results. In particular, in column 5 we measure the cost of equity using the forward earnings-to-price ratio (K_{FEYD}), which is defined as FEPS_{t+1} divided by P_t (Easton 2004),[24] in column 6 we use the price–earnings–growth (PEG) model, which assumes no dividend payments to estimate the equity premium using short-term earnings forecasts (K_{PEG}), and in column 7 we apply the trailing earnings yield (K_{TEYD}), which is defined as current EPS divided by P_t. In each of these specifications, we find that the significant positive relation between ENVCOST and equity financing costs continues to hold. In other words, firms with low ENVCOST (i.e., high CER) benefit from a lower cost of equity capital. In columns 8 and 9 we re-estimate the baseline regressions employing alternative growth assumptions because cost of equity estimates are sensitive to the underlying assumptions (Easton et al. 2002). In particular, in column 8 we employ a constant long-run growth rate of 3 %, and in column 9 we employ a perpetual growth rate equal to the annual real GDP growth rate plus long-run inflation rate (Hail and Leuz 2006) in computing the cost of equity using the Claus and Thomas (2001) and Ohlson and Juettner-Nauroth (2005) models.[25] The results of applying each of these alternative specifications show that ENVCOST is positively associated with firms' cost of equity capital.[26]

Noise in Analyst Forecasts

One concern in relying on analyst earnings forecasts to estimate equity financing costs is their accuracy and sluggishness,[27] which can lead to biased estimates of the cost of capital (Hail and Leuz 2006). We address this concern by excluding the top 5, 10, and 25 % of firm-year observations in the forecast optimism bias (FBIAS) distribution. The results reported in Table 6, columns 1–3, respectively, strongly support our earlier conclusions.[28] Second, we follow Hail and Leuz (2006) and control for analyst forecast accuracy by estimating weighted least squares regressions where the weight equals the inverse of the forecast error. This technique assigns less (more) weight to less accurate (more precise) forecasts. The evidence in column 4 shows that ENVCOST is significantly positively related to the cost of equity. Fourth, in columns 5 and 6, we tackle analyst forecast sluggishness by re-estimating the implied cost of equity capital using stock prices lagged by 4 months (measured 6 months after the fiscal year end instead of 10 months after the fiscal year end) following Guay et al. (2005) and Hail and Leuz (2006), and controlling for price momentum estimated as compound stock returns over the past 6 months following Guay et al. (2005) and Chen et al. (2009). The results strongly corroborate our earlier evidence. Overall, the results in Table 6 show that our main evidence that firms with high CER have a lower cost of equity continues to hold after mitigating concerns related to noise in analyst forecasts.

Endogeneity

As in related studies, one important concern in our analysis is potential endogeneity, which may affect interpretation of the causal relation between CER and the cost of equity

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24 FEPS_{t+1} is forecasted earnings for year $t + 1$ and P_t is stock price measured 10 months after the fiscal year-end.

25 In our main analysis, we assume that the perpetual growth rate is equal to the future inflation rate when we estimate the cost of equity following Claus and Thomas (2001) and Ohlson and Juettner-Nauroth (2005).

26 In untabulated tests, we examine whether our evidence is robust to alternative specifications for the cost of equity estimates. We use the median and the first principal component instead of the average of the four individual cost of equity models and employ the 'real' cost of equity by subtracting the inflation rate from the cost of capital. Our evidence remains intact.

27 For instance, Ali et al. (1992) argue that analysts have a tendency to react gradually to publicly available information.

28 In untabulated tests, we eliminate the top 5, 10, and 25 % of firm-year observations in the long-term growth forecast (LTG) distribution, respectively. We continue to find a significant positive relation between ENVCOST and the cost of equity capital.

Table 5 Robustness to alternative cost of equity capital estimates

	Individual cost of equity estimates				Alternative cost of equity estimates			Alternative long-run growth assumptions (country-level)	
	K_{CT}	K_{GLS}	K_{OJ}	K_{ES}	K_{FEYD}	K_{PEG}	K_{TEYD}	Long-run growth (3 %)	Real GDP growth + long-run inf. rate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ENVCOST	4.127***	4.335***	5.841***	3.564**	5.778***	3.326**	5.368***	3.910***	3.559***
	(2.80)	(3.88)	(3.08)	(1.98)	(4.03)	(2.03)	(3.15)	(2.92)	(2.66)
RVAR	5.677***	5.017***	7.265***	11.619***	4.160***	10.693***	4.563***	9.781***	9.566***
	(8.32)	(7.35)	(10.47)	(11.12)	(6.18)	(13.21)	(6.84)	(10.82)	(10.68)
BTM	0.859***	3.198***	1.258***	1.826***	1.072***	1.531***	1.611***	1.710***	1.973***
	(2.93)	(19.22)	(6.54)	(6.54)	(6.48)	(6.81)	(7.46)	(7.95)	(9.46)
LEV	3.857***	1.063**	2.443***	3.808***	0.976**	2.798***	0.169	3.872***	3.400***
	(6.89)	(2.46)	(4.13)	(4.48)	(2.09)	(3.88)	(0.28)	(5.55)	(4.88)
INFL	0.270**	−0.092	−0.100	−0.292**	−0.029	−0.245**	0.167	−0.120	−0.035
	(2.17)	(−1.26)	(−0.81)	(−2.07)	(−0.53)	(−2.16)	(1.51)	(−1.47)	(−0.41)
SIZE	0.024	0.277***	−0.096*	−0.371***	0.473***	−0.361***	0.609***	−0.236***	−0.234***
	(0.44)	(6.45)	(−1.68)	(−3.70)	(9.55)	(−4.36)	(10.13)	(−2.78)	(−2.78)
FBIAS	0.239***	0.274***	0.352***	0.444***	0.256***	0.368***	0.270***	0.336***	0.338***
	(3.96)	(7.66)	(5.25)	(5.16)	(4.46)	(5.09)	(5.05)	(4.85)	(4.96)
DISP	−0.137	−0.283	2.570***	5.490***	−4.853***	5.781***	−0.205	2.478***	2.428***
	(−0.38)	(−1.55)	(7.57)	(12.39)	(−19.35)	(14.46)	(−0.37)	(8.07)	(8.04)
LGDPC	−1.190***	0.766	−1.236***	−0.223	−0.558**	0.163	−0.029	−0.159	−0.663
	(−3.62)	(1.10)	(−3.36)	(−0.60)	(−1.98)	(0.39)	(−0.12)	(−0.43)	(−1.25)
INTERCEPT	17.510***	−3.524	24.025***	16.213***	6.744**	9.688**	−8.490	10.582***	16.717***
	(5.06)	(−0.48)	(6.22)	(4.08)	(2.26)	(2.21)	(−0.30)	(2.70)	(3.01)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Obs.	6444	6822	5900	6259	6970	6191	6528	7122	7122
Adj. R^2	0.200	0.518	0.257	0.299	0.270	0.339	0.200	0.273	0.276

This table presents estimation results from regressing the alternative implied cost of equity capital estimates on external environmental costs–total assets (ENVCOST) and controls for the full sample of 7122 firm-years from 30 countries. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). All regressions include (unreported) year, industry, and country fixed effects. Beneath each coefficient estimate is reported the *t*-statistic based on robust standard errors adjusted for clustering by firm. The superscript asterisks ***, **, and * denote two-tailed statistical significance at the 1, 5, and 10 % levels, respectively. "Appendix 3" section outlines definitions and data sources for the regression variables

Table 6 Robustness to noise in analyst forecasts

	Forecast optimism bias less than *j*th percentile			Noise in analyst forecasts		
	$j = 95\ \%$	$j = 90\ \%$	$j = 75\ \%$	Accuracy weighted regression	Sluggish forecasts	Price momentum
	(1)	(2)	(3)	(4)	(5)	(6)
ENVCOST	3.825***	3.732***	3.170**	3.264***	3.580***	2.907**
	(3.22)	(3.04)	(2.49)	(3.55)	(2.60)	(2.38)
RVAR	7.661***	7.759***	7.034***	7.932***	8.792***	7.056***
	(12.59)	(12.37)	(10.50)	(22.63)	(11.36)	(11.74)
BTM	1.791***	1.792***	1.828***	1.721***	2.242***	1.915***
	(10.51)	(10.34)	(9.92)	(16.72)	(10.06)	(10.30)
LEV	3.740***	3.762***	3.752***	3.678***	3.571***	3.157***
	(6.72)	(6.76)	(6.19)	(9.89)	(5.18)	(5.47)
INFL	0.024	0.009	0.055	−0.008	−0.006	0.011
	(0.38)	(0.15)	(0.81)	(−0.15)	(−0.10)	(0.14)
SIZE	−0.124**	−0.102*	−0.069	−0.224***	−0.238***	−0.001
	(−2.12)	(−1.73)	(−1.15)	(−5.85)	(−3.26)	(−0.01)
FBIAS	0.153**	0.125*	−0.152*	0.155***	0.157**	0.179***
	(2.44)	(1.73)	(−1.68)	(5.37)	(2.51)	(3.52)
DISP	2.439***	2.617***	2.279***	2.575***	2.124***	2.248***
	(8.75)	(9.09)	(6.70)	(14.30)	(7.09)	(6.83)
LGDPC	−0.099	−0.193	−0.189	−0.208	−0.321	−0.11
	(−0.23)	(−0.47)	(−0.46)	(−0.62)	(−0.75)	(−0.30)
MMT6						−3.151***
						(−12.80)
INTERCEPT	9.553**	10.430**	9.894**	11.953***	12.946***	9.735***
	(2.12)	(2.45)	(2.29)	(3.41)	(2.89)	(2.58)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm
Obs.	6766	6410	5342	7122	7118	5365
Adj. R^2	0.322	0.327	0.313	0.314	0.279	0.377

This table presents estimation results from regressing the implied cost of equity capital (K_{AVG}) on external environmental costs–total assets (ENVCOST) and controls for the full sample of 7122 firm-years from 30 countries. K_{AVG} (%), our dependent variable, is the average cost of equity obtained from four models developed by Claus and Thomas (2001), Gebhardt et al. (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004). K_{CT} (%) is the implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end. K_{GLS} (%) is the implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end. K_{OJ} (%) is the implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end. K_{ES} (%) is the implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). All regressions include (unreported) year, industry, and country fixed effects. Beneath each coefficient estimate is reported the *t*-statistic based on robust standard errors adjusted for clustering by firm. The superscript asterisks ***, **, and * denote two-tailed statistical significance at the 1, 5, and 10 % levels, respectively. "Appendix 3" section outlines definitions and data sources for the regression variables

Table 7 Robustness to endogeneity

	2SLS		Dynamic system GMM
	First stage	Second stage	
PREDICTED ENVCOST		4.933***	
		(3.47)	
ENVCOST_F0	0.804***		
	(140.76)		
ENVCOST_I0	0.060***		
	(4.21)		
ENVCOST			4.575**
			(2.25)
$K_{\mathrm{AVG}\ t-1}$			0.152**
			(2.03)
RVAR	−0.002	8.366***	6.369**
	(−1.26)	(14.87)	(2.41)
BTM	−0.001	1.632***	0.809***
	(−0.30)	(9.69)	(2.85)
LEV	0.005**	2.199***	1.747
	(2.49)	(3.99)	(1.47)
INFL	−0.001	0.337***	0.114
	(−0.50)	(6.06)	(1.62)
SIZE	−0.001***	−0.252***	−0.088
	(−3.58)	(−4.77)	(−0.07)
FBIAS	0.001	0.421***	0.223***
	(1.76)	(9.42)	(3.10)
DISP	0.001	2.473***	1.396**
	(0.11)	(8.79)	(2.05)
LGDPC	−0.002**	0.203**	0.826
	(−3.93)	(2.08)	(0.94)
Corr. of instruments	0.892/0.472		
(*p*)	(0.00)/(0.00)		
F-test of instruments	768.26		
(*p*)	(0.00)		
Sargan overidentification test		0.377	
(*p*)		(0.54)	
AR(1) test *p*			0.000
AR(2) test *p*			0.352
Sagan test of overid. *p*			0.562
Hansen test of overid. *p*			0.684
Diff-in-Hansen test of exog. *p*			0.344
Obs.	7122	7122	4294

Table 7 continued

	2SLS		Dynamic system GMM
	First stage	Second stage	
Adj. R^2	0.798	0.258	–

This table presents estimation results of two-stage least squares (2SLSs) and dynamic system GMM regressions of the implied cost of equity capital (K_{AVG}) on external environmental costs–total assets (ENVCOST) and controls for the full sample of 7122 firm-years from 30 countries. K_{AVG} (%), our dependent variable, is the average cost of equity obtained from four models developed by Claus and Thomas (2001), Gebhardt et al. (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004). K_{CT} (%) is the implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end. K_{GLS} (%) is the implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end. K_{OJ} (%) is the implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end. K_{ES} (%) is the implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). All regressions include (unreported) year, industry, and country fixed effects. Beneath each coefficient estimate is reported the *t*-statistic based on robust standard errors adjusted for clustering by firm. The superscript asterisks ***, **, and * denote two-tailed statistical significance at the 1, 5, and 10 % levels, respectively. The instruments used in 2SLS are: ENVCOST_F0, the initial environmental costs–total assets recorded when the firm enters the sample, and ENVCOST_I0, the industry average environmental costs to total assets in the first year of data. In 2SLS, we use Pearson correlation tests, *F*-tests, and Sargan's overidentification tests to confirm the robustness of our instrumental variables. In dynamic system GMM estimation, AR(1) and AR(2) tests are tests of first-order and second-order serial correlation in the first differenced residuals. The null hypothesis is no serial correlation. The Hansen test of overidentifying restrictions is a test of the joint null hypothesis that instrumental variables are valid, i.e., uncorrelated with error terms. The difference-in-Hansen test of exogeneity is a test of the null hypothesis that the subsets of instruments that we use in the levels equation are exogenous. Robust *z*-statistics are presented. Beneath each coefficient estimate is reported the *t*- or *z*-statistic. The superscript asterisks *** and ** denote two-tailed statistical significance at the 1 and 5 % levels, respectively. "Appendix 3" section outlines definitions and data sources for the regression variables

capital. In our context, endogeneity may arise from two sources. First, there is potential *measurement error* in CER—direct environmental costs (ENVCOST) are estimated by Trucost and might be subject to estimation errors. Second, there might be potential *omitted variables* that are correlated with both the cost of equity capital and CER, which we may have failed to include in the right-hand side of Eq. (1). In Table 7, we tackle this concern using two-stage least squares (2SLSs) estimation and dynamic system GMM. For 2SLS, in columns 1 and 2, we use the initial environmental costs to total assets recorded when the firm enters the sample (ENVCOST_F0) and the industry average environmental costs–total assets in the first year of data (ENVCOST_I0) as instruments. If CER is path-dependent, past CER will affect contemporaneous CER. In addition, it is likely that industry standards in terms of CER practices affect firm-level CER practices. However, lagged values of firm- and industry-level CER are unlikely to *directly* affect contemporaneous firm-level cost of equity capital. These instruments are predetermined because they have already been set before contemporaneous firm's cost of equity capital is determined.

Following Aggarwal et al. (2011), we confirm the robustness of our instrumental variables using Pearson correlation tests, *F*-tests, and Sargan overidentification tests, which are reported at the bottom of Table 7. As instrumental variables for 2SLS, we need variables that are highly correlated with the endogenous variable (i.e., ENVCOST), but uncorrelated with residual error term. The Pearson correlation tests show that our instrumental variables are highly correlated with ENVCOST. The *F*-tests also confirm that the hypothesis that instrumental variables can be excluded from the first-stage regressions is strongly rejected, which suggests that our instruments are not weak. The Sargan overidentification tests show a *p* value of 0.54, indicating that our instruments are not related to the residual error term. As can be seen in column 2 of Table 7, we continue to find evidence that CER reduces a firm's equity financing costs.[29]

[29] Alternatively, we employ the industry average environmental costs–total assets in the first year of data and a dummy variable for whether prior year's earnings are negative as instruments. We use a negative earning dummy variable because when previous year's earnings are negative, the firm has fewer resources to invest in CER. At the same time, it is unlikely that previous year's earnings will affect contemporaneous cost of equity. The (untabulated) results provide similar evidence to that reported in Table 7.

Table 8 Robustness tests to alternative and additional independent variables

	Alternative independent variables			Alternative control variables		Additional control variables	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ENVCOST				3.803***	3.826***	4.076***	4.561***
				(2.96)	(2.98)	(3.34)	(3.70)
ENV/SALES	1.129**						
	(2.01)						
LNENV		0.089**					
		(2.09)					
BCENV			2.428***				
			(3.55)				
BETA1YR				1.121***			
				(6.89)			
BETA2YR					2.150***		
					(12.65)		
R&D/SALES						4.479**	2.594
						(2.05)	(1.30)
ROA							−7.895***
							(−5.22)
RVAR	8.946***	8.975***	8.950***			7.898***	7.206***
	(14.86)	(14.94)	(14.92)			(13.32)	(13.13)
BTM	0.308	0.308	0.309	2.150***	2.154***	1.767***	1.494***
	(1.51)	(1.51)	(1.52)	(12.65)	(12.73)	(10.28)	(8.15)
LEV	3.385***	3.425***	3.420***	4.479***	4.403***	3.802***	2.814***
	(5.87)	(5.94)	(5.95)	(7.41)	(7.32)	(6.68)	(4.79)
INFL	0.009	0.010	0.010	−0.013	−0.022	−0.013	−0.020
	(0.14)	(0.16)	(0.16)	(−0.21)	(−0.38)	(−0.21)	(−0.31)
SIZE	−0.111*	−0.193***	−0.115*	−0.382***	−0.382***	−0.176***	−0.192***
	(−1.81)	(−2.71)	(−1.88)	(−5.70)	(−5.74)	(−2.98)	(−3.45)
FBIAS	0.279***	0.281***	0.279***	0.344***	0.347***	0.307***	0.310***
	(6.11)	(6.16)	(6.12)	(7.29)	(7.36)	(6.70)	(6.97)
DISP	2.836***	2.846***	2.822***	2.906***	2.856***	2.460***	2.158***
	(10.15)	(10.23)	(10.14)	(10.20)	(10.11)	(9.01)	(7.69)
LGDPC	−0.408	−0.391	−0.433	−0.131	−0.109	−0.275	−0.521*
	(−1.14)	(−1.07)	(−1.19)	(−0.34)	(−0.28)	(−0.82)	(−1.87)
INTERCEPT	13.625***	13.841***	16.931***	14.145***	13.827***	11.899***	15.546***
	(3.62)	(3.59)	(4.28)	(3.44)	(3.35)	(3.38)	(5.18)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8 continued

	Alternative independent variables			Alternative control variables		Additional control variables	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Obs.	7122	7122	7122	7122	7122	7122	7122
Adj. R^2	0.311	0.311	0.312	0.297	0.298	0.336	0.350

This table presents estimation results from regressing the implied cost of equity capital (K_{AVG}) on external environmental costs–total assets (ENVCOST) and controls for the full sample of 7122 firm-years from 30 countries. K_{AVG} (%), our dependent variable, is the average cost of equity obtained from four models developed by Claus and Thomas (2001), Gebhardt et al. (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004). K_{CT} (%) is the implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end. K_{GLS} (%) is the implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end. K_{OJ} (%) is the implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end. K_{ES} (%) is the implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). All regressions include (unreported) year, industry, and country fixed effects. Beneath each coefficient estimate is reported the *t*-statistic based on robust standard errors adjusted for clustering by firm. The superscript asterisks ***, **, and * denote two-tailed statistical significance at the 1, 5, and 10 % levels, respectively. "Appendix 3" section outlines definitions and data sources for the regression variables

As another approach to mitigate endogeneity issues, in column 3 of Table 7, we use the dynamic system GMM method developed by Blundell and Bond (1998). In a dynamic panel data model it is common to transform the model into first differences. Arellano and Bond (1991) use lagged levels of the variables as instruments for the endogenous differences. However, the Arellano and Bond estimator can be biased if the ratio of the variance of the panel-level effect divided by the variance of idiosyncratic error is too high or the autoregressive parameters are too large. Thus, Blundell and Bond (1998) propose the use of the combined moment restrictions from the first-differenced and levels equations, which can improve the efficiency of the GMM estimator.

For the dynamic system GMM, we employ the third, fourth, and fifth lags of the levels and differences of environmental costs–total assets as instrumental variables following Jo et al. (2015a). To assess the instrument validity, we perform three specification tests: (i) the first- and second-order serial correlation tests of the residuals in the differenced equations [i.e., AR(1) and AR(2)], (ii) the Sargan and Hansen *J*-test of overidentification, and (iii) the difference-in-Hansen test. In column 3, the *p* value of the AR(1) test is lower than 0.01, and the *p*-value of the AR(2) test is higher than 0.10, which indicate the absence of serial correlation. The *p*-values of the Sargan and Hansen tests are 0.562 and 0.684, respectively. These results indicate that the overidentifying restrictions for the GMM cannot be rejected and then the instrumental variables are valid (i.e., uncorrelated with the error term). The *p*-value of the difference-in-Hansen test is higher than 0.10, indicating that the subsets of instruments in the level equations are exogenous. Overall, the results of three specification tests for instruments confirm that our instrumental variables perform adequately and our specifications do not suffer from weak instrument concerns. Importantly, we continue to find a negative and statistically significant effect of CER on the cost of equity financing.

Alternative and Additional Independent Variables

To ensure that our evidence is not sensitive to using alternative or additional independent variables, we re-estimate our baseline regression after substituting or adding independent variables in Table 8.

Following Kim et al. (2015), our main test variable is environmental costs deflated by total assets. We assess whether our results hinge on the choice of the deflator variable. As a robustness check, we use environmental costs deflated by sales (ENV/SALES) instead of ENVCOST. The results reported in column 1 continue to show that firms with better CER enjoy cheaper equity financing costs.

Table 9 Subsamples tests

	US, UK, and Japan		Legal origin		Economic development		Continent		
	Exclude US, UK, and Japan (1)	US, UK, and Japan only (2)	Common law (3)	Civil law (4)	Emerging (5)	Developed (6)	Asia Pacific (7)	Europe (8)	North America (9)
ENVCOST	3.707***	4.691*	3.086**	5.873***	2.864*	4.417***	3.184***	6.718***	3.412*
	(2.85)	(1.93)	(2.31)	(2.70)	(1.66)	(2.85)	(2.69)	(3.61)	(1.70)
RVAR	5.519***	10.726***	9.407***	3.680***	1.770**	8.928***	5.538***	5.806***	11.706***
	(8.87)	(11.04)	(11.88)	(5.48)	(2.11)	(13.11)	(10.57)	(11.36)	(17.81)
BTM	1.959***	1.509***	1.130***	1.771***	1.816***	1.302***	2.027***	1.675***	1.672***
	(9.14)	(5.76)	(4.31)	(7.01)	(4.36)	(6.62)	(13.40)	(10.76)	(5.90)
LEV	1.937***	5.013***	3.051***	3.703***	2.905***	3.512***	3.934***	2.138***	4.582***
	(2.89)	(5.86)	(4.04)	(5.30)	(3.11)	(5.42)	(6.30)	(3.54)	(6.24)
INFL	−0.031	0.235	0.194*	−0.068	0.008	0.007	−0.112	−0.002	−0.008
	(−0.46)	(1.57)	(1.67)	(−0.92)	(0.12)	(0.07)	(−1.08)	(−0.03)	(−0.02)
SIZE	−0.211***	−0.134	−0.478***	−0.226***	−0.300***	−0.369***	−0.192***	−0.112**	−0.287***
	(−3.00)	(−1.44)	(−5.38)	(−3.20)	(−2.91)	(−5.31)	(−2.97)	(−1.97)	(−3.49)
FBIAS	0.292***	0.333***	0.336***	0.258***	0.239***	0.335***	0.202***	0.125***	0.122***
	(5.92)	(3.71)	(4.83)	(4.94)	(3.81)	(5.48)	(7.96)	(4.49)	(3.75)
DISP	2.704***	2.186***	2.420***	2.459***	3.426***	2.247***	2.167***	2.767***	1.008***
	(7.30)	(5.57)	(6.11)	(6.59)	(5.64)	(7.69)	(8.00)	(9.85)	(4.06)
LGDPC	−0.415	0.204	0.154	−0.778	0.333	−0.256	−0.940**	−4.215	2.378
	(−1.02)	(1.08)	(0.49)	(−1.30)	(0.14)	(−0.31)	(−2.13)	(−1.36)	(0.21)
INTERCEPT	14.103***	2.153	9.429***	15.044***	8.268	12.953	19.787***	5.979*	−6.898
	(3.29)	(0.99)	(2.81)	(3.35)	(0.42)	(1.52)	(4.34)	(1.71)	(−0.06)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Obs.	3640	3482	3878	3244	1489	5633	2810	2239	2009

Table 9 continued

	US, UK, and Japan		Legal origin		Economic development		Continent		
	Exclude US, UK, and Japan (1)	US, UK, and Japan only (2)	Common law (3)	Civil law (4)	Emerging (5)	Developed (6)	Asia Pacific (7)	Europe (8)	North America (9)
Adj. R^2	0.330	0.344	0.356	0.360	0.323	0.359	0.368	0.381	0.340

This table presents estimation results from regressing the implied cost of equity capital (K_{AVG}) on external environmental costs–total assets (ENVCOST) and controls for various subsamples. The full sample comprises 7122 firm-years from 30 countries. K_{AVG} (%), our dependent variable, is the average cost of equity obtained from four models developed by Claus and Thomas (2001), Gebhardt et al. (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004). K_{CT} (%) is the implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end. K_{GLS} (%) is the implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end. K_{OJ} (%) is the implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end. K_{ES} (%) is the implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end. ENVCOST is external environmental costs–total assets. The external environmental costs are calculated as (greenhouse gases external costs + water external costs + waste external costs + land and water pollutants external costs + air pollutants external costs + natural resource use external costs). All regressions include (unreported) year, industry, and country fixed effects. Beneath each coefficient estimate is reported the *t*-statistic based on robust standard errors adjusted for clustering by firm. The superscript asterisks ***, **, and * denote two-tailed statistical significance at the 1, 5, and 10 % levels, respectively. "Appendix 3" section outlines definitions and data sources for the regression variables

A closer look at Panel B of Table 1 indicates that the distribution of ENVCOST is negatively skewed. For instance, the mean ENVCOST is 0.023 while its first quartile and median are 0.001 and 0.003, respectively. Thus, a potential concern is that the asymmetric distribution of ENVCOST is somehow driving our results. To address this concern, in column 2, we employ the natural logarithm of environmental costs (LNENV) following Jo et al. (2015a). In addition, in column 3, we further employ the Box–Cox transformation (BCENV) of ENVCOST following Mester (1992), which has been widely used in applied data analysis. Box and Cox (1964) argue that the Box–Cox transformation could make the residuals more closely follow a normal distribution and less heteroskedastic.[30] In columns 2 and 3, the findings show that the relations between LNENV and cost of equity capital, and BCENV and cost of equity capital, are positive and statistically significant, consistent with our main evidence.

As discussed above, we proxy for firm risk using the volatility of stock return instead of beta because we want to avoid taking a stance on whether international equity markets are integrated (Hail and Leuz 2006, 2009). In columns 4 and 5, we use the betas instead of stock return volatility to test whether our findings are sensitive to a particular proxy for risk. Specifically, we employ BETA1YR and BETA2YR, which are defined as the betas of individual stocks measured with respect to the local market index using daily stock returns over 1 and 2 years, respectively. As expected, we find that BETA1YR and BETA2YR load with positive and significant coefficients. More important for our purposes, we continue to estimate positive and significant coefficients on ENVCOST in these regressions.

Finally, although we saturate our main regression models with an extensive set of control variables based on prior research, we assess whether our evidence is sensitive to including potentially omitted variables. McWilliams and Siegel (2000) argue that performance regressions are misspecified if they do not control for R&D intensity. In addition, these authors find that CSR loses its significance if R&D intensity is included. In column 6, we control for R&D intensity using the ratio of R&D expenses–sales (R&D/SALES). Moreover, better performing firms likely have lower cost of equity and, at the same time, might be better positioned to reduce their environmental costs. In column 7, we control for firm performance using return on assets (ROAs).[31] We find that firms with higher R&D

[30] The Box–Cox transformation of ENVCOST is $(\text{ENVCOST}^{\lambda} - 1)/\lambda$. Our estimate of λ is 0.747.

[31] In an untabulated regression, we find that our results remain qualitatively unchanged if we proxy for firm performance using Tobin's *q* instead of ROA.

intensity (performance) exhibit higher (lower) cost of equity. Importantly, ENVCOST continues to load with a positive and significant coefficient in these regressions, indicating that our evidence is not sensitive to including additional control variables.

Additional Analyses: Evidence Across Subsamples

Our sample comprises manufacturing firms from 30 countries. Given the heterogeneity of our sample, one would not expect the intensity of the positive relationship between CER and equity financing costs to be the same across all countries. Therefore, we investigate the relationship between CER and the cost of equity in different subsamples of countries. The results of this investigation are reported in Table 9.

We start our analysis with the US (1756 observations), UK (865 observations), and Japan (861 observations)—the top three countries in terms of number of observations. We isolate two subsamples. In column 1, we consider a subsample that eliminates these three countries (subsample size = 3640 observations). In column 2, we consider a subsample consisting of only these three countries (subsample size = 3482 observations). In both columns, we find a significant positive association between ENVCOST and equity financing costs.[32]

Next, we split our sample according to countries' legal origin, economic development, and geographic region. In columns 3 and 4, we consider common law and civil law countries, respectively. We obtain the legal origin from La Porta et al. (1998). In columns 5 and 6, we analyze emerging and developed countries, respectively. We obtain data on economic development from MSCI ACWI and MSCI emerging indexes. In columns 7–9, we consider three geographic regions: Asia Pacific, Europe, and North America, respectively. We consistently find a positive and significant coefficient on ENVCOST in all subsamples. This indicates that our evidence that high CER firms enjoy cheaper equity financing costs holds in different legal, economic, and geographic environments.[33]

[32] In an alternative (untabulated) test to assess whether the heterogeneity in the number of observations across countries affects our results, we run a weighted least squares (WLSs) regression where the weight is the inverse of the number of firm-year observations per country. We continue to estimate a positive and significant coefficient on ENVCOST.

[33] Interestingly, we note that the coefficient on ENVCOST is less significant for emerging countries relative to developed countries, and is less significant for North America relative to Asia Pacific and Europe.

Conclusion

In this paper, we empirically examine investors' response to CER. More specifically, we examine how CER affects the cost of equity capital for a sample of 7122 firm-year observations representing 2107 manufacturing firms from 30 countries over the 2002–2011 period. Using a multivariate regression framework that controls for firm-level characteristics as well as industry, year, and country effects, we find that the cost of equity capital is lower for firms with a high level of CER. Our evidence is robust to addressing endogeneity using instrumental variables and GMM, to using alternative proxies for the cost of equity capital, to accounting for noise in analyst forecasts, and to using alternative specifications. In addition, we find that the relation between environmental costs and equity financing costs holds across different legal, economic, and geographic settings. Taken together, our findings consistently suggest that improving environmental responsibility reduces firms' equity financing costs.

Our paper has practical implications for managers. While prior research finds that CSR activities in general contribute to reducing a firm's risk exposure, our cross-country results further suggest that in line with recent anecdotal evidence, a firm's CER activities in particular can reduce firm risk and thus the cost of equity capital. In addition, because investors concerned about environmental issues such as global warming, pollution, and the depletion of natural resources can screen out environmentally irresponsible companies—even if they are considered attractive in terms of risk and return—CER investment can increase a firm's investor base and thus further work to decrease the cost of equity capital. Our evidence that a firm's CER performance is valued by investors should therefore provide managers with incentives to actively engage in environmental risk management activities.

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Appendix 1

Cost of Equity Models

In this appendix, which is adapted from El Ghoul et al. (2015), we describe the cost of equity models used in this paper. We start by defining variables and specifying assumptions common to all models. We then successively cover each model and its assumptions.

Common Variables and Assumptions

K_{CT} = implied cost of equity from the Claus and Thomas (2001) model;

K_{GLS} = implied cost of equity from the Gebhardt et al. (2001) model;

K_{OJ} = implied cost of equity from the Ohlson and Juettner-Nauroth (2005) model;

K_{ES} = implied cost of equity from the Easton (2004) model;

P_t = stock price measured 10 months after the fiscal year end;

$\mathrm{FROE}_{t+\tau}$ = forecasted return on equity for year $t + \tau$;

$\mathrm{FEPS}_{t+\tau}$ = forecasted earnings for year $t + \tau$;

B_t = current (beginning of period) book value per share;

k_t = expected dividend payout at time t;

$B_{t+\tau}$ = forecasted book value per share for year $t + \tau$, measured using the clean surplus relationship; i.e., $B_{t+\tau} = B_{t+\tau-1} + \mathrm{FEPS}_{t+\tau}(1 - k_{t+\tau})$;

$\mathrm{ae}_{t+\tau}$ = forecasted abnormal earnings for year $t + \tau$;

LTG_t = forecasted long-term earnings growth at time t; and

i_t = expected perpetual earnings growth at time t.

We require firms to have positive 1-year-ahead (FEPS_{t+1}) and 2-year-ahead (FEPS_{t+2}) earnings forecasts, and either a 3-year-ahead forecast (FEPS_{t+3}) or a long-term growth forecast (LTG_t). If a 3-, 4-, or 5-year-ahead forecast is not available in I/B/E/S, we impute it from the previous year forecast and the LTG forecast, i.e., $\mathrm{FEPS}_{t+\tau} = \mathrm{FEPS}_{t+\tau-1} \cdot (1 + \mathrm{LTG}_t)$. Similarly, if the LTG forecast is missing, we impute it from the growth rate implied by the 3- and 2-year-ahead forecasts, i.e., $\mathrm{LTG}_t = \frac{\mathrm{FEPS}_{t+3} - \mathrm{FEPS}_{t+2}}{\mathrm{FEPS}_{t+2}}$.

We estimate the expected dividend payout (k_t) using the average dividend payout over the previous 3 years. If this ratio is missing or outside [0, 1], we replace it with the country–year median. We estimate the expected perpetual earnings growth (i_t) using next year's realized inflation rate.

Model Descriptions

Model 1: Claus and Thomas (2001) This model assumes clean surplus accounting, allowing current share price to be expressed in terms of the cost of equity, current book value, forecasted abnormal earnings, and a perpetual abnormal earnings growth. Forecasted abnormal earnings is forecasted earnings minus a charge for the cost of equity. The explicit forecast horizon is set to 5 years, beyond which forecasted residual earnings grow at the expected inflation rate. The valuation equation is given by:

$$P_t = B_t + \sum_{\tau=1}^{5} \frac{\mathrm{ae}_{t+\tau}}{(1 + K_{\mathrm{CT}})^{\tau}} + \frac{\mathrm{ae}_{t+5}(1 + i_t)}{(K_{\mathrm{CT}} - i_t)(1 + K_{\mathrm{CT}})^{5}}, \quad (2)$$

where $\mathrm{ae}_{t+\tau} = \mathrm{FEPS}_{t+\tau} - K_{\mathrm{CT}} \cdot B_{t+\tau-1}$.

Model 2: Gebhardt et al. (2001) This model also assumes clean surplus accounting, allowing current share price to be expressed in terms of the cost of equity, current book value, and forecasted ROE and book values. The explicit forecast horizon is set to 3 years, beyond which forecasted ROE decays to a target ROE by the 12th year, and remains constant afterward. The valuation equation is given by:

$$P_t = B_t + \sum_{\tau=1}^{11} \frac{\mathrm{FROE}_{t+\tau} - K_{\mathrm{GLS}}}{(1 + K_{\mathrm{GLS}})^{\tau}} B_{t+\tau-1} + \frac{\mathrm{FROE}_{t+12} - K_{\mathrm{GLS}}}{K_{\mathrm{GLS}} \cdot (1 + K_{\mathrm{GLS}})^{11}} B_{t+11}, \quad (3)$$

For the first 3 years, $\mathrm{FROE}_{t+\tau}$ is set equal to $\frac{\mathrm{FEPS}_{t+\tau}}{B_{t+\tau-1}}$. Beyond the third year, $\mathrm{FROE}_{t+\tau}$ fades linearly to a target ROE by the 12th year. To determine the target ROE, we compute, for each firm in each year, the average ROE over the previous 3 years. The target ROE is the country–industry–year median. We define industries according to Campbell's (1996) classification. Negative target ROE is replaced by country–industry median, and if still negative, by country–year median.

Model 3: Ohlson and Juettner-Nauroth (2005) This model is an extension of the Gordon constant growth model. It allows share price to be expressed in terms of the cost of equity, 1-year-ahead earnings forecast, and near-term and perpetual growth forecasts. The explicit forecast horizon is set to 1 year, after which forecasted earnings grow at a near-term rate that decays to a perpetual rate. The near-term earnings growth is the average of: (i) the growth rate of FEPS from year $t + 1$ to year $t + 2$, and (ii) the I/B/E/S LTG forecast. The perpetual growth rate is the expected inflation rate. The valuation equation is given by:

$$P_t = \frac{\mathrm{FEPS}_{t+1}(g_t - i_t + K_{\mathrm{OJ}} \cdot k_{t+1})}{K_{\mathrm{OJ}}(K_{\mathrm{OJ}} - i_t)}, \quad (4)$$

where $g_t = \frac{1}{2}\left(\frac{\mathrm{FEPS}_{t+2} - \mathrm{FEPS}_{t+1}}{\mathrm{FEPS}_{t+1}} + \mathrm{LTG}_t\right)$.

The model requires that $\mathrm{FEPS}_{t+2} > 0$ and $\mathrm{FEPS}_{t+1} > 0$ to yield a positive root.

Model 4: Easton (2004) This model is a generalization of the PEG model based on Ohlson and Juettner-Nauroth (2005). It allows share price to be expressed in terms of the cost of equity, expected dividend payout, and 1- and 2-year-ahead earnings forecasts. The explicit forecast horizon is set to 2 years, after which forecasted abnormal earnings grow in perpetuity at a constant rate. The valuation equation is given by:

$$P_t = \frac{\mathrm{FEPS}_{t+2} - \mathrm{FEPS}_{t+1}(1 - K_{\mathrm{ES}} \cdot k_{t+1})}{K_{\mathrm{ES}}^2}. \quad (5)$$

The model requires that to yield a positive root.

Additional Models

Model 5: Forward Earnings–Price Ratio This is a special case of the Easton (2004) model assuming that abnormal earnings growth is set to zero. The forward earnings–price ratio is given by;

$$K_{\mathrm{FEYD}} = \frac{\mathrm{FEPS}_{t+1}}{P_t}. \quad (6)$$

Model 6: Price–Earnings–Growth (PEG) ratio This is a special case of the Easton (2004) model assuming no dividend payments. The valuation equation is given by:

$$P_t = \frac{\mathrm{FEPS}_{t+2} - \mathrm{FEPS}_{t+1}}{K_{\mathrm{PEG}}^2}. \quad (7)$$

Model 7: Trailing Earnings Yield This is a special case of the earnings–price ratio where the numerator is current earnings per share:

$$K_{\mathrm{TEYD}} = \frac{\mathrm{EPS}_t}{P_t}. \quad (8)$$

Appendix 2

See Table 10.

Table 10 Trucost data explanation

External environmental costs (i.e., total direct external cost)	External environmental costs are called total direct external cost. Direct external environmental impacts are those that a company has on the environment through its own activities (equivalent to Scope 1 of the Greenhouse Gas Protocol). For example, the water that a company uses from a river would be a direct impact, whereas water provided by a utility company would be an indirect impact. Trucost calculates these direct environmental impacts in quantity terms (i.e., tonnes, cubic meters, etc.), and financial terms, so that they can be ranked accordingly as direct external costs. The quantities of all direct emissions are multiplied by their respective environmental damage costs as calculated by Trucost and its academic panel
Impact ratio	The total direct and indirect external cost/revenue. The impact ratio represents the proportion of a company's revenue that would be at risk if it were to internalize the external environmental damage costs associated with its direct operations and those of its supply chain
Greenhouse gases direct cost	The total cost of all GHG emissions caused by the burning of fossil fuels and production processes that are owned or controlled by the company. Greenhouse gases are so called because they contribute towards the greenhouse effect. All greenhouse gases are adjusted by their respective global warming potential (GWP) to calculate their carbon dioxide equivalent. The quantity of each GHG emission is multiplied an external cost
Water direct cost	This is water extracted by the company from rivers, groundwater, lakes, and seas. The water is used in the company's own operations, such as for cooling or processing. The quantity of water is then multiplied by its associated external cost
Waste direct cost	Hazardous and non-hazardous waste produced by the company including mining tailing, mining overburden and nuclear waste. The quantity of waste is multiplied by an associated external damage cost that is based on the type of waste and its method of disposal. Recycled waste has no associated damage cost in the Trucost model
Land and water pollutants direct cost	The cost of pollutants that are released to water or land. These are pollutants from fertilizer and pesticides, metal emissions to land and water, acid emissions to water, and nutrient and acids pollutants. The quantities of pollutants are multiplied by their associated external damage costs
Air pollutants direct cost	Emissions released to air by the consumption of fossil fuels and production processes that are owned or controlled by the company. This includes acid rain precursors (e.g., nitrogen oxide, sulfur dioxide, sulphuric acid, and ammonia), ozone-depleting substances (HFCs and CFCs), dust and particles, metal emissions, smog precursors, and VOCs. The quantities of emissions are multiplied by their associated external damage cost
Natural resource use direct cost	The direct extraction of minerals, metals, natural gas, oil, coal, forestry, agriculture, and aggregates by the company. The quantity of extraction is multiplied by an external damage cost

Source http://www.trucost.com

Appendix 3

See Table 11.

Table 11 Variable definitions and data sources

Variables	Definitions	Sources
Panel A: dependent variables		
K_{CT}	Implied cost of equity capital estimated from the Claus and Thomas (2001) model 10 months after the fiscal year-end	Authors' calculations based on I/B/E/S and Compustat data
K_{GLS}	Implied cost of equity capital estimated from the Gebhardt et al. (2001) model 10 months after the fiscal year-end	As above
K_{OJ}	Implied equity premium capital estimated from the Ohlson and Juettner-Nauroth (2005) model 10 months after the fiscal year-end	As above
K_{ES}	Implied cost of equity capital estimated from the Easton (2004) model 10 months after the fiscal year-end	As above
K_{AVG}	Average of K_{CT}, K_{GLS}, K_{OJ}, and K_{ES}	As above
Panel B: independent variables		
ENVCOST	Defined as the ratio of (external) environmental costs–total assets. The external environmental costs are direct external environmental costs. They are calculated as (greenhouse gases direct external costs + water direct external costs + waste direct external costs + land and water pollutants direct external costs + air pollutants direct external costs + natural resource use direct external costs)	Authors' calculations based on Trucost
RVAR	Volatility of stock returns over the previous 12 months	Authors' calculations based on Compustat, CRSP and CFRMC data
BTM	Book value to the market value of equity	Authors' calculations based on Compustat data
LEV	Leverage ratio defined as the ratio of long-term debt–total assets	As above
INFL	Realized inflation rate over the next year	Authors' calculations based on I/B/E/S and Compustat data
SIZE	Natural logarithm of total assets in $ million	Compustat
FBIAS	Signed forecast error defined as the difference between the 1-year-ahead consensus earnings forecast and realized earnings deflated by beginning of period assets per share	As above
DISP	Dispersion of analyst forecasts defined as the coefficient of variation of 1-year-ahead analyst forecasts of earnings per share	Authors' calculations based on I/B/E/S data
LGDPC	Natural logarithm of real GDP per capita	World development indicators
Panel C: variables for robustness tests		
Dependent variables for robustness tests		
K_{FEYD}	Forward earnings–price ratio defined as $FEPS_{t+\tau}$ divided by P_t	Authors' calculations based on I/B/E/S and Compustat data
K_{PEG}	Implied cost of equity capital from price–earnings–growth (PEG) model, which assumes no dividend payments to estimate the equity premium using short-term earnings forecasts and longer-term forecasts	As above
K_{TEYD}	Trailing earnings yield defined as current EPS divided by P_t	As above
Independent and control variables for robustness tests		
ENV/SALES	Ratio of environmental costs–sales	Authors' calculations based on Compustat data
LNENV	Natural logarithm of environmental costs	Authors' calculations based on Trucost
BCENV	Box–Cox transformation of ENVCOST	As above
MMT6	Compound stock returns over the past 6 months	Authors' calculations based on CRSP data
BETA1YR	Beta of individual stocks over 1 year based on daily stock returns	Authors' calculations based on Compustat data
BETA2YR	Beta of individual stocks over 2 years based on daily stock returns	As above

Table 11 continued

Variables	Definitions	Sources
R&D/SALES	R&D expenditures divided by sales	As above
ROA	Net income–total assets	As above
HIGHJUD	Dummy variable that takes the value of 1 if the country's judicial efficiency is higher than the median, and 0 otherwise	La Porta et al. (1998)
LOWOWN	Dummy variable that takes the value of 1 if the country's corporate ownership concentration is lower than the median, and 0 otherwise	La Porta et al. (2006)
Instruments for 2SLS		
ENVCOST_F0	Initial environmental costs–total assets recorded when the firm enters the sample	Authors' calculations based on Trucost
ENVCOST_I0	Industry average environmental costs–total assets in the first year of data	As above

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