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Dynamics of Environmental and Financial Performance: The Case of Greenhouse Gas Emissions

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Abstract

While corporate sustainability has been defined as an approach that creates long-term value with minimum environmental damage, there is still little understanding of the time horizon over which improved environmental performance leads to improved financial performance. We investigate the relationship between environmental and financial performance under increasing likelihood of environmental regulation. We leverage longitudinal data for 1,095 U.S. corporations from 2004 to 2008, a period of increasing activity for climate change legislation, in order to estimate the effect of greenhouse gas emissions on short- and long-term measures of financial performance. We find that during this period, improving corporate environmental performance causes a decline in an indicator of short-term financial performance, return on assets. Nonetheless, investors see the potential long-term value of improved environmental performance, manifested by an increase in Tobin's *q*. These results suggest that limited uptake of proactive strategies may in part be attributable to short-term financial performance targets that guide managerial decision making.

Keywords

corporate sustainability, financial performance, climate change, carbon footprint

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Introduction

There has been a long-standing debate in the business strategy literature over whether or not firms profit from reducing their impact on the environment (Ambec & Lanoie, 2008; Margolis & Walsh, 2003; Orlitzky, Schmidt, & Rynes, 2003; Peloza, 2009). This literature is supported by a large number of empirical studies and meta-analyses (Ambec & Lanoie, 2008; Margolis, Elfenbein, & Walsh, 2007; Margolis & Walsh 2003; Orlitzky et al., 2003). While the balance of these studies supports the view that proactive corporate sustainability creates value, we still have little understanding of the time horizon over which improved environmental performance leads to improved financial performance. As scholars have deplored, "Prior research has virtually ignored the differences in the time frames associated with creating, social, environmental and financial value" (Slawinski & Bansal, 2009, p. 1).

In this study, we investigate how changes in institutional conditions affect the profitability of corporate strategies that mitigate damages related to emerging environmental issues. Drawing from a process-based view of environmental issues (Rivera, 2010; Rivera, Oetzel, deLeon, & Starik, 2009), we argue that there are important differences in external conditions associated with the stages of an environmental issue's evolution—from emergence to implementation of regulations—and that such differences influence the returns to firms' investments in mitigation.

We investigate the impact of corporate environmental performance on financial performance during the initiation stage of climate change policy, a period marked by high legislative and regulatory uncertainty. We find that during this period, improving corporate environmental performance causes a decline in an indicator of short-term financial performance, return on assets (ROA). Nonetheless, investors see the potential long-term value of improved environmental performance, and this is manifested by an increase in Tobin's q.

The issue of climate change is particularly suited to analyze the profitability of strategies that target emerging environmental issues. Climate change is a high-profile environmental issue entailing considerable regulatory and scientific risk and uncertainty. However, it has received relatively little attention in the pays-to-be-green literature. The existing empirical research has focused on a subset of industries with established regulatory regimes and rarely have researchers tested their hypotheses with climate-related emissions (Ziegler, Busch, & Hoffmann, 2009). We estimate the effect of changes in greenhouse gas (GHG) emissions on financial performance using longitudinal environmental impact data for 1,095 U.S. corporations from 2004 to 2008. This period is appropriate for our analysis because it tracks the efforts to regulate GHG emissions, starting from the formation of the Regional Greenhouse Gas Initiative in 2003 to the final refusal of the Senate to pass the Waxman–Markey Bill, which the House approved in 2009.

We use two complementary measures of financial performance. First, we use ROA, a short-term measure of financial performance that takes into account tangible costs and revenues. With this measure, for investments to be profitable, they must pay off immediately. Second, we use Tobin's q, a longer term measure of financial performance that takes into account potential future cash flows and profitability. These measures of performance allow us to elucidate the relationship between GHG emissions and financial performance during a period characterized by heightened public sector concern for climate change and investor scrutiny of GHG emissions.

This study contributes to the literature on whether it pays to be green by investigating returns to corporate sustainability in emerging environmental issues. In their discussions of the preimplementation stages of protective policy process, Rivera et al. (2009) and Rivera (2010) focus on business resistance to protective policies. However, they do not examine the subset of businesses that, instead of resisting, adopt proactive stances in these issues and the value of such strategies. In this study, proactive approaches involve "anticipating future regulations and social trends and designing or altering operations, processes, and products to prevent negative environmental impacts" (Aragón-Correa & Sharma, 2003, p. 73).

Literature Review

Understanding the relationship between corporate social and financial performance has been the focus of considerable research since the 1970s (Ambec & Lanoie, 2008; Barnett & Salomon, 2006; Dixon-Fowler, Slater, Johnson, Ellstrand, & Romi, 2013; Endrikat, 2015; Endrikat, Guenther, & Hoppe, 2014; Margolis & Walsh, 2003; Orlitzky et al., 2003). Many scholars have investigated whether firms are financially rewarded for improving environmental performance. One plausible argument is that any investment in the natural environment comes as a cost to firms and detracts from profit maximization (Friedman, 1970). Without clearly defined ownership rights to public goods such as air or water quality, society incurs the cost of a firm's pollution (Figge & Hahn, 2004; McWilliams, Siegel, & Wright, 2006). A firm that voluntarily internalizes these externalities incurs cost and is not maximizing profit.

Proponents of a "win–win" argument (e.g., Porter & van der Linde, 1995) claim that environmental performance often constitutes a latent profit opportunity. Ambec and Lanoie (2008) present arguments supporting several opportunities for firms to increase revenue or reduce costs by reducing their environmental impact. For example, research and development into greener production processes can lead to revenue-generating or cost-minimizing innovations that would otherwise be unexploited (Porter & van der Linde, 1995).

Some researchers fuse the two approaches, proposing an inverted U–shaped or a U-shaped relationship between financial and environmental performance (e.g., Fujii, Iwata, Kaneko, & Managi, 2013; Lankoski, 2008). Whether it is an inverted U or a U depends on whether the "additional cost" or the "win–win" argument prevails as environmental performance increases.

Although the balance of empirical studies suggests a positive relationship between improved environmental and financial performance (Ambec & Lanoie, 2008; Margolis & Walsh, 2003; Orlitzky et al., 2003), the literature provides little guidance on *when* firms benefit from their environmental investments. Indeed, if the returns from proactive environmental strategies were immediately tangible, then we would see more firms investing in such strategies. However, so far, we have observed more corporate resistance to than enthusiasm for investing in environmental proactive strategies (Boiral, 2006; Delmas & Pekovic, 2013; Jones & Levy, 2007; Kolk & Pinkse, 2005; Rivera, 2010). For example, organizations' failure to seize self-evident opportunities for long-term gains via energy efficiency continues to mystify analysts and researchers (Biggart & Lutzenhiser, 2007; Blass, Corbett, Delmas, & Muthulingam, 2013).

Surprisingly, while the original proponents of the win–win hypothesis have criticized the static perspective of the conventional cost arguments (Porter & van der Linde, 1995), the pays-to-be-green literature has offered little to explain the dynamic interactions between proactive environmental strategies and financial performance (Elsayed & Paton, 2005; Slawinski & Bansal, 2009). For example, Porter and van der Linde (1995) argue that more stringent environmental policies can lead to innovations that reduce inefficiencies and cost. However, the timing of this process, especially as it relates to the maturity of the environmental issue, has not been explored.

There remains little guidance to managers regarding strategies for emerging environmental concerns such as climate change. When not relying on subjective environmental performance ratings produced for institutional investors (e.g., KLD Energy Technologies and the Council on Economic Priorities), scholars have relied on data measuring mature environmental issues, such as in the case of the Toxics Release Inventory (e.g., Elsayed & Paton, 2005; Hart & Ahuja, 1996; King & Lenox, 2002; Konar & Cohen, 2001; Russo & Fouts, 1997). Researchers have framed environmental strategy as choosing to either comply with established environmental regulation and norms or go beyond compliance, overlooking unregulated pollutants such as GHGs to the detriment of investigating emerging and as-yet unregulated environmental issues.

Additionally, existing studies commonly use accounting- or market-based measures of financial performance interchangeably (Margolis et al., 2007; Peloza, 2009). However, both methods do not necessarily substitute for each other. For example, accounting measures are often used to evaluate initiatives that affect the firm in the short term, such as those that reduce operating costs (Peloza, 2009). In contrast, market valuations are based on investors' perceptions of the future profitability of a firm's current or recent management practices (Dowell, Hart, & Yeung, 2000; King & Lenox, 2002; Konar & Cohen, 2001), which account for financial outcomes that may manifest differently over the long term as an issue matures. Both types of measures provide complementary assessments of financial performance, yet few studies have used them to systematically test their hypotheses. This is a concern when the economic outcomes of environmental strategies may change over time, as may be the case if there is a lag between implementing proactive environmental strategies and realizing their competitive outcome.

In summary, scholars have empirically investigated the relationship between environmental and financial performance for several decades with varying results, while recent studies predominantly support a "win–win" relationship. Characteristic of this research, however, is an almost exclusive focus on long-regulated pollutants and a lack of attention to the issue of the timing of the returns from investments in the mitigation of emerging environmental issues.

Hypotheses

The Stages of Environmental Protection

A process-based perspective of environmental issues takes into account the institutional context of firm strategies (Lawrence, Winn, & Jennings, 2001); describes how firms respond to institutional pressures from government, public opinion, media, and professional associations (Delmas & Toffel, 2008); and how these pressures evolve over time (Bansal, 2005; Delmas & Montes-Sancho, 2010). Building on this line of research, Rivera et al. (2009) and Rivera (2010) describe businesses' response to an evolving institutional environment as a three-stage process. At the *initiation* stage, managers often underestimate the threat and legitimacy of environmental groups advocating for greater protection. As the issue progresses to the *formulation–selection* stage, policy solutions to address the emerging issue are first developed and debated within and across institutions, while businesses remain resistant to changes in established modes of legitimate business behavior. Absent a precedent for how to comply with new environmental demands and institutional pressures to do so, only "first mover" or "green leader" firms adopt proactive strategies during the second, *pre-implementation* stages (Rivera et al., 2009). Similarly, other researchers have studied firms' environmental strategies in dealing regulatory uncertainty (Aragón-Correa & Sharma, 2003; Engau & Hoffmann, 2011; Wijen & van Tulder, 2011).

New regulations, standards, and norms are formalized in the final, *implementation* stage of the framework. By this point, most managers and stakeholders have internalized the new institutional order and noncompliance is viewed as illegitimate behavior. These conditions impose several constraints, which do not exist in the preceding two stages: First, failing to comply with established rules, regulations, and norms can threaten a firm's legitimacy, resources, and survival (Bansal, 2005); second, regulation forces firms to internalize pollution costs. Nonetheless, such conditions can foster investment—for instance, Rivera and Oh (2013) found that certainty in regulations encouraged multinational corporations to enter foreign markets.

We argue that current applications of the win–win hypothesis assume a business environment consistent with the *implementation* stage. In the remainder of this section we contend that the profitability of environmental strategies is limited by the business conditions that prevail during *pre-implementation* stages—those associated with emerging environmental issues. Opportunities to profit from investing in such strategies, however, arise in the implementation stage. This is illustrated using the issue of climate change.

Climate Change and Greenhouse Gas Emissions

Climate change, perhaps the most serious of environmental concerns (Pinkse & Kolk, 2009), is in large part an outcome of the release of pollutants that are currently unregulated, such as carbon dioxide (CO_2) and methane. These pollutants are released through the combustion of fossil fuels for energy production, thus implicating virtually all organizations in the global economy. The track record of international policy mechanisms such as the Kyoto Protocol makes it difficult to predict precisely if, when, and at what scales such instruments will be put in place, and what their overall effect will be. Economic incentives and disincentives for ameliorating climate emissions, such as carbon taxes and emissions trading, are still in their infancy, with limited geographical and sectoral scope. But policy developments did accelerate measurably during the latter half of the 2000s, including initiation of the European Union Emissions Trading Scheme and the passage of California's Global Warming Solutions Act (Assembly Bill 32; Kolk, Levy, & Pinkse, 2008), to name only a few. Observing these developments, Porter and Reinhardt (2007) expected GHG emissions “to be increasingly scrutinized, regulated and priced” (p. 22).

In particular, climate change has attracted the attention of the investment community. Shareholder resolutions requesting GHG emissions disclosures have grown more common. Furthermore, shareholder coalitions, such as the Ceres (Coalition for Environmentally Responsible Economies) and the CDP (formerly the "Carbon Disclosure Project"), advocate greater transparency in carbon emissions and management strategies in order to inform asset valuation and investment decisions (Kolk et al., 2008; Makower, Pernick, & Wilder, 2008; Pinkse & Kolk, 2009; Williams & Crawford, 2012). The number of climate–related shareholder resolutions filed between the years 2000 and 2007 increased almost twelvefold, while shareholder voting support for these resolutions has also increased significantly (Ceres, 2009; Rindfleisch, 2008). Notwithstanding these developments, the fate of climate change legislation and GHG regulation during the mid- to late 2000s remained uncertain (Kolk et al., 2008). Consequently, there was much uncertainty regarding the short- and long-term financial effects of corporate reductions in GHG emissions.

GHG Emissions and Financial Performance

In the following hypotheses we use two complementary measures of financial performance to examine the relationship between environmental and financial performance on an emerging environmental issue. We posit that the relationship depends on whether the measure of financial performance is based on short-term returns or on market recognition of the long-term value of such investments. Short-term assessment of financial performance takes into account existing cash flows in current market conditions. The long-term assessment, in contrast, starts with a market-based perspective of financial performance and integrates estimations of a firm’s future profitability under perceived external conditions, such as the prospect of climate change legislation. Thus, while the short-term measure emphasizes contemporaneous performance, the long-term measure addresses a firm’s future performance (Peloza, 2009).

Short-Term Returns to Reducing Greenhouse Gas Emissions. When firms reduce GHG emissions, they in essence follow a pollution prevention strategy, as opposed to a strategy of pollution capture and remediation (Anderson & Newell, 2004; Riahi, Rubin, & Schrattenholzer, 2004). **In contrast with capture and remediation,** prevention results in significant savings from efficiency and productivity gains as well as avoided compliance and liability costs (Hart, 1995; Hart & Ahuja, 1996; Reinhardt, 1999). Unsurprisingly, pollution prevention has been identified as a strategy that can lead to sustainable cost advantages (Christmann, 2000; Hart, 1995; Russo & Fouts, 1997).

The cost savings attributed to pollution prevention depend strongly on savings from two sources: liability and compliance costs and efficiency gains. These savings are difficult to realize in the short term. First, as GHG emissions are not regulated, there are no compliance or liability cost savings to be gained through their reduction. Second, even without regulatory or institutional pressures to mitigate climate change, there has been a long-standing demand for firms to indirectly reduce GHG pollution through energy conservation and efficiency (DeCanio, 1998). Simply put, by becoming more energy efficient, firms have always been able to reduce operating costs, even before climate change became a pressing concern.

This suggests that in contrast to other types of pollution (e.g., toxic releases), less unrealized waste (energy) saving opportunities have always existed for GHGs. The “low-hanging fruit” typically available in the early stages of pollution prevention initiatives (Hart & Ahuja, 1996) are less likely to exist for GHGs. Additional measures to conserve energy become progressively more expensive (Hart, 1995; Hart & Ahuja, 1996) and increasingly likely to be perceived as competing with more immediately productive investments (Sassone & Martucci, 1984). All told, at the current level of regulatory and institutional pressures, it is difficult for firms to offset the costs of energy conservation in the short-term. Thus, we hypothesize the following:

Hypothesis 1: All else equal, the more a firm decreases GHG emissions the lower its short-term financial performance.

Long-Term Effects of Reducing Greenhouse Gas Emissions. Recent studies (e.g., Busch & Hoffmann, 2007, 2011) suggest that financial markets may be responding to increased corporate reporting of GHG inventories and devaluing more carbon-intensive firms. There are also signs that capital markets value climate-friendly practices (Delmas, Etzion, & Nairn-Birch, 2013). For example, the HSBC Global Climate Change Benchmark Index, developed by HSBC as a reference index to measure the stock market performance of companies well positioned to benefit from climate change mitigation efforts, was shown to outperform key common benchmark indices by approximately 70% between 2004 and 2007 (HSBC, 2007). Similar funds that screen for climate-friendly firms (e.g., the Credit Suisse Global Warming Index and the Amro Climate Change and Environment Index) also claim to have outperformed standard stock market indices since their inception in the early 2000s.

These examples suggest that investors' perceptions of future market conditions take into account the likelihood of carbon emissions becoming more regulated, and consequently a greater likelihood for profitability or loss to be affected by a firm's GHG emission profile. Firms capable of reducing their GHG emissions demonstrate to investors that they possess, or at least are developing, internal capabilities that will allow them to be more competitive in a business environment facing increased institutional pressure to comply with regulations, standards, and norms directed at mitigating climate change. Consequently, we hypothesize the following:

Hypothesis 2: All else equal, the more a firm decreases carbon emissions the more positive the investors' perceptions of future market performance.

Method

Environmental Performance Data

In this section we describe the data and analytical approach we used. We acquired environmental performance data from Trucost. Trucost provides environmental performance data for the socially responsible investment community and has been used in peer-reviewed academic research (e.g., Dawkins & Fraas, 2011; Delmas et al., 2013; Delmas, Lim, & Nairn-Birch, 2015). The data quantify a broad range of environmental impacts of a sample of 1,200 publicly traded U.S. companies each year from 2004 through 2008. The variables cover direct and supply chain activities, such as emissions and waste production, water abstraction, natural resource use, and raw materials extraction. Trucost quantifies the environmental impacts and associated damage costs attributed to both sources (e.g., extraction, resource use) and sinks (e.g., waste, pollutant emissions) in multiple media, with a total of 751 variables for each firm. Each variable is measured as a damage quantity (e.g., mass of pollutant or volume of water) and has a corresponding damage cost. Trucost determines the marginal costs of these damages from a review of environmental economics literature, which are vetted by an independent academic advisory panel. The data generated by Trucost measure the environmental impacts of a firm's direct operations, as well as those associated with all levels of its upstream supply chain. The variables are distributed within seven broad categories of environmental issues: GHGs, general waste, heavy metals, natural resources, volatile organic compounds (VOCs), water abstraction, and other emissions. Companies are given the opportunity to vet the data produced by Trucost. Appendix A describes Trucost's methodology in more detail.

Trucost's environmental impact profile of each firm is a combination of model estimates and standardized company reported data. Thus, the balance of environmental impacts that are imputed versus directly measured varies for each firm and, where high, may obscure unique firm-level characteristics important to our analysis. We control for variation in this ratio by including a disclosure control variable that captures whether a firm's environmental data were publicly available versus imputed by Trucost (see the Controls section below).

The study period of 2004 to 2008 is particularly suited for our analysis because it captures the uncertainty of and increasing interest in regulation during the pre-implementation stages of protective policy—tracking the gradual buildup of interest in GHG regulation until the failure of the Waxman–Markey Bill. The first serious GHG regulation in the United States started in 2003 with formation of the Regional Greenhouse Gas Initiative, a cap-and-trade program for power plant GHG emissions in northeastern United States and eastern Canada. On the international front, the Kyoto Protocol went into force in early 2005. Domestic regulatory efforts intensified with the 2006 passage of Assembly Bill 32 in California, which established cap-and-trade regulation of GHG emissions in the state. In 2007, the Intergovernmental Panel on Climate Change and Al Gore shared the Nobel Peace Prize, showing recognition of climate change as a serious problem. Efforts for comprehensive climate legislation continued in the Senate debate of the Lieberman–Warner Bill in 2008. The efforts culminated in 2009 when the House passed the Waxman–Markey Bill. However, the Senate's refusal to pass the bill and the subsequent shift in the political climate reduced the chances of federal climate legislation, thus eliminating the uncertainty around this issue.

We also compiled environmental performance ratings for each firm using data provided by KLD Analytics. KLD rates the social performance of all firms listed on the Russell 3000 and is a commonly used source of corporate social performance data in academic research (Chatterji, Levine, & Toffel, 2009; Etzion, 2007). The KLD database includes ratings for environmental performance, which are divided into "strength" and "concern" categories. In contrast to tangible output-based measures of environmental impact, KLD ratings primarily reflect process-based environmental performance (e.g., managerial practices and reputation).

Finally, the Trucost and KLD data were merged with financial performance data from Compustat's North American database. All the companies listed in the Trucost database were available in Compustat. Less than 1% of firms from the Trucost sample space were not found in KLD's universe of firms and were subsequently dropped from the analysis. The use of panel data analysis methods further restricts our sample to firms with at least 2 years of complete data. The sample contains 1,095 firms and 3,316 firm-year observations.

Dependent Variables

Existing studies commonly use accounting- or market-based measures of financial performance interchangeably (Margolis et al., 2007; Peloza, 2009). However, both methods are not perfect substitutes. Accounting measures are often used to evaluate initiatives that affect the firm in the short term, such as those that reduce operating costs (Peloza, 2009). In contrast, market-based measures capture investors' long-term perceptions of the future profitability of a firm's current or recent management practices (Dowell et al., 2000; King & Lenox, 2002; Konar & Cohen, 2001). Both types of measures provide complementary assessments of financial performance, yet few studies have used them to systematically test their hypotheses.

We use ROA and Tobin's *q* to approximate short- and long-term perspectives of financial performance, respectively. We calculate these variables based on financial information provided by Compustat. ROA is a standard accounting measure of financial performance, which is calculated by dividing earnings before interest by total assets (King & Lenox, 2002). Tobin's *q* is defined as the ratio of a firm's market value to the replacement cost of its assets, which this study approximates using the method developed in Chung and Pruitt (1994), which we describe in Appendix A. Tobin's *q* incorporates the market value of firms and is thus able to reflect intangible attributes, which are not captured by an accounting-based measure like ROA.

ROA and Tobin's *q* provide complementary information regarding a firm's financial performance, which allows us to differentially evaluate the effect of environmental performance. Whereas the former demonstrates how efficiently a firm generates profit per unit of production, the latter reflects intangible measures of performance, like investor confidence and reputation (Dowell et al., 2000; King & Lenox, 2002; Konar & Cohen, 2001). In this sense, Tobin's *q* can incorporate how robust the market interprets a firm to be in the face of future climate legislation, whereas ROA only acknowledges a firm's GHG emissions indirectly via the efficiency of its use in producing earnings (Busch & Hoffmann, 2011). Both measures have been used in empirical research into the effect of environmental performance on financial performance (Dowell et al., 2000; Elsayed & Paton, 2005; King & Lenox, 2002). However, to the best of our knowledge, only King and Lenox (2002) and Nakao, Amano, Matsumura, Genba, and Nakano (2007) used both measures in the same study. Notably, both studies uncovered substantively equivalent effects of environmental performance on Tobin's *q* and on ROA.

Compared to ROA, calculating Tobin's *q* requires a relatively high number of financial variables and is more susceptible to missing values. This creates a discrepancy in the number of observations for each dependent variable in this study, resulting in asymmetric sample spaces (see Table 4). To check whether this introduces sample bias, an identical analysis was conducted on the set of observations common to both dependent variables. The results were robust to both sample spaces (results available on request from the authors).

Independent Variables

Our study accounts for all six of the GHGs identified by the Kyoto Protocol. Each of these is converted into CO_2-equivalent (CO_2-e) emissions mass based on global warming potential factors. Direct and supply chain emissions sources are categorized in accordance with the GHG Protocol, the prevailing international GHG accounting tool (Ranganathan et al., 2004). The GHG Protocol categorizes emissions into three disparate categories: Scope 1 emissions are all GHGs emitted from sources directly owned or operated by the responsible firm; Scope 2 emissions include all indirect emissions resulting from purchased electricity, heat, or steam; and Scope 3 emissions include all other sources. Natural log transformations were applied to adjust for the skewed distribution. Appendix A describes how GHG emissions were measured.

Controls

Five additional environmental variables from the Trucost database are included as controls. These variables account for the range of disparate environmental impacts of each firm's operations. Their inclusion allows us to analyze the effect of GHGs on financial performance while assuming all other sources of environmental performance variation are constant. Each environmental issue aggregates a unique subset of Trucost's environmental impact variables under the following categories: general waste, heavy metals, natural resources, VOCs, water abstraction, and other emissions. To explore collinearity concerns raised by relatively high pairwise correlations between several of these environmental control variables (see Table 2), we conducted identical analyses excluding the VOC and general waste variables. Their exclusion does not alter the results or indicate the presence of collinearity. Moreover, the range of variance inflation factors for the environmental control variables is within acceptable limits.

As mentioned above, we included a binary *disclosure* variable to account for variation across firms in whether environmental data were imputed versus publicly available or provided by the firm. This variable allows our analysis to control for any potential bias accorded companies based on their disclosure of environmental impact data. It also provides some control over endogeneity, alleviating the concern that firms that choose to disclose may be those that believe they can benefit financially from reducing their GHG emissions. Approximately, 21% of the firms in our sample disclosed information on their environmental performance; however, this percentage varies considerably across industries (e.g., <5% disclosed performance data in the financial sector vs. >60% in the utilities and oil and gas sectors).

Our analysis includes several financial variables to control for sources of firm-level heterogeneity, in line with previous studies of financial and environmental performance (Dowell et al., 2000; Elsayed & Paton, 2005; King & Lenox, 2002). Firm total assets account for variation in *firm size*, while *leverage* is approximated by the ratio of total debt to total assets. *Growth* is defined as the annual change in sales divided by total sales and controls for variations in production (King & Lenox, 2002). Capital expenditures divided by total sales controls for *capital intensity* (Elsayed & Paton, 2005; King & Lenox, 2002). Due to a prohibitively large number of missing values for research and development expenditures in the Compustat database, this variable was not included in our analysis (see McWilliams & Siegel, 2000). To correct for skewed distributions, the financial control variables are transformed using the natural logarithm.

We created a KLD strength variable as the sum of all environmental *strength* items, and similarly created a KLD concern variable as the sum of all *concern* items (Chatterji et al., 2009). Under the *strengths* category, KLD included an item for climate change. This was removed from the aggregated strength variable to avoid correlation with the model's independent variables. The KLD variables were included as controls to account for any effect process-based environmental performance variables could have on financial performance (Chatterji et al., 2009; Harrison & Freeman, 1999). Finally, we use year dummy variables to account for any time trend effects.

Data Analysis

Panel data include observations on *N* cross section units (i.e., firms) over *T* time-periods. As panel data analysis uses variation in both these dimensions, it is considered to be one of the most efficient analytical methods for data (Asteriou, 2006). Both models start from the general form:

$$y_{i,t+1} = \alpha_i + X'_{i,t}\beta + \mu_{i,t},$$

where $y_{i,t+1}$ is the financial performance of firm i in year $t+1$, α_i the unobserved firm-level effect, and β the vector of estimated regression coefficients for each of the explanatory variables measured in the matrix, $X'_{i,t}$. The observations in $X'_{i,t}$ are lagged 1 year behind the dependent variables. By lagging the independent variables 1 year behind financial performance, we further increase our confidence in the direction of the relationship.

Panel data analysis differs from regular time series or cross section regression and is conducted using fixed or random effects model estimation. These are competing models based on contradictory assumptions. To the extent that a panel data model may not be fully specified, fixed effects estimation takes a conservative approach. Viewing each α_i as a constant (i.e., an intercept) unique to each firm, the fixed effects model allows researchers to control for all time-invariant unobserved firm characteristics that might otherwise confound the explanatory variables, including the firm's industry. This means that variation in financial performance is associated only with changes in GHG emissions occurring over time within each firm. Additionally, a Hausman test rejected the random effects model in favor of the fixed effects model for both dependent variables ($p < .01$). Thus, we do not present the random effects models.

Results

We begin with descriptive statistics, presented in Table 1. Table 2 contains the matrix of correlation coefficients for the regression variables.

Table 3 and Figure 1 show mean total GHG emissions (tons CO_2-e) by supersector for our samples. The utilities and basic resources sectors are the most carbon-intensive.

Table 1. Descriptive Statistics.

Variable	Description	*M*	*SD*	Minimum	Maximum
Return on assets	Earnings before interest over total firm assets	0.05	0.10	−1.24	0.95
Tobin's *q*	Market value of assets divided by book value of assets	1.75	1.56	−0.78	36.13
Total greenhouse gas emissions	Log of total greenhouse gas emissions (tons CO_2-equivalent)	13.45	2.05	3.88	19.64
Water abstraction	Log of direct water abstraction (volume)	8.19	8.23	0.00	24.71
General waste	Log of directly generated general waste (mass)	9.03	2.04	0.00	15.15

Volatile organic compounds	Log of directly produced of volatile organic compounds (mass)	4.46	2.69	0.00	14.12
Heavy metals	Log of damage costs (millions US$) due to environmental release of heavy metals	–4.27	4.48	–16.12	6.00
Natural resources	Log of damage costs (millions US$) due to direct natural resource use and extraction	–15.00	4.31	–16.12	8.70
KLD concerns	Sum of all environmental concerns from the KLD Social Ratings Index	0.40	0.89	0.00	5.00
KLD strengths	Sum of all environmental strengths from the KLD Social Ratings Index	0.23	0.62	0.00	4.00
Disclosure	Binary variable indicating whether or not a firm publicly disclosed their environmental performance	0.20	0.40	0.00	1.00
Growth	Log of annual change in sales ratio	–2.26	1.02	–16.12	2.33
Leverage	Log of total debt divided by total assets	–2.83	4.01	–16.12	1.41
Capital intensity	Log of capital expenditures divided by total sales	–3.92	3.28	–16.12	8.55
Firm size	Log of total assets	8.53	1.57	0.27	14.61

Our regression analyses and the results are organized in Table 4. Model 1 shows the fixed effects estimates using ROA as the dependent variable to test Hypothesis 1. As predicted, *GHG emissions* is positive and significant ($p < .05$). A 1% decrease in GHG emissions decreases ROA by 0.00019. We test Hypothesis 2 in Model 2. *GHG emission*s negatively affects Tobin's *q*. The coefficient is significant ($p < .01$); a 1% decrease in carbon emissions increases a firm's Tobin's *q* by 0.0075. The results thus provide strong support for Hypothesis 2.

None of the environmental control variables show consistently significant impacts. The coefficient of *VOCs* is significant for ROA but not for Tobin's *q*, and the coefficients for *general waste*, *natural resources*, and *KLD strengths* are significant for Tobin's *q* but not ROA. Note that KLD variables for each firm vary minimally during the time period of our study. As fixed effects estimation relies on within-firm variability, this may explain KLD variables' lack of significance. Observing the financial control variables, both *firm size* and *growth* are statistically significant and their signs (negative and positive, respectively) constant across both models. These results are consistent with antecedent studies (Elsayed & Paton, 2005; King & Lenox, 2001, 2002). The other financial control variables, *leverage* and *capital intensity*, have no significant impact. Somewhat surprisingly, *disclosure* does not have an effect on Tobin's *q*. This finding suggests that although the market appears sensitive to GHG emissions, it is not concerned with how forthcoming firms are with their environmental performance. It is worth noting this variable reflects overall disclosure of environmental information, not just GHG emissions.

Table 2. Correlation Coefficients.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Return on assets	1.00														
2. Tobin's *q*	.38	1.00													
3. Total GHG	.00	−.39	1.00												
4. Water abstraction	−.06	−.16	.48	1.00											
5. General waste	.03	−.29	.75	.20	1.00										
6. Volatile organic compounds	.01	−.25	.71	.45	.57	1.00									
7. Heavy metals	−.04	−.22	.68	.82	.40	.61	1.00								
8. Natural resources	.03	−.09	.17	.21	.04	.04	.18	1.00							
9. KLD concerns	−.03	−.21	.60	.44	.36	.38	.51	.26	1.00						
10. KLD strengths	.03	−.06	.31	.25	.19	.20	.30	−.05	.28	1.00					
11. Disclosure	.00	−.14	.46	.36	.19	.17	.40	.47	.43	.36	1.00				
12. Growth	.02	.25	−.23	−.05	−.20	−.17	−.11	.04	−.11	−.11	−.09	1.00			
13. Firm size	−.11	−.37	.74	.17	.61	.49	.36	.07	.42	.29	.38	−.19	1.00		
14. Leverage	−.22	−.33	.32	.16	.25	.25	.24	.08	.17	.09	.16	−.12	.30	1.00	
15. Capital intensity	−.12	.00	.01	.13	−.15	−.08	.13	.32	.12	.00	.31	.09	.05	.03	1.00

Note. GHG = greenhouse gas. $N = 3,316$ variables other than Tobin's q; $N = 2,678$ for Tobin's q; coefficients above 0.06 are significant ($p < .05$).

Table 3. Summary Statistics: Firm-Level Total GHG Emissions Normalized by Total Revenue (per million US$).

ICB supersector	*n*	*M*	*SD*	Minimum	Maximum
Automobiles & Parts	38	382.08	169.21	96.90	685.89
Banks	164	22.45	6.75	7.84	45.82
Basic Resources	73	2068.00	1472.59	100.88	5827.74
Chemicals	100	1067.81	678.76	151.32	3272.29
Construction & Materials	54	491.52	546.18	69.42	3317.24
Financial Services	156	49.03	50.53	5.34	454.01
Food & Beverage	112	828.83	684.31	100.62	3138.16
Healthcare	319	161.03	64.94	30.30	511.49
Industrial goods & services	536	407.85	530.20	36.83	9775.05
Insurance	131	64.95	341.18	−10.17	3938.96
Investment instruments	4	41.31	2.18	39.64	44.52
Media	123	113.51	106.64	40.75	1013.22
Oil & Gas	234	805.40	888.50	206.97	11165.36
Personal & Household Goods	179	404.00	451.20	45.06	3696.86
Real Estate	141	116.93	108.16	19.03	995.11
Retail	272	146.22	53.24	46.56	517.12
Technology	344	174.14	120.86	34.81	1070.77
Telecommunications	40	91.37	26.41	74.93	207.87
Travel & Leisure	115	462.61	554.54	59.44	3475.61
Utilities	181	4168.28	4186.92	226.28	18902.36

Note. GHG = greenhouse gas; ICB = Industry Classification Benchmark.

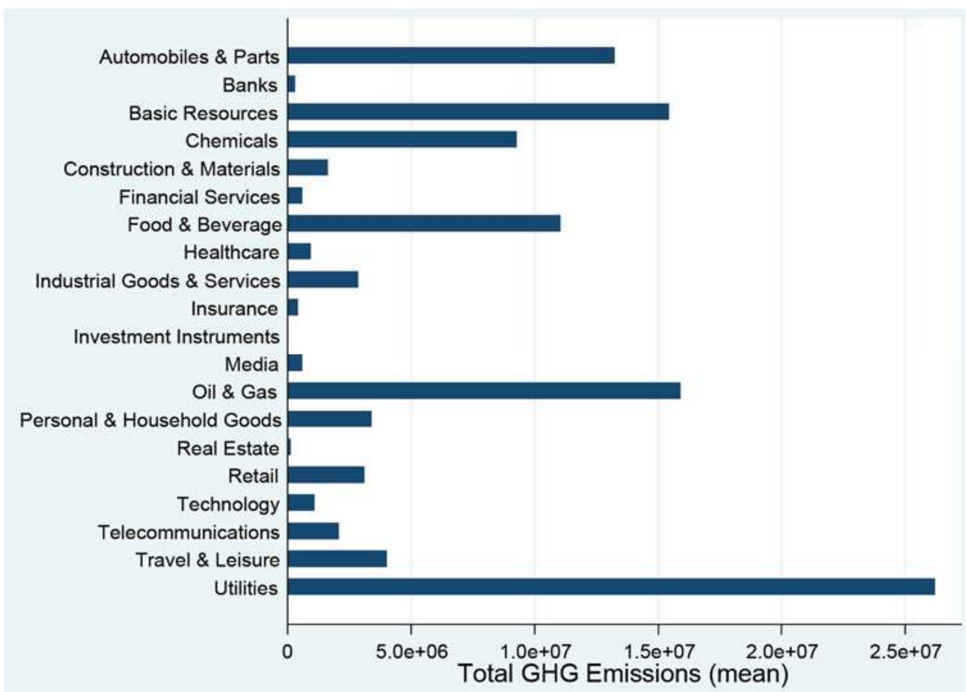

Figure 1. Mean of total GHG emissions by ICB supersector (tons CO_2-e).
Note. GHG = greenhouse gas; ICB = Industry Classification Benchmark; CO_2-e = CO_2 equivalent.

Table 4. Fixed Effects Regression Analysis of GHG Emissions on ROA and Tobin's *q*.

Dependent variable	(1) ROA (*t* + 1)	(2) Tobin's *q* (*t* + 1)
Total GHG emissions	.019** (.009)	−.750***(.107)
Controls		

Water abstraction	.000 (.001)	.017 (.012)
General waste	.000 (.003)	−.060* (.032)
VOCs	−.003* (.002)	.006 (.017)
Heavy metals	.003 (.003)	.006 (.031)
Natural resources	.002 (.001)	.029* (.016)
KLD concerns	.001 (.005)	.076 (.053)
KLD strengths	−.000 (.005)	−.098** (.049)
Disclosure	.003 (.007)	−.008 (.080)
Growth	.007*** (.002)	.045** (.022)
Leverage	.000 (.001)	−.010 (.009)
Capital intensity	−.003 (.003)	−.024 (.057)
Firm size	−.046*** (.008)	−.568*** (.086)
n	3,316	2,678
No. of firms	1,095	880

Note. ROA = return on assets; GHG = greenhouse gas; VOCs = volatile organic compounds. Firm and year dummy effects not presented. Standard errors are in parentheses.
$^*p < .1$. $^{**}p < .05$. $^{***}p < .01$.

The financials industry tends to have low ROA and low GHG emissions, and it is possible that the financials industry is driving our results. In order to test for this, we performed a robustness analysis without the financials industry. The regressions, provided in Appendix B, show that our results are robust to exclusion of the financials industry. Additionally, to explore the possibility of a curvilinear relationship between GHG and financial performance, we ran the same regression with the quadratic GHG term as additional variable and found little evidence of a curvilinear relationship. Results of this robustness test are available from authors on request.

Discussion

The relationship between environmental strategies and competitive advantage has been extensively studied. Recent studies and reviews corroborate the “win–win” hypothesis. However, much of this research has focused on regulated environmental issues, and there has been minimal theoretical or empirical examination of how emerging environmental issues affect competitiveness prior to regulation. Contexts of emerging concerns, such as climate change, raise important questions regarding the appropriate time horizon for evaluation of the environmental–financial performance relationship.

Drawing from a process-based view of environmental issues, we integrate a more dynamic view of external conditions to examine the economic impacts of proactive climate change strategies. We examine these impacts using complementary conceptualizations of financial performance that represent short- and long-term perspectives.

Overall, our results suggest that the relationship between environmental and financial performance depends on the time horizon over which financial performance is evaluated. Using fixed effects estimation and a wealth of control variables, we find that decreased GHG emissions have a *positive* effect on Tobin’s *q*. Our study also shows that decreased GHG emissions have a *negative* effect on ROA. These findings suggest that reducing emissions is unprofitable only from a short-term perspective. Markets recognize the value of reduced emissions in the long-term and firms gain financial advantage from reducing GHG emissions.

We attribute these divergent effects to the unique context of climate change. Our study period corresponds to a period of considerable debate over the appropriate business response to climate change and uncertainty over GHG regulation. Under these conditions, as our results indicate, the costs of mitigating emissions were difficult to offset in the short term. Nonetheless, during this period, the perceived likelihood of regulation under existing statutes or the enactment of new legislation was relatively high (Kolk et al., 2008). Our results indicate that investors placed a premium on reduced GHG emissions, suggesting that they anticipated a change in external conditions that would favor firms with a proactive stance toward climate change.

As such, our study makes an important contribution to the literature on environmental performance and financial performance. We show that environmental strategies have differing effects on short- and long-term measures of financial performance. Thus, we reconcile two opposing views that frame the “pays-to-be-green” debate: Investing in proactive environmental strategies might be costly in the short term, yet profitable in the long term. We contend that the financial effects of firm environmental behavior may be time-dependent, thus resolving the conundrum of whether it pays to be green. In evaluating how to respond, our results suggest that managers adopting a short-term perspective will eschew proactive strategies in favor of less risky and more immediately profitable investments. On the other hand, a forward-looking manager who anticipates a shift toward conditions more amenable to proactive environmental behavior will gain competitive advantage over a longer time horizon by developing the necessary resource base and capabilities. This difference in time orientation has been observed by Slawinski and Bansal (2009), who describe short-term–oriented firms as disconnected from the past and the future and more likely to think about emerging issues such as climate change in terms of trade-offs rather than opportunities. On the opposite, long-term–oriented firms are more likely to justify a higher investment in GHG reductions with the idea that the firm will benefit over time.

It is important to note the limitations of our study and avenues for future research. First, there is a caveat regarding our measure of environmental performance, which is not uncommon to research on corporate environmental performance. Even though the Trucost environmental performance data provide novel information on environmental impacts, they are produced by a combination of public disclosure and model estimates. To ensure accuracy and minimize measurement error, we would prefer to analyze only emissions reported due to regulatory mandates. However, in the absence of regulatory requirements, the data used in our study provide one of the most comprehensive firm-level GHG inventories available.

Second, our measures of financial performance are not perfect. For instance, ROA can be manipulated and Tobin's *q* excludes the replacement value of intangible assets. Furthermore, these measures do not capture all dimensions of firm performance (Richard, Devinney, Yip, & Johnson, 2009). Nonetheless, the fixed effects estimator controls for that to a large extent. If accounting practices and intangible assets remain constant for a firm over time, the shortcomings of various measures of financial performance will not affect our results. Future research could examine other measures of financial performance to verify the robustness of these results.

Third, ROA and Tobin's *q* are imperfect measures of short- and long-term financial performance. An alternative measure of short- and long-term impacts would be to add longer lags to the data. Our study of the pre-implementation stage of protective policy limits our time frame, making longer lags infeasible, but future work could examine longer lags.

Fourth, future research should investigate the impact of changes in GHG emissions on financial performance after the pre-implementation stage of protective policies. Unfortunately, we were unable to do so because the Waxman–Markey bill was not passed and there has not been any significant climate change legislation since. Extending a study to cover the implementation stage of protective policies will further the understanding of the relationship between environmental and financial performance, for instance: How does the firm's industry affect the relationship? Does the relationship strengthen or weaken during the implementation stage? How does a firm's preimplementation strategies affect financial performance during the implementation stage? Examining this in the context of already-implemented policies, such as the Emissions Trading Scheme of Europe, will prove enlightening.

Fifth, our results are based on average behavior. That is to say, we were able to observe the effect of proactive environmental strategies for an average firm (controlling for many factors). However, it is possible that some firms possess different capabilities and organizational characteristics that might influence our conclusions. Further research should open the organizational black box (Delmas & Toffel, 2008) and investigate the effect of different organizational characteristics on firm choices. For example, Marginson and McAulay (2008) emphasize the importance of distinguishing between short-termism—"a preference for actions in the near term that have detrimental consequences for the long term"—and myopia—"the difficulty of assessing long-term consequences." The former attributes the ills of a short-term focus to policy; the latter emphasizes what is perhaps a more mundane explanation: Executives prefer focusing on the short term simply because it is easier to do. Our analysis cannot ascertain which of these two phenomena is guiding each organization's GHG strategy.

It is precisely at this intraorganizational, managerial level of analysis where we see the greatest need for additional research. Margolis and Walsh (2003) argued that academics should expend less effort on attempting to synthetically reconcile competing societal and economic viewpoints but rather should study the principles and guidelines for managing trade-offs in organizational contexts. In particular they proposed the following areas of inquiry: "how companies extract and appraise the stimuli for action; how companies generate response options; [and] how companies evaluate these options and select a course of action" (p. 285). But whereas Margolis and Walsh suggested examining the tensions between economic and noneconomic priorities, we believe it no less important to examine the different ways in which managers conceptualize economic value and thereby, indirectly, sustainability and corporate social responsibility (see also Garcia-Castro, Ariño, & Canela, 2011).

Such research can harness different methodological approaches in varied empirical settings. We know that many of the cognitive and conceptual heuristics that guide corporate decision making are formed in educational settings (Ferraro, Pfeffer, & Sutton, 2005; Lewis, Walls, & Dowell, 2013). Simulation-based experiments, conducted before and after university training, as well as at different managerial levels, will provide valuable insight into the way managers and managers-in-training perceive temporal trade-offs, particularly as pertaining to sustainability. Qualitative work based on interviews and ethnography can uncover the actual decision-making processes on which managers rely in deciding on project feasibility. CFOs and financial staff are increasingly involved in decisions related to environmental issues and are becoming avid supporters of sustainability initiatives in many organizations (Ernst & Young, 2011). The way in which they rationalize their decision making criteria, particularly as it pertains to short- and long-term priorities, can be assessed via surveys or through interaction in executive education programs. Quantitative analyses can continue to explore the role of financial incentives in steering managerial attention to environmental issues and to the contingencies under which such schemes are more or less effective, both in terms of economic and noneconomic performance (Kock, Santaló, & Diestre, 2012; Walls, Berrone, & Phan, 2012).

Conclusion

In this article, we examined the relationship between corporate sustainability and financial performance in the context of an emerging and unregulated issue, GHG emissions. We found that short-term payoffs to corporate sustainability, measured by ROA, are negative. At the same time, we also found that a decrease in GHG emissions increased Tobin's *q*. This implies that the market sees long-term value in GHG emissions reductions, even for an emerging and unregulated environmental issue.

Appendix A

Trucost Data

Where available, Trucost collects, standardizes, and validates company reported environmental data from annual reports, corporate websites, or other public disclosures. Where not disclosed publicly, data are calculated from global fuel use or imputed by conducting a detailed sector breakdown of each firm and applying a proprietary input–output (IO) economic model based on government census and survey data, industry data, and statistics and national economic accounts. Economic IO models estimate the amount of resources (and their associated environmental impacts) from all 426 sectors of the U.S. economy required for a particular firm to produce one unit of its good or service (output; Rosenblum, Horvath, & Hendrickson, 2000). Economic IO models account for interactions between sectors and can be augmented to incorporate resource consumption and environmental damages, allowing for the delineation of environmental damage associated with each economic activity into direct and multilevel supply chain activities (Huang, Weber, & Mathews, 2009; Mathews, Hendrickson, & Weber, 2008; Rosenblum et al., 2000).

Trucost adapts the IO framework to estimate the environmental impacts of 464 business activities or processes. By mapping each firm's operations to a subset of these business activities, Trucost calculates the magnitude of each environment impact variable based on a firm's subsector revenue profile. A firm's subsector profile is derived from the six-digit North American Industrial Classification System and segmental revenue data acquired from company accounts.

Tobin's q

Chung and Pruitt (1994) define an approximation of Tobin's *q* as follows:

$$\text{Approximate } q = \frac{MVE + PS + DEBT}{TA},$$

where MVE is the product of a firm's share price and the number of common stock shares outstanding, PS is the liquidating value of the firm's outstanding preferred stock, $DEBT$ is the value of the firm's short-term liabilities net of its short-term assets, plus the book value of the firm's long-term debt, and TA is the book value of the total assets of the firm (p. 71).

Appendix B

Fixed Effects Regression Excluding Financials Industry.

Dependent variable	ROA ($t + 1$)	Tobin's q (t+1)
Total GHG emissions	0.026** (0.009)	–0.775*** (0.103)
Controls		
Water abstraction	–.000 (.001)	.014 (.011)

General waste	.001 (.003)	−.058** (.030)
VOCs	−.003 (.002)	−.002 (.017)
Heavy metals	.004 (.003)	.013 (.029)
Natural resources	.002 (.002)	.026* (.015)
KLD concerns	.001 (.005)	.068 (.050)
KLD strengths	.000 (.005)	−.112** (.046)
Disclosure	.001 (.008)	−.026 (.076)
Growth	.008*** (.002)	.043** (.021)
Leverage	−.000 (.001)	.002 (.009)
Capital intensity	−.009 (.006)	.020 (.056)
Firm size	−.052*** (.009)	−.420*** (.087)
n	2,719	2,603
No. of firms	895	857

Note. ROA = return on assets; VOC = volatile organic compounds. Firm and year dummy effects not presented. Standard errors are in parentheses.
**p* < .1. ***p* < .05. ****p* < .01.

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