DOES ENVIRONMENTAL PERFORMANCE AFFECT ORGANIZATIONAL PERFORMANCE? EVIDENCE FROM GREEN IT ORGANIZATIONS

Completed Research Paper

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Abstract

The growing concern about the environment and the realization that organizations are major contributors of harmful emissions and waste as well as major consumers of finite natural resources have resulted in the growing push towards the adoption of green IT. However, there is a lack of empirical research that examines the impact of environmental performance on organizational performance of green IT organizations. By drawing on the resource-based perspective on corporate environmental performance, we examine the relationship between environmental performance measured in terms of emissions, and different measures of organizational performance such as profitability and operational performance using objective data. We move beyond correlational approach and employ advanced econometric methods to test the relationships. The result shows that there is a positive impact of different measures of environmental performance on organizational performance. Implications for research and practice are discussed.

Keywords: Environmental performance, organizational performance, green IT

Introduction

Recent years have witnessed growing concerns about the harmful ramifications of industrial development and urbanization in the form of climate change and global warming. The findings of the International Panel on Climate Change (IPCC), a body formed by the United Nations (UN), suggest that greenhouse gases (GHGs) are responsible for global warming (National Geographic 2011). A major source of the GHGs emissions is caused by organizations' operations. In addition to GHGs emissions, organizations are also major consumers of finite natural resources (Ekins 1993) and are often responsible for generating harmful waste (Shrivastava and Hart 1995; EPA 2011a) that poses significant health hazards. The increasing cognizance of adverse environmental impact has resulted in organizational efforts targeted at reducing harmful environmental impact. This is illustrated by the growth in sustainability related investments by organizations (Haanaes et al. 2011). A recent industry report indicates that IT infrastructure such as data centers contributes to 2% of the annual GHGs emissions (Computerworld 2007). This has resulted in the emergence of green IT as a significant component of a broad stream of initiatives focused on improving environmental performance of organizations. Green IT is defined as computing technologies that are energy-efficient and have minimal adverse impact on the environment (Boudreau et al. 2008). The salience of technology in shaping organizations and society (Orlikowski 2008) implies that green IT will be a crucial component of the organizations' environmental initiatives. Hence, the increased environmental focus has resulted in imbuement of green IT by organizations.

Despite this growing trend of utilization of green IT for addressing the adverse environmental impact of organizations, research on the business value of green IT is limited. Recent research has primarily focused on the institutional factors that facilitate the adoption of green IT. These researches have emphasized the role of regulatory norms and policies in promoting the organizational adoption of green IS (Chen et al. 2009). In addition, a framework, which laid down the various dimensions of organizational readiness for the adoption of green IT has been developed (Molla et al. 2009). This framework emphasized the role of dimensions such as attitude and policy in facilitating the adoption of green IT by organizations. Recent research such as Mithas et al. (2010), and Thambusamy and Salam (2010) have examined the impact of green IT on organizational performance. Though these researches have found support for the positive association between green IT and organizational performance, they did not examine the relationship between environmental performance and organizational performance. They have examined the relationship of specific dimensions of the sustainability portfolio such as pollution prevention, product stewardship and clean technology with corporate payoffs.

However, the objectives of green IT is to reduce the adverse environmental impact of organizations' operations. The adoption of green IT entails costs as organizations have to invest in new technologies such as green data centers, virtualization, green software, hardware and Leadership in Energy and Environment Design (LEED) compliant infrastructure. The primary organizational objective behind investments in green IT is to achieve cost savings (Storage Expo 2008). Hence, there is a need to examine the relationship between environmental performance and organizational performance in the context of green IT organizations (organizations that have adopted green IT). If green IT organizations do achieve an enhancement in their organizational performance due to improvement in their environmental performance, it would demonstrate the business value of improvement in environmental performance, which is the result of green IT initiatives. However, an absence of positive relationship between environmental performance and organizational performance would reveal that organizations are still not able to reap benefits from better environmental performance. From the organizational perspective, environmental performance is comprised of dimensions such as emissions and waste tracking. Global reporting initiatives (GRI) guidelines for providing a sustainability reporting framework also emphasize these dimensions (GRI 2011). Organizations may perform differently on different dimensions of environmental performance. In addition, improvement in different dimensions of environmental performance may have different impact on different measures of organizational performance. This raises another research question on the impact of improvement in various dimensions of environmental performance on different measures of organizational performance. Hence, we examine two key research questions in the context of green IT organizations:

***RQ1**: Is environmental performance positively associated with organizational performance?*

***RQ2**: Do different dimensions of environmental performance have different relationships with different measures of organizational performance?*

This study makes the following contributions. First, while the business value of green IT has been theoretically recognized in the literature (Watson et al. 2010), and empirically examined using the case study and survey approaches, prior empirical studies have primarily explored the direct relationship between green IT and organizational performance. However, this approach ignores the salience of environmental performance in the relationship between environmental performance and organizational performance. Green IT is targeted at improving environmental performance. Thus, environmental performance is the intermediate variable between the green IT and organizational performance. Prior research such as Wade and Hulland (2004), and Benitez-Amado and Walczuch (2012) argue for investigation of the business value of IT at the level of intermediate variable which in turn lead to better organizational performance. We attempt to fill this gap by examining the relationship between environmental performance (an intermediate variable) and organizational performance in the context of green IT organizations. In doing so, we provide empirical evidence of the performance impact of green IT and environmental performance. The study also indicates that though green IT entails cost, it contributes positively to different dimensions of organizational performance by improving environmental performance. This will help motivate more organizations to adopt green IT.

Second, we use archival data and objective measures of environmental performance and organizational performance to examine the relationships between them. This allows us to go beyond the case study and survey approaches adopted in some recent empirical work on green IT such as Mithas et al. (2010), and Thambusamy and Salam (2010). These works are based on perceptual data (survey) or lack generalizability (case study). In contrast, our analysis is based on objective measures of organizational performance and environmental performance reported by organizations. In addition, our analysis spans a multi-year time period rather than a single point of time and thus our results indicate the impact of environmental performance on organizational performance in the context of green IT organizations over a longer time period. Many prior studies focusing on the relationship between environmental performance and financial performance suffer from methodological limitations such as sample from single sector, self-reported measures, simple analysis, and omitted variables (Horváthová, 2010). We address these methodological limitations using advanced econometric methods. We use objective data that have been validated by a key environmental agency as a measure of environmental performance for our analysis. In doing so, we attempt to compute robust estimates to unravel the relationships between environmental performance and financial performance.

Third, we examine whether there are different relationships between different dimensions of environmental performance and measures of organizational performance. In doing so, we provide empirical evidence of the performance impact of dimensions such as emissions and waste tracking on organizational performance. The results illustrate how different dimensions of environmental performance may have different orientations and consequently different impact on organizational performance. Such insights can guide organizations in their green IT investment decision. Depending upon the dimension of organizational performance, which organizations want to focus on, they can target environmental performance dimensions closely associated with the specific organizational performance measure.

The rest of the paper is structured as follows. We review the literature streams that are relevant to this study. We then propose our framework and hypotheses. Next, we describe our datasets and analysis procedure. This is followed by the results, discussion, implications for research and practice, and concluding remarks.

This study draws on the resource-based perspective on corporate environmental performance to demonstrate the value behind reduction in emissions and waste tracking.

Background

This study is at the confluence of two distinct streams of research: (i) business value of environmental performance; and (ii) green IT. In the following sections, we describe prior work in each of these streams.

Environmental Performance

The last three decades have seen a stream of research on the impact of environmental performance and regulations on an organization's financial performance. There have been two distinct views on the possible direction of the relationship between environmental performance and organizational performance. Views based on the neoclassical theory have argued for the negative impact of environmental performance on organizational performance (Palmer et al. 1995). Prior research such as Cordeiro and Sarkis (1997), and Stanwick and Stanwick (1998) found empirical support for the negative relationship between environmental performance and organizational performance. On the other hand, views based on the innovation-offsets argue for the positive relationship between environmental performance and organization performance (Porter 1992, Porter and Van Linde 1995). The underlying argument is that the drive towards better environmental performance would result in innovations that would offset the compliance cost. Empirically, research such as King and Lenox (2001), and Konar and Cohen (2001) found support for the positive relationship between environmental performance and organizational performance. Few empirical analyses such as Wagner (2005), and Earnhart and Lízal (2007) could not ascertain the exact nature of the relationship. Overall, the results seem to be inconclusive (Horváthová, 2010) as various empirical researches have reported mixed findings. The meta-analysis of "environmental performance-financial performance" linkage attributes such findings to different methods used in such studies. Empirical studies using simple correlation-based approaches and portfolio studies have been found to provide support for the negative relationship between environmental performance and financial performance. Although, there have been few studies in the past, which have found support for the positive relationship between environmental performance and organizational performance (Russo and Fouts 1997), most of these studies have focused on a single sector (Russo and Fouts 1997), and also involve different measures of environmental performance such as pollution performance and compliance with environmental regulations (Margolis et al. 2007).

Green IT

Green IT is an emerging phenomenon, which has gained prominence in the last few years. Green IT is defined as "the suite of information and communications technologies and information systems that are used directly or indirectly to reduce the harmful environmental impacts of human activities" (Corbett 2010, pp. 3). Green IT involves four different types of IT infrastructure: information to support decision-making, direct IT assets and infrastructure, collaboration and sustainable products and services (Corbett 2010). These are primarily linked to manufacturing or service delivery process as they pertain to an organization's internal operations. The information to support decision-making via business intelligence facilitates more efficient utilization of resources and results in less waste generation. Direct IT assets and infrastructure that are green result in less utilization of resources such as water and electricity and are associated with less emissions. Collaboration via electronic media helps in the reduction of emissions by reducing the need for transportation. The introduction of sustainable products and services such as new online services reduces the need for complex physical service delivery mechanism. This reduces energy consumption, subsequent emissions, and waste associated with physical service delivery mechanism. Hence, green IT is associated with various measures of environmental performance. The objective of green IT as a sub-set of sustainability initiatives is to achieve resource efficiency, improve the reputation of organizations, reduce cost of operations, and help organizations acquire competitive advantage (Haanaes et al. 2011). Therefore, green IT is expected to improve organizational performance through improvement in environmental performance. Hence, it is pertinent to examine the relationship between environmental performance and organizational performance in the context of green IT organizations.

Resource-based perspective on corporate environmental performance

In this study, we attempt to investigate the relationships between different dimensions of environmental performance and organizational performance in the context of green IT organizations. We use the resource-based perspective on corporate environmental performance developed by Russo and Fouts (1997) as the theoretical lens in our study. Russo and Fouts developed this perspective to examine the relationship between environmental performance, and profitability. However, one of the major limitations of the study is the use of environmental ratings rather than objective measures of environmental performance, and the data spans only two years. The estimation technique used in the study was OLS regression. This limits the potential of analysis to control for endogeneity, and heterogeneity issues. However, despite various limitations, the study provides an important theoretical lens to understand the impact of environmental performance on organizational performance. The resource-based perspective on corporate environmental performance posits that organizations that attempt to improve their environmental performance acquire resource base, which will affect their ability to generate profits. Organizations that are more proactive in their attempt to improve environmental performance acquire better physical assets, and technology due to their focus on the redesign of the process or service delivery process. The increased focus on improving environmental performance is also associated with a fundamental shift in the organization's culture and human resources. The improvement in environmental performance is also associated with improvement in organization's reputation and political acumen (Russo and Fouts 1997). Better reputation helps organizations to increase their appeal among environmentally-conscious consumers, and thus improve sales. Political acumen is defined as the organizational ability to influence public policies to acquire competitive advantage. Organizations focused on improving environmental performance, rather than compliance with existing regulations tend to develop skills that help them raise the standards for environmental performance and acquire competitive advantage. To summarize, improvement in environmental performance should result in better organizational performance. In the context of green IT organizations, green IT artifacts are the physical and technological assets acquired by organizations to improve their environmental performance. Hence, the resource-based perspective on corporate environmental performance is an appropriate theoretical lens to examine the relationships between different dimensions of environmental performance and organizational performance in this context.

Research Model and Hypotheses

Our research model (Figure 1) hypothesizes the relationship between environmental performance and organizational performance.

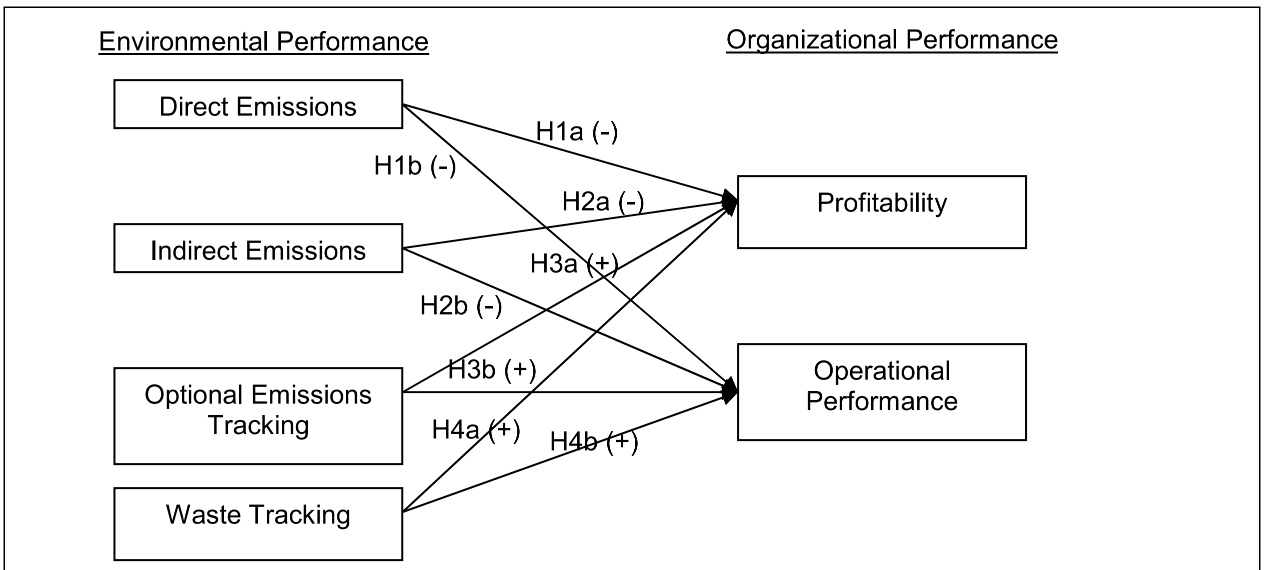

Figure 1. Research Model

Environmental Performance and Organizational Performance

The GRI guidelines which are directed towards an effective framework for sustainability reporting emphasizes on reducing emissions and waste, and conserving water, fuel, and electricity usage as critical environmental performance metrics. Hence, we use emissions and waste as different measures of environmental performance. It is worthwhile noting that emissions also capture fuel and electricity usage (EPA 2011a). These guidelines are consistent with the key objectives behind sustainability initiatives, namely, to achieve cost and resource efficiency, and improve profitability (Haanaes et al. 2011). Since the primary objective behind sustainability initiatives in general is to reduce costs, and better utilize resources, they are salient in an organization's operational performance and profitability. Hence, we consider profitability and operational performance as organizational performance metrics for our study.

Measures of Environmental Performance

One of the important components of the environmental performance of organizations is GHG emissions, which refers to discharge of gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases. These gases trap heat in the atmosphere and thus contribute to global warming and climate change (EPA waste website 2011). The GHG emissions are measured and tracked using a protocol developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) (The Greenhouse Gas Protocol Initiative 2011). The protocol has been adapted by US EPA to fit the organizational context (EPA 2011b). The sources of organizational emissions are from its operations and comprise activities such as fuel consumption, energy use, process related emissions, refrigeration use, emissions from electricity purchases, and other sources. Based on the sources of operations, emissions are classified into three categories: direct emissions, indirect emissions and optional emissions (EPA 2011b).

Direct emissions refer to emissions from sources that are owned or controlled by the organization. It comprises emissions from the manufacturing or service generation process, refrigeration, mobile combustion sources (different modes of transport), and stationary combustion sources (combustion of fuel in stationary equipment). Direct emissions reflect the fossil fuel consumption by an organization. Indirect emissions refer to the emissions from utilities purchased by the organization. It comprises emissions from energy sources such as purchased electricity, steam, hot water and cold water (EPA 2011c). Emissions are indicators of inefficient combustion process and thus indicators of inefficient resource usage (EPA 2011d). Hence, less emissions indicate that energy resources are used with higher usable output to input ratio and less wastage in form of emissions, i.e., higher energy efficiency as energy efficiency is interlinked with pollution emissions (Worrell et al. 2009). Energy expenditure is reduced, thereby affecting the bottom-line of organizations. Reduced energy expenditure and effective utilization of energy resources also improve organizations' operational performance. In addition, reduced emissions are indicators of improved environmental performance. Better environmental performance improves the reputation of organizations, and helps organizations attract environment-conscious customers, and improve sales of the organizations. Better environmental performance, manifested in the form of reduced emissions, suggests that organizations have adopted pollution prevention. This approach requires organizations to acquire, and install new technologies (Russo and Fouts 1997). Organizations also need to redesign their processes to reduce emissions. Acquisition of new technological assets and new processes may help organizations acquire competitive advantage, as processes employed in organizations for waste reduction, and fuel efficiency are less transparent to other organizations. Better environmental performance is also associated with better quality of human capital in the organization, which may help organizations improve their financial performance. Thus, organizations' profitability will improve. Hence, we hypothesize:

H1a: Direct emissions are negatively associated with profitability

H1b: Direct emissions are negatively associated with operational performance.

H2a: Indirect emissions are negatively associated with profitability.

H2b: Indirect emissions are negatively associated with operational performance.

Optional emissions refer to emissions from employees' business travels (vehicles not owned by organizations) or non-standard sources such as purchased heat in heat transfer fluid, resale process (in the context of utility organizations) (EPA 2011c). Its reporting is not mandatory for organizations. However, reporting of optional emissions suggests that organizations are tracking their resale process and employee business travels. The tracking of optional emissions helps organizations to better assess their expenditure on business travels and non-standard emissions sources more effectively. This can facilitate the adoption of telecommuting to reduce business travel. Such initiatives result in fuel savings and reduction in energy expenditure. Thus, organizations' profitability will improve. In addition, reduced expenses due to such initiatives help reduce organization's cost of operations and enhance organizations' operational performance. Tracking optional emissions is more challenging compared to tracking direct and indirect emissions (UCAR 2011). Therefore, tracking optional emissions require developing additional skills on the part of organizations. These additional skills may help organizations acquire competitive advantage, and improve their profitability and operational performance. We summarize the above arguments in the following hypotheses:

H3a: Optional emissions tracking is positively associated with profitability.

H3b: Optional emissions tracking is positively associated with operational performance.

In addition to emissions, the other important metric of environmental performance is waste tracking. The waste generated by organizations include waste from manufacturing and industrial processes, toxic waste, batteries, pesticides, mercury–containing equipment, garbage refuse, and sludge from water treatment and air treatment (EPA waste website 2011). Organizations may or may not track their waste. Organizations engaged in waste tracking will be aware of the waste generated by their processes. Due to various legal requirements such as Resource Conservation and Recovery Act (RCRA 1976), organizations have to devise systems for effective and efficient disposal of their waste. This entails additional expenditure for organizations. Tracking of waste enables organizations to have more knowledge about their waste generation processes as well as facilitate the development of processes that generate less waste. This reduces expenditure on waste disposal, thus positively influencing the organization's bottom-line. In addition, the development of less waste generating process results in more efficient processes and more efficient utilization of resources, thus improving operational performance. We therefore hypothesize:

H4a: Waste tracking is positively associated with profitability.

H4b: Waste tracking is positively associated with operational performance.

Method

Sample Selection

We compiled a list of publicly listed organizations with published GHG inventory for at least 2 years from the EPA Climate Leaders program website (http://www.epa.gov/climateleaders/ 2011). EPA climate leader program was initiated in 2002, and was based on industry-government partnership. Under this program, organizations worked with EPA to set emissions goals, and track their progress. EPA helped organizations to measure and report their emissions. Thus, the numbers reported by the organizations were under the supervision of a government agency, thus lending credence to the numbers. The GHG inventory published through this program followed the standard guidelines set up by the EPA based on WRI framework. We arrived at a list of 54 organizations. We then examined their sustainability reports and websites to investigate if the organization's initiatives involved components of green IT. We identified the presence of IT artifacts such as IT infrastructure and IT policies as the criteria for distinguishing between green IT organizations and non-green IT organizations. We developed a list of IT artifacts based on literature review of research focused on green IT and the list includes IT technical infrastructure (hardware and software) (Molla et al. 2009), deployment of IT in the environment management (Watson et al. 2010), IT to provide information to support decision making, IT tools for collaboration and IT for delivery of sustainable products and services (Corbett 2010). Based on these green IT artifacts, we classified organizations as green IT organizations if their initiatives involved any such artifacts. The classification of green IT versus non-green IT was done by one of the authors and a doctoral student. Out of 54 organizations, 47 were classified as green IT organizations. The reliability of classification was tested using Perrault and Leigh's (1989) reliability index. The test yielded value of 0.94, thereby providing credence to our classification. The sample development procedure is summarized in Figure 2. We have 223 observations for 47 organizations (about 4.75 observations per organization). Note that the sample covers a wide range of industries, thereby indicating that green IT is not restricted to any industry sector.

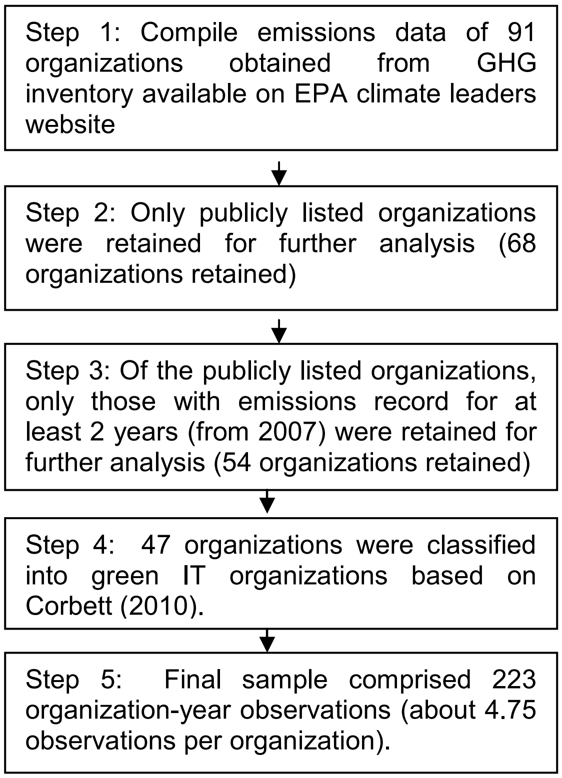

Figure 2. Sample Development Process

Constructs and Their Measurement

A summary of the constructs and their measures is shown in Table 1. Environmental performance is measured using direct emissions, indirect emissions, optional emissions tracking, and waste tracking available in GHG inventory and sustainability reports. Profitability is measured by net margin (Bharadwaj 2000). Operational performance is measured by the ratio of cost of goods sold (COGS) to revenue (Bharadwaj, 2000; Bardhan et al., 2006). Some prior studies such as Zhu and Kraemer (2002) have used solely COGS as the measure of operational performance. However, the ratio of COGS to revenue is a better measure of operational performance as it is an indicator of operational expenses to the revenue generation and an organization's enhanced engagement in revenue generation will result in increased operational expenses. In this study, we use organization size, year, and industry as control variables. We measure size as the log of the number of employees and industry type is captured using 2-digit standard industry classification (SIC) code. We examine if size can be used as an appropriate control for the output level. We therefore also operationalize size as the log of annual revenue as revenue accounts for output level. However, we observe very high correlation between size as log of employee count and size as log of revenue ($r = 0.93$), suggesting effectiveness of size in terms of log of number of employees as a control for the output levels. We therefore operationalize size as the log of number of employees only for testing our models. Further, by using size as a control for the output levels, we also control for the change in emissions due to changes in the output level, thus controlling for an alternative explanation for the change in emissions. This ensures that changes in emissions are primarily driven by the acquisition of new physical and technological assets as proposed in the resource-based perspective on corporate environmental performance.

By controlling for industry, we control for industry specific characteristics such as industry concentrations, regulations and industry specific variations in organizational performance. By controlling for time, we control for year-specific macro-economic factors that may influence the organizational performance, such as international economic downturn. The use of time as a control variable therefore control for macro-economic factors that may be salient in measures of organizational performance as well as environmental performance. We also control for the impact of spread of environmental performance. Under the climate leaders program, organizations may report their global emissions apart from their U.S. emissions. Organizations with global emissions tracking are expected to have higher emissions compared to those with U.S. specific emissions tracking, since their reporting is at the global level. Organizations that are based in the U.S. only and hence have reported emissions at the U.S. facilities were considered on par with global organizations who report global emissions as both of them are reporting emissions for their complete facilities and processes.

Table 1. Constructs and their Measures

Construct	Data Type	Measures	Data Source
Direct Emissions	Continuous	Absolute emissions (in Annual CO2 Metric Tonne scaled by 1000000)	GHG Inventory
Indirect Emissions	Continuous	Absolute emissions (in Annual CO2 Metric Tonne scaled by 1000000)	GHG Inventory
Optional Emissions Tracking	Categorical	0: Not Tracking, 1: Tracking	GHG Inventory
Waste Tracking	Categorical	0: Not Tracking, 1: Tracking	Sustainability Reports
Profitability	Continuous	Net Margin (NM)	COMPUSTAT, Google Finance
Operational Performance	Continuous	COGS percentage	COMPUSTAT, Google Finance
Size	Continuous	Log of employee strength	COMPUSTAT, Wolfram Alpha
Spread	Categorical	0: Local, 1: Global	GHG Inventory

Econometric Specification

We therefore test two distinct models to investigate relationships between environmental performance and organizational performance. In the first model, we use net margin as the measure of profitability, whereas in the second model, we use COGS/Revenue as the measure of operational performance. Prior research such as Aral and Weill (2007), have analyzed the relationship between different measures of organizational performance and IT assets classes separately. Following them we test the relationships between different measures of organizational performance, and environmental performance separately. We lag measures of organizational performance by a year to address potential issue of reverse causality. The econometric specification for our model is as follows:

Model I

$$\text{Net Margin}_{i,\,t+1} = \beta_0 + \beta_1(\text{direct emissions})_{i,t} + \beta_2(\text{indirect emissions})_{i,t} + \beta_3(\text{optional emissions tracking})_{i,t} + \beta_4(\text{waste tracking})_{i,t} + \beta_5(\text{firm size}) + \beta_6(\text{sector}) + \beta_7(\text{year}) + \beta_8(\text{spread})_{i,t} + \varepsilon_{i,t}$$

Model II

$$\text{COGS/Revenue Percentage}_{i,\,t+1} = \beta_9 + \beta_{10}(\text{direct emissions})_{i,\,t} + \beta_{11}(\text{indirect emissions})_{i,\,t} + \beta_{12}(\text{optional emissions tracking})_{i,\,t} + \beta_{13}(\text{waste tracking})_{i,\,t} + \beta_{14}(\text{firm size}) + \beta_{15}(\text{sector}) + \beta_{16}(\text{year}) + \beta_{17}(\text{spread})_{i,\,t} + \Phi_{i,,\,t}$$

Note that higher net margin implies better profitability, whereas higher COGS/revenue percentage implies decline in operational performance.

Analyses and Empirical Results

We used STATA 11 for our analysis. The descriptive statistics for the variables are shown in Table 2 and the correlation table is shown in Table 3. We conducted various analyses to test our model as shown in Table 4 and Table 5. The meta-analysis by Horváthová (2010) delineates the need for comprehensive advanced econometric analyses to establish any relationship between environmental performance and financial performance. There is also a need for appropriate time coverage to address causality concerns. We address these concerns using a variety of econometric analyses techniques. Our data is unbalanced panel data. Hence, we use pooled OLS regression (data is pooled and estimates are computed using OLS regression), fixed effect panel data model, and random effect panel data model. Pooled OLS model is the basic model, and takes into consideration both within and between variations unlike cross-sectional regression, which is focused on between variations only. The panel data fixed effect model removes the between variations and focuses on within variation. The panel data random effect model considers both within and between variations. We compute estimates using the above three models and conduct a statistical test to find out which model is better.

Table 2. Descriptive Statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
Direct Emissions	223	8.63	29.21	0.0005	162.08
Indirect Emissions	223	1.11	17.09	0.00	8.76
Optional Emissions Tracking	223	0.43	0.50	0.00	1.00
Waste Tracking	223	0.39	0.49	0.00	1.00
Net Margin	221	7.38	11.50	-30.90	100.22
COGS/Revenue Percentage	221	56.25	26.84	0.00	129.20
Log(size)	223	4.63	0.53	3.38	5.59
Spread	223	0.58	0.49	0	1

Table 3. Correlation Table

	1	2	3	4	5	6	7
1.Direct Emissions	1.00						
2.Indirect Emissions	-0.07	1.00					
3.Optional Emissions Tracking	-0.07	0.05	1.00				
4.Waste Tracking	-0.19*	0.25*	-0.03	1.00			
5.Net Margin	0.01	-0.01	0.06	0.06	1.00		
6.COGS/Revenue %	0.17*	0.11	-0.04	-0.10	-0.30*	1.00	
7.Log(size)	-0.16*	0.35*	-0.07	0.27*	0.05	-0.06	1.00
8.Spread	0.24*	0.29*	0.05	0.19*	0.08	0.20*	-0.08

*Notes: * denote significance at 5%*

The use of multiple models also offers advantages such as computation of estimates for time invariant variables such as industry dummies, whose estimates are not computed in the fixed effect model. We use clustered robust standard errors to address the potential problem of serial correlation and heteroskedasticity. In addition to panel models, we also conducted 3SLS and Hausman Taylor regression to test whether the panel data models results are robust to potential correlation between different measures of organizational performance and reverse causality respectively. We conduct Hausman specification test (see Table 6) to select the most appropriate model for our analysis.

The results show that the fixed effect model is better than pooled OLS, and random effects model. Hence, we interpret our results from the fixed effect models. The use of various controls facilitates addressing the problem of endogeneity due to omitted variables bias, and use of lagged dependent variables addresses the problem of reverse causality.

Table 4. Results for Environmental Performance and Net Margin

Dependent Variable: Net Margin	Pooled OLS	Panel Fixed Effect	Panel Random Effect	Three Stage Least Square (3SLS)	Hausman Taylor Regression
Direct Emissions	-.02 { .025}	**-.51* { .258}**	-.01 {.0309}	-.02 {.032}	-.106 {.159}
Indirect Emissions	-.91 { .545}	**-7.88** { 1.248}**	**-1.32* { .7913}**	**-.91* {.527}**	**-5.510* {2.143}**
Optional Emissions Tracking	-.045 { 3.037}	-.99 {1.3041}	.38 {2.987}	-.04 {1.99}	.231 {7.68}
Waste Tracking	-2.57 { 2.041}	1.73 { 3.2722}	-1.86 { 2.019}	-2.57 {1.94}	1.74 {4.029}

Table 5. Results for Environmental Performance and COGS/Revenue Percentage

Dependent Variable: COGS/Revenue %	Pooled OLS	Panel Fixed Effect	Panel Random Effect	3SLS	Hausman Taylor
Direct Emissions	**.15* { .071}**	-.35 { .5900}	.15 { .0990}	**.15** {.05}**	.181 {.2127}
Indirect Emissions	**3.29** { 1.173}**	**8.09* { 3.681}**	**4.30** { 1.255}**	**3.29** {.858}**	**5.09* { 2.999}**
Optional Emissions Tracking	2.43 { 5.4191}	**15.91** { 3.013}**	2.41 {6.162}	2.42 {3.25}	8.49 {10.834}
Waste Tracking	6.725 { 5.303	4.89 { 5.772}	5.70 { 4.855}	**6.72* {3.17}**	5.86 { 5.781}

*Notes: **, * denote significance at 1% and 5% respectively (one-tailed). Standard errors are in parentheses. All standard error estimates for pooled OLS and Panel Models are clustered robust errors. Year dummies, size, spread and industry control were included in the regressions, but their estimates are not shown for the sake of brevity.*

Table 6. Hausman Specification Test Results

Variable	Hausman Test (p- values)	Better Model
Net Margin	0.06	Fixed effect
COGS/Revenue Percentage	0.00	Fixed effect

The results show that direct emissions and indirect emissions have negative relationships with net margin [direct emissions (β= -.51, p<.05), indirect emissions (β= - 7.88, p<.01)]. Hence, H1a and H2a are supported. The results provide support for the positive relationship between indirect emissions and the COGS / Revenue percentage (β= -8.09, p<. 05). This indicates that with increase in indirect emissions, COGS relative to revenue increases, thus suggesting decline in operational performance. Hence, H2b is supported. The results also indicate a positive relationship between optional emissions tracking and COGS/Revenue percentage (β= 15.91, p<.05), suggesting a decline in operational performance with engaging in optional emissions tracking. This result contradicts H3B. The results of the fixed effect analysis do not provide support for the association between optional emissions tracking and waste tracking with net margin (β= - .99, p>. 05; β= 1.73, p>. 05). Likewise, the results do not provide any support for the relationship between direct emissions and waste tracking with COGS/Revenue percentage (β= -35, p>.1; β=

4.89, p>.05). The other methods provide comprehensive support for the association between indirect emissions with net margin and COGS/Revenue percentage.

Alternative Measures

In addition, we use return on assets (ROA) and efficiency ratio (ratio of operational expense to revenue) as alternative measures of profitability and operational performance. Prior research such as Bharadwaj (2000) have used two different measures for the same dimension of organizational performance. Following them, we use two different measures for profitability and operational performance in our study. This would show that if the relationships are similar across different measures of same dimensions of organizational performance or differ across different measures. The descriptive statistics for our alternative measures are shown in Table 7.

Table 7. Descriptive Statistics for ROA and Efficiency Ratio

Variable	Observation	Mean	Std. Dev.	Min	Max
Return on Assets	223	4.98	8.31	-33.89	76.91
Efficiency Ratio	221	81.33	11.17	52.89	129.20

The econometric specification for the model is as follows:

$$\text{ROA}_{i,\,t+1} = \beta_{18} + \beta_{19}(\text{direct emissions})_{i,\,t} + \beta_{20}(\text{indirect emissions})_{i,\,t} + \beta_{21}(\text{optional emissions tracking})_{i,t} + \beta_{22}(\text{waste tracking})_{i,t} + \beta_{23}(\text{firm size})_{i,\,t} + \beta_{24}(\text{sector}) + \beta_{25}(\text{year}) + \beta_{26}(\text{spread})_{i,t} + \gamma_{i,,\,t}$$

$$\text{Efficiency Ratio}_{i,\,t+1} = \beta_{27} + \beta_{29}(\text{direct emissions})_{i,\,t} + \beta_{30}(\text{indirect emissions})_{i,t} + \beta_{31}(\text{optional emissions tracking})_{i,\,t} + \beta_{32}(\text{waste tracking})_{i,\,t} + \beta_{33}(\text{firm size})_{i,\,t} + \beta_{34}(\text{sector}) + \beta_{35}(\text{year}) + \beta_{36}(\text{spread}) + \eta_{i,\,t}$$

Note that higher ROA implies better profitability, whereas the higher efficiency ratio implies decline in operational performance. The results are shown in Table 8.

Table 8. Results for Environmental Performance and ROA/ Efficiency Ratio

Dependent Variable: ROA	Pooled OLS	Panel Fixed Effect	Panel Random Effect	3SLS	Hausman Taylor
Direct Emissions	0.01 { .016}	-.32 { .212}	.01 {.0190}	.003 {.023}	-.072 {.1066}
Indirect Emissions	**-0.14*** **{ .381}**	**-5.30**** **{ .849}**	-.78 {.487}	**-.66*** **{.217}**	**-3.79*** **{1.535}**
Optional Emissions Tracking	0.10 { 1.899}	**-1.29*** **{ .604}**	1.56 {1.994}	1.68 {1.46}	-.28 { 5.611}
Waste Tracking	-0.02 { 1.133}	.19 { .991}	-.59 { 1.047}	-.27 {1.42}	.62 {2.906}
Dependent Variable: Efficiency Ratio	**Pooled OLS**	**Panel Fixed Effect**	**Panel Random Effect**	**3SLS**	**Hausman Taylor**
Direct Emissions	.04 {.027}	**.43**** **{ .0992}**	.05 {.040}	**.04*** **{.024}**	.04 {.1318}
Indirect Emissions	.40 { .6033}	**-2.91*** **{ 1.310}**	-.59 {.678}	.30 {.36}	-1.84 {1.497}
Optional Emissions Tracking	-.07 { 3.129}	**-8.33**** **{ 1.401}**	-1.79 {3.589}	-.16 { 1.51}	-6.29 {5.227}
Waste Tracking	3.89 { 2.542}	2.28 { 2.388}	2.737 { 2.117}	**3.79*** **{1.47}**	2.39 {2.610}

*Notes. **, * denote significance at 1% and 5% respectively (one-tailed). Standard errors are in parentheses. All standard error estimates for pooled OLS and Panel Models are clustered robust errors. Year dummies, size, spread and industry control were included in the regressions, but their estimates are not shown for the sake of brevity.*

We observe that there is support for the negative relationship between indirect emissions with ROA and efficiency ratio. This suggests that the reduction in indirect emissions will have a positive influence on profitability (ROA), but the negative influence on operational performance (efficiency ratio). The increase in the indirect emissions by 1000000 MT is associated with a decline in ROA by 5.30% and decrease in efficiency ratio by 2.91%. Among the control variables, estimates for the size were not significant for both profitability, and operational performance. Most of the estimates for year dummies were significant for measures of operational performance suggesting salience of macroeconomic variables in operational performance. Estimates for time invariant variables such as industry were available for the random effect model. Few of the industry dummies were significant. Estimates for spread were not significant for any measures of organizational performance. The results are summarized in Table 9.

Table 9. Results Summary

Hypothesis	Proposed Relationship	Hypothesized Effect	Supported?
H1a	Direct Emissions ---> Profitability	-	Partially supported (Support for Net Margin, Non-support for ROA)
H1b	Direct Emissions ---> Operational Performance	-	Partially supported (Support for Efficiency Ratio, Non-support for COGS/Revenue percentage)
H2a	Indirect Emissions ---> Profitability	-	Fully Supported (Support for both Net Margin and ROA)
H2b	Indirect Emissions ---> Operational Performance	-	Partially supported (Support for COGS /Revenue percentage, Non-support for Efficiency Ratio)
H3a	Optional Emissions Tracking ---> Profitability	+	Not supported
H3b	Optional Emissions Tracking ---> Operational Performance	+	Partially supported (Support for Efficiency Ratio, Non-support for COGS/Revenue percentage)
H4a	Waste Tracking ---> Profitability	+	Not supported
H4b	Waste Tracking ---> Operational Performance	+	Not supported

Discussion

Since we have addressed various endogeneity issues through model specification as well as model estimation, we can argue for the causal impact of various measures of environmental performance. The results show that indirect emissions are negatively associated with profitability in terms of net margin and ROA. This suggests that the reduction is indirect emissions has a positive impact on profitability both in terms of asset utilization as well as a proportion of net income to revenue. A plausible explanation is that indirect emissions represent purchased electricity, purchased fuel, and water. With the reduction in indirect emissions and hence the use of resources such as purchased electricity and fuel, organizations are able to earn more dollars on their assets, thus resulting in an increase in ROA. In addition, the reduction in use of resources also reduces cost, thus improving the net margin. The support for this relationship is also apparent in recent industry surveys where almost a quarter of organizations have identified reduced cost due to energy (electricity) efficiency and material efficiency (water) as the greatest benefits of sustainability initiatives (Haanaes et al. 2011). The results also show that reduction in indirect emissions has a positive impact on the measures of operational performance such as COGS/Revenue percentage. A plausible explanation is that reduction in indirect emissions will result in a reduction in overhead costs and hence the decline in COGS relative to revenue. However, the results show that the reduction in the indirect emissions results in an increase in operating expense. This is surprising. A plausible explanation is that the reduction in indirect emissions will require more sophisticated technology, thus resulting in an increase in maintenance cost (part of operating expenses) and hence, an increase in efficiency ratio. The results further show that the reduction in direct emissions has a positive impact on one measure of profitability, namely, net margin but there is no support for its positive impact on ROA. This suggests that the reduction in direct emissions which refers to emissions from the manufacturing or service generation process, refrigeration, mobile combustion sources (different mode of transports), stationary combustion sources (combustion of fuel in stationary equipment) result in an improvement in energy efficiency of the process, thus bringing down the cost and hence improving the net margin. However, this does not result in significant change in its asset turnover. One of the possible arguments is that such costs will account for small change in net income compared to total asset value. The results suggest that reduction in direct emissions has no significant impact on the COGS / Revenue percentage suggesting that it does not have a significant impact on overhead costs. However, a decrease in direct emissions has a positive impact on operational expense. This suggests that with the decrease in direct emissions, operational expense comprising of power and maintenance may decrease as power utilized for refrigeration, and fuel combustion will decrease.

The results show that the tracking of optional emissions has a positive impact on Efficiency ratio but negative impact on ROA. One possible explanation is that in order to track optional emissions, organizations need to track the cost incurred in non-standard sources such as business travel and hence may incur additional costs. This result in lower net income compared to the value of assets, thus resulting in a decrease in ROA. The advantages of collaborative technologies whose deployment is facilitated by optional emissions tracking have been demonstrated by examples such as IBM (annual savings of $700 million in real estate costs) and AT&T (annual savings of $550 million and productivity improvement) (Nidumolu et al. 2009). Such benefits may require a longer time frame for realization. The optional emissions tracking will however result in an increase in overhead expenditure but decline in travel and vehicle expense, thus resulting in an increase in COGS/Revenue percentage but decline in operating expense and hence improvement in Efficiency ratio.

The results further show that waste tracking has no significant impact on both profitability and operational performance. This can be explained by the fact, that though waste tracking has potential benefits such as increasing organizational awareness of waste generation processes, organizations will have to incur additional expenses for deploying such processes. In other words, the cost nullifies the positive impact. Thus, there is no significant relationship with profitability. For operational performance, this does not result in significant change in overhead expenses. Hence, there is no significant relationship with the COGS / Revenue percentage. It also does not lead to significant change in operating expenses.

Implications for Research and Practice

This study has several implications for research. First, this study focuses on empirical validation of the impact of different dimensions of environmental performance on organizational performance. The results show that the reduction in indirect emissions has an impact on different measures of organizational performance, whereas other dimensions have an impact on selective measures of organizational performance. These results are interesting as different measures of different dimensions of organizational performance are interlinked to each other. However, we observe that different dimensions of environmental performance barring indirect emissions have significant impact on one measure but not on the other. The reasons behind the absence of such causal relationship require further exploration in future research.

Second, the study shows that a decrease in indirect emissions results in an increase in operational expense and hence the negative impact on efficiency ratio. This result indicates that the reduction in the indirect emissions somehow results in increase in costs such as maintenance cost and power cost. Such costs may be higher in the context of new technology in the initial phases. This indicates that benefits of reduced indirect emissions in terms of reduced operational expense may take some time to be realized.

Third, there is no support for the positive impact of waste tracking on any of the measures of organizational performance. This suggests that organizations tracking of various kinds of wastes such as mercury, sludge, etc. have no impact on profitability and operational performance. This indicates that either organizations are not engaging in any improvement in processes based on this information or the costs nullify the benefits. The possible reasons behind the lack of relationship requires further exploration

Fourth, this study is primarily restricted to US based organizations or global organizations with headquarters in the US. The US is a developed economy and the presence of various environmental laws and federal agencies dedicated to environmental issues facilitates the realizations of the benefits of environmental performance. In emerging economies, such laws and such institutional arrangements may be less prevalent. Whether the magnitude and direction of relationships are similar across economies require further exploration.

This study also has several implications for practice. First, this study provides some empirical evidence that better environmental performance results in improvement in measures of profitability and operational performance. Business executives and top management usually decide on the deployment of a technology based on its cost-benefit analyses. Our results provide some idea on the strength of association between different measures of environmental performance, and organizational performance. Take for example; the estimates for indirect emissions suggest that in the context of green IT organizations, the increase in the indirect emissions by 1000000 MT is associated with a decline in ROA by 5.30% and decrease in efficiency ratio by 2.91%. Executives and top management can use this information to explore possible means that can reduce indirect emissions by this magnitude and compare them in terms of their cost of ownership. They can then decide on the means which they think to be appropriate for their organizations based on constraints such as costs.

Second, the lack of support for waste tracking suggests that organizations may not be utilizing the information derived from tracking of waste to reengineer the processes to achieve an increase in profitability and operational performance or the cost balances the benefits. Organizations need to devise cost-effective ways to gain benefits from waste tracking.

Third, the lack of support for waste tracking has also implications for policy and federal environmental agencies. There is a need for more government incentives to support waste tracking initiatives as currently organizations are not able to derive benefits from it.

Fourth, the results suggest that optional emissions tracking has a positive impact on few measures of operational performance. Optional emissions tracking requires advanced technological capabilities on the part of organizations. Our results suggest that the development and deployment of such technologies may be beneficial to organizations. Organizations can also use collaborative technologies such as teleconferencing and virtual rooms to reduce their optional emissions and reap benefits such as reduction in travel expenditures of the executives.

Limitations

This study has three main limitations. First, the sample of 47 organizations is small. This is due to the difficulty of obtaining environmental performance data. With an increase in the audit of environmental performance of organizations, future research could overcome the information availability constraint.

Second, our sample comprises organizations that were members of the climate leader program. This was a voluntary program; hence there is a possibility of self-selection bias in the sample. Future research could examine the relationships between environmental performance, and organizational performance in the context of broader sample comprising organizations chosen at random.

Third, we conducted our analysis using various methods to compare the results from the best panel model with them. The underlying rationale is to test the relationships with various econometric techniques with different assumptions, and thus arrive at the robust estimates for different relationships. The results provide a comprehensive support for the relationship of indirect emission with the different measures of organizational performance. However, the support for other relationships was less comprehensive. A plausible reason is that due to the small sample size, relationships could not be captured adequately. Future research could overcome this constraint as more data become available.

Fourth, due to the paucity of data; we have considered broad categories such as waste tracking and optional emission tracking, rather than the waste generated and optional emission. This limitation will be reduced as more granular data become available in future.

Fifth, our finding is valid for only profit-seeking organizations, it cannot be extended to non-profit or government organizations.

Concluding Remarks

This study contributes to the research on green IT by providing empirical evidence for the positive impact of the environmental performance of green IT organizations on the measures of their organizational performance. Our results empirically establish the salience of environmental performance in contributing to better organizational performance. Further, our study shows that among the different measures of environmental performance, indirect emission has a strong positive impact on organizational performance (through net margin, ROA, and COGS/Revenue percentage), whereas other environmental performance measures have a positive impact on selected measures of organizational performance. Future research can provide a deeper view of how organizations can develop mechanisms to leverage their environmental performance to improve their financial performance in terms of profitability and operational performance.

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