Enterprise Information Systems Capability and GHG Pollution Emissions Reductions

Research-in-Progress

Daniel E. Rush
University of Northern Colorado
Dan.Rush@unco.edu

Nigel P. Melville
University of Michigan, Ann Arbor
npmelv@umich.edu

Ronald V. Ramirez
University of Colorado, Denver
ronald.ramirez@ucdenver.edu

Kevin Kobelsky
University of Michigan, Dearborn
kobelsky@umich.edu

Abstract

This paper adds to IT sustainability literature by empirically examining the degree to which enterprise information systems capability impacts organizational greenhouse gas emissions (GHG). We accomplish this by analyzing a unique data set combining surveys of corporate IT, GHG emissions and environmental practices with other secondary sources that contain financial and environmental metrics. We find that high levels of Enterprise Support IS Capability combined with the adoption of firm GHG pollution reduction targets help to reduce firm GHG emissions. On the other hand, the adoption of reduction targets in less IS-capable firms is associated with higher emissions. Our research highlights the role of information technology in firm sustainability programs and the value of information to pollution reduction.

Keywords: Business value of IS/value of IS, Green IT/IS, Sustainability

Introduction

Greenhouse gases (GHG), including carbon dioxide, methane, nitrous oxide, and fluorinated gases, remain in the atmosphere once emitted and trap heat as measured by their level of Global Warming Potential (GWP). A higher GWP indicates more energy absorption and higher contribution to the Earth's warming.[1] Governments around the world have introduced schemes and regulations to encourage or require organizations to report and limit their GHG emissions (Kauffmann et al. 2012). These efforts are directed toward reducing the impact of climate change, its global impact and lasting consequences (IPCC 2013). Measuring and managing GHG emissions can be a complex task for large, multi-national organizations, and information systems (IS) are being developed to facilitate these efforts (Corbett 2013; Melville and Whisnant 2014; Rush and Melville 2012). While IS have been found to enable corporate social responsibility strategy (Benitez-Amado and Walczuch, 2014), impact electricity usage (Cho et al. 2007; Collard et al. 2005) and affect firm financial performance (e.g. Mithas et al. 2012), the extent and pathways through which firms can utilize IS and related capabilities to reduce GHG emissions remain unanswered.

Professional and academic case studies have detailed company efforts to utilize information systems to reduce greenhouse gas emissions (Melville and Whisnant 2014; Seidel et al. 2014; Watson, Boudreau, Li, et al. 2010; Watson et al. 2011). Our paper adds to this knowledge by empirically examining the degree to which enterprise information systems capability impacts organizational greenhouse gas emissions. We accomplish this by analyzing a unique data set combining surveys of corporate IT, GHG emissions and environmental practices with other secondary sources that contain financial and environmental metrics. We find that high levels of Enterprise Support IS Capability combined with the adoption of firm GHG pollution reduction targets help to reduce firm GHG emissions. On the other hand, the adoption of reduction targets in less IS-capable firms is associated with higher emissions.

Theoretical Background

IS Impacts on Firm Performance

Organizational information systems perform three fundamental roles: they can automate, inform, and transform an organization's operations. Automating existing business processes replaces human labor, informing the business provides data to senior management and their employees across the organization, and transforming changes business processes and industry relationships in fundamental ways (Dehning et al. 2003; Otim et al. 2012; Zuboff 1988). One of the ways that IS can transform an organization is by providing a platform for organizational integration, allowing disparate organizational components (e.g. functions, business units, people and technology) to operate as a collective whole (Ranganathan and Brown 2006).

The value impacts of IS can be viewed through the lens of the Resource Based View (RBV). RBV conceives of IT and its associated capabilities as a bundle of resources that, when Valuable, Rare, Inimitable and Non-substitutable, can lead to superior competitive performance (Liang et al. 2010; Mata et al. 1995; Melville et al. 2004; Wade and Hulland 2004). Research examining the IS resource and firm performance relationship has identified beneficial IS assets and capabilities and estimated their performance influences (see table 1).

Recently, IS scholars have extended the conceptualization of value impacts to those in the natural environment (Benitez-Amado and Walczuch 2012; Elliot 2011; Watson, Boudreau, and Chen 2010). One perspective extends the RBV of the firm to a "Natural" Resource Based view, and examines the strategic outcomes of organizations' environmental decisions (Benitez-Amado and Walczuch 2012; Hart 1995). Another perspective proposes harnessing the transformative aspect of IS to increase energy efficiency (Watson, Boudreau, and Chen 2010). In this paper we examine the influence of information systems on firm greenhouse gas emissions, a natural environment measure of organizational performance.

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[1] Source: U.S. Environmental Protection Agency (EPA), accessed on 8/14/15, http://www.epa.gov/climatechange/ghgemissions/gases.html

Paper	Theoretic Lens	IS Construct	Categories of IS	Definitions
(Aral and Weill 2007)	Resource Based View (extension)	IT Assets and IT Capabilities	IT Assets: Infrastructure, Transactional, Informational, Strategic; IT Capabilities: Competences (Skills) and Practices (Routines)	Assets: Infra: foundation of shared services, Trans: automate processes, Info: Accounting, reporting, planning, Strategic: support market entry, product & service innovation; IT Capabilities: Practices: IT use for communication, Digital transaction intensity, Internet architecture; Skills: HR, IS Management
(Ranganathan and Brown 2006)	Organization Integration and Option Value generation	ERP as IT infrastructure for integration, and future growth as well as commitment signaling	Physical Scope of ERP and Functional Scope of ERP	Value Chain modules (materials management, operations, sales and distribution) Enterprise Support modules (human resources, accounting and finance)
(Benitez-Amado and Walczuch 2012)	Resourced Based View, Dynamic Capabilities Theory, Natural Resource Based View	IT capability	IT Capability (one category), which includes both investment and management practices	Technological IT effort (0-10 scale based on investment in IT infrastructure (hardware & software) and IT management practices to improve operations efficiency

Table 1. IS Business Value Conceptualization Examples

IS Impacts on Greenhouse Gas Emissions

Information Systems impact GHG emissions both directly and indirectly. IT contributes directly to GHG emissions as a result of energy usage by IT infrastructure, the physical component of IS. Such IT (datacenters, broadband networks, etc.) is estimated to consume 3% of the world's electricity, and through that consumption, contribute up to 3% of the world's GHG emissions (Ruth 2009). Countering an upward trend in this consumption are advances in energy efficient IT products and practices, often known as 'Green IT'. Indeed, econometric research presents some evidence of ICT-enabled electricity reduction in manufacturing sectors, though not in service sectors (Cho et al. 2007; Collard et al. 2005). The focus of this study, however, is the indirect contribution of Green IS' (Loeser 2013; Watson, Boudreau, and Chen 2010) and the much larger GHG emission reductions made possible through IS-enabled enterprise-wide GHG management and core business process improvement.

Green IS can affect emissions indirectly via two primary pathways. First, IS are essential to informing an organization by enabling measurement of its GHG impact across geographic and functional units; measurement that enables GHG management. While an assumption of enterprise measurement and management is implicit in corporate and government policies to report and reduce GHG emissions (e.g. the Kyoto Protocol, Australia's NGER, the EU's emissions trading scheme, the US EPA's program to regulate CO2 as an air pollutant), success in IS deployment projects is not guaranteed (Markus and Robey 2004; Nelson 2007). And even if the IS were successfully installed, there is no guarantee that its value objectives would be realized. The business value of IS literature demonstrates that not all companies are equally capable of realizing value objectives from IS. For instance, to see results, an IS needs to be actually used (Devaraj and Kohli 2003), and the category of IS investment makes a difference on the type of value realized (Aral and Weill 2007; Liang et al. 2010; Mithas et al. 2012). Value realization also relies on complementary investments in organizational resources, including IT exploitation capability (Aral and Weill 2007), and it often takes time for an investment to yield its intended value (Brynjolfsson and Hitt 2000; Melville et al. 2004).

The second indirect pathway through which Green IS can affect emissions is business process transformation. The potential for IS-based transformation to reduce GHG emission in industries other than its own has been estimated to be as high as 7.8 billion metric tons, five times the direct emissions of ICT industries (Raghupathi et al. 2014; Webb 2008). One transformative example is the dematerialization of high carbon goods such as books into low carbon goods such as e-books, which could save 500 metric tons of CO2 globally by 2020 (Raghupathi et al. 2014; Webb 2008). Another example is reducing transportation emissions by switching to video conferencing and teleworking, which could save 140M to 22M tons of CO2 annually by 2020 (ibid). Larger scale examples of IS-enabled transformation include using IS to improve logistics, creating IS-enabled smart electrical grids to manage demand and reduce unnecessary energy consumption, and automating lighting and ventilation systems in 'smart buildings', the combination of which could save over 5.23B tons of CO2e[2] by 2020 (Boudreau et al. 2008; Raghupathi et al. 2014; The Economist 2008; Watson, Boudreau, and Chen 2010; Webb 2008). This aggregate potential is promising, and case studies have cataloged early efforts in these areas (Seidel et al. 2014; Watson, Boudreau, Li, et al. 2010). However, it is unknown which types of IS achieve emissions reductions, what scale of reductions are experienced on average (if any) and how existing IS capability affects reductions.

This paper represents the next step in quantifying the impact of IS on GHG emissions by directly examining IS capability's impact on GHG emissions output while accounting for important organizational complements such as sustainability orientation, targets and performance. We test pathways from IS to firm value identified in the literature to determine their impact on this new dimension of firm performance, utilizing detailed firm-level IT data. By doing so, we provide a first and unique cross-company empirical quantification of the impact of enterprise IS on GHG emissions.

Hypothesis Development

Sustainability Commitment and Management Practices

It is unlikely that an organization will achieve superior GHG performance without its leaders first committing it to that goal. Executives can signal their commitment to the management of GHG through instituting specific practices, pursuing business processes changes and communicating relevant messages to employees and external stakeholders (Bettenhausen et al. 2014; Eccles et al. 2013; Martin et al. 2012). One direct practice associated with emissions reductions in recent literature is setting a CO2 reduction target (Bettenhausen et al. 2014). One view is that such a target quantifies leadership commitment and defines an observable success measure to coordinate organizational effort. An alternate view is that setting emissions reduction targets could be part of a 'greenwashing' campaign, whereby a company attempts to deflect criticism and avoid meaningful action by adopting external appearances of environmental sustainability, but not engaging in the actions necessary to reduce emissions. Under this view, reduction targets would not be associated with emissions reductions. We find the former view more compelling than the latter, as global business leaders are sending consistent signals regarding climate change and reduction targets. For instance, 43 CEOs from firms as diverse as Dow Chemical, Enel, Ericsson, HSBC Holdings and Accenture recently joined together to announce their commitment to reduction targets for their companies and to communicate that "climate change is real and addressable."[3] We thus hypothesize:

H1: Organizations with CO2 emissions reduction targets will be associated with reduced CO2 emissions.

Information Systems Resources

In this paper we investigate *which* and *to what extent* IS assets and capabilities are relevant to reducing GHG emissions. This joint exploration is appropriate given the various constructs and value pathways examined in IS research. Are IS resources and capabilities that inform the firm most important in

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[2] CO2e is Carbon Dioxide equivalent and is a common measure to account for the differing warming potential of greenhouse gases. For the remainder of this paper, CO2e is shortened to CO2 for brevity.

[3]Source: NBC News, Accessed 9/5/2015 http://www.nbcnews.com/science/environment/climate-ambassadors-43-ceos-pledge-cut-greenhouse-gas-emissions-n343131

mediating the ability of management to make good on its commitment to environmental sustainability? Perhaps experience transforming the firm with IS for strategic and value-chain activities is of greater importance? Answering the questions of *which* IS resources and capabilities are associated with the largest GHG emission reductions will allow managers to tailor their GHG reduction efforts to their company's specific situation and efficiently allocate scarce resources and realize results that are most beneficial to society.

Because study of IS impact on GHG emissions is at an early stage, we form our hypotheses based on known IS relationships on business processes and outcomes from areas other than the emissions. We then use reasoning to build the bridge to our hypotheses regarding their impacts on emissions. We first build on existing research and adopt a measure from enterprise systems literature to explore the relationship between IS, a firm's emissions reduction targets and its emissions performance. In our conceptualization, ERP implementations are an IS asset which can both automate and inform the firm through its enterprise support modules, as well as automate and transform the firm via value chain modules. ERP implementations with greater functional scopes have been theorized to enable greater organization integration and have been shown to yield greater impact than ERP implementations with lesser scopes (Ranganathan and Brown 2006). In our context, an ERP with greater functional scope offers opportunities for more functional areas to coordinate their responses to management emissions reduction targets via software and thus represents an important IS asset.

In addition to a greater functional scope, literature highlights physical scope of ERP implementations as influencing realized value. We conceive physical implementation scope to be a proxy for IS capability, with differing effects for each class of packages (ES or VC). Intuitively, while purchasing multiple ERP modules represents an opportunity to use more functionality, measuring how widely deployed those modules are in the organization can represent how widespread the capability to use the asset has become. We hypothesize that the combination of the IS asset and IS capabilities will influence emissions performance and moderate emissions reduction targets as explained below.

IS informs large, distributed organizations utilizing IT infrastructure and information-oriented software in enterprise support (ES) packages such as Accounting, Financial, and Human Resources. Such software disseminates management targets, commitments and incentive structures to workers (informing down), as well as provides information about progress toward those targets from the workers and managers involved in the change (informing up) (Dehning et al. 2003). When emissions reduction targets have been set by senior management, we expect managers experienced with ES to leverage existing IS capabilities to achieve superior emissions management because of the similarities between software-mediated distributed accounting, financial and HR management and the complexities of capturing and measuring emissions activity accurately, verifiably, and in a timely enough fashion to use that data for managerial and incentive purposes. Absent management commitment to sustainability and the presence of emissions management practices, however, a capability with IS for enterprise support is not anticipated to impact emissions performance. Thus, IS for enterprise support is only anticipated to moderate otherwise existing sustainability practices and commitments (i.e. reduction targets) rather than directly affect emissions on their own.

In comparison, IS to transform business processes core to a company's value chain may have both direct effects on emissions, as well as moderating effects on sustainability management practices. Firms have adopted IS to support product procurement and supply chain management, manufacturing and resource planning, as well as sales and customer support. Widespread implementation of these VC modules may have resulted in the widespread adoption of business logic to reduce waste and its associated costs, yielding greater efficiencies and less pollution, thus directly reducing emissions.

The experience of transforming core value-chain processes using IS is also likely to create a capability within firms to utilize their IS to implement new practices that management adopts to improve emissions performance. The more widespread this VC transformation experience is, the greater the capability a firm may have to respond to new management targets. We thus hypothesize the following regarding both the aggregate IS resources and capabilities as well as specific disaggregated capabilities:

H2: IS resources will moderate the impact of a firm's emission reduction targets on its CO_2 reductions.

H3a: Enterprise Support capability will moderate the impact of a firm's emission reduction targets on its CO_2 reductions.

H3b: Value Chain capability will moderate the impact of a firm's emission reduction targets on its CO2 reductions.

H4: Value chain capability will be associated with a direct reduction in emissions.

The conceptual model is summarized in Figure 1.

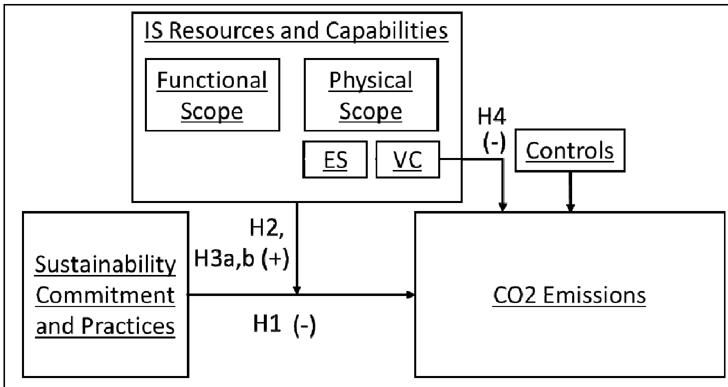

Figure 1. Conceptual Model

Data

The population for our study is large global firms with a presence in North America. Data on environmental, IT and financial dimensions were gathered from secondary sources including CDP, Harte Hanks, and Compustat, respectively. First, environmental commitment and performance measures were collected from CDP (formerly known as the Carbon Disclosure Project) and the Asset4 database. CDP conducts an annual survey of the world's largest firms on behalf of institutional investors seeking to understand the impact on the value of their investment from factors connected to climate change such as regulation, taxation, technological innovation, shifts in consumer attitudes and demand, and changes in the climate system. Greenhouse gas emissions are directly requested, as are details related to projected risks, risk management and projected opportunities. The data in this paper are drawn from the surveys conducted in 2007, 2008, 2009 and 2010. The letter accompanying the 2007 survey states that the questionnaire was on behalf of institutional investors whose collective assets under management were in excess of $41 trillion USD, that it was sent to 2,400 of the world's largest companies, and that in the prior year 72% of the FT500 responded. In the 2008 survey, the number of companies requested increased to 2,800 and the response rate for 2007 was noted as over 1,300. Each subsequent year more companies were contacted and more responders were incorporated into the database. Responders are given the option to report historical data.

Second, IT data were gathered by the firm Harte Hanks, which conducts detailed IT surveys of North American and European company operations, though we limit our investigation to North American sites at this time. In addition to enterprise-level information on IT employees, infrastructure, and vendors there are also detailed breakdowns of enterprise software and its deployment to the company's various sites, the number of users of that software, and the number of employees in each business function that are in the site. Third, financial data were collected from Compustat.

Variable Definition

Regarding the dependent variable, examination of CO2 as a measure of firm performance is nascent in the IS literature. We build on studies in other management fields analyzing the association between organizational features and CO2 emissions performance (Bettenhausen et al. 2014; Eccles et al. 2013). Consistent with this literature, we choose to focus on only the first two dimensions of CO2 emissions: Scope 1 and Scope 2. Scope 1 consists of GHG emissions from stationary combustion of fossil fuels (e.g. boilers, kilns, flares) and mobile combustion sources that are owned or leased by an organization (e.g.

trucks, tankers, trains), and guidance to measure such sources are well developed and reliable[4]. Scope 2 emissions are from purchased energy including electricity. Scopes 1 and 2 are used due to their validity and reliability compared with Scope 3 emissions, which are indirect emissions associated with the supply chain[5]. Consistent with management literature, we construct a GHG emissions measure by summing Scope 1 and Scope 2 emissions and calculating the natural logarithm of this sum. We include controls for those factors that were indicated to likely be associated with CO2 performance, including third party environmental ratings (Lyon and Shimshack 2012), incentives for CO2 performance, and controls for country (which may differ because of environmental regulations), industry (based on the GICs 10 sector classifications), year and size. We operationalized a company's sustainability orientation using the "Environmental Pillar" score from the Asset4 database (accessed via Datastream). A firm's commitment to reducing emissions was operationalized as a binary variable from the CDP survey indicating whether the firm had an emissions reduction target. We operationalized firm size using indicator variables for categories of annual firm revenue similar to Mithas et al. (2012). Enterprise IS classifications were obtained from literature and applied to the enterprise application modules identified at each site in the detailed IT survey. We followed Ranganathan and Brown's (2006) measure of a firm's IS Resources by using a two-point scale (applied at the site level instead of the announcement level) for whether an ERP installation was of greater or lesser functional scope. A greater functional scope is defined as either having a full suite ERP installed (e.g. SAP R/3, SSA ERPLN), or 2+ value chain modules of an ERP. Value-chain modules perform core procurement, manufacturing and sales functions (e.g. CRM, Supply Chain, MRP modules). A lesser functional scope is defined as 0-1 value chain modules and 1 or more Enterprise Support modules (e.g. HR, Accounting, Finance modules). We adopt their definition of greater physical scope, measured at the VC and ES module level, where a module is considered to be of greater physical scope when it is deployed to more than one site within the same company, and of lesser physical scope when it is only deployed at a single site. These three measures are then aggregated to the corporate level into measures that are calculated as follows: Greater ERP Functionality Proportion is the quotient of a count of sites with Greater Functionality (Full ERP or 2+ VC modules) divided by the total number of a firm's total sites in that year. VC and ES Physical Scope Proportion are ratios of VC and ES packages that span multiple sites to multiple sites (E.g. if a company has 4 sites, 3 of which have an HR module, 2 with Accounting and 1 with Finance, the ES ratio would be 2/4 = .5 because HR and Accounting are ES modules with greater physical scope). This results in three measures of IT resources which are summarized in table 2. All IT measures were lagged by one year, so that they represent the functional and physical scope of the indicated ERP systems in the year prior to the measured emissions. This is consistent with prior literature that has found that there is a lag between IS implementation and performance impacts (Aral and Weill 2007; Brynjolfsson and Hitt 2000; Devaraj and Kohli 2003).

Variable (n=129)	mean	sd	median	min	max	Sum
CO2 emissions ln(Scope1+2)	14.058	2.544	14.060	1.099	19.152	1813.517
Environmental Orientation	72.073	23.066	78.860	11.480	96.650	9297.450
Reduction Target[6]	0.744	0.438	1	0	1	96
Incentive[7]	0.543	0.500	1	0	1	70
Sales (gross annual sales in millions of US dollars)	18472.688	23092.904	10494.983	118.529	124936	2382976.727
Greater ERP Functionality Proportion	0.075	0.158	0	0	1	9.618
Value Chain Physical Scope	0.028	0.068	0	0	0.333	3.603

[4] See http://epa.gov/climateleadership/documents/resources/mobilesource_guidance.pdf and http://www.epa.gov/climateleadership/documents/resources/stationarycombustionguidance.pdf for examples of emissions sources and measurement techniques.

[5] http://www.ghgprotocol.org/files/ghgp/public/ghg-protocol-revised.pdf

[6] Yes/No (coded 1/0) in response to "Do you have a current emissions reduction target?"

[7] Yes/No in response to "Do you provide incentives for individual management of climate change issues including attainment of GHG targets?" (2009 wording for both questions, other years similar)

Proportion						
Enterprise Support Physical Scope Proportion	0.024	0.040	0	0	0.250	3.044
Size1: Sales < $5B	0.225	0.419	0	0	1	29
Size2: Sales $5B-10B	0.364	0.483	0	0	1	47
Size3: Sales $10B-25B	0.186	0.391	0	0	1	24
Size4: Sales > $25B	0.225	0.419	0	0	1	29
COGS (thousands of USD per employee)	0.517	0.546	0.26	0.01	2.35	66.72
Indicator variables for GICS Industry Sectors, Country, and Year were also included but are omitted for space.						

Table 2. Firm Descriptive Statistics

Results, Discussion and Conclusion

For this early stage work, we estimate the relationship between the independent variables of interest and CO2 emissions using pooled cross-sectional OLS with indicator variables to capture year, industry and country fixed effects. The results of this regression are presented in panel A of table 3. We then introduce the IT variables described above and present the results in Panel B. Moderation is tested by interacting the IT variables with the emissions reduction target indicator and the results are presented in Panel C. The results from panel A indicate that industry and size are the most influential factors associated with CO2 emissions, consistent with findings in management literature (Eccles et al. 2013). Hypothesis 1 that an organization's adoption of a CO2 emissions reduction target will lead to reduced CO2 emissions is only marginally significant (p-value = .082). This significance disappears in panel B after introducing the IT variables, of which Enterprise Support Physical Scope IT measure is marginally significant (p = .085). We further refine our understanding of IT's influence in panel C, where the three measures of IT are interacted with the reduction plan variable. In this panel, both Reduction Plan and it's interaction with Enterprise support are significant at the 5% level (p = .035 and p=.018). Taken together, these results indicate that H1, H2, H3b and H4 are not supported, but H3a is. Thus, only an Enterprise Support IS capability moderates a firm's reduction targets' impact on reducing CO2 emissions.

OLS Regression Estimates of Effects on ln(CO2) Emissions			
Variable	A. Environmental Practices	B. IT direct effect	C. Moderated Model
Intercept	10.655*** (1.133)	10.627*** (1.139)	10.225*** (1.139)
Environmental Orientation	0.006 (0.007)	0.006 (0.007)	0.008 (0.008)
Reduction Target	0.673~ (0.383)	0.611 (0.385)	1.004* (0.47)
Incentives	0.686* (0.34)	0.522 (0.355)	0.632~ (0.356)
Greater ERP Functionality		0.488 (1.505)	-1.711 (3.242)
Value Chain Physical Scope		0.281 (3.259)	2.142 (6.454)
Enterprise Support Physical Scope		-6.923~ (3.984)	5.459 (6.565)
Reduction Plan x Functional Scope			2.16 (3.582)
Reduction Plan x VC Phys. Scope			-2.062 (7.544)
Reduction Plan x ES Phys. Scope			-19.514* (8.094)
Controls			
Size (Sales $5B-$10B)	1.981*** (0.444)	2.211*** (0.461)	2.213*** (0.459)
Size (Sales $10B-$25B)	3.212*** (0.592)	3.475*** (0.626)	3.396*** (0.622)
Size (Sales > $25B)	1.312** (0.469)	1.289** (0.471)	1.484** (0.478)
COGS	-0.403 (0.395)	-0.497 (0.406)	-0.481 (0.399)
Consumer Staples	1.302 (0.83)	1.521~ (0.838)	1.522~ (0.827)
Energy	2.364** (0.822)	2.391** (0.822)	2.428** (0.811)

Financials	0.858 (0.927)	0.948 (0.938)	1.164 (0.936)
Health Care	-0.421 (0.816)	-0.413 (0.839)	-0.249 (0.831)
Industrials	1.842* (0.859)	1.997* (0.862)	2.073* (0.848)
Information Technology	0.733 (0.876)	0.928 (0.92)	0.605 (0.916)
Materials	3.681*** (0.864)	3.929*** (0.874)	3.896*** (0.862)
Utilities	4.979*** (0.906)	5.272*** (0.93)	5.038*** (0.919)
Country Fixed Effects	All neg and N.S.	All neg and N.S.	All neg and N.S.
Year Fixed Effects	All neg and N.S.	All neg and N.S.	All neg and N.S.
Adj. R^2 (Overall)	0.607	0.608	0.621
F-Stat (degrees of freedom)	10.421*** (21 , 107)	9.285 *** (24 , 104)	8.765*** (27 , 101)
Observations	129	129	129
Number of Firms	67	67	67
***, **, *, ~ indicate significance at the .001, .01, .05 and .1 levels. (Standard Errors in parentheses). All coefficients relative to effect on ln(CO2) a US firm in the Consumer Discretionary industry, reporting for 2005			

Table 3. OLS Regression Estimates of Effects on CO2 Emissions

These results build on and add to the environmental management literature by introducing organizations' IS capabilities and assets on achieving GHG emissions reductions, which heretofore has been uninvestigated. We demonstrate IS's value to firm sustainability efforts, and we provide evidence of its role as a moderator in pollution control. Also, our results indicated that IS used for enterprise support represents the most effective IS asset for pollution control during the timeframe of our sample. Actual emissions reductions, however, are only achieved by the firms with the highest proportions of ES packages. In our sample, companies with the *mean* number of ES packages with greater physical scope per total sites are still associated with higher emissions (+711,506 metric tonnes of CO2e) when they have a reduction plan in place. However, the top 16 (12.4%) of company observations with the highest proportion of ES packages with greater physical scope do achieve lower CO2e emissions with a reduction plan in place than without, further indicating the importance of IS assets in achieving environmental goals. Graphs and tables demonstrating these relationships are planned for the visual presentation of results at ICIS, as is a fuller discussion of limitations to this research-in-progress presenting some of the first empirical evidence of how installed IS capabilities can impact an organization's GHG emissions.

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