Eco-efficiency of Service Co-production: Connecting Eco-certifications and Resource Efficiency in U.S. Hotels

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Abstract

This study investigates the relationship between eco-certifications (second or third party certified with an audit requirement) and resource efficiency in the U.S. hotel industry. Hotel properties become eco-certified by voluntarily conforming to environmental practice guidelines established by a certifying body, which assesses and recognizes the properties that meet their criteria. Eco-certifications therefore are key environmental sustainability initiatives that address both the internal operations and external customers. Based on regression analysis of 2,893 U.S. hotel properties for the year 2011, this analysis shows that eco-certified hotels maintain higher operational efficiency, as well as greater customer-driven resource efficiency, in comparison with properties with lesser or no eco-certifications. These results suggest that eco-certifications influence the resource consumption behavior of both the operators and the customers, although these effects are not consistent for all properties. The improvement from the operational effect is most pronounced in lower-tier properties, while the customer efficiency effect is most noticeable in upper-tier properties.

The use of second- or third-party certification for sustainable or environmentally friendly operations has mushroomed in the hospitality and related industries (Buckley 2002, 2013; Font 2002). By setting guidelines for environmentally friendly practices, and recognizing businesses that voluntarily meet those guidelines, organizations that offer so-called eco-certifications acknowledge firms that have engaged in environmental sustainability initiatives. The discipline involved in qualifying for such certifications can both improve operations and attract customers. Although researchers have found empirical evidence of operational benefits resulting from adopting eco-certifications (Butler 2008; Peiró-Signes, Verma, and Miret-Pastor 2012), the research on the connection between eco-certification and customers' behavior is still ongoing (Buckley 2013; Esparon, Gyuris, and Stoeckl 2014; Font 2002; Lübbert 2001; Reiser and Simmons 2005). One question, for example, is whether such a certification can allay customer confusion and suspicions about companies' environmental claims, even as some customers remain suspicious of eco-certifications themselves (Harbaugh, Maxwell, and Roussillon 2011; Mason 2011; Terrachoice 2009). This is an important issue, because cooperation of customers is essential to achieving hotels' environmental goals, given that resource consumption by operations and by customers directly has been shown to drive environmental

sustainability in hotel operations (Zhang, Joglekar, and Verma 2012a).

To address the continuing questions surrounding eco-certifications, we sought to determine how achieving such certification might improve environmental sustainability, both regarding operation and customer expenditures. Research addressing consumer goods has shown that the practices stipulated in the eco-certification guidelines brought both operational and pricing advantage through improvements in process and product quality (Delmas and Grant 2010; King, Lenox, and Terlaak 2005; Rondinelli and Vastag 2000). In the hospitality industry, researchers have begun to study the impact of eco-certifications on customers through perception surveys (Esparon, Gyuris, and Stoeckl 2014; Millar and Baloglu 2011), but challenges in sustainability reporting and communication remain (Ricaurte, Verma, and Witham 2012; Witham 2012a). On the operations side, there appears to be a link between

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Exhibit 1:
Recent Empirical Literature on Environment Sustainability in Hospitality.

Theoretical Focus	Selected Articles	Application Focus
Operations or firm centered—benchmarking, financial impact of environmental sustainability initiatives, employee perception, and behavior regarding environmental sustainability initiatives	Mihalič (2000); Bohdanowicz (2005); Chan and Wong (2006); Butler (2008); Chan (2008); Sloan, Legrand, and Chen (2009); Jarvis, Weeden, and Simcock (2010); Singh and Houdré (2011); Segarra-Oña et al. (2012); Chong and Verma (2013); Singal (2014); Sánchez-Ollero, García-Pozo, and Marchante-Mera (2013)	Understand the hoteliers' and employees' motivations for environmental sustainability, improve pricing and financial performance by enhancing environmental sustainability initiatives in terms of both managerial and marketing efforts, cost–benefit comparisons, standards, stakeholders, best practices
Customer centered—perceptions of and responses to environmental sustainability initiatives (including green room attributes, environmental certifications, etc.) from the customer	Miller (2003); Dolnicar (2010); Susskind and Verma (2011); Millar and Baloglu (2011); Hu (2012); Esparon, Gyuris, and Stoeckl (2014); Barber and Deale (2013); Peiró-Signes et al. (2013); Kim and Kim (2014); Sirakaya-Turk, Baloglu, and Mercado (2013)	Understand the drivers of customer's sustainable behavior and implications for environmental advertising/marketing, customer mindfulness, message framing and source credibility, characteristics of green customers (value, demographic, etc.)
Environmental program centered—comparing certificates and programs	Buckley (2002); Font and Harris (2004); Haaland and Aas (2010); Bowman (2011)	Identify characteristics of effective environmental sustainability initiatives; analyze strengths and weaknesses of different programs

environmental responsibility and operating performance (Zhang, Joglekar, and Verma 2012b), although solid evidence of the effect of sustainability initiatives on financial performance remains elusive (Chong and Verma 2013; Peiró-Signes, Verma, and Miret-Pastor 2012; Singal 2014; Withiam 2012b). Such mixed results indicate that research has not yet identified the primary drivers of the observable performance outcomes of eco-certifications. In that regard, we propose that eco-certifications influence operations and customers by affecting their resource consumption behavior. Using archival data consisting of annual operating statements and eco-certification information, we measure and test the effect of that influence.

Applying multivariate multiple regression to a large-scale data set from the U.S. hotel industry, we empirically test the effects of eco-certifications on resource efficiency recorded by operations and by customers, while considering several key contextual variables, including average daily rate (ADR), occupancy rate, and property type. Furthermore, we compare eco-certified hotel properties to those that are not certified based on ADR and property type. Our analysis indicates that eco-certified hotels are associated with both higher operational efficiency and greater customer-driven resource efficiency.

This study advances the understanding of the effect of eco-certifications in the hospitality industry, in terms of environmental sustainability that results from increased resource efficiency on the part of both operators and customers. To facilitate that process, we propose several considerations for implementing eco-certification.

In the next section, we review studies of environmental sustainability and eco-certifications in hospitality and related industries and present two hypotheses that combine the insights from eco-certification research and the service co-production literature. After presenting our study, we discuss its theoretical and managerial insights.

Theory and Hypotheses

Environmental Sustainability in Hospitality

Extensive research on environmental sustainability in hospitality has been conducted since the term "sustainability" first gained traction in the 1970s (Singh and Houdré 2011; Stipanuk 1996). Recent studies can be categorized into three broad areas (see Exhibit 1): the operation (or firm), the customer, and the initiatives themselves. The research questions include operators' and customers' motivations for environmentally sustainable actions, their perceptions of environmental sustainability, and the factors influencing the firm's performance or the customer's willingness to stay, along with the resulting outcomes. Research on the environmental initiatives themselves has provided insights on the strengths and weaknesses of various sustainability programs. What we see in these studies is considerable understanding of individual elements of the environmental sustainability phenomenon—operations, customers, or environmental programs. What is needed is a systems-based approach (Melissen 2012), which considers both the operations- and customer-side effects of environmental sustainability initiatives in the context of hospitality service

co-production (Sampson and Froehle 2006; Zhang, Joglekar, and Verma 2012a). This study takes that approach.

Eco-certifications and Resource Efficiency in Hotel Operations

Research on eco-certifications in hospitality (and tourism in general) has taken one of the following three broadly defined approaches: conceptual, game-theoretical, and customer-oriented. In this section, we review these approaches and integrate their insights with the service co-production literature.

Conceptual approach. The conceptual approach provides in-depth reviews of the historical development of eco-certifications and their theoretical underpinnings (Buckley 2002; Coles, Fenclova, and Dinan 2013; Font 2002). This stream of literature puts eco-certification in the context of sustainable development and highlights the conditions that are critical to accomplishing the goal of informing outside stakeholders, including broad acceptance, openness, communication, and an independent audit. Informed by this research, our study compares eco-certified hotels with those that are not so certified. Certification in this instance comes from third parties that have no vested interest in the outcome or second-party purchasing or trade organizations. Whether the certifier is a second or third party, the key criterion for this study is that they guarantee an audit of their certification standard. We compare those hotels to the "other" group, consisting of hotels that are uncertified, self-certified, or certified by second parties but without outside verification.

Game theory. Buckley (2013) introduced game-theory analysis into eco-certification research by modeling the historical development of eco-certifications (especially those with social benefits) as a multi-move political game between firms and civic advocates. This work has a close connection with the environmental economics research that focuses on the welfare effects of eco-certifications (Mason 2006, 2011, 2012). These game-theory models underscore the information focus of eco-certification. In particular, Mason (2011) suggested that, in addition to being costly to the firms, eco-certification is most likely noisy for the customers, due to inconsistencies in certification. A third party could mistakenly certify some firms as environmentally friendly, for instance, or some environmentally friendly firms could find certification impractical. This "noise" may result in uncertain customer responses. Environmentally conscious customers may use the information to seek out eco-certified hotels, for example, while other customers may become frustrated with the inconsistent information and view eco-certified hotels in a negative light. Due to the uncertainty of customer responses, the actual influence of eco-certifications on resource efficiency is an empirical question.

Customer orientation. Customer-oriented research takes the perspective that eco-certification can be a selling tool (Ginsberg and Bloom 2004; Peattie and Crane 2005; Rex and Baumann 2007; Sloan, Legrand, and Chen 2009). But the perceived importance of eco-friendly attributes varies according to visitor characteristics (Esparon, Gyuris, and Stoeckl 2014), and one may run the risk of missing the big picture by drawing the conclusion that customers are indifferent to eco-certifications simply because there is no discernible increase in their choice of, or "willingness to stay" at, eco-certified hotels. A key aspect of this study tests the proposition that the informational effect of eco-certifications goes beyond what is captured in the customers' willingness to stay. What happens during the hotel stay is also important, and we measure this in terms of customer resource consumption.

Studies have shown that customers' resource consumption behavior matters as much as the service provider's operational decisions, given the co-produced nature of hotel services (Chase, Northcraft, and Wolf 1984; Foster, Sampson, and Dunn 2000; Sampson and Froehle 2006; Zhang, Joglekar, and Verma 2012a). For hotels, becoming eco-certified often involves installation of resource efficient technologies, such as energy- and water-efficient appliances, but realizing the efficiency gain from those technologies depends a lot on the customers. For example, it may be that guests take advantage of efficient appliances by actually using more resources. This counterintuitive phenomenon, known as the Jevons paradox (Alcott 2005), suggests that technological progress that increases the efficiency with which a resource is used tends to increase the rate of consumption of that resource. A low-flow showerhead, for instance, might invite longer showers. Consequently, to understand the empirical impact of eco-certification in the hotel industry, we need to consider the customers' willingness-to-stay decision along with other environmental-focused operational and customer choices, such as energy and water management practices, recycling, and towel and linen reuse programs. For this purpose, we use two measurement factors from an earlier study that derives resource consumption data from annual operating statements (Zhang, Joglekar, and Verma 2012a). These factors measure resource efficiency driven by operations and by customers.

Hypotheses

Empirical evidence is mixed regarding financial performance gained from eco-certifications in the hotel industry (Chong and Verma 2013; Peiró-Signes, Verma, and Miret-Pastor 2012), and regarding the inconclusive relationship between eco-certification and customer behavior (Alcott 2005; Mason 2012). Studies have failed to consider the fundamental roles of eco-certifications in services: namely, providing guidelines to service providers and communicating to the customers about desired practices. For our

purposes, we consider hotels to be eco-certified when they have earned the "ecoleaf" designation from Travelocity.com. As we explain below, the ecoleaf indicates eco-certification by a second or third party that is open to an audit of the certification. These criteria contribute to more scrutiny and fewer chances for false designation, and truly eco-friendly hotels are more likely to meet the criteria and become certified (Mason 2012). Therefore, if we compare the operations-driven resource efficiency factors in eco-certified hotels versus others, eco-certified hotels should have higher operations-driven resource efficiency.

> **Hypothesis 1:** Eco-certified hotels have higher operations-driven resource efficiency.

The additional scrutiny on "eco-certified" hotels leads to eco-certifications with higher clarity, comparability, and credibility, which are characteristics important to customers (Lübbert 2001) and which reduce the eco-certification "noise." Such eco-certifications are more effective in influencing customers by attracting customers that are more eco-friendly (influencing the willingness-to-stay decision), and by affecting resource consumption during their stay through education or enabling mechanisms. For example, Leadership in Energy and Environmental Design (LEED) certification provides a hotel with name recognition (Millar and Baloglu 2011), in addition to its mandates for convenient recycling and energy efficient ventilation, cooling, and lighting systems. Therefore, we hypothesize the following:

> **Hypothesis 2:** Eco-certified hotels have higher customer-driven resource efficiency.

We include several contextual variables in the model to control for alternative explanations of the observed variation in resource efficiency as follows.

- ADR is closely related to the amenities and service levels at each property and the associated resource requirement. As ADR increases, generally the amenities and functions provided by the hotel property also increase. This is likely to give rise to more opportunities for resource efficiency improvements. So we expect a positive relationship between ADR and resource efficiency.
- Similarly, different amenities and services offered by various property types also have a large impact on the resource consumption. The implementation of eco-certifications often involves careful process documentation and monitoring, which helps uncover wasteful activities hidden in complex operations. We expect that hotel properties with a wide range of offerings, such as convention centers and resorts, will have more opportunities for efficiency improvement through eco-certification.

- Occupancy rate can affect resource efficiency by spreading fixed costs over a larger customer volume (when occupancy rises). Many variable expenses in hotels also have fixed components (Walls and Lane 2011). For example, guest supplies are traditionally considered variable expenses, but a minimum quantity of supplies must be purchased to operate the hotel regardless of the occupancy rate. So we expect a positive relationship between resource efficiency and occupancy rate.
- We use the number of rooms to measure the size of a hotel property, as a gauge of overhead. Larger hotels have more rooms and public space that require heating and cooling to keep temperature regulated, whether the rooms are occupied or not. Operations-driven resource efficiency could suffer as a result, but the effect of hotel size on customer-driven resource efficiency is not clear.

We control for these contextual variables to make consistent comparisons among the many heterogeneous properties in our data set.

Method

To test for the effects of eco-certifications, we developed a data set using two data sources. First, we compiled a list of hotels with 2011 operating statement data from PKF Hospitality Research (PKF-HR), completed in early-2012. (The appendix provides details on the PKF-HR survey and data management methodology.) Concurrently, we searched the Travelocity Green Hotel Directory for whether each hotel property in the PKF-HR sample held an eco-friendly hotel designation. In the end, our sample included PKF-HR data for hotels that had an ecoleaf, and for hotels that did not. For each hotel in the sample, we had information on consumption of key resources (water, electricity, and materials).

As we mentioned above, ecoleaf is not an eco-certification per se but is instead an indicator that a hotel has received one or more of several certifications. We can use the ecoleaf as our discriminating criterion because Travelocity only awards this eco-friendly designation to hotels certified by second and third parties whose standards closely align with the Global Sustainable Tourism Criteria (GSTC) and who can guarantee an audit of the certification criteria (Travelocity 2011).

Sample and Analysis

The cross-sectional sample consists of 2,893 hotel properties in forty-nine U.S. states (including the District of Columbia, or D.C., and omitting only the Dakotas due to the data merge). Exhibit 2 presents an overview, using bars to indicate the number of hotel properties by state and the

Exhibit 2:

Sample Distribution.
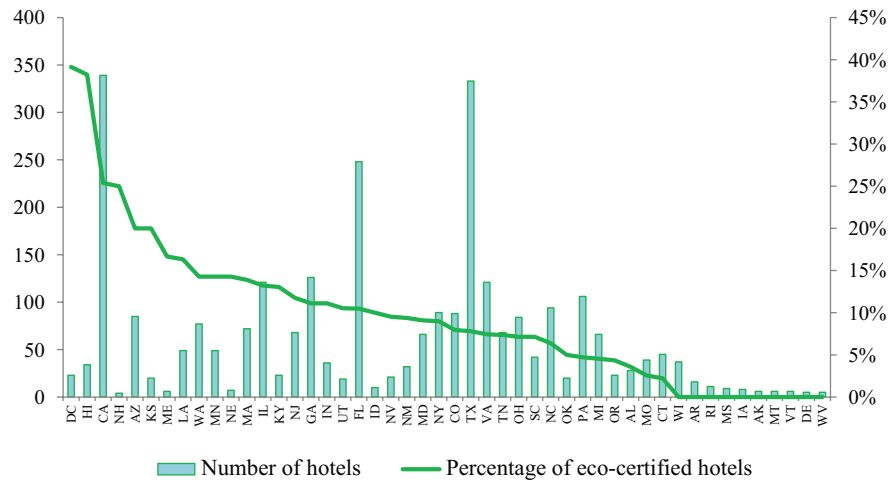
Note. Number of hotels in the sample by state is shown in the bar chart on the primary vertical axis; the percentage of eco-certified hotels in each state is shown as a line chart on the secondary vertical axis.

line to represent the percentage of eco-certified hotels in each state. The sample, which is representative of the hotel distribution in the United States, shows significant variation in the eco-certified hotel percentage across the states. Not surprisingly, the eco-certified hotel percentage is higher for areas with more progressive environmental regulation (e.g., Washington, D.C., and California) and those highly dependent on the natural environment (e.g., Hawaii).

We adopt the resource efficiency benchmarking method detailed in Zhang, Joglekar, and Verma (2012a) to derive the standardized scores of the resource efficiency driven by hotel operations or by customers at the hotel property level. Primary resource expenses, including electricity, water, and sewer, as well as various supplies consumed for Food and Beverage (F&B) service, and in the rooms, maintenance, and engineering departments, are normalized by revenue per available room (RevPAR) and then entered in the exploratory factor analysis (EFA). As shown in Exhibit 3, the results of EFA factor loading returned an operations-driven factor (ODF) and a customer-driven factor (CDF). The factor loadings become the weights for calculating standardized scores that measure resource efficiency along these two factors. The standardized scores are the weighted sum of relative resource efficiency (Mean = 0). A lower score means that fewer resources are consumed per dollar of revenue, indicating higher resource efficiency.

We then use multivariate multiple regression to study the two resource efficiency measures as the dependent variables. Multivariate multiple regression estimates the same

Exhibit 3:

Factor Analysis Identified Two Factors Underlying Resource Consumption in Hotel Operations ($N = 2,893$).

Items Entering Factor Analysis: Operating Statement Expense Items Normalized by Revenue per Available Room	CDF	ODF
Electricity	0.11	**0.64**
Water	−0.21	**0.56**
Maintenance other expense	0.29	**0.49**
Supplies used in Food and Beverage (F&B) Department	**0.66**	0.04
Supplies used in Rooms Department	**0.62**	0.02

Note. Promax-rotated loadings reported in the table. CDF = customer-driven factor; ODF = operations-driven factor. Loadings in boldfaced font highlight the fact that Supplies used in F&B and Rooms Department weight more heavily on CDF and Electricity, Water and Maintenance other expense weight more heavily on ODF.

coefficients and standard errors as one would obtain using separate regressions, with the additional benefit that multivariate multiple regression jointly estimates the between-equation covariance, which allows comparison of coefficients across equations. The model specification is as follows:

$$ODF = \beta_0 + \beta_1 Ecoleaf + \beta_2 Zadr + \beta_3 Occupancy + \beta_4 Zlogrooms + \beta_{5-11} PropertyTypeDummies + u. \quad (1)$$

Summary Statistics of the Variables in the Multivariate Multiple Regression Model.

Variable	Observations	M	SD
ODF	2,893	0.00	1.32
CDF	2,893	0.00	1.33
Ecoleaf (eco-certification indicator)	2,893	0.12	0.32
Zadr (standardized ADR)	2,893	0.00	1.00
Occupancy rate	2,893	0.70	0.11
Conference center	2,893	0.01	0.09
Convention hotel	2,893	0.03	0.16
Extended stay hotel	2,893	0.39	0.49
Full-service hotel	2,893	0.27	0.44
Limited-service hotel	2,893	0.21	0.41
Resort hotel	2,893	0.04	0.20
Suite hotel	2,893	0.05	0.23
Zlogrooms (standardized log transformed number of rooms)	2,893	−0.01	1.00

Note. ODF: Factor score of operations-driven resource efficiency; CDF: Factor score of customer-driven resource efficiency. Lower scores indicate higher resource efficiency. The sample averages for both ODF and CDF are 0. ODF = operations-driven factor; CDF = customer-driven factor; ADR = average daily rate.

$$CDF = \beta_0 + \beta_1 Ecoleaf + \beta_2 Zadr + \beta_3 Occupancy + \beta_4 Zlogrooms + \beta_{5-11} PropertyTypeDummies + u. \quad (2)$$

Exhibit 4 presents the summary statistics of the variables. We standardized ADR and the number of rooms to facilitate interpretation of the coefficients.

Results

In general, we found that the eco-certified hotels operated more efficiently, as indicated by the two factors. However, we found considerable variation among various hotel types. Regression analysis found that eco-certified hotels had higher resource efficiency on both the operator and the customer factors. Exhibit 5 reports the regression results (STATA command: mvreg) for operations-driven resource efficiency (ODF) and customer-driven resource efficiency (CDF). For both equations, the coefficient estimates for the eco-certified hotel indicator variable ecoleaf are statistically significant and negative. The lower standardized scores for the eco-certified hotels indicate higher resource efficiency on both the operator and the customer factors, supporting both Hypotheses 1 and 2. That is, controlling for key contextual variables, including size, price, property type, and occupancy rate, eco-certified hotels, achieved higher operations-driven and customer-driven resource efficiency.

A visual interpretation of the statistical results is shown in Exhibits 6 and 7, allowing us to discuss the findings for

hotel subgroups based on ADR and property type. It is important to note that Exhibits 6 and 7 show results of one contextual variable at a time, and thus the observations sometimes appear counterintuitive. On one hand, this shows that it is important to understand the eco-certification effects by controlling for those contextual variables through multivariate multiple regressions. On the other hand, these exhibits present opportunities for additional insights through subgroup analyses. In these exhibits, solid bars represent the resource efficiency measures of eco-certified hotels and hatched bars represent those of "other" hotel properties. Again, the resource efficiency measures are standardized with their means at 0.

Looking at Exhibit 6, we see that the average resource efficiency measures for the operations-driven and customer-driven factors move in different directions across the various rate groups. Based on ADR, the sample is divided into three groups of equal sizes: high, medium, and low, and we note that the operations-driven resource efficiency decreases as the rate increases, while the customer-driven resource efficiency increases as rate goes up. This is consistent with the coefficient estimates for ADR in Exhibit 5. This phenomenon could be related to the cost structures of hotels in different rate groups. For example, economy hotels charge low rates but provide limited amenities, resulting in a low ratio of resource expenses driven by operations per dollar of revenue generated, and relatively high operations-driven resource efficiency. However, the extensive amenities offered by high-end hotels results in low operations-driven resource efficiency. Relative to the high rate, by contrast, resource expenditures driven by customers constitute a smaller portion of total expenditures, but the customer-driven portion still demonstrates high resource efficiency.

We also see that the relative resource efficiency of the eco-certified hotels is not consistent in all three ADR subgroups. For operations-driven resource efficiency, the eco-certified hotels have a slight lead in resource efficiency in the high- and low-rate groups, but they are much less efficient in the medium-rate group. In terms of customer-driven resource efficiency, the eco-certified hotels outperform in the low-rate group only. These uneven effects suggest that hotels in different rate groups may be focusing on different eco-certification criteria in their resource efficiency improvement measures.

When we divided the sample according to property type (Exhibit 7), we found that ODF varied across different types, while CDF was consistently greater for eco-certified properties. With regard to operations, the resource efficiency gain from conforming to eco-certification criteria appears to accrue mostly to hotel properties offering more amenities and functions, including conference centers, resort hotels, convention hotels, and suite hotels. This is consistent with our earlier analysis regarding the process improvement effect from implementing eco-certification.

Exhibit 5:
Multivariate Multiple Regression Results Confirming the Eco-certification Effects on Operations and Customers.
Part A:

Equation	Observations	Parameters	RMSE	R^2	F	p Value
(1) ODF	2,893	11	0.8853	.5502	352.532	.000
(2) CDF	2,893	11	1.0871	.3308	142.436	.000

Part B:

Dependent Variable	Independent Variable	Coefficients	SE	p Value
ODF	Ecoleaf	−0.233	0.059	.000
	Zadr (standardized ADR)	0.183	0.021	.000
	Occupancy	−2.995	0.169	.000
	Zlogrooms (standardized log transformed number of rooms)	0.224	0.026	.000
	Conference center	1.729	0.200	.000
	Convention hotel	0.661	0.141	.000
	Extended stay hotel	−0.346	0.083	.000
	Full-service hotel	0.973	0.079	.000
	Limited-service hotel	−0.067	0.085	.433
	Resort hotel	1.597	0.113	.000
	Suite hotel	Omitted		
	Constant	1.924	0.140	.000
CDF	Ecoleaf	−0.193	0.073	.008
	Zadr (standardized ADR)	−0.368	0.025	.000
	Occupancy	−5.262	0.207	.000
	Zlogrooms (standardized log transformed number of rooms)	0.017	0.032	.596
	Conference center	1.830	0.245	.000
	Convention hotel	−0.004	0.173	.981
	Extended stay hotel	0.437	0.102	.000
	Full-service hotel	−0.015	0.097	.879
	Limited-service hotel	−0.357	0.105	.001
	Resort hotel	1.319	0.139	.000
	Suite hotel	Omitted		
	Constant	3.562	0.172	.000

Note. Part A reports the statistical results from the two equations. The dependent variables are ODF and CDF, respectively. Part B reports the corresponding coefficient estimates. RMSE = root mean square error; ODF = operations-driven factor; CDF = customer-driven factor.

With regard to CDF, again, the link between eco-certifications and customer-driven resource efficiency is positive and strong.

The findings on the other two control variables are largely as expected. Occupancy rate has a positive relationship with both resource efficiency measures. Hotel size negatively affects operations-driven resource efficiency but has no statistically significant effect on customer-driven resource efficiency (Exhibit 5).

## Discussion and Future Research

Theoretical

The primary purpose of eco-certificates is to inform customers that a particular firm follows an established set of environmental practices. The results from our study showed a clear resource efficiency advantage for eco-certified hotels, driven by both operations and customers, after controlling for such key contextual variables as hotel size, rate, and type (Exhibit 5). This finding underscores the credibility of eco-certifications by second and third parties that include audits and provides further empirical evidence for the operational benefits of eco-certifications.

However, we found uneven effects related to eco-certifications on the operations across various rate groups and property types (Exhibits 6 and 7). Possible explanations for such variation include (1) the criteria stipulated in eco-certifications vary widely and (2) hotels may favor certain eco-certification guidelines over others depending on their own idiosyncratic characteristics. For example, in aforementioned LEED certification, hotels can gain points in six

Exhibit 6:

Average Resource Efficiency Comparison between Eco-certified Hotels and Others across Three Equal-Size ADR Groups.

Average resource efficiency comparison across ADR sub-groups:
eco-certified vs. others
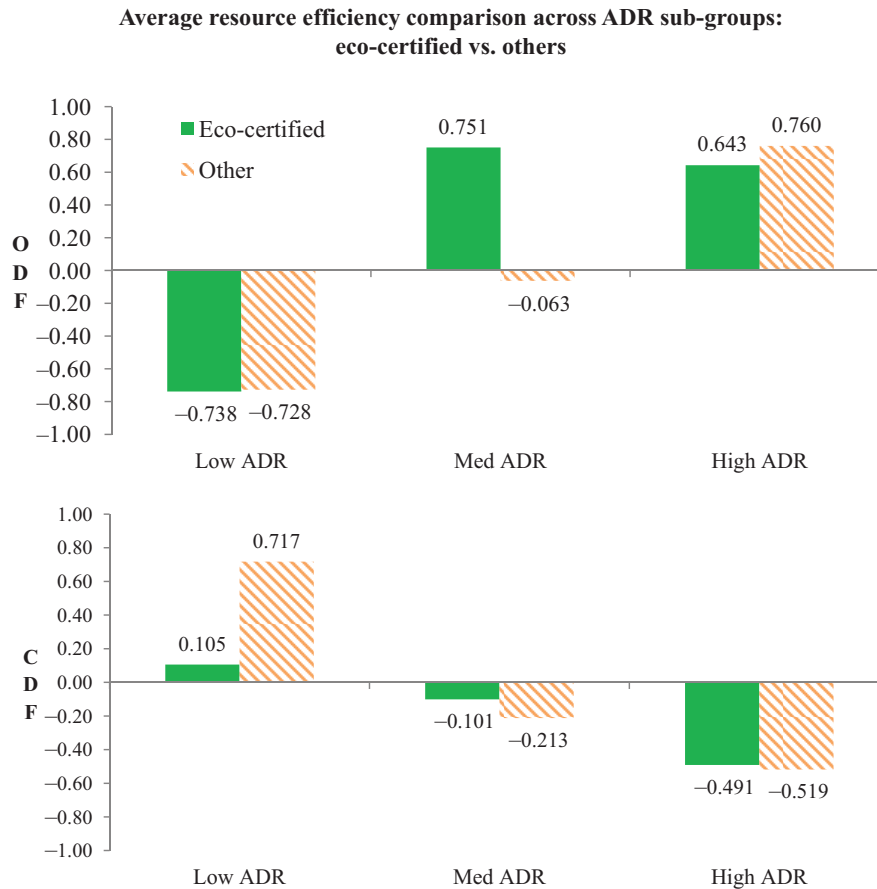
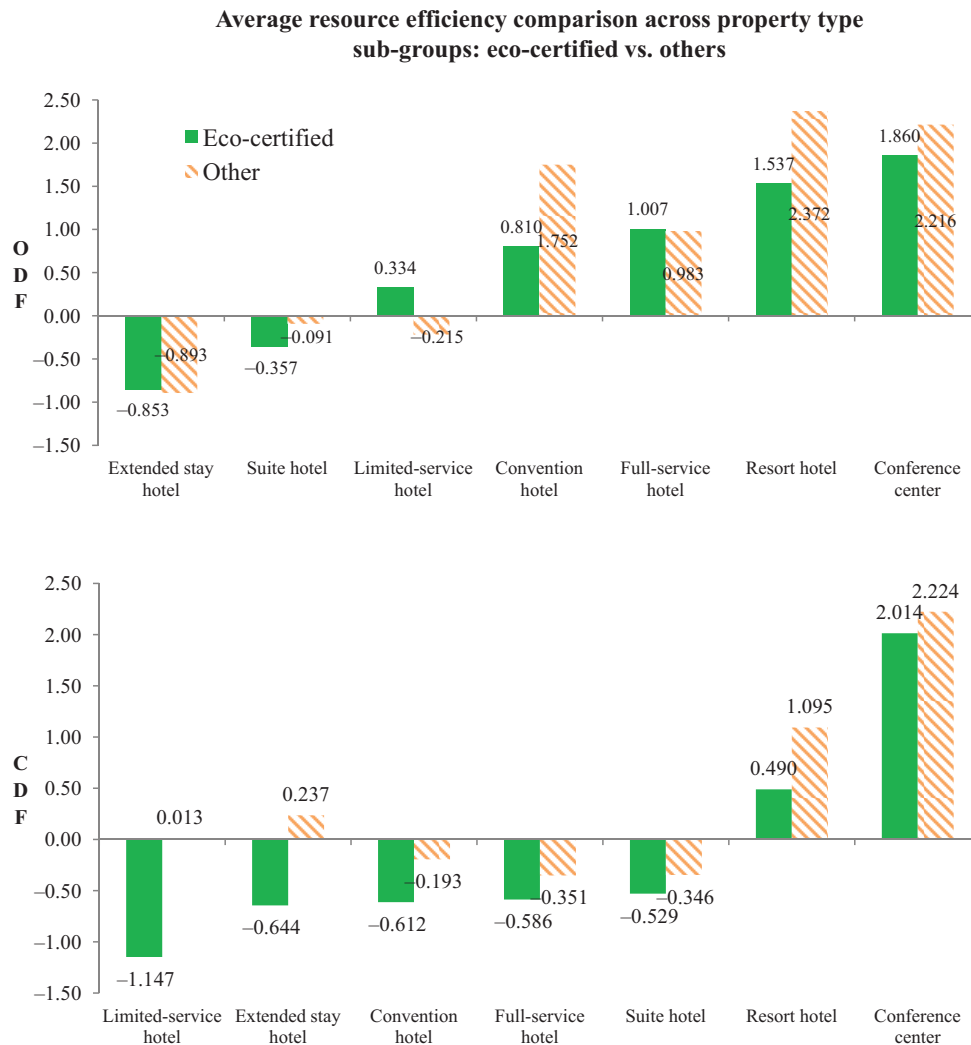| ADR Group	Obs.	Min	Max
High ADR	965	$109.04	$976.78
Med ADR	964	$65.32	$108.9
Low ADR	964	$20.55	$65.3

Note. ODF: Factor score of operations-driven resource efficiency; CDF: Factor score of customer-driven resource efficiency. Lower scores indicate higher resource efficiency. The sample averages for both ODF and CDF are 0. ODF = operations-driven factor; CDF = customer-driven factor; ADR = average daily rate.

different categories. Depending on factors such as location and building plan, the hotel owner may decide to focus on certain categories over the others. For these reasons, inconsistent effects may manifest in the aggregate resource consumption outcome.

Regardless of the "noise" in eco-certifications, relevant information seems to get across to customers, as demonstrated by consistently higher customer-driven resource efficiency for eco-certified hotels in this study (Exhibits 5-7). Tourism-based research found little evidence of eco-certifications' appeal to customers beyond some survey evidence of favorable opinion (Buckley 2002, 2013; Esparon, Gyuris, and Stoeckl 2014; Font 2002), which could be an artifact of perceiving eco-certification merely as a green selling tool. In contrast, our findings show that the information conveyed by eco-certifications could lead to multiple benefits, including attracting more environmentally friendly customers (i.e., shifting demand),

Exhibit 7:

Average Resource Efficiency Comparison between Eco-certified Hotels and Others across Property Types.

Average resource efficiency comparison across property type sub-groups: eco-certified vs. others

Note. ODF: Factor score of operations-driven resource efficiency; CDF: Factor score of customer-driven resource efficiency. Lower scores indicate higher resource efficiency. The sample averages for both ODF and CDF are 0. ODF = operations-driven factor; CDF = customer-driven factor.

educating customers about being more environmentally friendly, and providing mechanisms to enable customers to become green co-producers, all of which may contribute to the increase in customer-driven resource efficiency. Thus, we conclude that perceptions of eco-certification as merely a green selling tool ignore several important effects of service eco-certifications.

These findings are generalizable to tourism and other service industries where the benefits of informing stakeholders go beyond the purchase decision due to the collaborative efforts required in the operations. We see this principle as applying to higher education institutes, many of

which are pursuing credible eco-certifications. Given the importance of such externalities as financial aid packages, we believe such certifications will have little influence on prospective students' choice of schools, but we propose that the information conveyed through various communication channels and facility modifications will enable long-lasting behavior changes.

Managerial

Eco-certifications granted by second and third parties that include guaranteed audits should be the target of any

Exhibit 8:
Summary of Managerial Implications for Hotels Based on Operating Contexts.

Dimension	Operations-Driven	Customer-Driven
ADR	High-rate group is likely to see more resource efficiency gain driven by operations from implementing eco-certification.	Low-rate group is likely to see more resource efficiency gain driven by customers from implementing eco-certification.
Property type	Hotel properties that offer more functions and amenities are likely to see more resource efficiency gain driven by operations as a result of implementing eco-certification.	Hotel properties see consistent resource efficiency gain driven by customers across all property types.

hotelier serious about the environment, as the property will reap economic benefits. One possible development for the industry would be a consolidation of eco-certifications over time, with a consensus of exactly what constitutes actual sustainable practices and agreement on a critical mass of demonstrated positive outcomes associated with trustworthy eco-certifications. Eco-certifications adhering to a widely accepted standard are likely to lead to uniform criteria and to generate more comparable outcomes. This will further reduce the confusion and miscommunication regarding industry sustainability. As an additional benefit, with high credibility and consistent criteria, an industry standard eco-certification can deliver the promise of being an effective alternative to any prospective regulatory requirements for improving the environment (Mason 2012).

Our findings allow managers to set expectations for eco-certification based on the operating context of their property (as summarized in Exhibit 8). First, in terms of ADR, this study indicates that hotels in the high-rate group enjoy efficiency gains in their operations from implementing eco-certifications, while those in the low-rate group benefit more from customer-driven resource efficiency. This could be related to cost structures as well as the specific eco-friendly measures that each property selects. Second, depending on the property type (and the corresponding service level and functions), hotels providing more amenities have more opportunities for operational resource efficiency gains, while all hotel properties benefit from resource efficiency gain driven by customers by becoming eco-certified.

More important, the strong, positive customer-driven resource efficiency effect from eco-certifications underscores the importance of transparency in managing eco-certification programs. This transparency must be both internal and external. Managers themselves must understand the resource implications of various business activities. For example, environmental management programs such as InterContinental Hotels Group's "Green Engage"[1] and Hilton Worldwide's "LightStay"[2] monitor, measure, and compare the environmental impact of hotel operations. Aided by these programs, managers can understand not only the big picture of resource efficiency but also the contribution of various partners and stakeholders. To achieve external transparency, hotels can include information about the contribution of each sustainability initiative in the communications with stakeholders, as well as share the savings with them to demonstrate commitment and provide ultimate verification of the credibility of the firm's eco-certification.

Future Research

Among the directions for further research suggested by this study is the relationship between eco-certification and pricing in the hotel industry. This study found that the relationship between room rate and resource efficiency varies across different rate groups (Exhibit 6). Past research has found evidence of a price premium for eco-certified goods (Delmas and Grant 2010), but a study of the hotel industry found no overall revenue effect of sustainability (Chong and Verma 2013). Given this contradiction, future research can explore whether (and when) similar price premiums occur in service settings, especially in an industry that employs highly dynamic pricing mechanisms. Together with what we have learned regarding resource expenditures, this information will advance the knowledge about the underlying mechanisms that link eco-certification and economic performance.

Second, there are opportunities for different methodologies to investigate specific eco-certification effects on customers. Using archival data, this research was able to study the eco-certification effects at the aggregate level but lacked the precision to identify the underlying driver of these effects. For example, did the resource efficiency gain arise from attracting green customers or from enabling existing customers to become more environmentally responsible, or some combination of the two? Experimental designs such as choice modeling are excellent methods to study these questions as they are capable of teasing out confounding factors.

Conclusion

This study investigates the impact of eco-certifications by comparing resource efficiency measures between eco-certified hotels and others. By considering the two primary

drivers of resource efficiency during service co-production, we can begin to understand the effects of eco-certifications for hotel operations from a systems perspective. The findings provide empirical support for the hypotheses, showing positive links between eco-certifications and both operations- and customer-driven resource efficiency. In particular, the findings underscore the informational effects of eco-certification on operations and customers during service co-production. The successful implementation of eco-certifications requires hoteliers to carefully consider their operating contexts. These results contribute to sustainable development in the hotel industry by identifying key issues in effective eco-certification implementation: choosing credible eco-certifications and maintaining high transparency.

Appendix

For over seventy-five years, PKF Hospitality Research (PKF-HR) has collected annual operating statements from thousands of hotels across the United States, reporting over two hundred revenue and expense items in their proprietary Trends in The Hotel Industry database. Participation in the survey is voluntary. Every year, after receiving the survey forms or copies of December profit and loss statements, PKF-HR enters all the data in accordance with the classification system prescribed by the most current edition of the Uniform System of Accounts for the Lodging Industry (USALI).

Authors' Note

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Notes

1. The InterContinental Hotels Group describes the Green Engage program on the company website: "Green Engage is our comprehensive online sustainability system. It tells our hotels what they can do to be a 'green' hotel and gives them the means to conserve resources and save money—by measuring, managing and reporting on their hotel energy, water and waste consumption, as well as benchmarking and the ability to create action plans to track progress. We believe this offers a huge advantage to owners for whom energy is the second largest cost in their hotels. It also puts us in a strong position to respond to rising energy prices and any future carbon taxes IHG and our hotels may face" (http://www.ihgplc. com/index.asp?pageid=742, accessed on August 19, 2013).

2. The Hilton Worldwide describes the LightStay program on the company website: "LightStay is our proprietary system of measurement. It calculates sustainability performance impact across our global portfolio of hotels. LightStay delivers value to hotel owners without any additional cost. The system's data is used to improve the guest experience and drive economic returns" (http://www1.hilton.com/ts/corporate/aboutus/aboutlightstay.htm, accessed on August 19, 2013).

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