Exploring the Relative Efficiency of Sustainable Industry Leaders: A DEA Approach

Daphne Simmonds
Metropolitan State University of Denver

Abel Moreno
Metropolitan State University of Denver

We examine the relative efficiency of organizations named as sustainability industry leaders in the 2017 DJSI index. Our study uses the overall sustainability as well as dimensional -- economic, social and environmental -- scores to examine the extent to which these dimensional scores were instrumental in producing overall scores. We also examine what improvements in dimensional scores would be necessary for better sustainability reputations. We use data envelope (DEA) to examine our questions. Our research has implications for both academic research and practice. Our main contribution is the application of DEA for benchmarking and improving organizations' sustainability reputations.

INTRODUCTION

Organization Call to Sustainability

Scientific findings related to climate change and other environmental phenomena may be subject to criticism; however, there is some consensus that we have, in many cases, exceeded the limits of many of our social and environmental systems, and are therefore operating in a manner that is not sustainable. Sustainability implies that we meet "*the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland, 1987). This idea gained traction in the business community in the 1990's after the Brundtland Commission outlined the degradation of the natural and social environments and the need for urgent corporate and individual actions to address these issues. After more than a decade of discussion, business managers understood that a response was imperative (Dyllick & Hockerts, 2002; Lubin & Esty, 2010). Soon, the concept of the *sustainable organization* emerged -- the organization that contributes to "*sustainable development by simultaneously delivering economic, social, and environmental benefits - the so-called triple bottom line*" p56 (Hart, Mark, & Joseph, 2003).

Organization Sustainability Response

Several factors have been used to explain the organizational imperative to address sustainability. One is the growing concern of stakeholders and the consequent pressure they exert on organizations. For example, customers may exert market pressure by refusing to purchase products, investors may give up or not acquire stocks, regulators may impose fines, and monitoring organizations such as GreenPeace may direct public attention to organizational practices that are either antisocial or damage the natural

environment (Elkington, 1998). Starik and Rands (1995) noted that while including sustainability was obviously an organizational imperative, it would be difficult to enact based on the nature of the popularly accepted definition (Brundtland, 1987), which they described as "(a) anthropocentric; (b) indefinite on what "needs" are and whose "needs" have priority; (c) silent on changes in technology, resource distribution, and quality; and (d) unclear regarding the benefits, costs, and strategies of intergenerational sacrifice and transfers. Many turned to the concept of "*corporate social responsibility* (CSR) (Carroll, 1979; Van Marrewijk, 2003); however, it too was considered to lack basis for action being, as it were, too broad in scope (Banerjee, 2001; Henderson, 2001). Eventually, through a process of collaboration, salient industry-based sustainability issues were identified and metrics developed to capture the impact organizations had with respect to each. Sustainable organizations designed operational initiatives to address and report on many or all the relevant issues so as to ensure their competitiveness, legitimacy, and harmony with the values and concerns of internal stakeholders (P. Bansal & K. Roth, 2000; Høgevold, 2011).

Sustainability Indices: Ranking Sustainable Organizations

Sustainable organizations now demonstrate (to their stakeholders) their commitment through various channels including sustainability or CSR reports. These reports demand initiatives that are not only clearly defined, but also measurable. In addition to enabling CSR reports, measurement of the impact of sustainable initiatives also positions organizations to increase their revenues. Studies have shown that highly sustainable organizations perform better than others in their industries over the long-term in terms of their stock market and accounting performance (Eccles, Ioannou, & Serafeim, 2014). Measurement also positions sustainable organizations to compete with each other in the marketplace and for awards. For example, the last few decades have seen the emergence of a number of sustainability awards such as the Golden Peacock Global Award for Sustainability and sustainability indices such as the Dow Jones Sustainability Index (DJSI). Both recognize organizations according to their sustainability initiatives; however, the indices, because they rank organizations, provide the added advantage of a platform that is useful, not just for competing organizations seeking to be recognized for the efforts, but also for investors seeking to compare how member organizations' values align with their own.

Like their financial performance-based predecessors (for example, the S&P500 and the Dow), sustainability indices provide a tool that both investment management companies and individual investors can use to track the performance of environmentally and socially responsible companies. For investment management, the indices are considered to be simple – given they represent multiple performance criteria. They are also considered to be credible, and they render organizations comparable, while being applicable to many audiences or purposes. Inclusion in such indices is therefore a goal for many sustainable organizations.

The Dow Jones Sustainability Index (DJSI)

The Dow Jones Sustainability Index (DJSI) is considered to be among the most prominent sustainability indices. As such, many organizations compete for inclusion in the index. The DJSI includes four measures of an organization's sustainability: 1) its environmental sustainability score, which captures its efforts to improve its practices so they are more environmentally friendly; 2) its social sustainability score, which captures its efforts to improve its practices so they are less hostile to individuals and communities; 3) its financial (or economic) score, which captures its efforts to improve its practices so they are attract greater profits for the company; and 4) its overall score, which represents its sustainability rank – a composite of the three dimensions.

Assessment for inclusion in the DJSI is conducted by Robeco SAM – an investment specialist company focused exclusively on sustainability investing. Inclusion is based on a positive screening or "Best-in-Class" approach to identifying best-practices across the economic, social and environmental dimensions of corporate sustainability. Organizations' efforts, regardless of their initiatives or methods of contributing to sustainability, are assessed. Each organization is then given an individual score for each of

the three dimensions – economic, environmental and social, as well as overall score representing their sustainability performance rank.

The DJSI ranked within the top three most credible sustainability ratings of organizations surveyed by SustainAbility in 2010, 2012 and 2013 (http://www.sustainability.com/). The index has been said to serve as "an effective engagement platform for investors who want to encourage companies to improve their corporate sustainability practices" https://seekingalpha.com/article/4104698-djsi-temperature-gauge-sustainability-investing. On the other hand, criticisms of the DJSI decry its focus on benchmarking companies against each other rather than against an ideal (https://www.naturalinvestments.com/blog/why-sustainability-indices-fall-short/). Such a ranking method has been criticized as a comment on the index' failure to benchmark the effectiveness with which organizations are in fact addressing issues related to environmental and social sustainability. Despite criticisms, companies not only vie for inclusion annually, but also constantly seek to improve their abovementioned scores to either remain included, or improve their positions, in the index, or possibly even attain leadership of their industry.

Research Questions

In this study, we investigate how relatively efficient are the sustainability efforts of individual DJSI member organizations in achieving their overall scores, and also seek to identify what dimensions less efficient organizations would need to focus on in order to be as efficient as their benchmarks and thus achieve similar scores. We ask the following questions:

1. How do sustainable organizations compare in terms of how efficient are their efforts at influencing their performance scores and rankings?
2. Given the assessment of their performance across the three sustainability dimensions, what organization displays the greatest efficiency at attaining a high overall score?
3. How can less relatively efficient sustainable organizations improve their efforts along each dimension to be as efficient as the benchmark organization(s)?

Our study uses a known method – Data Envelopment Analysis (DEA) -- to examine our research questions. DEA is used to assess the *relative efficiency* of our selected business units. Our unit of analysis is the organization. In the context of the present study, an organization that displays a *relative efficiency* of one (1) is deemed to be most efficient at obtaining their sustainability rank from their sustainability efforts and reports.

DEA methodology has been used in the analysis of hundreds of different processes. For example, Moreno et al. (2002) used DEA to evaluate the efficiency of academic departments at a public university, and to identify the causes behind the inefficiencies exhibited by poor performing units, as well as the changes needed to improve their efficiencies. The methodology has also been used to help manufacturing managers select robots that involve several competing features and characteristics (A. Moreno & Lall, 1999). In sustainability research, DEA has been used to evaluate sustainability of supply chains (Cortes, 2017; Su & Sun, 2018), logistic service providers (Klumpp, 2017) and port operations (Carlucci, Cirà, & Coccorese, 2018; Chen & Lam, 2018), among other business aspects.

Our findings show two organizations that display a relative sustainability efficiency of 1 and were therefore used as benchmarks to analyze the efforts needed by the other, less efficient, organizations. Our study makes two major valuable contributions. First, we answer calls for other methods that may be used in sustainability investigations (Elliot, 2011) – we propose the application of DEA for benchmarking and improving organizations' sustainability efforts. We also contribute to practice by demonstrating how sustainability scores may be benchmarked for direct feedback on how improvements can be made. The rest of this paper proceeds as follows. In the next section, we outline our methodology in detail. We then present our results and a discussion of same. We end with a discussion of the implications and limitations of our study, and directions for future research.

RESEARCH METHODOLOGY

We use Data Envelopment Analysis (DEA) to examine our questions. Data Envelopment Analysis (DEA) is an application of the linear programming technique and was developed by Charnes et al (1978) to measure the relative efficiencies of various options, referred to as decision-making units (DMUs). The technique involves the analysis of multiple, incommensurate inputs and outputs related to the DMUs. The efficiency score of each DMU is determined by the weighted sum of outputs divided by weighted sum of inputs. Charnes et al (1978) recognized difficulty in seeking common weights because each DMU may value inputs and output differently; they proposed to use a set of weights that give the highest possible relative efficiency scores.

DEA Analysis

The fractional form of DEA, which maximize the efficiency h_0 of the j_0 DMU is defined as follows:

$$\text{Max} \quad h_0 = \frac{\sum_{r=1}^{t} u_r y_{rj_0}}{\sum_{i=1}^{m} v_i x_{ij_0}}$$

$$\text{s.t.} \quad \frac{\sum_{r=1}^{t} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \qquad j = 1\ldots, j_0 \ldots, n$$

$$u_r \geq \varepsilon \qquad r = 1\ldots t,$$

$$v_i \geq \varepsilon \qquad i = 1\ldots m, \qquad \text{(Model M1)}$$

where

y_{rj} = the amount of the r^{th} output from unit j,
u_r = the weight given to the r^{th} output,
x_{ij} = the amount of the i^{th} input to the unit j,
v_i = the weight given to the i^{th} input, and
ε = a very small positive number

Charnes and Cooper (1962) provide approaches to convert the DEA model above into a linear programming model by setting the denominator in the objective function to some arbitrary constant and moving the denominator in the first constraints to the right-hand side of the constraint. For computational convenience, the DEA linear programming model is converted into a dual model as follows:

$$\text{Max} \quad Z_0 - \varepsilon \left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{t} s_r^+ \right)$$

$$\text{s.t.} \quad Z_0\, x_{ij_0} - \sum_{j=1}^{n} x_{ij} \lambda_j - s_i^- = 0 \qquad i = 1\ldots m$$

$$\sum_{j=1}^{n} y_{rj} \lambda_j - s_r^+ = y_{rj_0} \qquad r = 1\ldots t$$

$$\lambda_j,\ s_i^-,\ s_r^+ \geq 0 \qquad \text{(Model M2)}$$

where λ_j, s_i^-, s_r^+ are the dual variables.

There are alternatives to measure the efficiency of a DMU. One may use either the input-reducing efficiency or an output-increasing efficiency measure. Both model M1 and M2 measure output-increasing efficiency. In measuring the input-reducing efficiency, the relative efficiency of DMU (for example DMU j_0) is evaluated by finding the best practice DMU's minimum effort required to produce the same amount of outputs as DMU j_0 does. In other words, how much effort it takes for the best practice DMU -- known as the "*reference DMU*" -- to produce as much outputs as of DMU j_0.

TABLE 1
RAW DATA -- SUSTAINABILITY SCORES ASSIGNED - BY ORGANIZATION

Industry Leader	Sustainability Scores			
	Overall	Environmental	Social	Economic
Abbott Laboratories	87	85	85	91
Advanced Semiconductor Eng	86	88	81	91
Allianz SE	87	83	95	88
Amadeus IT Group	85	81	97	84
CNH Industrial NV	92	88	93	94
Coca-Cola HBC AG	90	85	100	90
Grupo Argos SA/Colombia	89	86	93	90
Henkel AG & Co KGaA	90	90	92	87
Industria de Diseno Textil SA	78	70	96	79
InterContinental Hotels PLC	79	77	77	81
Konica Minolta Inc	90	85	98	89
Koninklijke KPN NV	92	89	98	93
LG Electronics	87	83	91	90
Metro AG	80	81	88	69
Mirvac Group	83	79	89	79
Pearson PLC	75	69	100	71
Peugeot SA	83	71	88	82
Red Electrica Corp SA	93	87	99	93
Roche Holding AG	87	82	91	88
Royal Mail PLC	86	84	93	86
SGS SA	79	76	82	81
Thai Oil PCL	88	85	85	94
UBS Group AG	88	82	94	93
Westpac Banking Corp	94	94	97	93

Data

In this study, our choices of DMUs are the top 24 organizations in the 2017 DJSI Global Index. These organizations enjoy the status of being called industry leaders in the index – a significant reputational boost. We apply DEA to the evaluation of how these organizations' efforts toward sustainability along the three dimensions impact the overall score or sustainability rank they enjoy. As such, our data comprises their dimensional and overall sustainability scores. Inputs related to each DMU are the three sustainability dimensional scores (economic, environmental and social), while their overall sustainability score is used as the single output.

In Table 1, we present our research data -- the 24 industry leader organizations are listed with their respective economic, environmental and social dimension scores and overall scores, as assigned by Robeco SAM and used for computing their status in the Index. These data are estimated from data obtained from reports published by Robeco SAM at http://www.robecosam.com/en/sustainability-insights/about-sustainability/corporate-sustainability-assessment/industry-group-leaders.jsp.

RESULTS OF ANALYSIS

The outputs of our analysis, presented in Tables 1 and 2 were used to answer our three research questions, hereafter referred to as RQs 1 through 3. Direct results of the DEA included *Relative Sustainability Efficiency* (RSE) scores as well as *reduced cost* related to the three sustainability dimensions for each DMU in our data set. The RSEs are presented in Table 2 and reduced costs in Table 3. We used these results as described next.

TABLE 2
RELATIVE SUSTAINABILITY EFFICIENCY AND BENCHMARKS - BY ORGANIZATION

Industry Leader	Code	Relative Sustainability Efficiency	Reference Set
Abbott Laboratories	01	0.9087	24
Advanced Semiconductor Eng	02	0.8983	24
Allianz SE	03	0.8998	18
Amadeus IT Group	04	0.8962	18
CNH Industrial NV	05	0.9212	24
Coca-Cola HBC AG	06	0.9774	18
Grupo Argos SA/Colombia	07	0.9972	24
Henkel AG & Co KGaA	08	0.9143	24
Industria de Diseno Textil SA	09	0.8145	18
InterContinental Hotels PLC	10	0.7379	24
Konica Minolta Inc	11	0.9583	18
Koninklijke KPN NV	12	0.9840	18,24
LG Electronics	13	0.9005	24
Metro AG	14	0.7658	18,24
Mirvac Group	15	0.8051	18,24
Pearson PLC	16	0.8145	18
Peugeot SA	17	0.7934	18,24
Red Electrica Corp SA	18	1.0000	--------
Roche Holding AG	19	0.8674	18,24
Royal Mail PLC	20	0.8768	24
SGS SA	21	0.7379	24
Thai Oil PCL	22	0.9538	24
UBS Group AG	23	0.9362	24
Westpac Banking Corp	24	1.0000	--------

The data in Table 1 were used to answer RQs 1 and 2: "*How do sustainable organizations compare in terms of how efficient are their efforts at influencing their performance scores and rankings?*" and, "*Given the assessment of their performance across the three sustainability dimensions, what organization displays the greatest efficiency at attaining a high overall score?*" We had to perform further computations using the reduced costs presented in Table 3 to answer RQ3 – "*How can less relatively efficient sustainable organizations improve their efforts along each dimension to be as efficient as the benchmark organization(s)?*"

We present details of the tables, computations, and analyses next.

In response to RQ1, our DEA findings show that the RSEs of the 24 industry leaders varied between 0.7379 and 1.0000 – see Table 2. The organizations with the lowest RSE score were Intercontinental Hotels and SGS, the Travel and Tourism and Professional Services industry leaders respectively. Highest scores of 1.0000 were achieved by Red Electrica and WestPac Banking – the sustainability leaders in the Electricity and banking industries, meaning that for their individual economic, social and environmental dimensions' scores, no better total score can be obtained by any of the other organizations in the study. The next highest score, 0.9972, was attained by Grupo Argos, leader in the Construction industry.

TABLE 3
REDUCED COST OF EACH SUSTAINABILITY DIMENSION - BY ORGANIZATION

Organization	Input Slacks		
	Economic	Environmental	Social
1. Abbott Laboratories	0.0009	0.0012	0
2.Adv Semiconductor Eng	0.0005	0.0016	0
3.Allianz SE	0	0	0.0002
4.Amadeus IT Group	0.0005	0	0.0008
5.CNH Industrial NV	0.0006	0.0002	0
6.Coca-Cola HBC AG	0.0004	0	0.0004
7.Grupo Argos SA/Colombia	0.0010	0.0007	0
8.Henkel AG & Co KGaA	0	0.0001	0.0002
9.Industria de Diseno Textil SA	0.0020	0	0.0013
10.InterContinental Hotels PLC	0.0007	0.0009	0
11.Konica Minolta Inc	0.0002	0	0.0003
12.Koninklijke KPN NV	0.0001	0	0
13.LG Electronics	0.0010	0.0004	0
14.Metro AG	0	0	0.0019
15.Mirvac Group	0	0	0.0006
16.Pearson PLC	0.0025	0	0.0028
17.Peugeot SA	0	0	0.0001
18.Red Electrica Corp SA	--------	---------	--------
19.Roche Holding AG	0	0	0.0001
20.Royal Mail PLC	0.0009	0.0001	0
21.SGS SA	0.0008	0.0003	0
22.Thai Oil PCL	0.0013	0.0016	0
23.UBS Group AG	0.0015	0.0003	0
24.Westpac Banking Corp	---------	---------	---------

Our findings also included details of the organizations for which Red Electrica and WestPac Banking, the two benchmark organizations that achieved an RSE of 1, act as reference sets. In the circumstance of benchmarking, the efficient DMUs, as defined by DEA, are thought to represent the best-practices (Cook, Tone, & Zhu, 2014) – in this case – the best combination of dimensional scores, for the assigned

Robeco SAM overall scores. These benchmarks can therefore be used to determine how a particular organization – one that is less efficient than the benchmarks -- can improve its RSE.

In response to RQ3, we examined, we used the sensitivity analysis output from the DEA to compute the necessary specific improvements that each organization would need to make to its dimensional scores in order to achieve an RSE of 1.000 and thus bring it up to par with its benchmark organizations. In Table 3, we present the input slacks reported in the linear program associated with the various sustainability dimensions of each organizations. The input slacks represent the values we used to calculate the adjustments for each sustainability dimension that are recommended for each organization in order to achieve dimensional scores that will then lead to better overall scores. These are presented as percent changes for the twenty-four organizations and are reported in Table 4.

TABLE 4
SUGGESTED %CHANGES TO SUSTAINABILITY EFFORTS – BY DIMENSION

Organization	Recommended %Changes to Sustainability Efforts		
	Environmental	Social	Economic
1. Abbott Laboratories	1	-1	10
2.Adv Semiconductor Eng	6	-2	11
3.Allianz SE	12	12	8
4.Amadeus IT Group	7	11	4
5.CNH Industrial NV	3	6	9
6.Coca-Cola HBC AG	-1	2	-1
7.Grupo Argos SA/Colombia	-8	-6	1
8.Henkel AG & Co KGaA	10	8	7
9.Industria de Diseno Textil SA	4	23	9
10.InterContinental Hotels PLC	26	23	36
11.Konica Minolta Inc	2	4	2
12.Koninklijke KPN NV	1	2	1
13.LG Electronics	2	7	11
14.Metro AG	31	31	12
15.Mirvac Group	24	25	16
16.Pearson PLC	1	22	-1
17.Peugeot SA	26	26	24
18.Red Electrica Corp SA	--------	---------	--------
19.Roche Holding AG	15	15	14
20.Royal Mail PLC	5	13	14
21.SGS SA	25	32	36
22.Thai Oil PCL	-6	-8	4
23.UBS Group AG	-6	4	6
24.Westpac Banking Corp	---------	---------	---------

To directly answer RQ3 therefore, for example, consider Intercontinental Hotels and its reference set organization Westpac Banking. The economic, environmental and social dimension scores for Intercontinental Hotels as reported in Table 1 are 77, 77 and 81 respectively, with an overall score of 79. From Table 2, Intercontinental Hotels RSE was 0.7379. Westpac Banking's scores are 94, 97 and 93 respectively, with an overall score of 94. Westpac Banking RSE was 1.000. Observing the values included in Table 3 for Intercontinental Hotels, we see input slacks for the economic and environmental dimensions of 0.0007 and 0.0009 respectively and zero for the social dimension. After using these input slacks to find the necessary adjustments to the sustainability dimensions, we observe that in order for Intercontinental Hotels to attain an RSE of 1.000, it will have to increase the economic dimension score

from 77 to 97, the environmental dimension score from 77 to 95, and the social dimension score from 81 to 110, which will make it equally efficient as its reference organization Westpac Banking. Consider now Abbott Laboratories with dimensional scores of 85, 85, and 91, and with an overall score of 87. Abbott's RSE is 0.9087 and input slacks are 0.0009, 0012 and 0. After using the input slacks, Abbott will need to adjust its scores to 86, 84 and 100 for the economic, environmental and social dimensions in order to attain an RSE of 1.000.

We believe that an alternative, and more practical, use of our computational analysis of the results of the sensitivity analysis is to convert them into percent changes to the resources devoted to each of the sustainability dimensions. For example, for the case of Abbott Laboratories, rather than suggesting specific target values for the sustainability dimensions' scores, i.e. 86, 84 and 100, percent changes to the amounts of resources allocated to the respective dimensions will be suggested, i.e. 1%, -1%, and 10%. Percent changes for the twenty-four organizations are reported in Table 4.

We present our conclusions next, including a discussion of the results, the implications of our study, its limitations and some future research indicated.

CONCLUSION

We define a sustainable organization as one that pursues initiatives to improve their operations so as to contribute to a triple bottom line (as opposed to a single profit-oriented bottom line as obtained in the past). This means their performance efforts are measured along three dimensions – economic, environmental, and social. We used the RobecoSAM assigned sustainability dimensional scores as performance measures of the efforts organizations make along the three dimensions and set out to answer three research questions related to the efficiency of the sustainability efforts pursued in terms of how they afforded the overall scores attained. We used DEA to determine how efficient are the sustainability initiatives – measured by the dimensional scores – at affording a high overall score for the organizations competing for these scores in the Dow Jones Sustainability Index (DJSI).

We used the dimensional scores as the inputs for our DEA model and the overall score as a single output. We assessed the relative efficiency of twenty-four organizations assessed as sustainable leaders in their industries. Our results showed two benchmarks among the twenty-four organizations. That is to say, there were two organizations -- Red Electrica and WestPac Banking -- to which DEA assigned a relative efficiency score of 1. We interpreted these results as an indication that the two benchmark organizations were most efficient at attaining high overall sustainability scores given their sustainability efforts, and were therefore, while not necessarily more sustainable (so to speak), were either accidentally or deliberately better able to develop or report on initiatives so as to attain the best possible overall sustainability scores. The other twenty-two organizations had efficiencies that ranged between 0.7379 and 0.9972. We interpreted the lowest as indicative of either a less mature set of initiatives, or reporting protocol.

We also used the input slacks obtained from the results of the DEA to seek to understand what kind of improvements were necessary to improve the efficiency of the twenty-two organizations. We presented these results in terms of percentage improvements needed in each sustainability dimension across the organizations. We believe that these results do not only indicate potential changes in performance efforts that need to be made in each dimension across organizations, as suggested by the table caption. We wonder whether they also point to an issue of salience across industries as suggested by Bansal and Roth (2000). For example, let us take the case of Coca Cola. This company is benchmarked against Red Electrica Corp SA. The indications are that, in order to achieve similar efficiency to Red Electrica, Coca Cola should improve their social efforts by 2%, and pay 1% less attention to both their environmental and economic efforts. It may be that these indicate actual efforts needed within Coca Cola; however, they may also be indications of differences in the efforts needed across industries. We believe that future research may be needed to explore this question.

Implications of Our Research

Our research has implications for both academic research and practice. The main contribution to research is the application of the DEA to the sustainability outcomes of the DJSI ranking scores. We believe that our greatest contributions lie in pointing to DEA as a methodology that can be used to compare and benchmark organizations' sustainability performance, and also in showing how the results of the analysis can be used to highlight areas in need of change for improvement of scores.

Limitations and Future Research

One limitation of our research is the data set, which we believe would have yielded more and deeper insights had it been supplemented by primary and qualitative data, if even for some of the organizations. Future research could therefore include such data, particularly to answer questions related to differences in salience across industries as alluded to above

Another is that our assessment of relative sustainability efficiency compares very few organizations and only industry leaders. Future research could involve comparison of a larger number of organizations and also include intra-industry comparison of organizations.

REFERENCES

Banerjee, S. B. (2001). Managerial perceptions of corporate environmentalism: Interpretations from industry and strategic implications for organizations. *Journal of management studies,* 38(4), 489-513.

Bansal, P., & Roth, K. (2000). WHY COMPANIES GO GREEN: A MODEL OF ECOLOGICAL RESPONSIVENESS. *Academy of Management Journal,* 43(4), 717.

Bansal, P., & Roth, K. (2000). Why Companies Go Green: A Model of Ecological Responsiveness. *The Academy of Management Journal,* 43(4), 717-736.

Brundtland, G. H. (1987). *Report of the World Commission on environment and development:" our common future."*: United Nations.

Carlucci, F., Cirà, A., & Coccorese, P. (2018). Measuring and explaining airport efficiency and sustainability: Evidence from Italy. *Sustainability,* 10(2), 400.

Carroll, A. B. (1979). A three-dimensional conceptual model of corporate performance. *Academy of management review*, 497-505.

Chen, C., & Lam, J. S. L. (2018). Sustainability and interactivity between cities and ports: a two-stage data envelopment analysis (DEA) approach. *Maritime Policy & Management*, 1-18.

Cook, W. D., Tone, K., & Zhu, J. (2014). Data envelopment analysis: Prior to choosing a model. *Omega,* 44, 1-4.

Cortes, A. (2017). A Triple Bottom Line Approach for Measuring Supply Chains Sustainability Using Data Envelopment Analysis. *European Journal of Sustainable Development,* 6(3), 119-128.

Dyllick, T., & Hockerts, K. (2002). Beyond the business case for corporate sustainability. *Business strategy and the environment,* 11(2), 130-141.

Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The impact of corporate sustainability on organizational processes and performance. *Management Science,* 60(11), 2835-2857.

Elkington, J. (1998). Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental Quality Management,* 8(1), 37-51.

Elliot, S. (2011). Transdisciplinary perspectives on environmental sustainability: a resource base and framework for IT-enabled business transformation. *MIS Quarterly,* 35(1), 197-236.

Hart, S. L., Mark, B. M., & Joseph, C. (2003). Creating Sustainable Value [and Executive Commentary], 56.

Henderson, D. (2001). *Misguided virtue: False notions of corporate social responsibility*: New Zealand Business Roundtable.

Høgevold, N. M. (2011). A corporate effort towards a sustainable business model: a case study from the Norwegian furniture industry. *European Business Review,* 23(4), 392-400.

Klumpp, M. (2017). Do Forwarders Improve Sustainability Efficiency? Evidence from a European DEA Malmquist Index Calculation. *Sustainability,* 9(5), 842.
Lubin, D. A., & Esty, D. C. (2010). The sustainability imperative. *Harvard Business Review,* 88(5), 42-50.
Moreno, A., & Lall, V. (1999). Decision Models for Robot Selection: A Data Envelope Analysis Method. *International Journal of Operations and Quantitative Management,* 5(2), 12.
Moreno, A. A., & Tadepalli, R. (2002). Assessing academic department efficiency at a public university. *Managerial and decision economics,* 23(7), 385-397.
Prepoudis, A. (2017, September 7). DJSI - A Temperature Gauge For Sustainability Investing. Retrieved from https://seekingalpha.com/article/4104698-djsi-temperature-gauge-sustainability-investing
Starik, M., & Rands, G. P. (1995). Weaving an integrated web: multilevel and multisystem perspectives of ecologically sustainable organizations. *Academy of Management Review,* 20(4), 908-935.
Su, Y., & Sun, W. (2018). Sustainability evaluation of the supply chain with undesired outputs and dual-role factors based on double frontier network DEA. *Soft Computing*, 1-9.
Van Marrewijk, M. (2003). Concepts and definitions of CSR and corporate sustainability: between agency and communion. *Journal of Business Ethics,* 44(2), 95-105.