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Abstract

A meta analysis of key performance indicators (KPI) for a wide range of companies across the paper industry value chain was performed to understand whether disclosure- or performance-based sustainability metrics were better indicators for financial performance of the firms. The study aimed to contribute to theory development on the link between sustainability and competitiveness of the firm, by conducting a multivariate statistical analysis of a wide range of financial and sustainability metrics. Correlation matrices and principal component analysis (PCA) indicated: (i) a slight positive correlation between GHG emissions and disclosure score (e.g. ESG), (ii) a negative correlation between GHG emissions and financial performance (e.g. ROA, stock price, valuation), and (iii) disclosure based measures are better predictors or corporate sustainability performance (CSP) than are performance-based metrics. Targeted correlation analysis using three principal component indicator variables from four models were inconclusive as to links between sustainability and financial indicators. Even though companies clustered along the ESG score spectrum, there was no relationship with financial metrics. Then performance-based CSP scores were used, no clustering was observed. The lack of validation of the results from the meta analysis using the targeted KPIs was likely due to the loss of resolution of environmental sustainability data in the ESG or CSP scores, which mask trends as the result of decreased sensitivity. Future work should focus on preserving higher granularity of metrics and increased use of multivariate statistical tools to increase the 'signal-to-noise ratio' for sustainability-financial performance trends.

Keywords: Sustainability, multivariate statistics, financial performance

1. Background

A recent KPMG report highlights global, interactive sustainability megatrends, such as climate change, material resource and water scarcity, and population growth, which bring businesses both risks and opportunities (KPMG 2012). In a world that is increasingly more interconnected and globalized than it has ever been, businesses no longer operate just within their own firm boundaries. In this context, today's sustainability challenges and the resulting force from environmental NGOs, new regulations, and consumer demand, mean that they must consider the complex environmental, social and global economic context that they operate in. Literature has shown that competitiveness, defined as the potential to improve long-term profitability, is a motivation behind corporate ecological responsiveness, and anticipates financial benefits such as higher profits, larger market share, higher share price, and etc. (Bansal and Roth 2000). Therefore, the business case for sustainability has certainly been a much-discussed topic among both practitioners and academics alike.

There has also been extensive theory development in trying to incorporate sustainability into firm competitiveness. Hart extended the economics-driven resource-based view of the firm to include external ecological limits and argued for strategic capabilities that facilitate environmentally sustainable economic activities (Hart 1995). Other streams of research have addressed sustainability to be to be a competitive strategy range from firm-level activities in relatedness within divisions of a firm (Rumelt 1974, 1982) and differentiation strategies (Reinhardt 1998) to beyond firm-level strategies in globalization and diversification (Dowell et al. 2000). Research in the application and development of organizational theory has gained traction as well. Both stakeholder and institutional theories have successfully been applied by numerous scholars to show that environmentally sensitive stakeholder management is important for firm competitiveness (Bansal and Clelland 2004; Delmas 2001).

A number of empirical studies have focused on the correlation between environmental and financial performance. For example, a recent meta-analysis shows that there is a small, but significant, positive relationship between a firm's sustainability efforts and their financial performance (Figure 1). However, this study also highlighted a lack of consistent metrics for measuring sustainability. Both practitioner and academic literature uses metrics in different places along the value-creation chain. For example, an end-state outcome metric would be share price or return on assets, while an intermediate outcome metric would be change in cash flow. Because most literature focuses on the end-state outcome and not the mediating variables between different states, there is little understanding of the causality between the two [2].

For corporate financial performance (CFP), the most common metrics used are end-of-chain, or consumer- and shareholder-facing financial metrics. Most of these can be categorized as either market-based or accounting-based metrics. Market-based metrics, such as share price and profitability ratios, are popular because it makes it easy for firms to measure their own performance, and are easily comparable across sectors and geographies. Accounting-based metrics, such as returns on assets, are driven by accounting practices of the firm and thus not consistent across firms or industry sectors. Measures of corporate sustainability performance (CSP) are also highly variable across published studies, and are mostly limited to the availability of quantitative data. They can be based on the amount of information disclosed (disclosure-based, e,g, CDP), or actual environmental, social, and governance (ESG) performance (performance-based, e.g. MSCI).

Other measures of business sustainability include input-output life cycle analysis (Hendrickson et al. 1998), hybrid life cycle analysis (Lenzen and Crawford 2009), and "environmetrics" (Simeonov 2012). They represent some of the more rigorous and quantitative methods in industrial ecology to translate environmental performance to economic metrics. Methods to correlate sustainability performance to firm financial performance, however, have been dominated by statistical regression models.

Despite these empirical and theoretical developments, there is a lack of consistency and reliability in the measures used for CSP and CFP, and still little is known about the causality between investments in sustainability and CFP (Orlitzky et al. 2003; Peloza and Yachnin 2008). Without understanding the mediating process, it is difficult to develop a credible hypothesis of how sustainability creates value and to select indicators that can help us assess the value early in the process (Peloza and Yachnin 2008).

The work presented here seeks to gain better understanding of the different measures of sustainability – classified by performance- or disclosure-based measures – in the context of firm competitiveness with application to the paper industry. We are asking: What sustainability measures are the most predictive of CFP, and thus are most useful when studying *how* sustainability creates value for firms? Answering this will not only help set up future scholarly work in this area, but also holds managerial implications as it helps predict financial performance. Specifically, in this study, we aim to analyze the difference in using disclosure-based sustainability measures vs performance-based sustainability measures to correlate sustainability performance with financial performance.


Fig. 1. Sustainability-Corporate Financial Performance Relationships in the Academic and Practitioner Literature (%)
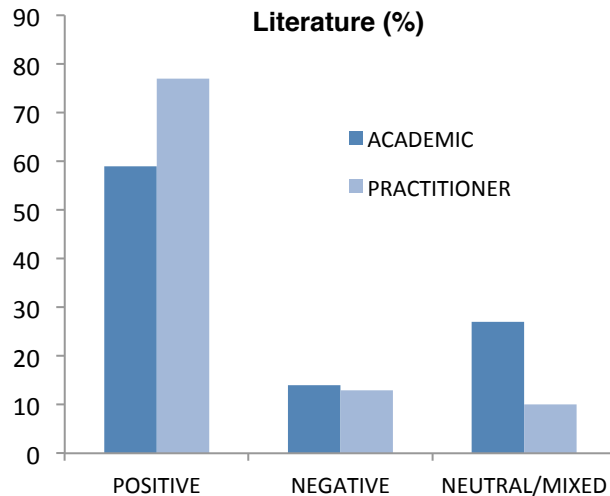
2. Methods

We chose to focus on the pulp and paper industry for several reasons. First, there is a clear financial motivation for paper companies to engage in sustainability strategies. Its heavy environmental impact (the industry as a whole is the fourth largest emitter of industrial greenhouse gases, the single largest industrial consumer of water used in industrial activities in OECD countries, and a historical emitter of priority pollutants in receiving water bodies) and issues in forestry management make firms in this industry under constant watch by environmental groups (World Wildlife Fund 2011). This close monitoring has proved to be critical for consumer-facing paper companies, as the recent battle between Greenpeace and Asia Pulp & Paper has shown (Greenpeace International 2012). Second, both performance- and disclosure-based sustainability measures are important targets for the industry, which is comprised of integrated and specialized firms with variable risk exposures. Disclosure through the Global Reporting Initiative (GRI) is standard practice, as well as obtaining performance-based forestry certifications for engagement in sustainable logging and forestry management practices. As certification opens access to large customers, and thus access to export markets, certification is closely tied to financial performance measures (ITS Global 2011; Bass et al. 2001).

Fig 2. Value chain for paper products (value added per ton paper product, Uronen 2010).
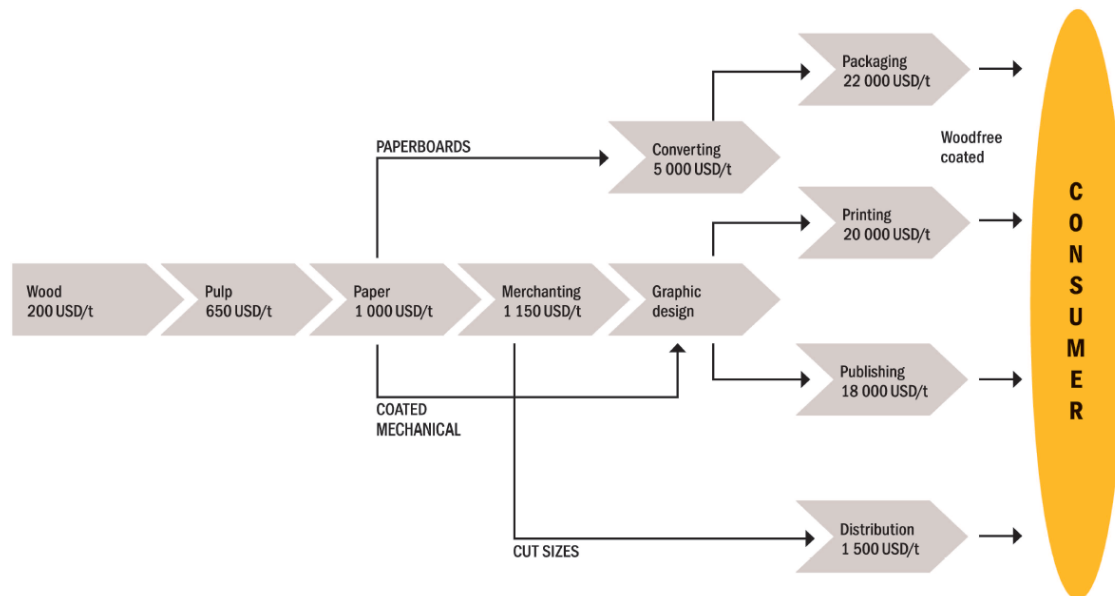
2.1. Company selection

Our comprehensive dataset included all Forest and Paper Products industry companies classified by GICS (GICS Industry 151050), the Paper Packaging sub-industry companies (GICS Sub-Industry 15103020), the Publishing sub-industry companies (GICS Sub-Industry 25401040), and the Diversified Chemicals sub-industry companies (GICS Sub-Industry 15101020). These companies and the industry

segments (or sub-industries) they belong in represent the value segment that make up the value chain of a paper product [Fig. 2]. The comprehensive dataset was then reduced to a subset of companies for which performance-based and disclosure-based data were available, based on third-party measures that were used.

2.2. Disclosure-based sustainability measure

The disclosure-based performance measures were based on Bloomberg's Environmental Social Governance (ESG) analysis of third-party information from GRI or other sustainability disclosures of the company, which were converted into a Bloomberg scoring system. According to information available on the Bloomberg terminal, which was used to collect the data, "*The score ranges from 0.1 for companies that disclose a minimum amount of ESG data to 100 for those that disclose every data point collected by Bloomberg. Each data point is weighted in terms of importance, with data such as Greenhouse Gas Emissions carrying greater weight than other disclosures. The score is also tailored to different industry sectors. In this way, each company is only evaluated in terms of the data that is relevant to its industry sector.*" Hence, we arrived at a total numbering 192 companies within our comprehensive set.

2.3. Performance-based sustainability measure

The third-party measures we used for performance-based sustainability measures were based on KLD Research & Analytics, commonly referred to as KLD STATS (Academic Ratings Data). KLD STATS provides a historical overview of a company's CSR activities. The CSR activities are divided into strengths and concerns and rated using a binary system, "1" being present of the rating and "0" being absent of the rating. The activities address CSR categories of community, human rights, corporate governance, employee relations, human rights, product, environmental issues and involvement in controversial business issues. In all of these categories, the ratings were either categorized as strengths or concerns. The overall strength or concern of each category is determined by adding up the total number of "strength" or "concern" ratings. The total number of companies within our comprehensive set analyzed by KLD STATS was 80.

2.4. Correlating to financial performance measures

Financial data was collected using the Bloomberg terminal. We collected the following indices: EBITDA, EBITA to Revenue, Return on assets, Historical market cap, and Average price-to-earnings (P/E) ratio. For both disclosure and performance based measures, sustainability performance and financial performance were observed for trends by plotting the two datasets using excel-based formulas.

The different financial and sustainability measures that were studied are summarized in Table 1. The first step in correlating financial and environmental performance is to choose the key performance indicators (KPIs) for analysis. We divided financial KPIs into market-based, and accounting-based indicators. Market-based KPIs reflect the public's (shareholders) notion of the company, while accounting-based KPIs capture a firm's internal efficiency. It is subject to managers' allocation of funds and strategic choices, and thus reflects internal decision-making capabilities and managerial performance. Accounting-based KPIs are important for strategic competitiveness

because they maintain a close connection to the variables controlled by managers. As mentioned earlier, the sustainability measures can be divided in disclosure-based or performance-based. Disclosure-based measures reflect the extent of reporting of environmental, or environmental, social, governance (ESG) data to the public and the company's shareholders. Performance-based measures are indicators of the actual environmental performance of a firm (energy use, emissions, etc).

Table 1. Summary of measures studied.

Subdivision	KPIs Investigated	KPI shown
FINANCIAL PERFORMANCE		
Market-based: external market responses to company behavior. Reflects notion that shareholders are the primary stakeholder group whose satisfaction determines the company's fate.	Price to Earnings (P:E) EBITDA Margin Market Cap	**EBITDA Margin**: Earnings Before Interest, Tax, Depreciation and Amortization (EBITDA) Margin Ratio calculated by dividing the EBITDA by Revenue. *100 x (EBITDA / Revenue)*
Accounting-based: capture a firm's efficiency. Reflects internal decision-making capabilities and managerial performance.	Return on Assets (ROA) Earnings per Share (EPS)	**ROA:** an indicator of how profitable a company is relative to its total assets. ROA gives an idea as to how efficient management is at using its assets to generate earnings. *(Trailing 12M Net Income / Average Total Assets) * 100*
SUSTAINABILITY PERFORMANCE		
Disclosure-based: amount of ESG or environmental data that is voluntarily disclosed by the company, mostly for investors that value intangible assets.	ESG Disclosure Score ENV Disclosure Score	**ENV Disclosure score:** ranges from 0.1 for companies that disclose a minimum amount of environmental data to 100 for those that disclose every data point collected by Bloomberg. Each data point is weighted in terms of importance. The score is also tailored to different industry sectors.
Performance-based: environmental or social impact due to company operations.	KLD Ratings (CSP)	**CSP:** Corporate social performance, sum of all strengths and concern binary ratings investigated by KLD.

3. Results

3.1 Meta-analysis

To get an overview of the trends underlying in the business-sustainability link, we first started with a meta-analysis of 11 financial and sustainability KPIs, of companies across the value chain of the paper industry. We developed a correlation matrix using 2010, 2009, 2008 datasets, as well as correlation of yearly increases in KPIs (2009-2010, 2008-2009), and correlation of 2010 and 2009 datasets, and 2009 and 2008 datasets, to test for annual shifts. Some of the most highly correlated pairs (shown by color intensity in Tables 2 through 8) were obvious, but were not significant to help uncover thematic features of the business-sustainability link because of their interdependence. For example, ESG and ENV Disclosure Scores were consistently highly correlated, as well as total GHG emissions and Market Cap, which is expected since both are signals of the size of a company with similar business operations. Of note however, were observations in the 2009 dataset, where GHG emissions were slightly positively correlated with disclosure score, possibly indicating that companies that emit more greenhouse gases tend to disclose more environmental or ESG data. This trend is becoming apparent in CDP (Carbon Disclosure Project) data as well, where large emitters that have risk management strategies in place, are more proactive in their disclosures. Other observations are that companies with higher greenhouse gas emissions and energy use tended to perform poorer financially (negative correlations), specifically in investability (KPI: Tobin's q) and returns (KPI: ROA), thus exhibiting a negative impact on share price and market capitalization.

Tables 2 to 8. Correlation matrices of 2010, 2009, 2008 datasets, yearly increase in KPIs, and yearly lag in KPIs.

2010 alone	Share Price	Tobin's q	ROA	Market Cap	P:E Ratio	ESG Disc Score	ENV Disc Score	Total GHG Emissions	GHG Intensity per Sales	Energy Intensity per Sales	Number of Employees
Share Price											
Tobin's q	0.000										
ROA	0.009	0.496									
Market Cap	0.033	0.094	0.083								
P:E Ratio	-0.018	0.000	-0.049	-0.017							
ESG Disc Score	0.068	-0.054	-0.003	0.349	0.086						
ENV Disc Score	0.029	-0.063	0.078	0.273	0.105	0.945					
Total GHG Emissions	0.216	-0.010	0.088	0.807	0.286	0.279	0.229				
GHG Intensity per Sales	0.269	-0.114	0.086	0.101	0.049	0.206	0.199	0.396			
Energy Intensity per Sales	0.064	-0.132	-0.097	0.084	-0.041	0.269	0.204	0.126	0.657		
Number of Employees	0.003	0.043	0.044	0.819	0.023	0.434	0.328	0.675	0.060	0.115	

2009 alone	Share Price	Tobin's q	ROA	Market Cap	P:E Ratio	ESG Disc Score	ENV Disc Score	Total GHG Emissions	GHG Intensity per Sales	Energy Intensity per Sales	Number of Employees
Share Price											
Tobin's q	-0.013										
ROA	0.030	-0.999									
Market Cap	0.031	-0.021	0.075								
P:E Ratio	0.295	0.024	-0.063	-0.026							
ESG Disc Score	0.027	-0.152	0.100	0.348	-0.024						
ENV Disc Score	0.138	-0.096	0.097	0.281	-0.067	0.949					
Total GHG Emissions	0.372	-0.040	-0.057	0.813	0.018	0.361	0.238				
GHG Intensity per Sales	0.194	-0.124	-0.236	0.154	-0.023	0.200	0.244	0.462			
Energy Intensity per Sales	-0.124	-0.179	-0.365	-0.121	-0.042	-0.337	-0.279	0.090	0.524		
Number of Employees	0.013	-0.033	0.037	0.848	-0.016	0.409	0.317	0.707	0.174	-0.057	

2008 alone

	Share Price	Tobin's q	ROA	Market Cap	P:E Ratio	ESG Disc Score	ENV Disc Score	Total GHG Emissions	GHG Intensity per Sales	Energy Intensity per Sales	Number of Employees
Share Price											
Tobin's q	-0.006										
ROA	0.025	0.195									
Market Cap	0.035	0.194	0.056								
P:E Ratio	-0.011	-0.016	-0.035	0.004							
ESG Disc Score	0.016	0.048	-0.068	0.317	0.180						
ENV Disc Score	0.164	-0.004	-0.072	0.294	0.182	0.941					
Total GHG Emissions	0.280	-0.069	0.010	0.671	-0.051	0.242	0.171				
GHG Intensity per Sales	0.153	-0.028	-0.209	0.063	-0.006	0.022	0.085	0.422			
Energy Intensity per Sales	-0.138	-0.225	-0.140	-0.150	-0.019	-0.355	-0.314	0.052	0.594		
Number of Employees	0.002	-0.036	-0.009	0.815	0.034	0.400	0.285	0.654	0.119	-0.061	

2008-2009

	Share Price	Tobin's q	ROA	Market Cap	P:E Ratio	ESG Disc Score	ENV Disc Score	Total GHG Emissions	GHG Intensity per Sales	Energy Intensity per Sales	Number of Employees
Share Price											
Tobin's q	0.011										
ROA	0.033	0.070									
Market Cap	-0.347	0.023	0.017								
P:E Ratio	0.002	0.013	0.048	-0.014							
ESG Disc Score	-0.133	-0.021	-0.030	0.065	-0.048						
ENV Disc Score	-0.089	0.009	-0.027	0.025	-0.030	0.928					
Total GHG Emissions	-0.273	0.041	-0.168	0.228	-0.218	-0.171	-0.154				
GHG Intensity per Sales	-0.284	0.168	0.126	0.383	-0.095	0.081	0.115	-0.032			
Energy Intensity per Sales	-0.046	0.078	-0.014	0.033	0.104	0.159	0.114	-0.282	0.150		
Number of Employees	-0.129	-0.007	-0.086	0.323	-0.039	0.173	0.131	0.507	0.195	-0.229	

2009-2010

	Share Price	Tobin's q	ROA	Market Cap	P:E Ratio	ESG Disc Score	ENV Disc Score	Total GHG Emissions	GHG Intensity per Sales	Energy Intensity per Sales	Number of Employees
Share Price											
Tobin's q	0.049										
ROA	0.050	0.199									
Market Cap	0.734	-0.009	0.054								
P:E Ratio	0.022	0.001	-0.057	0.015							
ESG Disc Score	-0.003	0.060	0.165	0.085	0.020						
ENV Disc Score	0.069	0.042	0.188	0.126	-0.036	0.923					
Total GHG Emissions	-0.782	-0.032	0.030	-0.429	-0.057	0.184	-0.041				
GHG Intensity per Sales	-0.585	-0.141	-0.110	-0.340	-0.086	0.165	0.020	0.576			
Energy Intensity per Sales	0.126	0.015	-0.256	0.105	-0.090	-0.085	-0.058	-0.100	0.035		
Number of Employees	0.124	0.001	-0.075	0.073	0.050	-0.032	0.038	-0.087	0.160	0.012	

2010 left, 2009 top

	Share Price	Tobin's q	ROA	Market Cap	P:E Ratio	ESG Disc Score	ENV Disc Score	Total GHG Emissions	GHG Intensity per Sales	Energy Intensity per Sales	Number of Employees
Share Price						0.051	0.011	0.252	0.297	0.116	
Tobin's q						-0.063	-0.045	-0.036	-0.129	-0.165	
ROA						-0.136	-0.064	-0.063	-0.189	-0.187	
Market Cap						0.373	0.293	0.809	0.118	0.093	
P:E Ratio						-0.060	-0.064	-0.062	-0.114	0.028	
ESG Disc Score	0.051	-0.063	-0.136	0.373	-0.060						0.456
ENV Disc Score	0.011	-0.045	0.097	0.293	-0.064						0.347
Total GHG Emissions	0.252	-0.036	-0.063	0.809	-0.062						0.703
GHG Intensity per Sales	0.297	-0.129	-0.189	0.118	-0.114						0.104
Energy Intensity per Sales	0.116	-0.165	-0.187	0.093	0.028						0.146
Number of Employees						0.456	0.347	0.703	0.104	0.146	

2009 top, 2008 left	Share Price	Tobin's q	ROA	Market Cap	P:E Ratio	ESG Disc Score	ENV Disc Score	Total GHG Emissions	GHG Intensity per Sales	Energy Intensity per Sales	Number of Employees
Share Price						0.018	0.168	0.319	0.164	-0.108	
Tobin's q						-0.101	-0.096	-0.071	-0.100	-0.211	
ROA						-0.066	-0.045	0.004	-0.290	-0.130	
Market Cap						0.321	0.295	0.690	0.104	-0.135	
P:E Ratio						0.150	0.180	-0.005	-0.009	0.004	
ESG Disc Score	0.014	-0.045	-0.031	0.337	0.022						0.384
ENV Disc Score	0.134	-0.097	-0.033	0.281	-0.025						0.277
Total GHG Emissions	0.344	-0.037	-0.047	0.792	0.000						0.699
GHG Intensity per Sales	0.175	-0.130	-0.265	0.083	-0.035						0.123
Energy Intensity per Sales	-0.157	-0.224	-0.351	-0.142	-0.086						-0.080
Number of Employees						0.412	0.317	0.657	0.161	-0.039	

In addition to correlation matrices and trend analysis, a principal components analysis (PCA) was performed to model all of these KPIs. A robust multivariate statistical tool, PCA allows for extracting the key variables that explain the variance in the datasets. By tracking these variables, emerging patterns can be identified and similarities and differences among the KPIs are highlighted. Thus, the principal components, which are composed of KPIs to maximize variability, inform us of the correlations of KPIs that are most statistically significant (Table 9). Multiple iterations and sensitivity tests are conducted to justify outliers that may be masking trends and build robustness of this model.

Table 9. Principal Components Analysis for 3-combination of KPIs

C1: PX-LAST C2: TOBINS Q C6: ESG DISC	C1: PX-LAST C3: ROA C6: ESG DISC
Eigenanalysis of the Correlation Matrix Eigenvalue 1.2403 1.1173 0.6424 Proportion 0.413 0.372 0.214 Cumulative 0.413 0.786 1.000 Variable PC1 PC2 PC3 C1 0.272 -0.812 -0.516 C2 -0.587 -0.565 0.580 C6 0.763 -0.145 0.631	Eigenanalysis of the Correlation Matrix Eigenvalue 1.1999 1.0957 0.7044 Proportion 0.400 0.365 0.235 Cumulative 0.400 0.765 1.000 Variable PC1 PC2 PC3 C1 0.771 0.057 0.635 C3 0.382 0.755 -0.532 C6 0.510 -0.653 -0.560
C1: PX-LAST C2: TOBINS Q C7: TOTAL GHG	C1: PX-LAST C3: ROA C7: TOTAL GHG
Eigenanalysis of the Correlation Matrix Eigenvalue 1.2673 1.0829 0.6498 Proportion 0.422 0.361 0.217 Cumulative 0.422 0.783 1.000 Variable PC1 PC2 PC3 C1 0.010 0.899 0.438 C2 0.709 0.302 -0.637 C7 -0.705 0.317 -0.635	Eigenanalysis of the Correlation Matrix Eigenvalue 1.1787 1.0878 0.7335 Proportion 0.393 0.363 0.245 Cumulative 0.393 0.755 1.000 Variable PC1 PC2 PC3 C1 0.738 0.259 -0.623 C3 0.663 -0.447 0.600 C7 0.123 0.856 0.502

This method has shown to be successful in reducing the large, multivariate set of KPIs for pulp and paper value chain companies to statistically significant measures. The results indicate that disclosure-based CSP measures appear to be better predictors of CFP, as compared to performance-based measures. This may be due to the fact that performance-based measures are self-reported, while disclosure-based measures are often third party verified, which ensures consistency across the industry.

3.2. Interactions between Disclosure- and Performance-based Sustainability Measures and Financial Performance Measures

Based on these findings and the results form the correlation matrices, KPIs were categorized to better understand their relationship and interactions. The KPI's (excluding Number of Employees) were grouped as follows: market-based financial, accounting-based financial, disclosure-based sustainability, performance-based sustainability. Previous literature has shown that accounting-based financial performance measures correlate more strongly with sustainability measures than market-based.
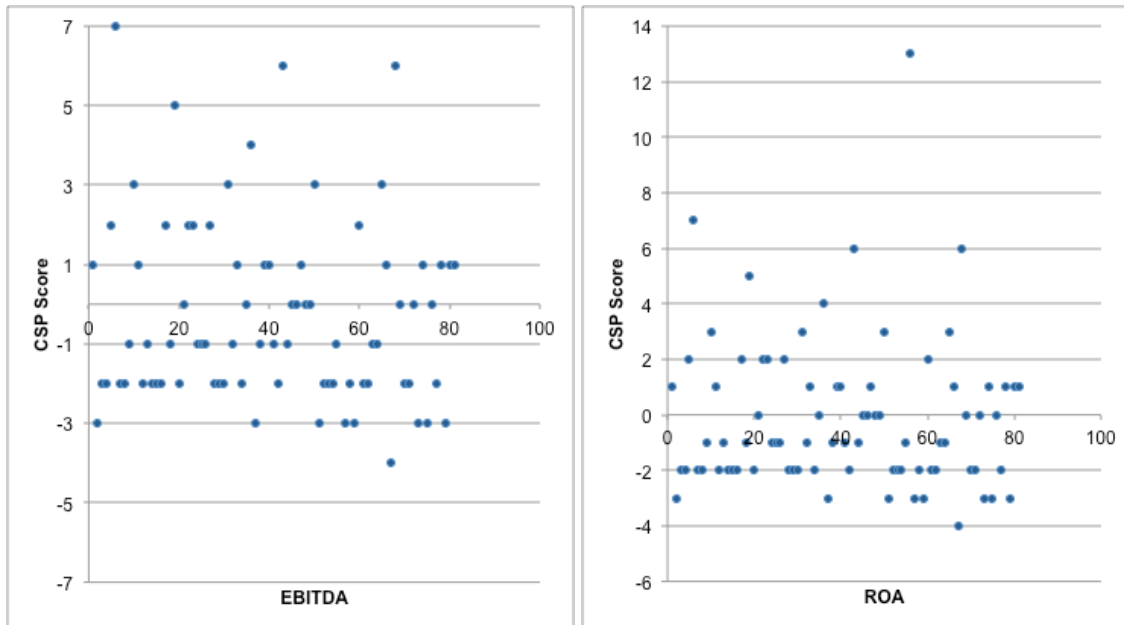
Fig. 3. Disclosure-based sustainability measures.
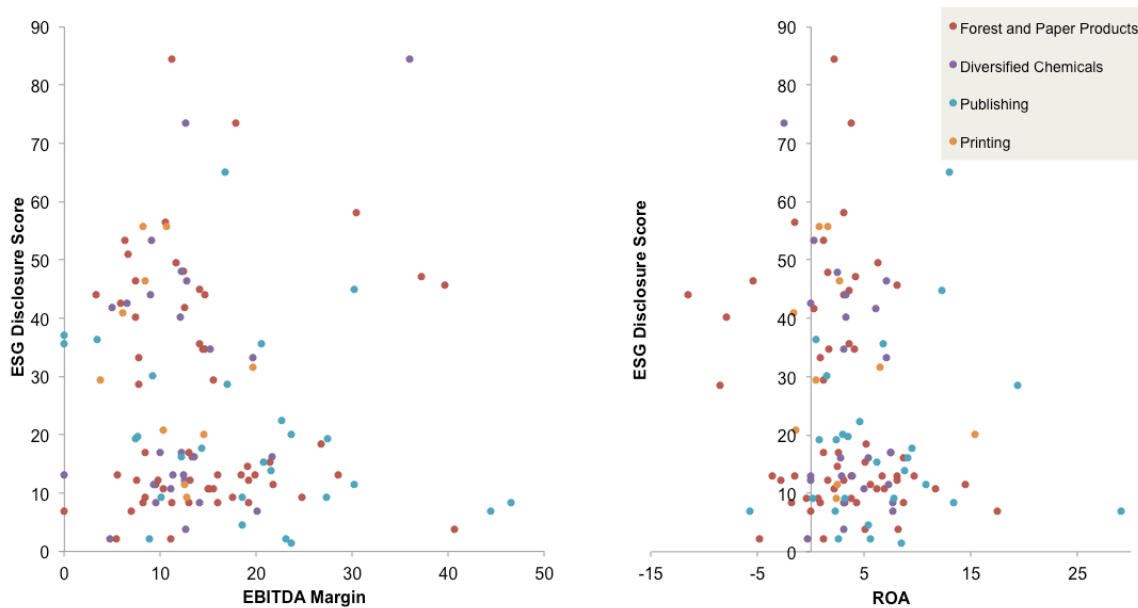
Even if there was no significant overall correlation between disclosure-based environmental performance and financial performance measures, the plots exhibit two statistically-significant clusters of firms along ESG disclosure score axis. There was no predominance of specific segments of the paper value chains among these clusters, except for less representation of publishing firms in the high disclosure score cluster. Similar clustering was observed in the correlation with market-based financial performance (ROA). There is a possible increasing performance with accounting-based performance, and an especially strong trend for firms in the forest and paper products industry. The lack of relation between ESG clusters and financial performance was not expected, given the fact that the meta analysis indicated that GHG emissions and financial performance were negatively correlated. This observation is possibly the result

of the loss of resolution of environmental data in the overall ESG score. Environmental metrics are weighted as 25% of the total ESG score, and the environmental component of ESG is composed of 14 measures of environmental performance, including GHG emissions.

Fig. 4. Performance-based sustainability measures.

As Figure 4 shows, there is very little, if no correlation between sustainability performance and financial performance, for both market-based and accounting-based measures. (The datapoints were not distinguished between different value segments because there were not enough to draw a significant conclusion.)

4. Discussion and Conclusions

Because there is no significant trend in correlation between performance-based sustainability and financial performance based scores, empirical studies could favor disclosure-based performance measures based on the PCA analysis of KPI. However, an alternative conclusion is that that adding up binary KLD STATS is not an appropriate measure to try to determine how "good" a company is performing in CSR.

There is an inherent difficulty in trying to measure CSR performance quantitatively, because of the highly varying objectives of companies for their CSR activities. Most companies do not internally link CSR to quantitative performance metrics. In addition, the success and nature of CSR activities are heavily dependent upon the context in which the firm operates, whether it is environmental, media landscape, specific crisis or scandals a company is dealing with, specific stakeholder relations, and more. Unlike financial performance measures, which are standards against markets that operate under the same rules and where the measures are regulated, CSR does not operate the same way.

A more productive way to measure CSR is to emphasize a specific activity or measure (instead of aggregate), e.g. GHG emissions instead of aggregate ESG score. In a way, disclosure-based measure is a specific component of performance-based measure, which is why it is easier to comprehend and draw out trends. Other specific performance-based measures could be water exposure (normalized to company size, or per good, etc), environmental violations, charitable giving (again, normalized), and specifically for paper and forest product companies, a measure of how much virgin wood they use vs recycled fiber, and whether this is imported or locally harvested.

This difficulty in trying to measure CSR in order to try to draw out trends against financial performance calls for a more systemic and dynamic approach to preserve granularity of the data, which we had to compromise when aggregating to subsets of KPIs. Keeping specific KPI, we can use a more rigorous and quantitative interpretation allows us to resolve multiple and measures to new constructs, such as principal components, that best predict a significant relationship between CSP and CFP. Additionally, new trends in industrial ecology, systems-based methods can help address this, such as agent-based modeling.

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