2° Investing Initiative

CARBON INTENSITY

CARBON RISK EXPOSURE

DISCUSSION PAPER - November 2015

Foreword

The carbon intensity of companies cannot be used as a proxy for their exposure to 'carbon' risks (a.k.a. 'energy transition' risks, 'carbon policy' risk, etc.) because it is only one factor among many others (cost pass through capacity, location of activities, etc.).

Portfolio carbon footprinting is very useful to raise awareness, but when it comes to actually measuring and managing exposure to financial risks related to the decarbonization of the economy, investors need to use more sophisticated metrics, such as the outputs from strategic asset allocation, discounted cash flow, and credit ratings models based on alternative assumptions regarding policy development and trends in technology deployments.

This idea seems trivial and is widely acknowledged by carbon accounting experts. Many of them, consulted before the publication of this paper, even wondered why we spent time documenting such an obvious fact (see Quotes).

The reason is that this basic fact is still widely present in many public statements made by investment professionals, in the press, in investor pledges, and, more worryingly, in public policy documents.

Now that governments, from France to G20, are actively supporting the development of carbon risk management-orientated disclosure frameworks, we think that this persistent confusion becomes a major threat for the consistency of public policies.

Moving forward, carbon accounting will remain an important source of raw data, at plant and product level, to inform risk analysis. In the context of disclosure frameworks, a key factor of success for policymakers will be to promote the right level of aggregation and the development of forward-looking data.

Stan Dupré, Executive Director, 2° Investing Initiative

"We agree that scope 1 and 2 intensity does not always provide a full picture of carbon risk, especially for the highest-emitting sectors with more complicated risk profiles. Many climate solutions providers (wind turbine producers for example) will have high direct emissions since they are manufacturing companies. Investors are keen to see increased scope 3 and carbon asset risk disclosure to enable them to create a better assessment of risk to their portfolios." **-CDP**

"The lacks of a significant carbon price signal makes it less important to screen carbon intensity indicators from direct emissions within our risk assessment framework. Against this backdrop we are putting more efforts to track the increasing financial impact of a carbon price dispersion among products and services through a wide range of Scope 3 related data." **-Kepler Cheuvreux**

"We applaud 2°ii's efforts to improve insights into the state of carbon-related metrics, as investors increasingly seek to integrate risks & opportunities related to climate change into their assessment. MSCI ESG Research continues to closely monitor risks associated with climate change – which are complex and evolving – while recognizing the need among investors for transparent, simple metrics that can be practically applied today in their investment process." **-MSCI ESG Research**

"An investment carbon footprint is a perfect tool for the large majority of investors that have never looked at climate risks in their portfolio. It serves as a starting point that helps in understanding the topic, prioritizing climate relevant sectors as well as companies and establishing focus points for deeper analysis. Therefore, investors should be encouraged to establish an investment carbon footprint as a means to create in- and external transparency and understanding but they should not use it to manage a portfolio - this requires additional information." **-South Pole Group**

"Trucost supports the argument made in this report that investors need multi-factor assessments of carbon risk. No single "magic bullet" carbon number will answer all questions related to climate risk, impact, exposure and transition and these different questions often require different metrics to answer them. To this end Trucost has a range of metrics that investors can utilise for different purposes and we support the 2 degrees investing initiatives work in promoting a deeper understanding in this field." **-Trucost Plc**

Executive summary

The concept of "carbon risk", financial risk to companies associated with the transition to a low-carbon economy, has steadily grown in the Environmental, Social, and Governance (ESG) and responsible investing fields in recent years. With this increasing interest, the number of commercial providers offering solutions for investors to assess their carbon risk exposure has increased in turn, with many relying on available data such as GHG emissions at company level (carbon footprint, carbon intensity of sales, etc.) as a proxy for this risk. However, many factors affect corporate carbon risk and it is thus important to ask whether such metrics are indeed a good and direct proxy for carbon risk. This report reviews how analysts, over a large set of reports published between 2003 and 2015, have assessed carbon risk and opportunity and how strong a relationship exists with corporate GHG emissions.

To answer this question, the report assesses the correlation between analyst rankings of companies by carbon risk with the companies' carbon intensity of sales (Scope 1 and 2, the most commonly used on the market today), which is often touted as a proxy for risk exposure. It concludes that the degree of correlation is rather low, at around 0.2 (on a scale of 0 – 1, with 1 representing a perfect 1:1 relationship between risk and intensity). Such correlation is far from sufficient to serve as a quality proxy for carbon risk exposure. It is likely that the low correlation is a consequence of the many other factors playing a role in defining carbon risk profile, including profitability, pricing power, geography, future capex and R&D plans, and overall management quality.

While the focus is on risk-oriented analysis, the report also considers thematic reports that identify and promote companies with "carbon opportunities", essentially a negative carbon risk. In a second step, the report shows that that company carbon intensity is also poorly related to such "opportunities". This weak relationship is likely due to the fact that such opportunities are primarily driven by companies having efficient or innovative product lines, an element not well captured by internal (Scope 1 and 2) GHG emissions. A more significant relationship may exist between company Scope 3 emissions and such opportunities, but current reporting of product-related Scope 3 emissions is too incomplete and uncertain for meaningful comparison.

Instead of relying on any single factor like carbon intensity or carbon footprint, it is critical for investors to resist the urge to oversimplify and to consider many different risk factors in order to draw a full picture of a company's carbon risk. Instead, investors should continue to test more advanced multi-factor approaches developed by investor consultants, credit rating agencies, and equity researchers. Such continued research and testing is needed to elucidate the most critical carbon risk factors for different industries.

Authors

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This report has been prepared by Grizzly Responsible Investment, in full collaboration with The 2° Investing Initiative.

1. Carbon risk assessments and carbon intensity

1.1 Objective of the report

The concept of "carbon risk"[i] has steadily grown in the Environmental, Social, and Governance (ESG) and responsible investing fields in recent years. Carbon risk is generally defined as the financial risk to companies associated with the transition to a low-carbon economy (excluding physical risks, generally called "climate risks") and, in the case of equity, the impact of this risk on stock financial performance.[ii] Recent reviews of the topic have described the various drivers for such risk (policy, technology, and market) as well as quantitative methods (primarily scenario-based stress tests at asset, company/security, or portfolio levels) that can be used to assess such risk.[iii]

As the concept of carbon risk has been popularized, institutional investors have faced a choice of how to assess its materiality and potentially manage it. ESG data providers, largely building off the growing availability of nonfinancial/CSR reporting data,[iv] have stepped in to offer data and services, often buoyed by investor coalitions.[v] One metric and method achieving increased prominence in the discussion has been "portfolio carbon footprinting", a term used broadly to mean portfolio-level GHG emissions associated with investee companies, projects, etc.[vi] For instance, the PRI Montreal Carbon Pledge explicitly states that "in order to better understand, quantify and manage the carbon and climate change related impacts, risks and opportunities in our investments, it is integral to measure our carbon footprint."

A related concept to portfolio carbon footprinting is the "carbon intensity of sales" of a single investee company or a portfolio carbon intensity weighted by portfolio positions.[vii] Whereas portfolio footprinting calculates an investor's *contribution* to investee emissions, as allocated through ownership fraction, carbon intensity is often seen as a more direct measure of the exposure of a single company to climate policy risk.[viii] Indeed, in a system of perfect regulatory coverage (i.e. all global GHG emissions were priced) and under certain assumptions of cost pass-through ability,[ix] carbon sales intensity directly measures the revenue impact of an increase in carbon price.

Thus, both portfolio carbon footprint and portfolio carbon intensity have been touted as proxies for investor exposure to carbon risk at portfolio level, implying that these measures at company level are also proxies for investee carbon risk.[x] At the same time, it is clear that these metrics are not the only relevant measures driving a company's carbon risk exposure. For instance, in their recent Carbon Asset Risk report, WRI and UNEP-FI list the following considerations of a carbon-intensive company as relevant to the risk profile: profile of its assets (for example, type, fuel mix, location, operational lifetime, GHG emissions, etc.), earnings margin, whether it faces low-carbon competitors, operational risk management, and capital expenditure plans, among others.[xi]

With all of these potential factors affecting companies' risk profiles, a critical question is the extent to which single metrics such as carbon intensity can predict a company's risk exposure. Further, investors are not only interested in unidirectional risk; it is also relevant to ask whether a lower carbon intensity suggests an investment opportunity due to high quality carbon risk management. Through an analysis of a set of published reports on carbon risk covering over a decade, this report examines whether and how much carbon sales intensity is correlated to analyst assessments of carbon risk and opportunity.

1.2 Methodology

The authors identified more than 240 reports on carbon risk published by brokerage houses, think-tanks, and other research firms (see Annex).[xii] However, as the analysis focuses on carbon risk

assessments specifically for corporates and required a cross-sectional ranking of companies, only a small fraction (38) of all the reports were kept for the purpose of the study (see Appendix). While the exhaustiveness of the literature review cannot be guaranteed, our analysis suggests the selected reports are likely representative of practitioners' work over the last 10 years.

The study asks a simple question—what is the relationship between a company's carbon intensity and expert analyst rankings of its carbon risk or opportunity? Two different methods are used to examine this relationship, since they involve different types of variables (carbon risk ratings being ordinal ranks whereas carbon opportunities are usually presented as nominal lists of "opportunities"). For carbon risk we examine the **rank correlation** between analyst risk ratings and carbon intensity and for carbon opportunities we examine the **proportion of above average carbon intensity performers identified as "opportunities"**.

The **rank correlation** tests the relationship between ordinal rankings, and is commonly used to test for relationships between data measured in different units. In this study, companies' ordinal carbon risk rankings were standardized to an order (rank 1 signifying the highest risk), and then coupled with data on annual carbon intensity at company level. As an example, data from one study is shown below. The first column shows the assessed carbon risk, followed by the companies' carbon intensities in the same year, the ranked carbon intensities, and finally the correlation coefficient (in this case negative, meaning a better (lower) carbon intensity is correlated to a worse (higher) risk ranking on average.

Table 1: Sample calculation of rank correlation for one study used in report

	Analyst Risk Ranking (1 = highest)	Carbon Intensity (tons CO2e/milUSD)	Carbon Intensity Rank (1 = lowest)	Rank Correlation
Company1	7	63	2	
Company2	6	73	5	
Company3	5	73	4	
Company4	4	41	1	- 0.32
Company5	3	109	6	
Company6	2	134	7	
Company7	1	72	3	

For both statistics, the study tests the relationship in the year the study was performed (year N) as well as forward into the future to test whether the relationship strengthens through time. For instance, a study conducted in 2011 using 2010 data would have N = 2010, and a correlation coefficient would be calculated for 2010 (N), 2011 (N+1), 2012 (N+2), 2013 (N+3), and 2014 (N+4). Following common practice in both the reviewed reports and in current ESG practices,[xiii] carbon intensity is defined as Scope 1 and 2 emissions per USD sales. The implications for this definition are discussed below. The full method is available in the Annex.

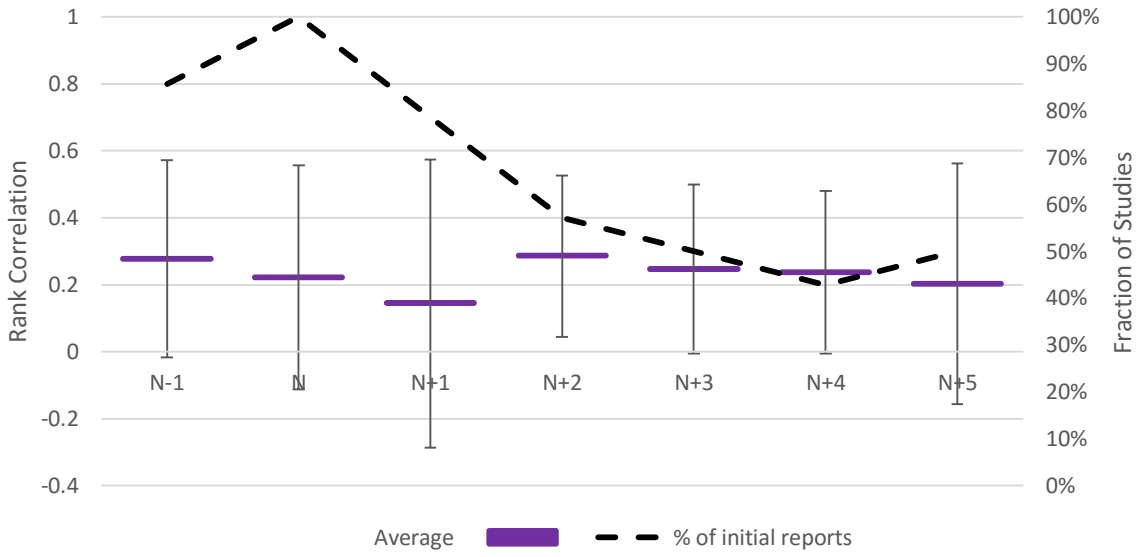
1.3 Result: A modest correlation between carbon footprint and carbon risk

On a concentrated panel of 20 selected reports on carbon risk published between 2003 and 2015**, the degree of correlation of company rankings between the carbon risk and carbon sales intensity is modest at best, with an average across studies of around 0.2** in the year of publication (year N).

Importantly, even this small correlation is uncertain—as some studies actually show a negative correlation, meaning higher carbon intensity firms are on average rated as lower carbon risk by the report's authors.

One could expect this correlation to improve with time, as analyst rankings are intended to be forward-looking. However, as Chart 1 shows, the correlation between carbon intensity and carbon risk hardly varies for five years after the publication of the study (+/- 11% of standard deviation over time).

Chart 1: correlation[xiv] between carbon sales intensity and carbon risk assessment: a dynamic view



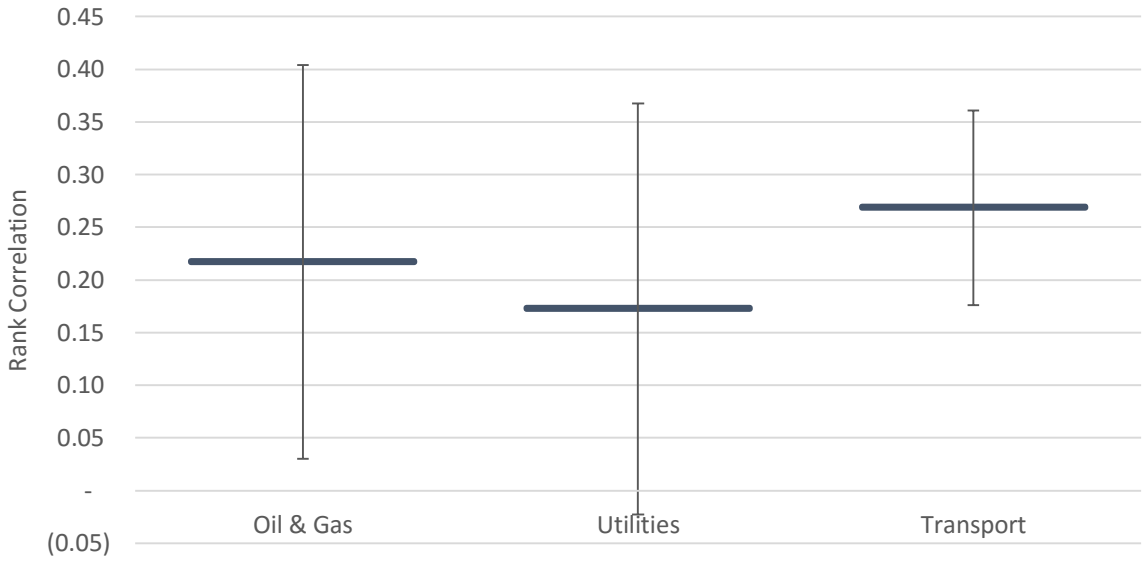
Source: Grizzly RI. *NB. The vertical bar describes the average rank correlation across studies in the relative year conducted (N) with error bars representing (+/- standard deviation) above or below. The dotted line (right axis) represents the percentage of reports available for a given year (a report is published on year N. A report is available on year N+X if it has been published on year 2015-X). Fewer reports are available for later years as some reports were conducted recently and could only be projected 0-3 years into the future (i.e. a study from 2013 can only be tested 1 year into the future, N+1 = 2014)*

1.4 The level of correlation is stable across sectors

Another important question is whether the carbon risk/carbon intensity relationship varies across sectors. In theory, the overall chart above could be biased by one or more sectors where the relationship does not hold while a stronger relationship emerges within others. However, based on the reports in the panel and focusing on the most studied three sectors, namely Oil & Gas, Utilities and Transport (mainly air and road), it is clear that the general trend is consistent (see chart 2).

Somewhat surprisingly, the level of correlation is similar for the Oil & Gas sector (where most ESG analysts utilize assets and reserves as the main quantitative metric, see Annex) as for utilities and transport, where direct emissions are more prominent. Despite the rationale of "stranded assets" being based on a very different premise than carbon intensity, the observed small positive correlation persists.

Chart 2: Correlation between carbon sales intensity and carbon risk assessment: a sector view



Source: Grizzly RI

1.5 Interpretation: the role of other factors in assessing carbon risk

The limited level of correlation between carbon risk and carbon footprint can be explained by the important role of other risk factors. As highlighted above, a company's GHG emissions is only one important consideration in its carbon risk:

- **Geography** (and whether the company currently operates under a carbon price or is soon expected to)
- **Proportion of priced GHG emissions covered by free allowances,** if any
- **Energy prices** and **proportion of energy from purchased electricity** (indirect effect of carbon cost in energy and electricity suppliers)
- **Pricing power of firms**: ability to pass on any additional costs to suppliers (upstream) or to the customer (downstream), related to the price elasticity
- **Operating margin level** (Margin EBIT / EBITDA / NOPAT)
- **Change in Capex and/or Depreciation & Amortization** and to renew equipment and production facilities
- **R & D expenditures** to cope with the new regulatory constraints or market developments
- **Competitive landscape and new entrants**
- The risk premium linked to the **quality and vision of the management.**

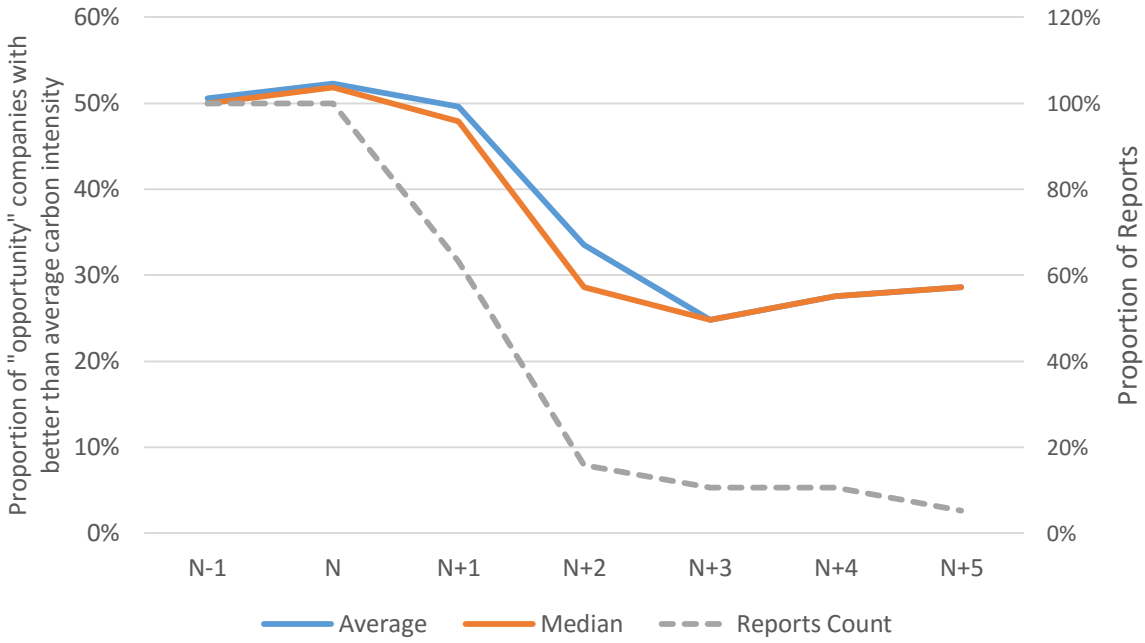
None of the reviewed reports examined all the potential factors listed above. However, the level of operating profit as well as pricing power (ability to pass on costs) were most widely quoted as important risk factors (or mitigating factors for risk), variables with little to no expected correlation with carbon intensity (see short summary in Annex). Assuming that all of these factors impact the risk profile of a company to varying degrees, yearly emissions, and hence carbon intensity, can only play a limited role in overall risk. Further research is required to determine, sector by sector, the relative weight of each risk factor.

2. Can carbon sales intensity help identifying opportunities?

A negative risk, or to be more precise a negative impact on risk and hence a lower risk, is a financial opportunity. The analysis further considers 18 additional studies that identified companies positively impacted by carbon risk (opportunities).

Again, data suggest that the carbon sales intensity (scope 1 + 2) does not help in detecting companies identified as carbon opportunities (Chart 2). As shown in Chart 2, only half of the companies presented as "carbon opportunities" have a better carbon sales intensity (scope 1+2) than their sector average. In short, the relationship between identified "carbon opportunities" and carbon intensity is no better than a coin flip—half the "opportunity" companies are better than sector average, half are worse.

Chart 2: Proportion of firms cited as "carbon opportunities" and carbon sales intensity (scope 1+2) vs. industry average



Source: Grizzly RI

3. What about Scope 3?

At least in the case of carbon opportunities, and in the case of fossil fuel sector carbon risk, part of the lack of relationship between carbon intensity and assessed risk can be interpreted as a discrepancy between companies' internal operations (i.e. Scope 1 and 2 emissions) and emissions associated with their products (i.e. downstream Scope 3 emissions). In the case of risk, this is why many ESG providers offer assessments of either total reserves or the GHG associated with such reserves. Similarly, for carbon opportunities analysts often examine companies' current and future product offerings rather than their internal operations.

This study did not directly assess the potential correlation between company Scope 3 emissions intensities and assessed carbon risk for several reasons. First and foremost this is because assessing the correlation of risk with Scope 1-2 carbon intensities is an important question in its own right given the prevalence of Scope 1-2 only carbon metrics on the market[xv]. Second, while reporting of Scope 3

emissions is improving, generally current reporting of product-related Scope 3 emissions is both too incomplete and too variable in method for meaningful comparison[xvi]. Finally, the relatively small amount of work that has been done to assess this interplay has shown a similarly small correlation between downstream emissions intensities or similar quantities with risk-relevant measures. For instance, past work [xvii]has shown that:

- Car manufacturers fleet's emissions efficiency has little relationship with the potential impact of potential carbon-related constraints on profit margins, because manufacturers of small (fuel-efficient) cars tend to have a limited cost past through capacity, while sport/luxury cars manufacturers tend to have a high cost-pass through capacity.
- The 'carbon content of oil reserves intensity' (carbon emissions related to reserves, vs. turnover or market capitalization) is poorly correlated with the exposure of companies to high cost projects.

Future work should assess these sector-specific relationships in greater detail, but preliminary results suggest that the inclusion of scope 3 emissions would not fundamentally change the equation.

4. Conclusion

Our analysis of available reports published by practitioners over the last 12 years underlines that there is a low degree of correlation between carbon risk assessments and carbon sales intensity (~0.2), despite the fact that carbon intensity is often described as a main causal factor in driving carbon risk. Carbon intensity further seems to have almost no relationship with companies identified as 'carbon opportunities', with only half such opportunity companies having better than average intensities.

In reality, this is not a surprising result. Given the large number of risk factors pertinent to carbon risk, any one factor will always be a simplification of a complex situation at best. Instead of relying on any single factor like carbon intensity or footprint, it is instead critical to consider many different risk factors in order to draw a full picture of a company's carbon risk. Even though the number of comprehensive sector reports on carbon risks is still low, investors should resist the urge to oversimplify and reduce carbon risk to a simple linear function of emissions.

Further research to extend this analysis could also benefit from a quantitative multi-factor study assessing the carbon-related financial performance and financial risk of portfolios of stocks over a long period and a broad geographical area. More refined models could also incorporate learning effects as the awareness of carbon risks raises. In the meantime, investors should continue to test such approaches, which are being developed by investor consultants, credit rating agencies, and equity researchers[xviii]. Such continued research and testing is needed to elucidate the most critical carbon risk factors for different industries.

ANNEX: SOURCES & METHODOLOGY

Sources

The full list of reports used for the study is accessible upon request. The two main sources for these reports were:

- **London Accord – Long Finance:**

http://www.longfinance.net/programmes/london-accord.html

The London Accord provides free access to investment research on environmental, social & governance (ESG) issues provided by contributors from the financial sector, academia, and NGOs.

Recognizing that today's extra financial issues are tomorrow's key investment drivers, the London Accord acts as a nexus between the financial services industry and society to encourage long-term thinking about ESG issues, finance, and policies.

By offering tangible examples through which finance connects with long-term sustainability, the London Accord contributes to achieving the overarching goals of Long Finance: to expand frontiers, change systems, deliver services and build communities.

- **UNEP FI Materiality Working Group:**

http://www.unepfi.org/materiality/

The Materiality Series

An increasing number of institutional investors are becoming interested in approaches to asset management that explicitly include environmental, social and corporate governance (ESG) criteria or metrics where they are or may become relevant to investment performance.

While there are increasing pressures for investment managers to address these issues, however, they generally receive little consideration from brokerage house analysts and policy-makers.

The UNEP FI Materiality Series is an effort to close this gap by delivering and analysing financial research on how ESG issues impact company share prices.

Methodology

Choosing the Panel of reports

This report focuses on studies published for the financial community, including those published by brokerage houses, think-tanks, and other research firms. The reports were compiled using desk research, direct contact to brokerage houses, and existing databases from the UNEP-Fi (working group materiality 1, 2 and 3) and London Accord Long Finance. The focus was on locating sectorial studies on carbon risk in the medium and / or long term that provided an analyst ranking of individual companies by carbon risk exposure.

The initial study sample covered 246 reports, but not all were suitable for the purpose of the study. Several types of studies were excluded for a variety of reasons, including:

- Reports on single stocks: no ranking available
- Studies focused on immediate carbon price risk in regulated market like EU ETS: no assessment of medium/long-term risk
- Reports classifying the companies directly on the basis of their carbon intensity: not suitable for testing the intensity-risk relationship since they implicitly assume it
- Reports primarily on valuation of companies, but with no indication - either qualitative or quantitative - of carbon risk.

Due to these exclusions, the initial list of 246 studies was narrowed down to 26 reports covering 38 distinct sectors suitable for testing the relationship between carbon risk or opportunity and carbon intensity. For the purpose of this report, carbon opportunity is defined as opportunities for additional sales and profits by companies updating their product offer through innovation or higher performing products and services. Thus, crucially, such opportunities are generally connected to improvements of Scope 3 "product use" (e.g. energy efficiency of sold products, etc.) rather than internal carbon intensity (Scope 1 and 2).

These 26 reports derived into 38 sector studies were divided into in 20 studies focusing on risk and 18 focusing on opportunities. Altogether, they cover 653 companies, without removing double-counting (some companies appear in several studies).

Table 2: Published reports used in the study

Author	Report	Year	Opportunities - # companies	Risks - # Companies
Bank Sarasin	Energy efficiency – hidden capital: How investors can benefit from the “cheapest source of energy”	2008	13	0
BofAML	Aviation In EU ETS:An Incentive For Efficiency	2008	0	6
	Cracking Down on Fracking: Shale Gas & HSE Risks	2011	20	0
	Global Drought - Opportunities and Risks	2012	39	0
	Less Is More - Global Energy Efficiency	2012	99	0
	Less is more – global energy efficiency primer picks	2013	128	0
Cheuvreux	Climate Change: The ETS Spring	2012	0	15
	Energy Transition	2012	11	0
	Utilities vs. Carbon: Act III	2011	0	9
KeplerCheuvreux	Climate Change Adaptation: Underwriting Risks for (Re)Insurers	2013	0	3
	Climate Change: demystifiyng climate effects	2013	0	23
CM-CIC Securities	On the road again	2005	0	13
Credit Suisse	The Inconvenient Math - Implications of Costed Carbon	2007	0	12
CTI	Carbon supply cost curves: Evaluating financial risk to oil capital expenditures	2014	0	20
	Oil & Gas Factsheet	2014	0	34
Daïwa	Asia Energy Sector	2009	59	0
Dresdner KW	Transport: Aviation emissions: Another cost to bear	2003	0	6
	Utilities: Emission trading - Carbon Derby Part II: And they’re off	2003	0	10
HSBC	Coal and carbon	2012	0	4
	Oil & carbon revisited. Value at risk from lunburnable(reserves)	2013	0	7
Oddo Securities	Transition énergétique en Europe : un choix déjà gagnant	2013	34	0
Société Générale	Auto & Pollution. Size still matters: bigger is better	2007	0	7
	Cream-ing carbon risk	2007	0	32
Trucost-Sinco	Dirty Feet: Portfolio Carbon	2012	10	0
UBS	European Emissions Trading Scheme - Bonanza or Bust?	2003	0	9
		total	413	210

Source: Grizzly RI

Figure 1: example of a carbon risk assessment (Société Générale, 16 April 2007)

Mass carmakers: estimated impact of additional CO2 costs on 2012e profits

	PSA SG Est.	Renault SG Est.	Fiat SG Est.	Volkswagen SG Est.
Turnover (Auto) (€m)	55,700	51,574	35,000	107,200
Op. Profit (Auto) (€m)	2,785	2,785	1,715	5,360
Op Margin (Auto) (%)	5.0%	5.4%	4.9%	5.0%
WORLD sales ('000s)	4,285	3,750	3,000	6,480
Op Margin in 2006	*0.6%*	*1.4%*	*1.2%*	*3.7%*
Peak Op Margin	*5.0% (in 2002)*	*5.9% (in 1999)*	*2.9% (in 1997)*	*5.9% (in 2001)*
W. European sales as % of TOTAL in 2006	*68%*	*70%*	*65%*	*59%*
Op Profit per unit (in €)	650	743	572	827
Estimated cost per unit in EUROPE (in €)	816	818	823	830
Estimated profit per unit in EUROPE (€)	-166	-75	-251	-3
World Op. Profit AUTO (€m)	2,785	2,785	1,715	5,360
Estimated CO2 cost in Europe (€m)	2,386	2,132	1,603	3,158
CO2 cost as % of WORLD Op. Profit AUTO	86%	77%	94%	59%
CONSOLIDATED Op. Profit	4,500	3,400	5,400	6,500
Auto as % of Consolidated	62%	82%	32%	83%
Net Earnings	3,100	4,600	3,800	4,000
Auto as % of NET earnings	89%	61%	45%	135%
Est. CO2 cost as % of CONSO Op. Profit	53%	63%	30%	49%
Est. NET CO2 cost as % of CONSO NET Profit	49%	30%	27%	51%

Source: SG Equity Research

Source: Société Générale, report “Auto & Pollution. Size still matters: bigger is better”, April 16, 2007

Metrics used for analyst carbon risk assessment

The panel of studies was analysed to determine which financial metrics were chosen by the various authors to come to their assessment of carbon risk. Five broad categories emerged and are presented in Table 2 below. The table suggests the most commonly used quantitative metric is EBIT/EBITDA and that qualitative metrics are nearly as prevalent. Sales/revenues are significantly less utilized, on par with capex and assets (primarily used in studies of fossil fuel sectors) and share price.

Table 3: Relevant financial metrics displayed to assess carbon risk (when used; % of reports)

Percentage by scope	Scope1	Scope2	Scope3	Scope 3 - Reserves	Total
Production/Revenues	11%	0%	14%	14%	11%
Capex/Reserves/Assets	0%	0%	0%	43%	11%
EBIT/EBITDA/Profit	33%	50%	43%	29%	37%
Market Price	22%	0%	0%	14%	11%
Others (qualitative)	33%	50%	43%	0%	30%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Grizzly RI

A number of studies - including some of the oldest - perhaps hampered by the lack of information and clarity on carbon costs and regulations, do not hesitate to stay qualitative and long-termist with no specific timeframe in their recommendations on level of carbon risk. 30% of the studies, although based on alleged financial impacts, were concluded by a qualitative assessment alone.

It is also revealing to note that the preferred metric type is specific to each sector. As above, here the Oil & Gas sector deviates from others, with a strong focus on capex/reserves/assets as a major determinant of the recommendations (see table 3). Other sectors again tend to focus on EBIT/EBITDA and qualitative considerations, albeit varying in their emphasis.

Table 4: Relevant financial metrics displayed per sector to assess carbon risk

Percentage by studied sector	Oil & Gas	Utilities	Transport / Aviation	Transport / Auto	Mining / Basic resources	Multi-sectors & Others	Total
Production/Revenues	17%	0%	50%	0%	33%	0%	14%
Capex/Reserves/Assets	50%	0%	0%	0%	0%	0%	14%
EBIT/EBITDA/Profit	17%	20%	50%	50%	67%	25%	32%
Market Price	17%	40%	0%	0%	0%	0%	14%
Others (qualitative)	0%	40%	0%	50%	0%	75%	27%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Grizzly RI

Correlation method applied to studies focusing on risk:

For each remaining study on carbon risk, companies' ordinal rankings were standardized to an order (rank 1 signifying the highest risk). These ordinal rankings were then coupled with data on annual carbon intensity at company level. Following common practice in both reports and in current ESG practices[xix], carbon intensity is defined as Scope 1 and 2 emissions per $ sales, using data reported by the companies, and in default on the basis of estimates by Grizzly RI®.

Such carbon intensities are generally available over many years (limited mainly be corporate reporting), whereas the analyst ranking of carbon risk is relevant only in the year when the ranking was performed (which because of reporting lag generally is based on emissions and financial data from previous years). It is possible, however, that analysts are able to rank companies with future performance in mind (making the ordinal ranking of carbon risk a leading indicator of carbon intensity performance). Thus, the correlation between analyst carbon risk ranking and carbon intensity was tested in the year of analysis, the year prior, and for future years through to the most recent value. In other words, if the risk assessment is made in year N = 2010, the correlation was tested in years N-1= 2009 to N+4=2014. By doing so, it is possible to check over time whether the degree of correlation is improving year after year or not (predictive ability of assessments).

In summary, the test employed here involves an examination of the correlation between analyst-derived ordinal rankings of carbon risk (generally within a certain sector that is the focus of the study) and the ranked companies' carbon intensities in the year of ranking and following years. Because one of the variables being tested is ordinal, the statistic used is the Spearman rank correlation coefficient, which tests the correlation between data ranks rather than the data itself (Pearson correlation coefficient). The Spearman ρ has the added benefit that it tests for any monotonic relationship between variables rather than assuming a linear relationship between them; in this case we attempt to test for any positive or negative relationship between carbon risk and carbon intensity.

Opportunity-related reports: Proportion of enterprises above or below the sector averages

A different type of analysis was necessary for testing the relationship between carbon intensity and 'carbon opportunity' companies. In general, companies considered as opportunities offer emission reductions to their purchasers through the products they sell (hence the relevant set of emissions are the company's Scope 3 emissions related to product use). In theory having more energy-efficient or 'greener' products makes their products and services more attractive for some customers or for a lower-carbon future.

However, most studies identifying opportunity companies generally highlight the companies corresponding to 'green' product lines without explicitly:

- calculating or providing the expected "avoided emissions"
- giving explanations for their rankings
- providing a comparative benchmark for non-opportunity companies
- providing the expected variability between companies selected by the study itself

Under these conditions, it was not possible to use a correlation coefficient, since one of the variables of interest is nominal (i.e. either an 'opportunity' or not). Instead, the statistic chosen is the proportion of "opportunity firms" that outperform the industry average carbon intensity (scope 1 + 2, ICB rev 4 subsector).

Notes

[i] Also known as "carbon asset risk" or alternatively "climate risk", though "climate risk" generally connotes both financial risk associated with the low-carbon transition as well as physical climate risks. Also related is the concept of "stranded assets" and "transition risk" as described by Bank of England/Mark Carney.
[ii] For a full study on carbon risk, see our other publications: The 2° Investing Initiative, UNEP Inquiry, CDC Climat Recherche (2015). "*Financial Risk and the Transition to a Low Carbon Economy*" and WRI/UNEP-FI (2015). "*Carbon Asset Risk: Discussion Framework*" and Prudential Regulatory Authority (2015) The impact of climate change on the UK insurance sector.
[iii] Ibid.
[iv] Such as from the Global Reporting Initiative (GRI), CDP, and mandatory programs like the European Union Nonfinancial Reporting Directive
[v] See the Investor Platform for Climate Actions, the PRI Montreal Pledge, and the UNEP FI/CDP Portfolio Decarbonization Coalition.
[vi] The term portfolio carbon footprint is not standardized and therefore has no single standard meaning. Generally major stakeholders such as PRI have used it as an equivalent to "financed emissions", which have been calculated by various researchers and NGOs for over 10 years. PRI describes a portfolio carbon footprint as "A portfolio's carbon footprint is the sum of a proportional amount of each portfolio company's emissions (proportional to the amount of stock held in the portfolio)."
[vii] Sometimes this weighted portfolio intensity is called "portfolio carbon footprint" such as in UNEP FI (2013).
[viii] Some groups distinguish between portfolio carbon intensity as an indicator of risk exposure vs. carbon footprint as an indicator of responsibility (see MSCI 2015).
[ix] Such an assumption could be zero cost pass through for the company's direct emissions (Scope 1) and full cost pass through for the electric utility it buys energy from (i.e. its Scope 2 emissions).
[x] Supra notes 5-7
[xi] See WRI, UNEP-FI (2015). "*Carbon Asset Risk: Discussion Framework*".
[xii] See the methodology in annex for more details on the sample and the number of reports available.
[xiii] See 2dii/WRI/UNEPFI (2015) *Climate Strategies and Metrics: Exploring Options for Institutional Investors*. While including Scope 3 emissions is becoming more common with some data providers, it is not yet standard practice and practices among those who do include them vary considerably.
[xiv] A correlation on ranks was used (also known as a Spearman correlation). See the methodological appendix for more details.
[xv] See 2dii/WRI/UNEPFI (2015) *Climate Strategies and Metrics: Exploring Options for Institutional Investors*. Half of the reviewed data providers either do not include downstream Scope 3 emissions or only include them when reported by companies.
[xvi] An informal review of reporting completeness and reporting practices by 2dii shows high levels of incomplete reporting for product emissions as well as highly variable or unclear methods to calculate such emissions.
[xvii] Supra note 16.
[xviii] See reviewed methods in WRI, UNEP-FI (2015). "*Carbon Asset Risk: Discussion Framework*" and 2° Investing Initiative, UNEP Inquiry, CDC Climat Recherche (2015). "*Financial Risk and the Transition to a Low Carbon Economy*".
[xix] See 2dii/WRI/UNEPFI (2015) *Climate Strategies and Metrics: Exploring Options for Institutional Investors*. While including Scope 3 emissions is becoming more common with some data providers, it is not yet standard practice and practices among those who do include them vary considerably.

About the 2° Investing Initiative
The 2° Investing Initiative [2°ii] is a multi-stakeholder think tank working to align the financial sector with 2°C climate goals. Our research and advocacy work seeks to:

- Align investment processes of financial institutions with 2°C climate scenarios;
- Develop the metrics and tools to measure the climate performance of financial institutions;
- Mobilize regulatory and policy incentives to shift capital to financing the transition to a low-carbon economy.

The association, founded in 2012, is based in Paris and New York, with projects in the US, Europe, and China. Our work is global, both in terms of geography and engaging key actors. We bring together financial institutions, companies, policy makers, research institutes, experts, and NGOs. Representatives from all of the key stakeholder groups are also sponsors of our research.

About Grizzly Responsible Investment (www.grizzly-ri.com)
Grizzly Responsible Investment is a research & services company in sustainable development, corporate social responsibility and responsible investment. The core of its activity is Quantitative Research.

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