CARBON DISCLOSURE AND CLIMATE RISK IN SOVEREIGN BONDS

DECEMBER 2016

Finance for Change
A Project of Global Footprint Network

In collaboration with:

south pole group

ACKNOWLEDGEMENTS

AUTHORS

Susan Burns, Jag Alexeyev, Ronna Kelly, David Lin
Global Footprint Network

WORKING GROUP MEMBERS

Larina Baird, Harald Walkate, Adrienne Hill-Strathy
Aegon Asset Management

Caroline Wu
Alliance Bernstein

Ashley Schulten, Silvio Zanardini
BlackRock

Daniel Ingram
BT Pension Scheme

Ophélie Mortier
DEGROOF Petercam

Willemijn Verdegaal, Frans Nijssen, Will-Jan Jacobs
MN

Eve Morelli
Swisscanto Invest

Imafidon Edomwonyi
Nippon Life Global Investors

Balazs Magyar
Vontobel

REVIEWERS

Darius Nassiry
ClimateBonds Initiative

Pablo Berrutti
Colonial First State

Archie Beeching
PRI

CONTENTS

CITATION

Burns, S., Alexeyev, J., Kelly, R., Lin, D., (2016) Carbon Disclosure and Climate Risk in Sovereign Bonds. Global Footprint Network, Oakland, CA.

EXECUTIVE SUMMARY

Sovereign bonds are one of the largest of all asset classes, yet few investors consider their climate risks.
A growing number of investors are disclosing carbon and climate risks in their portfolios. However, until now carbon disclosure has focused mostly on listed equities and to a lesser extent corporate bonds. Yet sovereign bonds represent one of the largest asset classes and a significant percentage of diversified investment portfolios, especially among institutional investors.

The lack of clarity on methodological approaches has been a major obstacle for assessing climate risk in sovereign bonds.
To address this gap, Global Footprint Network and South Pole Group convened a group of nine asset owners and managers to examine the methodological issues involved and develop a set of recommendations, which are provided in this paper.

Our analysis suggests that a carbon intensity approach is the most useful method for addressing carbon disclosure in this asset class.
Methodologies for carbon disclosure in equities, ranging from ownership-based carbon footprints to carbon intensity metrics, may be adapted to sovereign bonds. However, a number of potential distortions make certain methodologies, particularly those that rely on debt outstanding, less suitable for sovereigns. Some of the benefits of the intensity approach are that it is scalable, comparable, and provides insight into investment risk exposure.

The carbon intensity approach has commonly been applied to other asset classes, including corporate bonds and equities, and can be used to report on the carbon intensity of a mixed asset class portfolio. With mixed portfolios, however, intensity analysis should also be calculated on each asset class separately, since different dynamics are associated with each.

Carbon intensity of production, consumption, and trade all represent useful dimensions of carbon risk at the country level.
Each approach provides unique insights, and investors might miss important information using a production approach alone. Several additional dimensions can also be measured, including accounting for carbon absorption, land use emissions, and historical emissions, as well as narrowing the scope to just government emissions.

The benefit of carbon disclosure is limited without also addressing investment risk and taking advantage of the investment opportunities that result from a low-carbon transition.
Carbon intensity measurements provide the foundation for disclosure, reporting, and benchmarking carbon performance against other portfolios, but are only a first step.

A carbon intensity approach can provide a starting point for comparing the exposure of countries to energy transition and stranded asset risks, but further research is needed.
Transition risk analysis should include both an assessment of the country's economic dependence on fossil fuel reserves as well as the carbon dependence of the economy as a whole. Country carbon intensity trends can be analyzed against climate goal benchmarks. Measuring the economic dependence of countries on carbon-intensive sectors may further enhance transition risk assessment. Further research is needed to map more explicitly the transmission mechanisms between a country's carbon dependence and its economic performance and credit worthiness.

Beyond carbon intensity, a comprehensive climate risk approach should contain two additional dimensions: 1) physical climate change and 2) a country's policy response.
A "dashboard of indicators" may ultimately prove to be the most valuable approach for investors to take with climate and carbon risk assessment. A brief summary of leading research on the physical risks of climate change and approaches to assessing a nation's policy response are provided in this report; results from this research can be added to a comprehensive dashboard.

It is important that portfolio managers, rather than ESG teams alone, take the lead on incorporating carbon risks into their models, since these risks are material to a country's economic performance and there is considerable uncertainty surrounding them.
Carbon footprint and intensity analysis provides the basis for portfolio decarbonization, tilt and low-carbon strategies, incorporation of green investments such as green bonds, carbon offsetting measures, and enhanced ESG (environmental, social and governance) integration strategies. It is also important to recognize that low-carbon investment strategies may not be sufficient to address all risks in the face of uncertainty about the timing and extent of physical climate change, the low-carbon transition, technology changes, and a country's policy response.

Green bonds and even sovereign green bonds are emerging strategies for taking advantage of the low-carbon transition, but the market is still in its infancy.
The impact of carbon disclosure is limited without taking advantage of the investment opportunities that result from a low-carbon transition. This paper therefore also presents an overview of green bond investing and specifically the emergence of sovereign green bonds.

1. INTRODUCTION

Rising concerns about the impact of climate change on the global economy and financial markets have led to an increase in interest among asset owners and investment managers to more rigorously measure, analyze, and disclose carbon and climate risks. Efforts such as the Montréal Pledge[1] have prompted more than 120 institutional investors with $10 trillion in assets to commit to measuring and disclosing the carbon footprint of their investment activity.

However, until now, carbon disclosure has focused almost entirely on listed equities. Yet the sovereign bond market is one of the largest asset classes, representing a remarkable $21 trillion[2] in outstanding debt by national governments. Further, sovereign bonds typically represent a significant percentage of any given investment portfolio, especially among institutional investors. However, little or no consideration has been given to the climate impact of these investments or the carbon and climate risks to investors.

How do carbon and climate risks materialize in sovereign bond investments and how can they be measured and addressed? Many investors cite a need for greater clarity on methodologies for assessing carbon and climate risks in sovereign bonds as a crucial step toward disclosing and managing those risks.

Another development contributing to this growing need is Article 173 of the French Law on Energy Transition, which took effect on January 1, 2016. The law requires French institutional investors to disclose carbon emissions as well as their contribution to the "ecological transition."[3] The law provides flexibility with regard to the asset classes to be included and the methods for disclosure, but it does require that the reporting entity justify the approach it has taken. Therefore, if an investor does not report on its sovereign bond investments, it must explain why.

The law has created a ripple effect globally since asset managers with clients in France are seeking to develop their own approaches to serve those clients.

In response to this shifting landscape, Global Footprint Network and South Pole Group convened a group of nine asset owners and managers to examine the methodological issues involved and develop a set of recommendations, which are now laid out in this paper. The participating companies are Aegon Asset Management, Alliance Bernstein, BlackRock, BT Pension Scheme, DEGROOF Petercam, MN, Swisscanto Invest, Nippon Life Global Investors, and Vontobel.

Incorporating insights from these organizations, this paper reviews a variety of approaches for assessing the carbon exposure in sovereign bond investments, recommends a general approach and several alternatives, and provides case examples. Going beyond simple sovereign bond portfolios, it also recommends an approach for carbon disclosure of mixed asset class portfolios as well as an approach to company-wide reporting in multiple asset classes.

Carbon disclosure should be thought of as only a first step. Many investors disclose the carbon emissions associated with their investments as a matter of transparency, wanting to respond to stakeholder expectations. But the ultimate impact of carbon disclosure is limited, of course, without addressing investment risk and taking advantage of the investment opportunities that result from a low-carbon transition. This paper therefore also presents recommended approaches to enhancing our understanding of carbon risk in sovereign bond investments, as well as ways that fixed-income investors can play a proactive role in financing the transition to a low-carbon economy.

Worth the Effort

"While assessing the climate and carbon risks of sovereign bonds is not always easy, it is an effort worth making. Sovereign bonds are a large asset class and unaddressed issues at the country level could pose investment risk. Risk assessment also has the potential to create leverage for improvement in countries because debt issuance is an important financing source for national policies. Being deprived of it may have major consequences for a country's functioning."

– Ophélie Mortier, DEGROOF Petercam

[1]Supported by the United Nations Principles for Responsible Investment (PRI) and United Nations Environment Programme Finance Initiative (UNEP FI). The Montréal Pledge coincides with other initiatives such as the Portfolio Decarbonization Coalition, which goes beyond measuring and disclosing to reducing portfolio carbon footprints.
[2]Bank For International Settlements Debt Securities Statistics Database, http://www.bis.org/statistics/secstats.htm
[3]Principles for Responsible Investment. 2016. French Energy Transition Law – Global Investor Briefing. London, UK. https://www.unpri.org/download_report/14573

Risk, Responsibility, and Opportunity: How to Address This Asset Class

An investor's approach to this topic will reflect their individual views on investing in general. Many investors will want to take a risk-based approach, reducing exposure to countries at risk of incurring economic losses due to physical climate change, stranded assets, or costs in the event that carbon is priced. While the links between carbon intensity and credit worthiness are still being analyzed by researchers, some investors still perceive an economic risk to carbon-intense economies and consequently higher risk of default or repricing of outstanding debt.

To improve our assessment of investment risk, there is a need for further research based on plausible scenarios. However, because there is significant uncertainty as to the timing of physical climate change, countries' policy responses, and the pace of technological breakthroughs in energy systems, utilizing risk exposure metrics is a prudent approach until more robust methods are developed. Because carbon and climate risks are largely unpriced by the sovereign bond market, investors that incorporate them will be better positioned in the increasingly likely event that carbon pricing and other regulatory, technological, and consumer demand transitions take effect.

Investors may also wish to incorporate a responsibility approach, reducing exposure to countries that drive carbon emissions through their national policy decisions and economic activities, whether it is the consumption of their citizens or the structure of their economies. Investment decisions that consider climate impacts can also send a signal to issuers. Investors that choose lower carbon exposure in their sovereign bond portfolios are communicating a dual message: They prefer to see national governments taking action on reducing emissions and they want to avoid investing in countries that are contributing the most to climate change.

In the end, a dashboard of indicators will be the most prudent to ensure coverage of this complex topic.

Three key dimensions include:

1) carbon exposure (i.e., transition risk),
2) a country's policy response, which will have a significant impact on its risk exposure, and
3) potential economic losses due to the impact of physical climate change, which have also been estimated by research organizations and credit rating agencies.

In addition to risk and responsibility, investors can also take advantage of opportunities to benefit from the transition to a lower carbon economy, while shaping outcomes, such as investing in green bonds.

How to Use This Report

For investors who want to extend their existing carbon disclosure activity to sovereign bonds, this report provides a recommended approach. But more broadly, for those investors who want to go beyond disclosure to consider carbon risk exposure in sovereign bond investments, we hope this report can serve to map the landscape. For more advanced analysts, we provide additional insights, data sources, and frameworks for tackling further research.

[4] See Section 7 for a fuller discussion.

2. A RECOMMENDED APPROACH

Most investors contemplating disclosure for sovereign bond investments have already reported the carbon footprints of their equity portfolios and are looking to extend their analysis to other asset classes. Because existing disclosure practices for equities are most familiar to investors, we begin our discussion on recommended methods from this starting point. From there, we can examine the suitability of these methods for sovereign bond investing, understanding that equity investments differ from bond investments in some important ways. As this section will illustrate, we believe a carbon intensity approach is the most useful approach for carbon disclosure in this asset class and we build the rest of our recommendations on this foundation.

Introduction to Carbon Footprint Methodologies

Traditionally, investors have sought to understand both the amount of carbon associated with the money they have invested as well as the carbon intensity of the underlying companies they have invested in. Considering this framework, the three most common ways of measuring carbon in an equity portfolio are outlined in the table.

Although approach 2 and approach 3 are both expressed as tonnes of CO_2 per unit of revenue, the concepts and resulting calculations are different.

Approach 2, even when applied to only equities, can be complex, difficult to calculate, and challenging to explain to investors. Moreover, a key part of the calculation – allocating sales based on market value – cannot be meaningfully applied in practice to sovereign bonds.

Table 1: Measuring Carbon in an Equity Portfolio

Carbon Accounting Approaches for Equity Portfolios	How It's Measured	Relevance to Sovereign Bonds
1. OWNERSHIP APPROACH		
"How much emissions have we financed with our investment?"	If an investor owns X% of a company and the company emits Y tonnes of CO_2 annually, then the investor has financed: $X\% * Y = \text{tonnes of } CO_2$ By adding emissions across all companies in the portfolio, we obtain $\sum_n^i \frac{\$\ investment_i}{Issuer's\ full\ mcap_i} * Issuer's\ emissions_i = \text{total portfolio emissions in tonnes } CO_2$ We can then divide by the portfolio value to express carbon footprint in CO_2 per $M AUM.	Strictly speaking, equity shareholder ownership concept does not apply to sovereign bonds (loans).
2. CARBON INTENSITY (BASED ON COMPANY REVENUE AND MARKET VALUE)		
"How carbon efficient is my portfolio?" "What are the emissions per unit of sales for the portfolio companies?"	The emissions and revenues of companies in a portfolio are allocated based on the share of market value owned by an investor. Also referred to as Financed Emissions / Financed Revenue. Resulting portfolio intensity adjusts for company size and expressed as: $\frac{\sum_n^i \frac{\$\ investment_i}{Issuer's\ full\ mcap_i} * Issuer's\ emissions_i}{\sum_n^i \frac{\$\ investment_i}{Issuer's\ full\ mcap_i} * Issuer's\ sales_i} = \text{Carbon intensity in } \frac{\text{tonnes } CO_2}{\$M\ revenue}$	Strictly speaking, equity shareholder ownership concept does not apply to sovereign bonds (loans). Allocating revenues by market value not practical or meaningful for countries.
3. WEIGHTED AVERAGE CARBON INTENSITY (USING COMPANY REVENUE)		
"What is the exposure of a portfolio to carbon-intensive companies?"	Each company's emissions are divided by its revenues to obtain the carbon intensity of each holding. The results are averaged using company weights in the portfolio to obtain an overall carbon intensity of the portfolio. $\sum_n^i Portfolio\ weight_i \times \frac{Issuer's\ emissions_i}{Issuer's\ sales_i} = \text{Carbon intensity in } \frac{\text{tonnes } CO_2}{\$M\ revenue}$	This approach can be applied with country carbon intensities using GDP or value added as the denominator instead of revenue.

Thus, from a practical perspective, two approaches that could be applied to sovereign bonds remain: approach 1, the ownership approach, and approach 3, the carbon intensity (company revenue) approach. Much has been written about the pros and cons of an ownership versus an intensity approach.[5] Overall, though, it's important to note that the approaches are not interchangeable, since each answers unique questions.

Carbon Disclosure – Questions Addressed

Applying the Ownership Approach to Sovereign Bonds

Extending the logic of the ownership approach from equities to bond investments entails a similar methodology. The amount of carbon emissions of a given country "financed" by an investor is calculated based on how much of the country's debt the investor owns relative to total debt outstanding of the country. Financed carbon emissions for all countries are aggregated to arrive at total emissions per dollar invested for the portfolio.

$$\sum_{n}^{i} \frac{CO_2 \text{ emissions tonnes}_i}{\text{debt outstanding}_i} * \frac{\$ \text{ invested}_i}{\$ \text{ portfolio value}} = \text{Financed emissions in } \frac{CO_2 \text{ emissions tonnes}}{\$ \text{ AUM}}$$

Limitations of the Ownership Approach

Applying the ownership approach to bond investing raises a number of methodological questions. Specifically, carbon measurement in equities is often linked to an investor's "ownership" in a company, reflecting the idea that the investor has financed a share of a company's carbon emissions. However, bond investors do not own assets in the countries in which they invest; rather, they are providing a loan. If an investor is providing a loan, to what extent has the investor financed country emissions, and what emissions would one measure (the emissions of the government that issued the bond, or the emissions of the economy as a whole)? Is it logical to say that the investor has financed a portion of country-wide emissions by purchasing a bond?

Still, an investor may wish to calculate carbon emissions using an ownership approach to remain consistent with equities reporting and/or to quantify an absolute amount of carbon emissions for which it is "responsible". If so, one can either attribute emissions from government operations[6] or for the country as a whole. We provide a fuller discussion, including a case study, in Appendix A.

It is important to remember that the ownership approach, by measuring carbon emissions per dollar of debt, does not provide much of a window into the carbon efficiency of the country, nor is it a good metric for comparing countries to one another. The biggest challenge of this approach stems from the disparity between the size of national debt and a nation's GDP, which varies widely among nations, distorting the analysis for reasons that have little to do with carbon efficiency.

[5]One of the most recent studies was published by MSCI: Carbon Footprinting 101 Brief. Sept 2015. https://www.msci.com/www/research-paper/carbon-footprinting-101-a/0229050187
[6]See Section 5 for a discussion of calculating carbon emissions from government operations.

The Carbon Intensity Approach

We see many compelling reasons to recommend the carbon intensity approach, which answers the questions: "How carbon intense or efficient are the entities in which we are investing? How much carbon is emitted per unit of GDP? The carbon intensity of a portfolio can then be calculated by averaging the intensities weighed by each bond holding's position within the investor's total portfolio.

$$\sum_{n}^{i} \frac{CO_2 \text{ emissions tonnes}_i}{GDP_i} \times \frac{\$ \text{ invested}_i}{\$ \text{ portfolio value}} = \text{portfolio carbon intensity} \quad in \quad \frac{\text{tonnes}}{\$GDP}$$

Portfolio carbon intensity, also described as a "weighted average carbon intensity," helps address the risk exposure of a portfolio and its investors. Countries with a high carbon intensity, regardless of their level of debt outstanding, can be considered to be exposed to greater risks related to the transition to a carbon-constrained economy (transition risk).

Some of the benefits of the intensity approach include:

- It is scalable: Carbon intensity can be used to compare the performance of countries to one another and to global carbon intensity scenarios. It can also be used to examine the carbon intensity of economic sectors.
- The results can be used to tilt portfolios to favor lower carbon economies.
- It can be measured from a production or consumption perspective (see page 11), and can take into account the effects of international trade.
- It can be more easily expanded to include other asset classes, such as corporate bonds and equities, and to report the carbon intensity of an asset owner's investments company-wide.
- To the extent that investor decisions can influence government behavior, the carbon intensity approach can serve as an incentive for countries to reduce carbon emissions. Conversely, the ownership approach could be contra-productive for sovereigns (the bigger the outstanding debt is, the more diluted the carbon emissions are).
- Carbon intensity measures a portfolio's exposure to carbon-intensive countries. Since countries with higher carbon intensity are likely to face more exposure to carbon-related market and regulatory risks, this metric can serve as a proxy for a portfolio's exposure to potential climate change-related risks relative to other portfolios or relative to a benchmark.

EXAMPLE: Powershares Emerging Market Sovereign Debt ETF (Production basis)

Applying the Carbon Intensity Approach to an example portfolio and analyzing enables us to:

- Identify some of the practical issues involved in carbon disclosure,
- Highlight methodological challenges and data limitations, and
- Better understand how individual country emissions and economic characteristics drive results.

We chose the Powershares Emerging Markets Sovereign Debt ETF (Ticker: PCY), a US exchange-traded fund with over $3 billion in assets. The fund invests in the debt of 30 emerging market countries in roughly similar proportions.

For the 30 countries in the portfolio, the average carbon intensity is 516 tonnes CO_2 per $million GDP. Ukraine, with a carbon intensity of 1,720 tonnes CO_2 per $ million GDP, is the biggest contributor to the carbon intensity of the portfolio, followed by Kazakhstan and South Africa.

Using the Carbon Intensity Approach, the holdings in the Powershares ETF have a weighted average carbon intensity of 465 tonnes per $ million GDP.

Note: We applied the ownership approach to the same portfolio and the results are presented in Appendix A.

Table 2: Powershares Emerging Markets Sovereign Debt ETF: Top 10 Countries by Carbon Intensity

Country	GDP 2012 ($Billion)	Country Carbon Intensity t CO_2/$M GDP (2012)	Country Weight in Portfolio (%)	Country Contribution to Portfolio Carbon Intensity t CO_2/$M GDP	Country Contribution to Total Carbon Intensity (%)
Ukraine	176	1,719	3.3%	57	12%
Kazakhstan	204	1,150	3.3%	38	8%
South Africa	397	977	3.3%	32	7%
Russia	2,016	859	3.4%	29	6%
Pakistan	225	677	3.3%	22	5%
Poland	497	620	3.2%	20	4%
Venezuela	298	618	3.1%	19	4%
Morocco	98	591	3.3%	19	4%
Romania	172	512	3.3%	17	4%
Korea	1,223	511	3.1%	16	4%
TOTAL PORTFOLIO CARBON INTENSITY (TONNES/$M GDP)				465	

The example highlights several issues that may arise for any portfolio when analyzing carbon intensity per unit of GDP:

- Because we are not assigning carbon to the portfolio based on the value of the bond, one will not arrive at a carbon intensity per dollar invested. Instead, the intensity measure is reflective of the carbon intensity of the economies invested in, then weighted according to the bond's weight in the portfolio. The intensity measure therefore cannot be added to a calculation based on ownership, but if other investments are measured using the carbon intensity approach (see Section 3 for a discussion of mixed asset portfolios), these intensities can be compared and averaged.

- GDP in USD or other common currency is dependent on exchange rates: Significant currency depreciation relative to the dollar would increase the carbon intensity of a country in USD terms, even though no changes may have occurred in emissions or economic activity in local currency terms. Exchange rate movements can meaningfully affect cross-country comparisons over time. Hence, GDP measured in constant dollars would be more appropriate for multi-country, multi-year comparisons.

- GDP is partly dependent on the price of goods and services a country may command on the global market. The same type of good may be produced by two different countries, with similar production-related emissions, but the price and GDP contribution of the good may differ substantially between the countries. Countries producing luxury items, for example, would be shown to have a more carbon-efficient economy, while the countries producing a similar item with a lower price tag would be shown to have an economy with a higher carbon intensity. This example underscores how the carbon intensity measure specifically reflects the efficiency of the economy in generating GDP.

- The CO_2/GDP ratio tends to be lower for more developed, service-oriented economies relative to emerging economies. The use of carbon intensity to tilt portfolio weighting in favor of the debt of less carbon-intensive countries may thus reduce access to capital to developed economies, if done on a large scale. Thus, risk analysis should take into account qualitative factors, including the country's progress reducing the carbon intensity of its economy over time. Calculating carbon emissions on a consumption basis, as described in the next section, corrects for this problem as well.

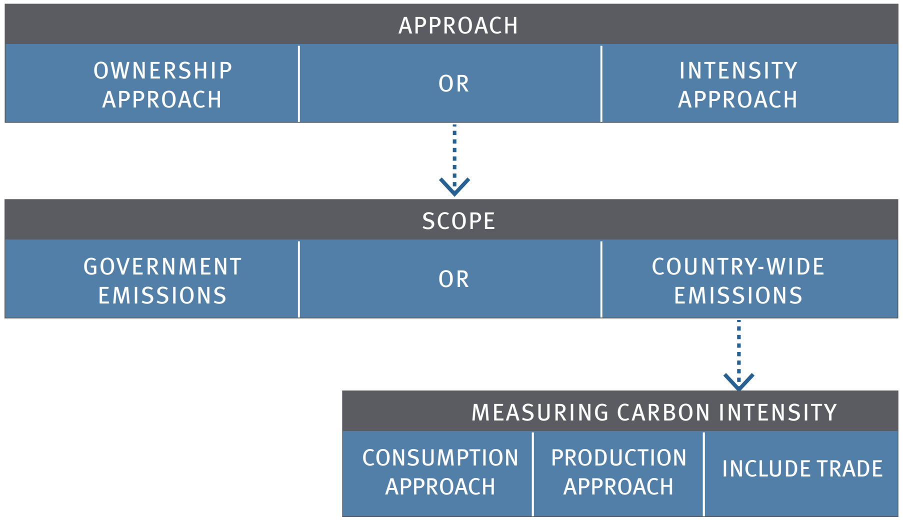
> **"The carbon intensity measure specifically reflects the efficiency of the economy in generating GDP."**

Measuring Carbon Emissions: Consumption, Production, and Trade

Measuring country emissions on a production basis is the most common approach at the national and international level. However, there are important reasons to consider the emissions associated with consumption by a nation's citizens and emissions embodied in its imports and exports.[7] Table 3 compares the consumption and production approaches.

At the global level, production and consumption are the same–everything that is produced is consumed. The difference between production and consumption is driven by to whom the emissions are allocated.

Figure 1: Methodological Choices



[7]For an extensive discussion of consumption metrics, see: Deloitte. 2015. Consumption-based Carbon Emissions. http://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-carbon-analytics-consumption-based-carbon-emissions-050815.pdf

Table 3: Comparison of Production and Consumption Approaches

Production Approach	Consumption Approach
QUESTION ADDRESSED	
What is the total amount of emissions of the national economy within the nation's territory?	What is the total (or per capita) amount of emissions associated with the consumption of the inhabitants of the country?
WHAT IT MEANS	
Production-based emissions reflect the direct GHG emissions stemming from all domestic production of goods and services within a country, regardless of whether those goods and services are consumed domestically or exported. It does not include emissions embodied in imports.	The consumption-based approach reflects domestic consumption. Starting with domestic production emissions, it adds emissions embedded in imports and subtracts emissions from goods and services produced for export.
STRENGTHS	
The most commonly used measure. Consistent with the Kyoto Protocol and the United Nations Framework Convention on Climate Change (UNFCCC).	Reflects total lifecycle and domestic consumption, which is the driver of carbon emissions. Includes carbon emissions no matter where they occur in the world.
WEAKNESSES	
Does not reflect "carbon leakage," i.e. the fact that carbon emissions driven by the country's consumption are being borne by other countries. Widespread use by investors may frustrate global efforts to reduce carbon emissions. It penalizes lower-income countries because they have structurally higher carbon intensity due to lower labor costs.	Although readily available, consumption figures are more difficult to calculate with precision, as trade statistics are often inaccurate and embodied carbon in products is not always fully known.

Production-and consumption-based emissions can differ substantially for countries depending on trade patterns. For example, consumption emissions are more than twice the production-based emissions in the cases of Sweden and Switzerland. For Norway, production emissions are more than twice consumed emissions. The largest economies generally experience smaller differences because trade flows are smaller for them compared to the size of their economy: China produces only 1% more emissions than it consumes, and the US consumes 6% more emissions than it produces.

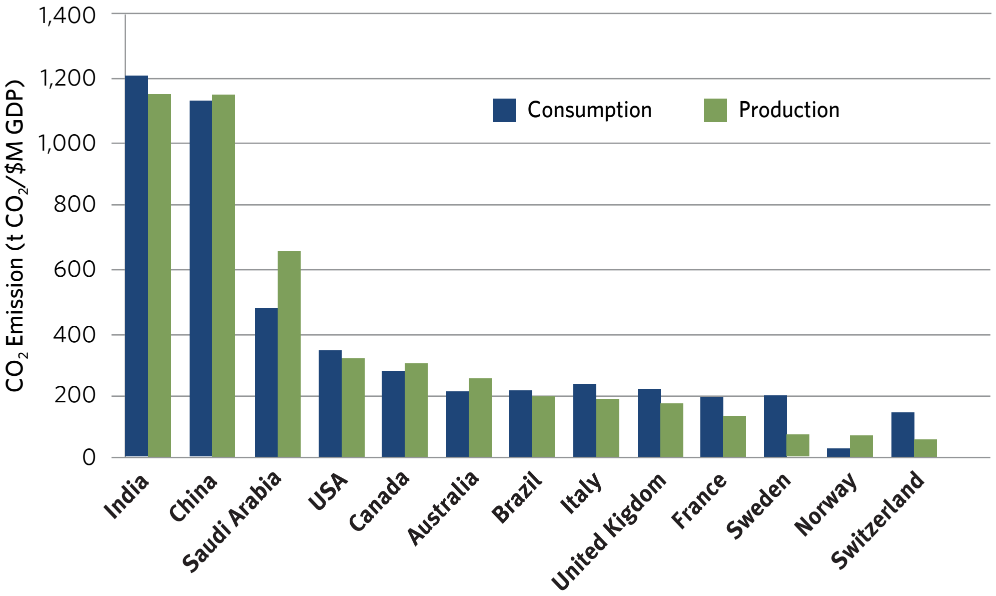
Large commodity exporters such as Saudi Arabia and Australia have much lower consumption emissions than production emissions. Meanwhile, several European countries consume far more emissions through net imports than they produce: France consumes 42% more CO_2 than it produces, Italy 23%, and the UK 22%.

Because consumption emissions are more closely tied to individual consumption, the most appropriate way to look at consumption may be on a per capita basis. Comparing per capita consumption to production per dollar GDP (see Figure 3), shows that individual consumption patterns in high-income countries clearly drive production emissions in countries with high exports.

Consumption-based emissions calculations can provide a different perspective in the analysis of sovereign debt portfolios. Debt portfolios tilted towards export-oriented emerging economies, for example, would have a lower consumption "carbon footprint" compared to their production-based footprint.

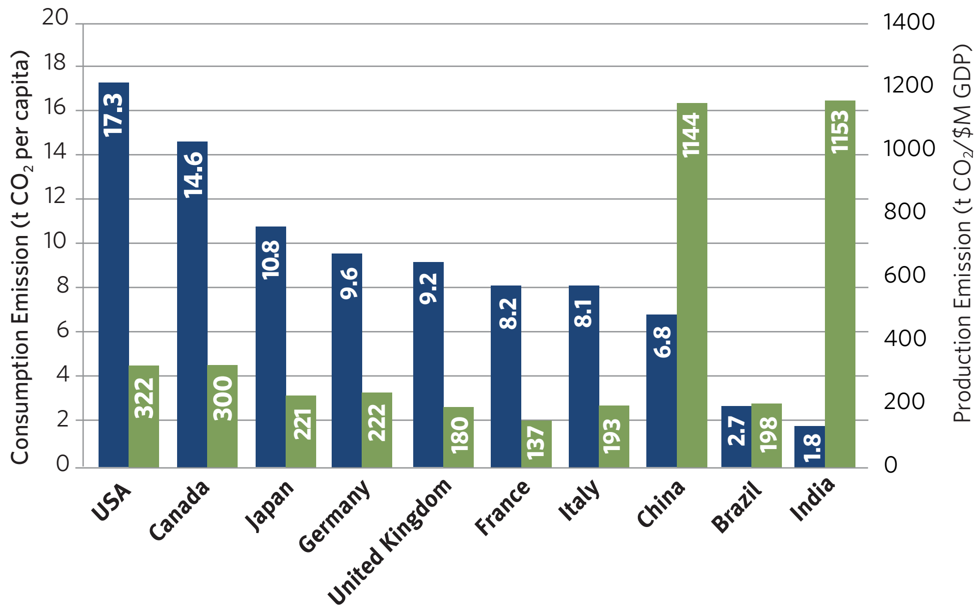
There may also be economic risks associated with carbon-intensive consumption that investors may wish to capture. In the event that carbon is priced, this may lead to higher prices for households. Thus from the perspective of transition risks, both production and consumption indicators will provide useful signals.

Figure 2: CO_2 Emissions from Consumption and Production, 2012 (t CO_2/$M GDP)



Source: Global Footprint Network, National Footprint Accounts

Figure 3: Emissions from Consumption (t CO_2 Per Capita) and Production (t CO2/$M GDP)



Source: Global Footprint Network, National Footprint Accounts

An investor seeking a holistic approach should consider the unintended consequences of a production-only approach:

- **Carbon Leakage**

  The data suggests that while many developed economies have achieved reductions in territorial emissions over the past decade, their emissions based on consumption have not decreased as much, or have even increased. In effect, many developed economies have been outsourcing their production of carbon-intensive products to emerging economies through "carbon leakage" and net importing carbon.

  For example, China's carbon footprint of production is high, but it exports a good portion of this production. In contrast, while Switzerland's direct use of carbon for its economy is relatively small, the Swiss ultimately consume a larger amount of carbon on a per capita basis. This is because the Swiss import resource-intensive products and export high value goods and services representing little carbon.

  A production approach, therefore, encourages displacement of carbon-intensive parts of the economy, rather than decreasing them.

- **Achieving Carbon Reductions**

  Many experts have suggested that national targets should include both production-based and consumption-based goals, to encourage countries to reduce total emissions consumed per capita.

  Because countries have little control over emissions associated with production in other countries, the only way to reduce consumption-based emissions related to imports would be to consume less or shift imports to countries with more efficient production.

  In the end, consumption drives production in the global economy. Reducing consumption, or creating incentives to shift consumption towards more carbon-efficient goods and services—both in domestic production and via trade—could have a meaningful impact on achieving global carbon reduction targets and mitigating climate change.

"Shifting investments away from countries with high production emissions could continue to penalize emerging market and low-income countries, while failing to reduce overall carbon emissions."

Example: Powershares Emerging Market Sovereign Debt EFT Portfolio Analysis, Consumption Basis

Consumption emissions can reveal additional carbon risk exposures when analyzed alongside production carbon intensity. Reverting back to our Powershares ETF example in the previous section, we analyze the same portfolio on a per capita consumption basis as well as on a GDP-normalized basis. On a per capita consumption basis, Qatar, stands out for its relatively high consumption (Figure 4).

Applying this alternative measure, we can derive the carbon intensity of the portfolio on a per capita basis (Table 4).

Next, we can conduct a similar analysis using a GDP- normalized approach (Figure 5). In this analysis, a different set of countries account for the carbon intensity of the portfolio and Qatar isn't in the top ten (Figure 5).

Figure 4: Top 10 Countries by Per Capita Carbon Intensity

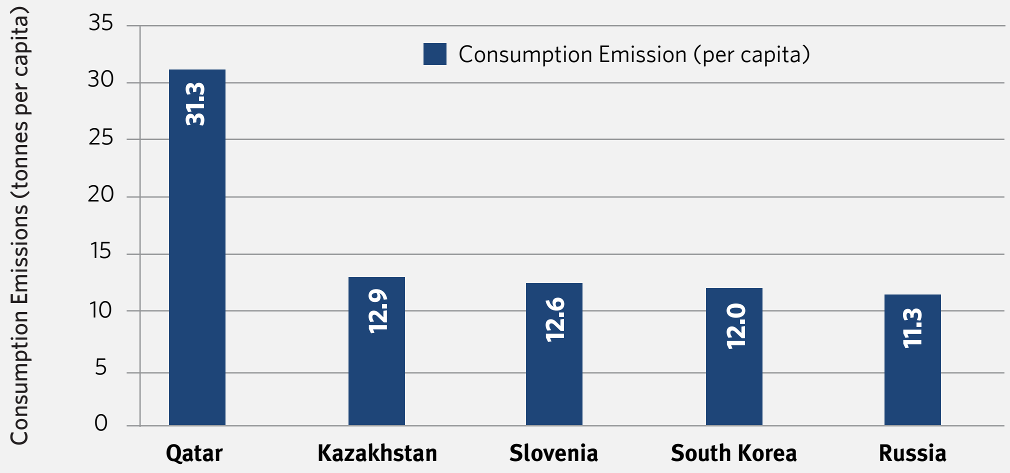


Table 4: Top 10 Countries by Per Capita Carbon Intensity

Country	Population	Consumption Emissions tCO_2 per capita	Country Weight in Portfolio (%)	Country Contribution to Total CO_2 Intensity (tCO_2 per capita)	Country Contribution to Portfolio CO_2 Intensity (%)
Qatar	1,837,000	31	3.2%	1.0	23%
Kazakhstan	16,912,000	13	3.4%	0.4	10%
Slovenia	2,055,000	13	3.3%	0.4	10%
South Korea	50,004,000	12	3.2%	0.4	9%
Russia	143,300,000	11	3.4%	0.4	9%
Poland	38,064,000	8	3.2%	0.3	6%
South Africa	52,342,000	7	3.3%	0.2	5%
Croatia	4,268,000	7	3.3%	0.2	5%
Lithuania	2,988,000	6	3.3%	0.2	5%
Venezuela	29,517,000	6	3.1%	0.2	5%
TOTAL CONSUMPTION CARBON INTENSITY (TONNES PER CAPITA)				4.3	

Table 5: Top 10 Countries by GDP-Normalized Consumption Carbon Intensity

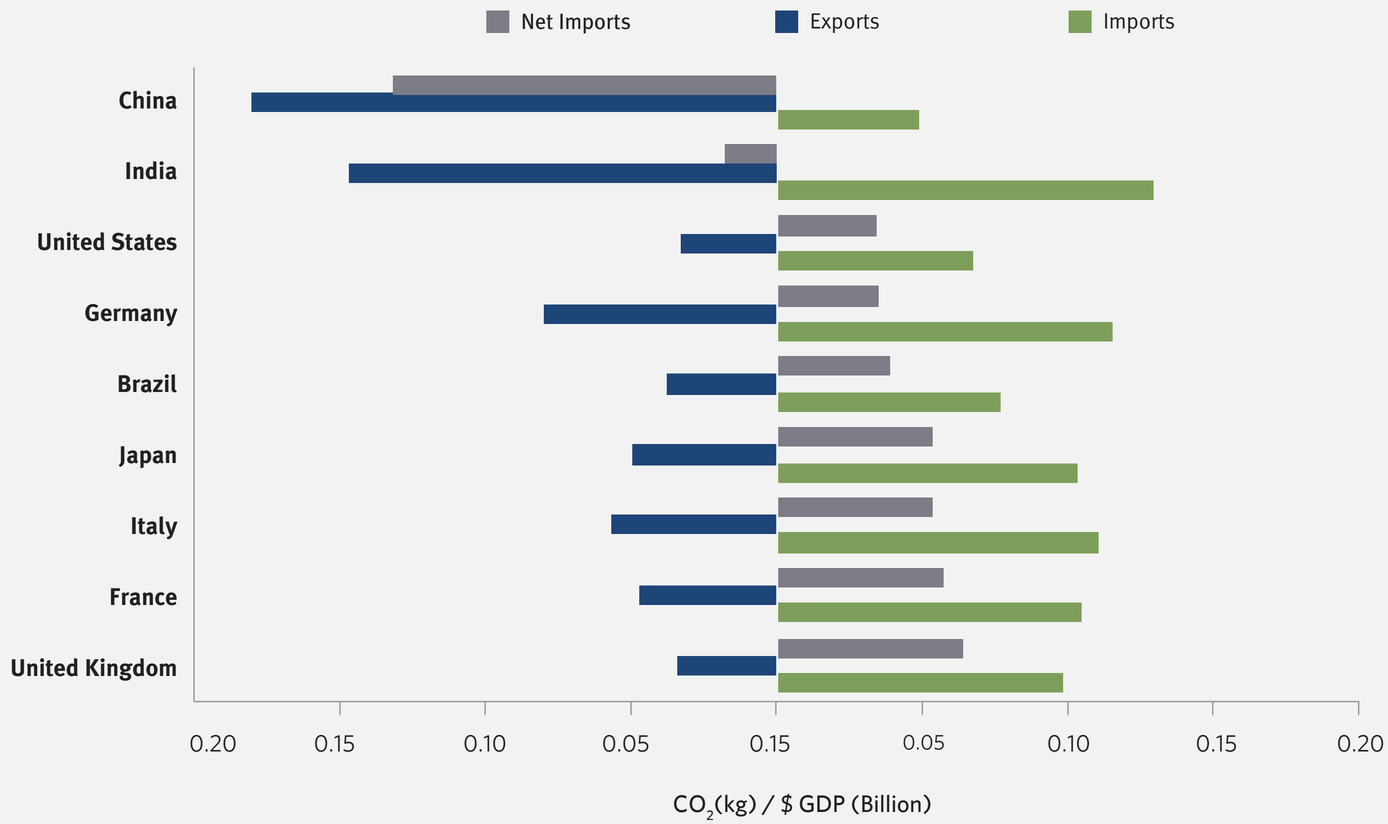
Country	GDP ($Bill)	Consumption Carbon Intensity (tCO2/$M GDP)	Country Weight in Portfolio (%)	Country Contribution to CO_2 Intensity (tCO2/$M GDP)	Country Contribution to Portfolio CO_2 Intensity (%)
Ukraine	176	1,461	3.3%	48	9%
Kazakhstan	204	1,076	3.4%	36	7%
South Africa	397	905	3.3%	30	6%
Pakistan	225	891	3.3%	29	6%
Russia	2016	805	3.4%	27	5%
Morocco	98	653	3.3%	22	4%
El Salvador	24	652	3.4%	22	4%
Venezuela	298	628	3.1%	20	4%
Poland	497	596	3.2%	19	4%
Slovenia	46	559	3.3%	19	3%
TOTAL CONSUMPTION CARBON INTENSITY (TONNES/$M GDP)				533	

Accounting for Trade

In a carbon-constrained world, countries could bear economic costs on production, consumption, as well as in trade. A variety of mechanisms have been proposed such as border taxes, carbon prices, cap and trade systems, etc. This is a rapidly changing landscape and we will learn more as countries move to implement their agreements under COP 21. Nevertheless, moves to price carbon could impact countries' import costs or could impact trade flows as importers look for lower carbon goods.

Figure 5 illustrates both the carbon embedded in imports and exports and net trade on a GDP-weighted basis, for the nine largest economies.

Figure 5: The Carbon Embedded in Trade for Select Countries ($KgCO_2$/$Bil GDP)



Source: Global Footprint Network, National Footprint Accounts

3. CARBON INTENSITY IN MIXED BOND AND MULTI-ASSET CLASS PORTFOLIOS

The carbon intensity approach can be applied to other asset classes, including corporate bonds and equities, and can be used to report on the carbon intensity of a mixed asset class portfolio. Rather than reporting only one combined number, however, it would be more meaningful to also report on each asset class separately since different dynamics are associated with each. This approach was taken by AXA Group,[8] which noted that "reporting on the drivers of carbon intensity in each asset class, including geographic and sector weightings, as well as individual holdings that contribute most to overall carbon intensity, helps to further communicate the carbon exposure of a portfolio."

The basic logic of carbon intensity applies in the case of corporate bonds and equities and we can use the same basic formula:

Multi-Asset Portfolio Intensity =

$$\sum_{n}^{i} \frac{\text{Carbon Emissions of Issuer}_i}{\text{Revenue or GDP}_i} \times \frac{\text{Exposure to Issuer}_i}{\text{Portfolio Value}}$$

And more specifically:

Sovereign Bond Intensity =

$$\sum_{n}^{i} \frac{\text{Country Carbon Emissions}_i}{\text{GDP}_i} \times \frac{\text{Country Exposure}_i}{\text{Total Sovereign Bond Exposure}}$$

Corporate Bond Intensity =

$$\sum_{n}^{i} \frac{\text{Company Emissions}_i}{\text{Revenue}_i} \times \frac{\text{Corporate Bond Exposure}_i}{\text{Total Corporate Bond Exposure}}$$

Equity Intensity =

$$\sum_{n}^{i} \frac{\text{Company Emissions}_i}{\text{Revenue}_i} \times \frac{\text{Company Exposure}_i}{\text{Total Equity Exposure}}$$

These approaches will cover the vast majority of assets for traditional long-only portfolios. Additional approaches and modifications would be required to incorporate other assets including supra-national and sub-national bonds, municipal bonds, private equity, infrastructure, real assets, hedge funds, derivative instruments, fund of funds, portfolio leverage, and short positions.

When calculating the carbon intensity of companies, the GHG Protocol[9] lists three specific types or "scopes" of emissions:

- **Scope 1** refers to those emissions that occur from sources that are owned or controlled by companies. For instance, this can be emissions generated by the burning of fossil fuels at factories or processing plants.
- **Scope 2** refers to emissions from purchased electricity by the company.
- **Scope 3** refers to the carbon emissions of a company's entire value chain, both upstream in its supply chain (which we refer to as 3a) and downstream during the use of its products (3b). Other Scope 3 emissions consider employee activities such as commuting or business-related traveling.

The majority of companies, if they do report their carbon emissions, report only Scope 1 and 2 emissions. Scope 3 emissions are expensive and time consuming to estimate because they require companies to calculate the emissions embedded in their supply chain as well as the emissions of their products. A variety of consultancies including South Pole Group, Trucost, and others provide estimates for Scope 3 emissions using input-output models. Improving the accuracy and reporting of Scope 3 emissions is a priority for the finance industry because for companies in most sectors, Scope 1 and 2 emissions are insensitive to important transition risks centered on supply chain and product carbon intensity. An investor may want to, therefore, use Scope 1 and 2 emissions when comparing companies to one another, and include estimated Scope 3 emissions when calculating the overall carbon intensity of its investments.

> **"The carbon intensity approach can be applied to other asset classes, including corporate bonds and equities, and can be used to report on the carbon intensity of a mixed asset class portfolio."**

[8]AXA. 2015, AXA Group Carbon Footprint 2015 Disclosure. https://cdn/axa.com/www-axa-com%2Fd7721ec8-9631-4306-8f63-0e04e9a72743_axa_group_carbon_footprint_2015_disclosure.pdf
[9]http://www.ghgprotocol.org

Ironing Out Methodological Issues Between Asset Classes

A potential issue in calculating the carbon intensity of a multi-asset portfolio is the question of whether the measurements used for companies are comparable to those used for countries. Below, we examine both the denominator and numerator:

The Denominator: The GDP of a country and an organization's revenue[10] are not totally parallel concepts. GDP, calculated from a production perspective, is more akin to a company's value added (revenue minus costs of inputs). If available, company value added would be a closer match to GDP *(see example 1).*

The Numerator: In order to match Scope 1 and 2 emissions at the country level, it would make sense to subtract household emissions from production emissions since households don't contribute to GDP generation *(see example 1).*

Table 6: Comparing Intensity Metrics Between Companies and Countries

Company		Country
EXAMPLE 1		
$\frac{\textit{Scope 1 and 2 Emissions}}{\textit{Value add*}}$ * revenue – COGS	*Is equivalent to:*	$\frac{\textit{Production Emissions} - \textit{Household Emissions}}{\textit{GDP}}$

Note: For the examples in this report, we use simple Scope 1 and 2/revenue. However, in portfolio analysis, we recommend that investors make the suggested adjustments it they want to increase comparability.

[10]Some have also noted that revenue is not always appropriate as the normalizing variable even in the context of single asset class equity portfolio analysis. The revenue of resource companies may, for instance, be affected by commodity prices, making physical units of output (tonnes, barrels, etc.) a better metric on which to assess carbon efficiency. For service or office-based firms, office square footage or number of employees may be more appropriate.

Further Refinements When Expanding to Scope 3

Scope 1 and 2 emissions represent the power purchased from local power companies and the emissions generated on-site. They do not account for carbon in the supply chain or emissions generated during the life of the products that are sold. This is a far smaller scope, relatively speaking, than production or consumption emissions at the country level. To address this lack of comparability, analysts can expand the scope of company emissions by including the emissions associated with a company's supply chain (Scope 3a). In this case, it makes sense to divide by revenue (rather than value add) as shown in Example 2.

Analysts can expand the scope even further, as shown in Example 3, by including the emissions from the lifecycle of products (Scope 3b). In this case, it makes sense to instead divide by total lifecycle costs. The equivalent at the country level would be consumption emissions/GDP.

Table 7: Further Refinements of Intensity Metrics

Company		Country
EXAMPLE 2		
$\frac{\textit{Scope 1, 2, and 3a emissions}}{\textit{Revenue}}$	*Is equivalent to:*	$\frac{\textit{Production Emissions} - \textit{Household Emissions}}{\textit{GDP}}$
EXAMPLE 3		
$\frac{\textit{Scope 1, 2 and 3a and 3b Emissions}}{\textit{Lifecycle cost*}}$ *which includes revenues, operational costs, and maintenance costs	*Is equivalent to:*	$\frac{\textit{Consumption Emissions}}{\textit{GDP}}$

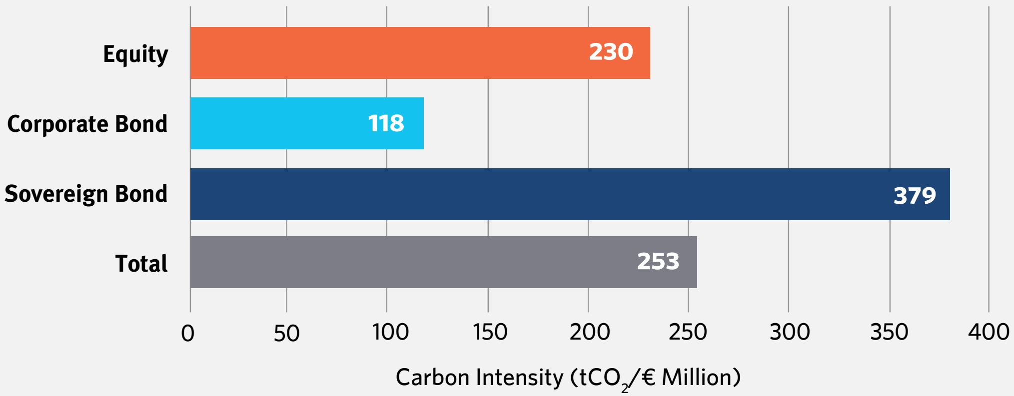
Multiple variables that approximate value added may be used to assess carbon intensities. Bank of America Merrill Lynch for example, through their "carbon portfolio audits," has calculated corporate carbon intensity in relation to three variables: EBIT (earnings before interest and taxes); NTA (net tangible assets); and MV (market value), and across 4 scopes (Scope 1, 2, 3 downstream, and 3 upstream).

EXAMPLE: BlackRock Global Allocation Fund

Applying the above methodologies to an actual multi-asset portfolio offers additional insights on the practical challenges and type of results that can be expected. BlackRock Global Allocation Fund is one of the largest multi-asset funds offered to retail and institutional investors. It has $43 billion of assets in the US mutual fund and $20 billion of assets in the European UCITS version of the strategy.

Based on our analysis, the BlackRock Global Allocation fund's sovereign bond investments, which account for 25% of the assets of the portfolio, have a weighted average carbon intensity of 379 tonnes CO_2 per €Million of GDP (using emissions based on production). Corporate equities, which comprise 59% of the portfolio, have a weighted average carbon intensity of 230 tonnes CO_2 per €Million of revenues, while corporate bonds, which comprise 8%, have a carbon intensity of 118 tonnes CO_2 per €Million of revenues.

Figure 6: Weighted Average Carbon Intensity Across Asset Classes (tCO_2 /€ Million)

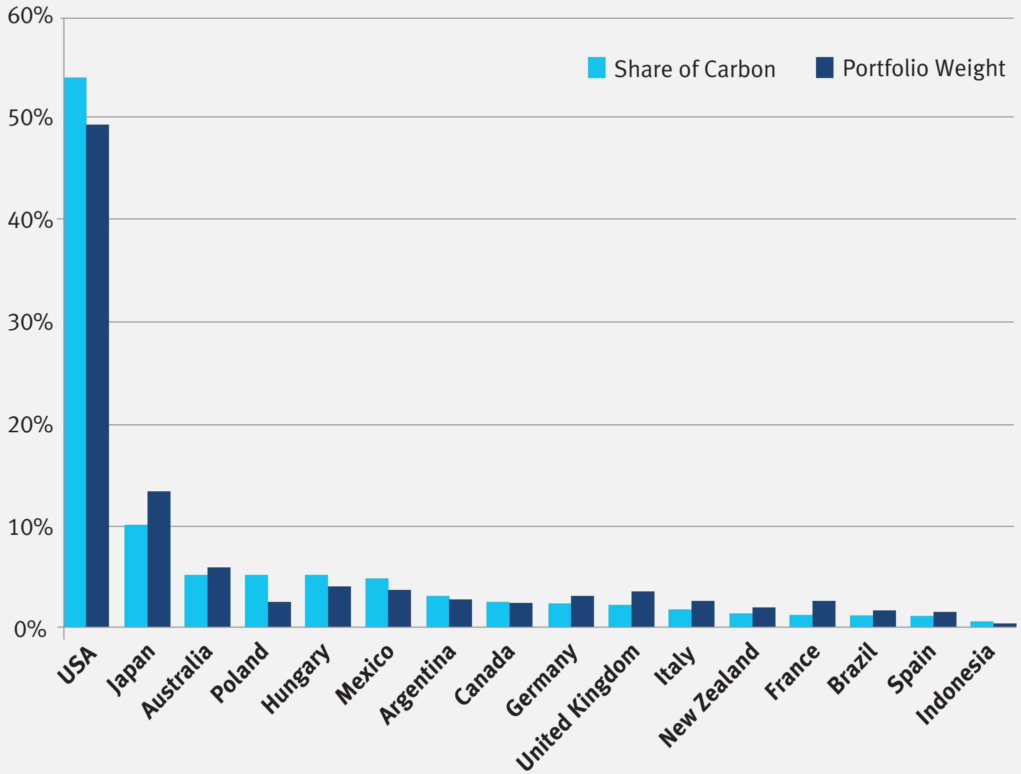


First, it is important to note that the results for corporate equities and corporate bonds, calculated using Scope 1 and Scope 2 emissions and revenues of the corporations in 2014, cannot be directly compared to the results for sovereign bonds, which are calculated using country emissions of production from 2012 and GDP data from the corresponding year. In other words, the sovereign segment cannot be considered less carbon efficient, or more exposed to carbon, than the corporate asset classes. The numbers, however, do enable comparisons with other discrete equity, corporate, or sovereign bond strategies and indices, or corresponding asset classes of other multi-asset portfolios.

Secondly, while a total for the portfolio has been provided in this example (253 CO_2 per €Million of revenue-GDP), for the reasons of comparability mentioned above, such a total portfolio carbon intensity number is not that meaningful.

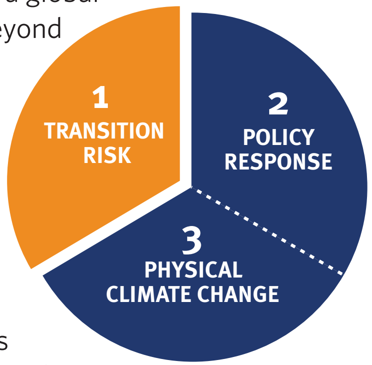
An analysis of the holdings of the sovereign bond asset class provides insights on the drivers behind the carbon intensity results. US Treasury Bonds represent 49% of the sovereign holdings of the portfolio. As a result, the carbon intensity of the United States economy contributed the most (54%) to the portfolio's sovereign bond intensity. The US had a carbon intensity of 322 tonnes CO_2 per €Million of GDP in 2012, a relatively high number among developed economies. In contrast, Japan, Germany, UK, France, and Italy had an average carbon intensity of 191 tonnes CO_2 per €Million of GDP, 41% lower than the US.

Figure 7: Country Portfolio Weights and Share of Portfolio Carbon Intensity (%)



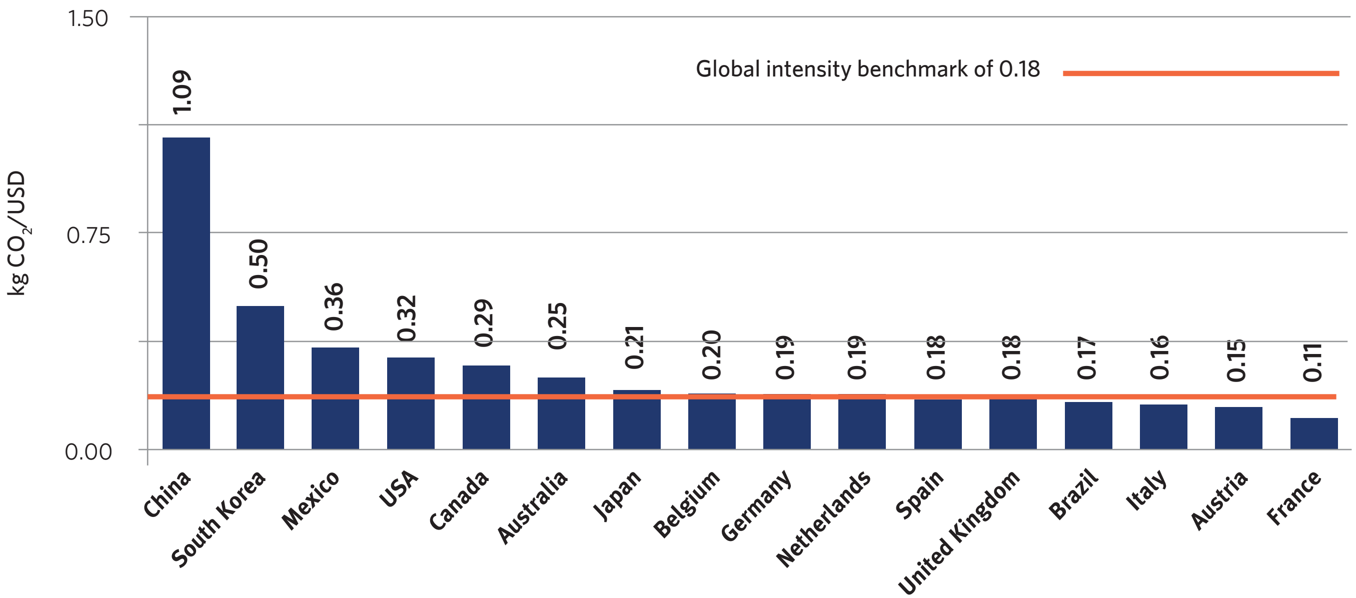
4. THE DIMENSIONS OF TRANSITION RISK

Most countries would need to significantly restructure their economies to reduce carbon emissions to a level that would prevent a global temperature increase beyond 2 degrees Celsius, a goal which many governments and scientists believe is needed to avoid the catastrophic effects of climate change.



The economic structures of countries vary significantly and will influence to what extent a country can make the transition easily or will be exposed to any number of risks. Indeed, countries that already have relatively low-carbon economies are expected to be less likely to face regulatory or market pressures to undergo rapid reform that may incur economic costs and/or lead to widespread asset stranding.

Figure 8 – Carbon Intensity of 16 Selected Countries on a Production Basis, 2012



The Global Intensity Benchmark (0.18 kg CO_2/ USD) is derived from a global carbon budget compatible with a 2-degree warming limit.
Source: Global Footprint Network, National Footprint Accounts

Carbon Intensity Gap

As a first step, carbon intensity can provide a simple means of comparing the exposure of countries to transition risk. Country carbon intensities can be analyzed against climate goal benchmarks using a metric such as the Carbon Intensity Gap (CIG). CIG is calculated as the gap between a country's carbon intensity (CO_2 per unit of GDP) and the world-average carbon intensity benchmark, derived from a global carbon budget compatible with warming limited to a maximum of 2 degrees Celsius.[11]

It is important to keep in mind that in a 2-degree scenario, net emissions would need to be reduced to zero by 2050. Therefore, the global benchmark is the average carbon intensity over that period. This means that countries that have lower than average carbon intensity are not exempt from the risks associated with the low-carbon transition, they are just better positioned in relative terms.

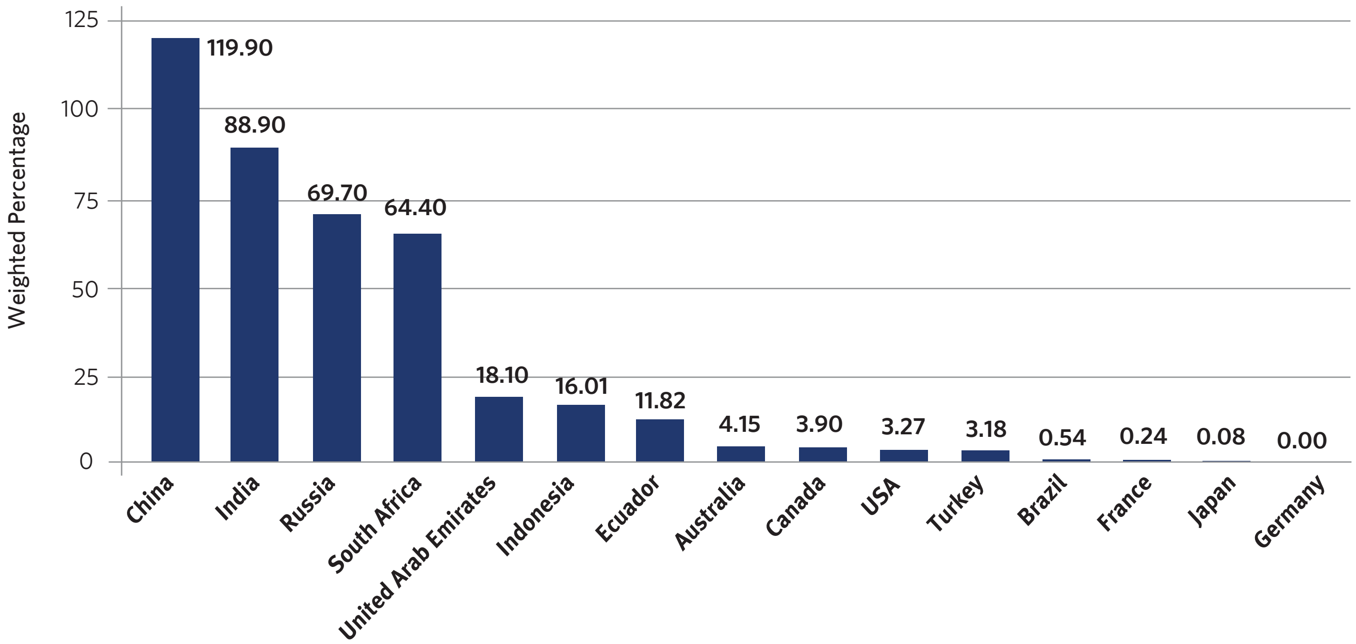
[11]This budget represents the upper limit of emissions that can be added to the atmosphere while still allowing for an 80% probability that global warming will stay within 2 degrees. Taking this emissions limit of 900 Gt CO_2, we divide the amount of CO_2 emissions by the cumulative GDP of all years between 2013 and 2049 (GDPw), allowing for a 3% global annual economic growth rate, to arrive at an average global intensity benchmark of 0.18 kg CO_2/USD that is consistent with the carbon budget.

Intensive Sector Burden

Transition risk assessment can be further enhanced by measuring countries' dependence on carbon-intensive economic sectors. Global Footprint Network's Intensive Sector Burden (ISB) measures to what extent carbon-intensive sectors represent a large share of economic output, assuming that higher costs and asset stranding in these sectors would lead to a greater macroeconomic risk.

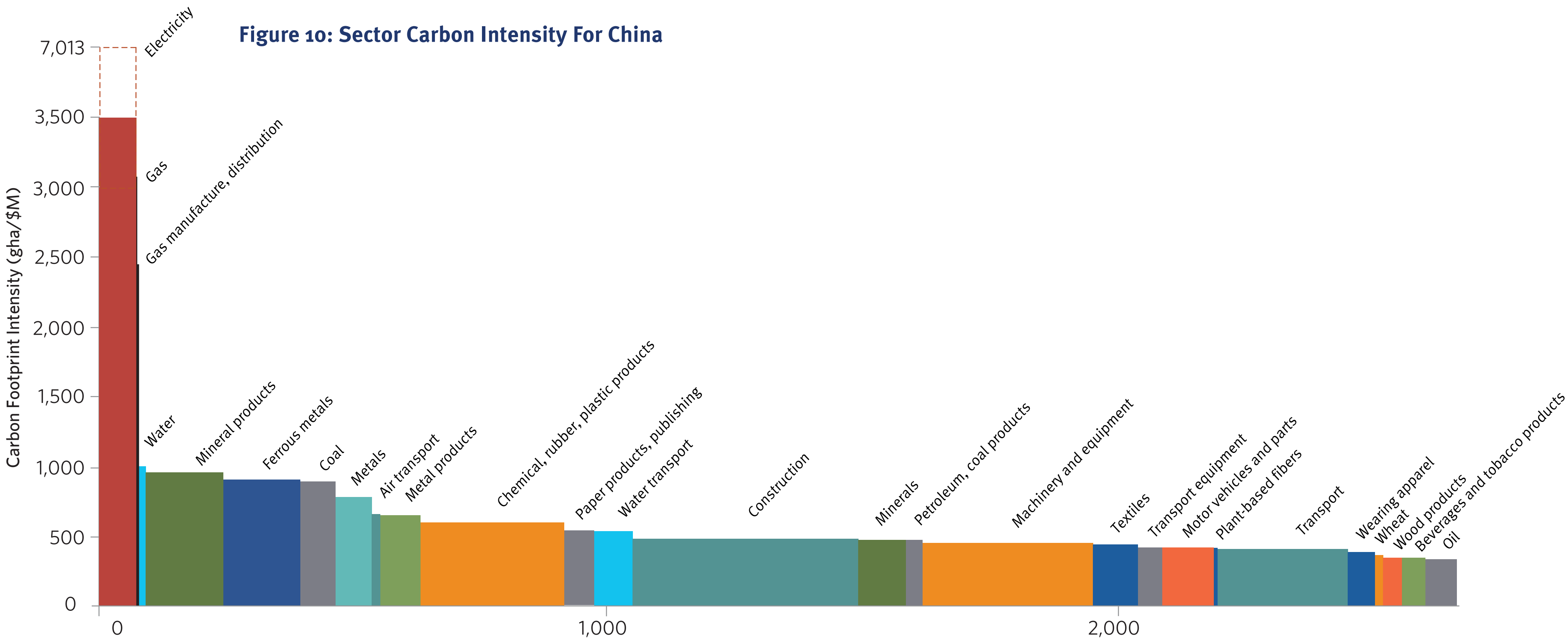
Countries are highly differentiated in terms of both the carbon intensity of different economic sectors and the economic importance of carbon-intensive sectors. China and India have a comparable number of economic sectors that are relatively carbon intense, at 43 and 44 out of 57 sectors respectively. Yet, carbon-intensive sectors in China account for a larger share of the economy and are more carbon intensive than India's. Should rapid changes occur in technology, consumer preferences, or in the regulatory environment, China could face higher economic risk as a result.

Figure 9: Intensive Sector Burden (ISB)



Source: Global Footprint Network, MRIO Database

Figure 10: Sector Carbon Intensity For China



Source: Global Footprint Network, MRIO Database

A 2-degree world will require reform far beyond the oil and gas sector. In the example of China (Figure 10), carbon-intense sectors include obvious ones like power, oil, and gas, but also less obvious sectors such as food, beverages, and clothing.

Drivers of Carbon Intensity

Breaking down the carbon intensity of a country into its component drivers–energy intensity of the economy and carbon intensity of energy–may provide additional useful insights for investors.

A lower energy intensity means a country is using energy efficiently to produce GDP. Meanwhile, the emissions per unit of energy is influenced by the energy mix of the country (in particular, the importance of coal versus oil, natural gas, and renewable energy in the economy).

CI = EIC x CIE

Where $CI = \text{Carbon intensity} = \frac{CO_2}{GDP}$

$EIC = \text{Energy intensity of the economy} = \frac{Energy}{GDP}$

$CIE = \text{Carbon intensity of energy} = \frac{CO_2}{Energy}$

Thus $\frac{CO_2}{GDP} = \frac{Energy}{GDP} * \frac{CO_2}{Energy}$

Fossil Fuel Reserves

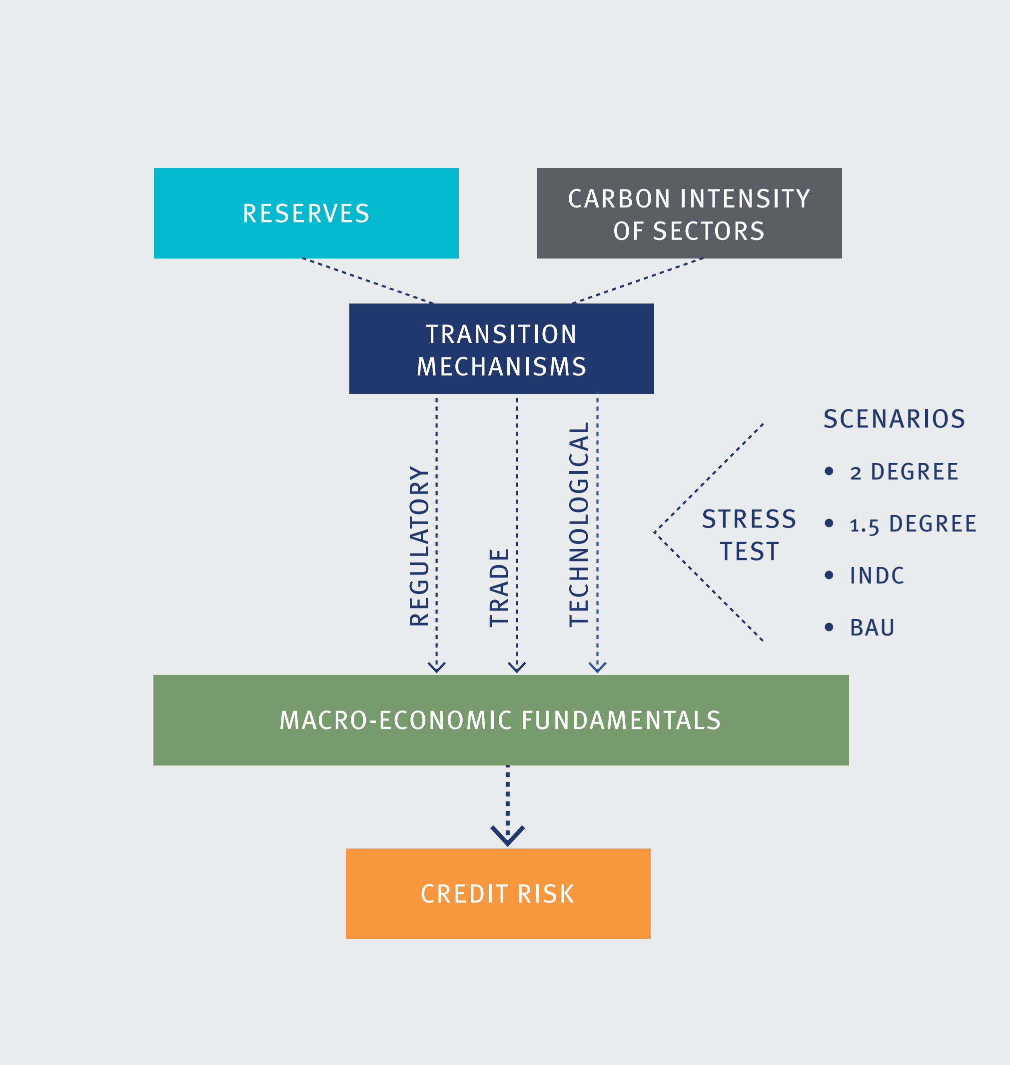
An important element of transition risk stems from the fossil fuel reserves owned by the government or by state-owned companies, which are at risk of stranding.[12] In addition, countries that depend on tax revenues from private companies operating fossil fuel assets within their borders may also be impacted by stranded assets. The restructuring of energy industries and resulting unemployment and other social costs may also impose additional burdens on these governments. Oil, gas, and coal producing nations are at highest risk. Beyond fossil fuel companies, stranded assets may be identified in other industries, such as energy infrastructure (e.g., the failure to approve Keystone pipeline is linked to the fate of the Canadian tar sand stranding) and transportation (public and private railroad companies dependent on transporting coal).

Avenues for Future Research

While carbon intensity is a useful exposure indicator, the important question is how a carbon-constrained economic environment will impact a country's ability to pay back its debt. While research has been done by S&P and others[13] on how physical climate change might impact credit ratings, and Moody's[14] has published a framework for estimating transition risk at the sector and company level, no definitive research has yet been conducted that ties transition risk to sovereign credit worthiness.

A robust assessment will 1) establish both the oil reserves and carbon intensity of each country's economic sectors, 2) establish transmission mechanisms describing how changes in the regulatory, technological and trade environment might impact macro-economic fundamentals, and 3) "stress test" the economy under various reference scenarios such as "Business as Usual, INDC scenario, and a 2-degree and 1.5-degree pathway.

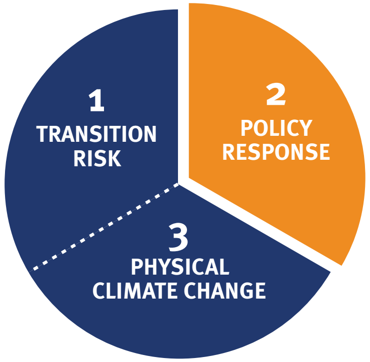
Figure 11: Country Transition Risk



[12]CarbonTracker. 2014. Unburnable Carbon – Are the world's financial markets carrying a carbon bubble? London. http://www.carbontracker.org/wp-content/uploads/2014/09/Unburnable-Carbon-Full-rev2-1.pdf
[13]See Section 7.
[14]Moody's. 2016. Moody's to Analyze Carbon Transition Risk Based on Emissions Reduction Scenario Consistent with Paris Agreement http://www.eenews.net/assets/2016/06/29/document_cw_01.pdf

5. POLICY RESPONSE: MONITORING DECARBONIZATION PROGRESS AND INDC TARGETS

One important way for a country to mitigate climate risk is through its policy response. Does the country set meaningful reduction targets? Is the country on track to achieve those targets? What has been the country's historical carbon emissions trends? Are a country's investments (i.e., subsidies, R&D) congruent with its public pledges?



COP 21 provided a unique opportunity for countries to signal their planned carbon reductions, raising significant interest among investors in better understanding the implications of the INDCs (Intended Nationally Determined Contributions) for investment decision making. While numerous sources[15] analyze the INDCs, most of these sources utilize a fairness or equity perspective, considering a country's historical emissions, a country's financial capacity, and other "effort sharing principles" to arrive at an estimate of what would be a 'fair' contribution to greenhouse gas reduction. While this analysis is beneficial, it isn't sufficient to understand a country's INDCs from a purely economic risk perspective. Therefore, more research and analysis are needed to apply this information to investment analysis.

Using Internal Carbon Pricing to Enhance Sovereign Bond Returns

"Any portfolio country or sector allocation will need to be harmonized with a sharp focus on regulation and awareness of the political capital needed to achieve national carbon reduction goals.

Federal governments will need the buy-in of the private sector to truly reduce country emissions, and investors will need to hold both the domestic entities and sovereigns accountable by demanding proper reporting as well as quantifiable targets.

In global portfolios, it may be prudent to overweight the sovereign bonds of countries in which companies are markedly increasing their disclosure of carbon prices.

Companies with improving carbon disclosure tend to generate risk-adjusted excess returns, in a sense a momentum mechanism. Firms in Brazil, China, India, Japan, Mexico, the Republic of Korea, and the US seem to be taking the lead on disclosing carbon prices. Since 2014, the number of US companies reporting on carbon has more than doubled. Mexico and Brazil have seen large jumps, with expectations of an emissions trading scheme to be implemented as early as 2018."

–Imafidon Edomwonyi, Nippon Life Global Investors

[15]Carbon Action Tracker http://climateactiontracker.org/, Climate Scope http://global-climatescope.org/en/policies/#/, The Global Calculator http://tool.globalcalculator.org/, Energy & Climate Intelligence Unit http://eciu/net/assets/comparing-countries/

One approach that could be developed would be to compare a country's carbon intensity trends to a global carbon intensity benchmark (see Figure 12). Based on the COP21 agreement, we can define a global scenario that assumes a linear reduction of carbon emissions to zero by 2050.[16] This emissions reduction can then be divided by global GDP growth to create a carbon intensity scenario. Carbon intensity country trends (and even portfolio decarbonization trends) can then be compared to the carbon intensity scenario.

Next, carbon intensity scenarios for individual countries can be developed based on INDC and GDP forecasts and compared to the global carbon intensity scenario. Figure 13 shows the comparison for three example countries based on historical carbon intensity, INDCs, and projections to 2050. Two datapoints can then be derived and compared: 1) average rate of decarbonization and 2) total excess carbon emissions.

To complete this assessment for all countries, we need to be able to quantify future carbon emissions based on each INDC. However, because not all INDCs follow the same format, creating comparable country scenarios might be challenging.

The analysis must also consider the degree of a country's adherence to their INDCs. The Grantham Research Institute has developed a useful method that scores the credibility of pledges,[17] which could be utilized to strengthen the analysis.

Figure 12: World CO_2 Intensity Reduction Benchmark

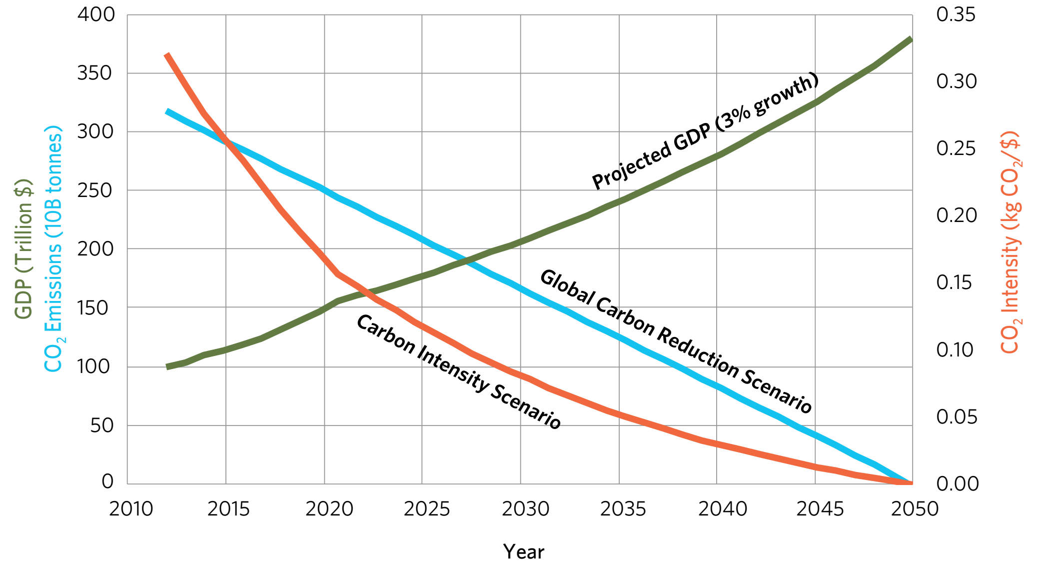
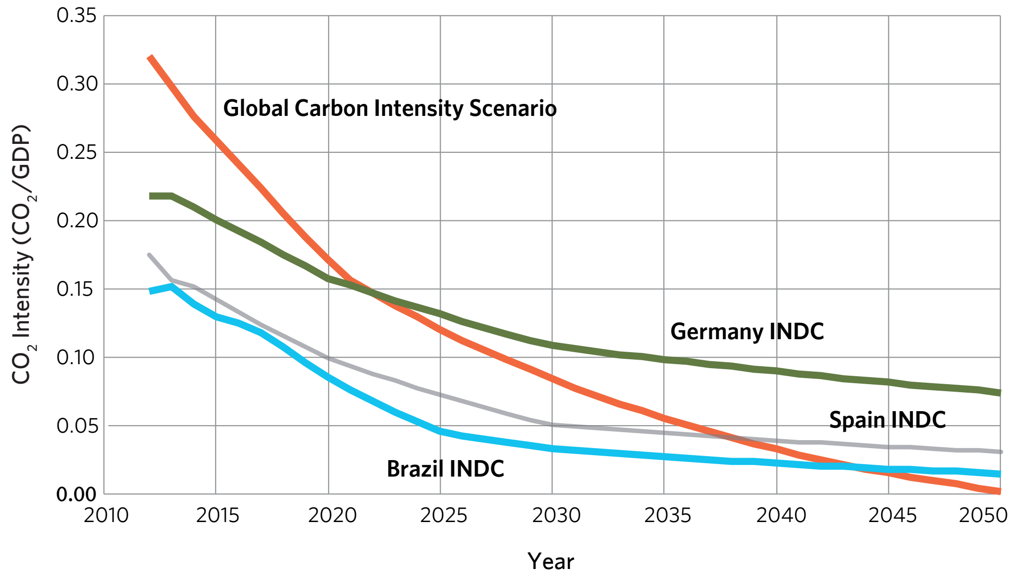


Figure 13: Decarbonization Projections for Spain, Germany, Brazil, and the World based on Intended Nationally Determined Contributions (INDCs)



Source: Global Footprint Network

[16] According to UNEP's Emissions Gap Report 2015, in order to limit warming to below 1.5 degrees, CO_2 emissions have to drop to net zero between 2045 and 2050 and total GHG emissions need to decline to net zero between 2060 and 2080. http://uneplive.unep.org/media/docs/theme/13/EGR_2015_301115_lores.pdf

[17] Grantham Research Institute on Climate Change and the Environment, Centre for Climate Change Economics and Policy. 2016. Beyond the Targets: Assessing the Political Credibility of Pledges for the Paris Agreement. http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/01/Averchenkova-and-Bassi-2016.pdf. UK.

6. VARIATIONS AND ADDITIONAL CONSIDERATIONS

While the carbon intensity method using either a production, consumption, or trade-enhanced approach is the most straightforward, there are several other considerations for special cases or for more advanced users. We outline three of these cases below.

> "Countries act not only as carbon emitters but also, through their ecosystems, as carbon sinks."

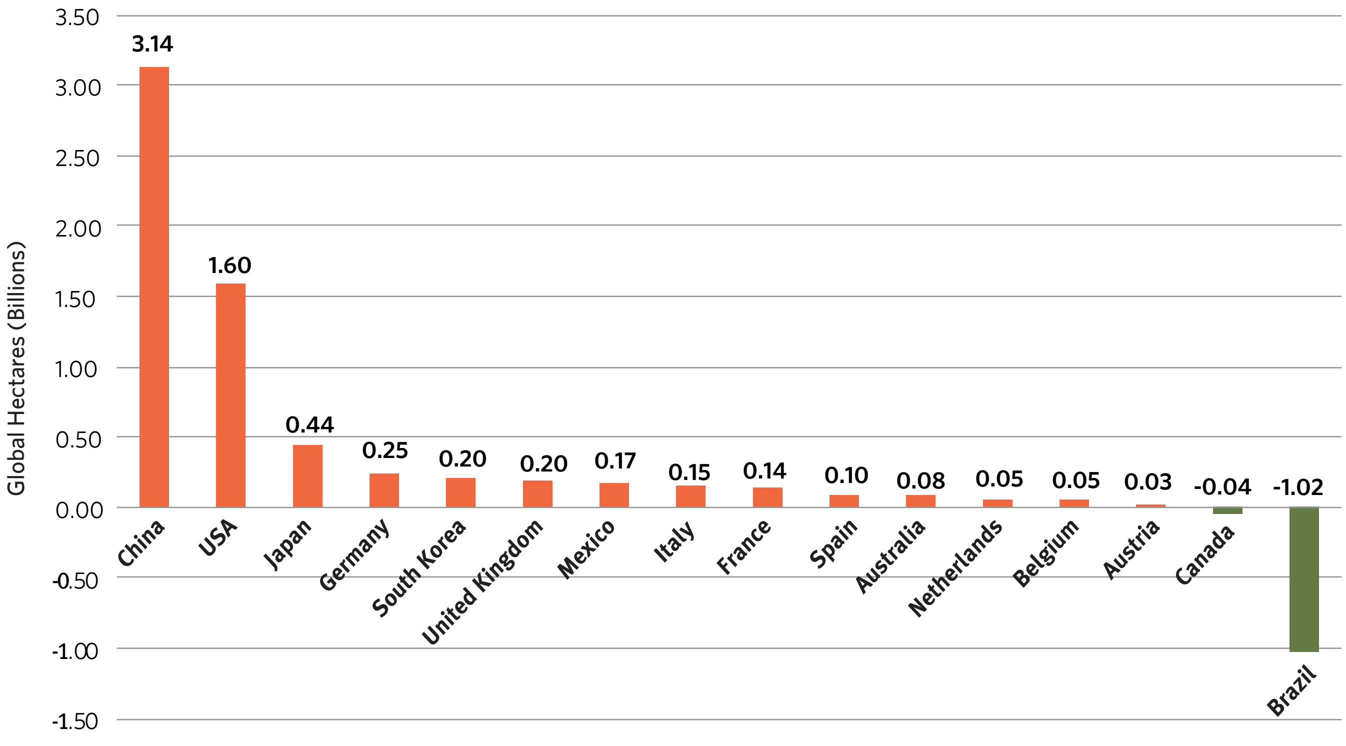
Net Carbon Footprint

Because countries have land areas that sequester carbon such as forests (or grassland managed for sequestration), they can essentially offset carbon emissions. While robust economic incentives for countries to leave forests standing currently do not exist, a country's standing forests will likely be seen as an asset in the long term, especially as competition for land increases.

A framework that accounts for both a country's carbon emissions and carbon sinks is supported by international climate organizations. For example, the Paris Climate Agreement emphasizes net carbon emissions. In addition, the IPCC guidelines consider the carbon sink capacity of a country's ecosystems in compiling national GHG inventories.

The net carbon footprint can be measured in global hectares by Global Footprint Network's National Footprint Accounts (NFAs). See Appendix A for more details on this calculation.

Figure 14: Net Carbon Footprint by Country, 2012 (Billion Global Hectares)



Source: Global Footprint Network, National Footprint Accounts

Government Emissions

It could be argued that just as the issuer of stock (a company) is responsible for its emissions, an issuer of a bond (a government entity) is also responsible for its carbon emissions. In this case, we can measure the carbon emissions generated by government, as a consumer of goods and services directly, such as public services, public schools, policing and governance, and defense (separate from the companies that operate within the nation).

This approach could be used in cases when an investor wants to use an ownership approach. The emissions from companies within the country could then be added to the emissions from the government, avoiding double counting.

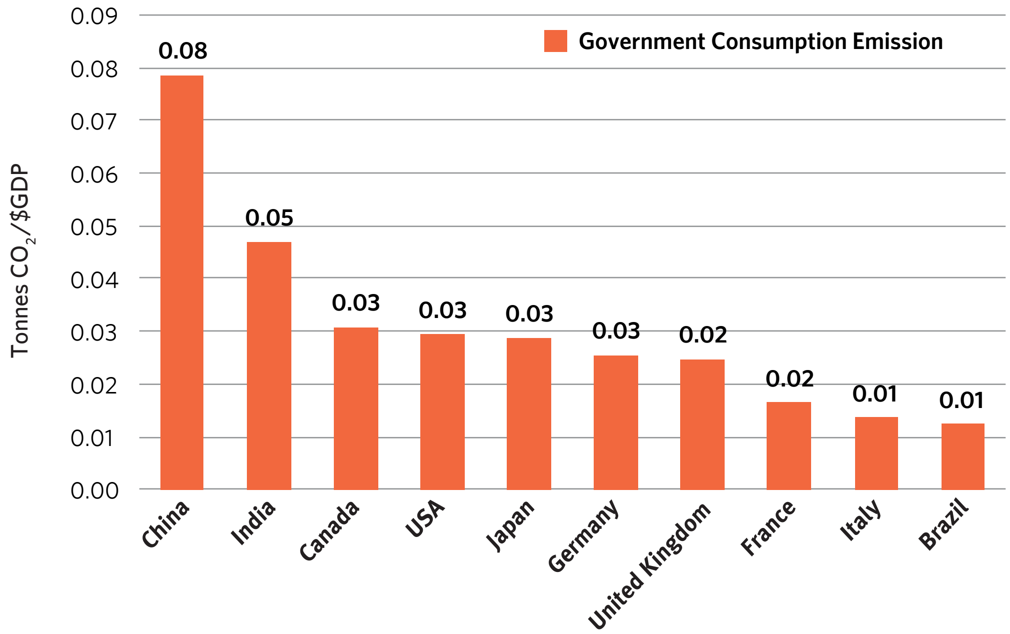
Beyond Ratings estimates that the Scope 1 and 2 emissions of the public sector are usually less than 5% of a country's total emissions. When including Scope 1, 2, and 3, public sector emissions represent between 10% and 13% of the country's total emissions (including emissions embodied in imports).

However, because government decisions affect the entire economy and shape the country's infrastructure, most of the carbon impacts caused by government decisions would be lost with this method. Moreover, revenue raised from issuing bonds not only funds government activities, but also can fuel the economy as a whole. The use of proceeds is difficult, if not impossible, to accurately assess.

Because most governments do not report Scope 1, 2, and 3 emissions, the most straightforward approach to data collection is to use a multi-regional input-output approach, which provides data on government consumption.[18] This data encompasses Scope 1 (the emissions from government operations), Scope 2 (the energy used by government), and Scope 3 (the carbon in the goods and services purchased by the government, and emissions from the government's delivery of good and services).

"It could be argued that just as the issuer of stock (a company) is responsible for its emissions, an issuer of a bond (a government entity) is also responsible for its carbon emissions."

Figure 15: CO_2 Emissions from Government Consumption, 2012 (tonnes/GDP)



Source: Global Footprint Network, MRIO Database

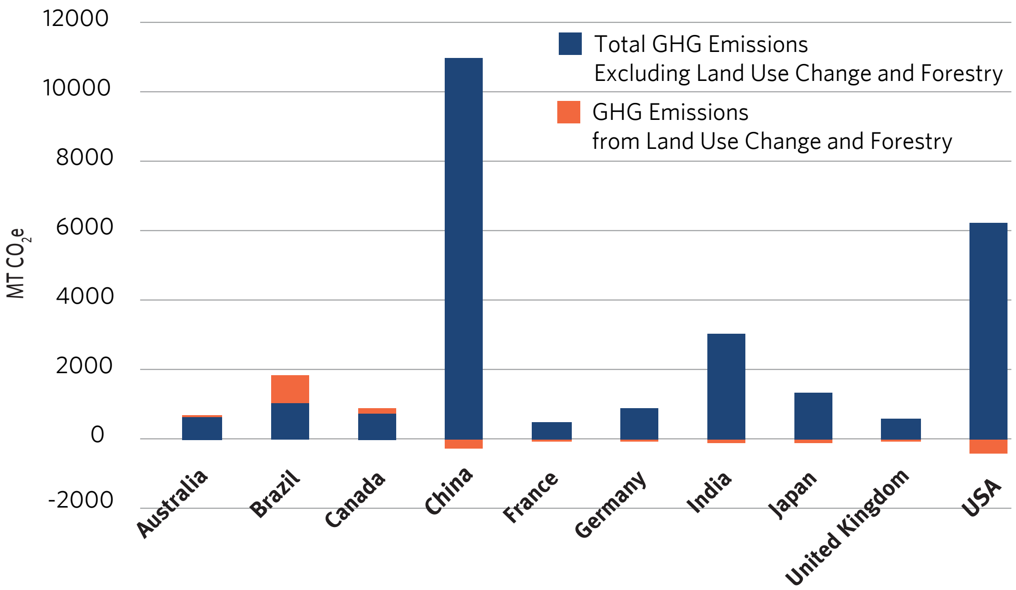
[18]Data source: Global Footprint Network MRIO database. See Appendix A for a fuller description of the database.

Land Use Emissions

Not all carbon emissions are from fossil fuel burning. With strengthened global efforts to decrease net carbon emissions, nations who have the means are encouraged to manage land use and forestry in order to decrease current emissions and increase carbon sequestration through agricultural management and afforestation. Annex I countries are committed to the annual reporting of land use, land use change, and forestry emissions following the United Nations Framework Convention on Climate Change (UNFCCC) treaty. Currently, most countries report these emissions, although the quality and accuracy of data differs by country.

If an investor wants a more accurate estimate of total GHG emissions at the country level, WRI's database can be used to supplement carbon emissions estimates. Figure 18 shows the additional contribution of GHGs from land use changes and forestry.

Figure 16: GHG Emissions from Land Use Change and Forestry



Source: World Resources Institute, 2012

Cumulative or Historical Emissions

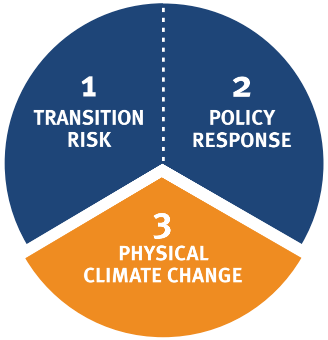
Historical carbon emissions have long been a point of fierce debate during climate negotiations, with developing countries arguing that developed countries should bear some responsibility for the historical emissions that have given rise to climate change. Emissions data supports such an argument.[19] As part of the 2015 negotiations, the UNFCCC adopted core equity principles which acknowledge "common but differentiated responsibilities and respective capabilities" and an "equitable access to sustainable development."

To incorporate a historical perspective, an investor may look for more carbon mitigation from countries with higher historical emissions. An investor will have to decide during which time frame to calculate historical emissions (data reaches back to 1900) and whether to normalize to historical GDP or current GDP. The Stockholm Environment Institute has developed a tool that allows analysts to allocate emissions based on historical responsibility or a mix between capacity and responsibility.[20]

"To incorporate a historical perspective, an investor may look for more carbon mitigation from countries with higher historical emissions."

[19]WRI CAIT Climate Data Explorer. http://cait.wri.org/
[20]Climate Equity Reference Project. https://climateequityreference.org/

7. RISKS RELATED TO PHYSICAL CLIMATE CHANGE



Because the economic risks due to physical climate change have been covered extensively in other publications, physical climate change is not a key focus of this report. However, it is an important risk factor for investors to consider. Below are the key dimensions with some of the most recent and relevant studies that can be used to incorporate this risk into risk models.

Physical Climate Change Risk

The physical effects due to global warming, including the frequency and severity of storms, sea level rise, and drought, can represent economic losses for countries and should be incorporated into a climate risk framework.

Several leading frameworks exist to quantify the physical risk and preparedness of countries associated with climate change.

- The ND-GAIN Country Index[21] assesses vulnerability in the categories of food, water, health, ecosystem services, and infrastructure and assesses readiness by looking at factors of political, economic, and social stability.
- HSBC's climate risk report[22] assesses four integrated categories: exposure (rising temperatures, water availability, and extreme events); sensitivity (number of people affected by extreme events and the damage costs); adaptive capacity (income and debt levels); and adaptive potential (rule of law, corruption, and education).
- S&P Global Ratings's first report on climate change in 2014[23] considered a variety of factors such as populations living in coastal areas below five meters altitude, agriculture as a share of GDP, and the GAIN Vulnerability Index.
- In its 2015 report,[24] S&P Global Ratings collaborated with Swiss Re to estimate the effect of increased catastrophic weather events such as flooding and tropical cyclones on nations' creditworthiness.

"The physical effects of global warming can represent economic losses for countries and should be incorporated into a climate risk framework."

Food and Water

The global food system is vulnerable to changing environmental conditions. A recent report by UNEP FI and Global Footprint Network, ERISC PHASE II: How food prices link environmental constraints to sovereign credit risk,[25] found that climate change along with land and water scarcity will increasingly affect food production on the supply side. At the same time, demand for food will increase as a result of global population and income growth. The growing imbalance between rising demand for food and the capacity to supply it will lead to greater variability in food production, higher and more volatile food commodity prices, and a higher likelihood of price shocks which will affect every country differently. If these impacts are significant enough, they may affect a country's credit rating and the risk exposure of sovereign bondholders. The report presents impact on GDP, inflation, and balance of payments from a simulation of a doubling of food prices similar to the 2008 food price spike.

[21]Notre Dame Global Adaptation Index (ND-GAIN). http://index.gain.org/.
[22]HSBC Global Research. September 2013. Scoring Climate Risk: Vulnerability and adaptability in G20 Countries. http://www.gbm.hsbc.com/solutions/global-research.
[23]Standard & Poor's Ratings Services. 2014. Climate Change is a Global Mega-Trend for Sovereign Risk. http://maalot.co.il/publications/GMR20140518110900.pdf
[24]S&P Rating Services. November, 2015. The Heat is On: How Climate Change Can Impact Sovereign Ratings. https://www.agefi.com/uploads/media/S_P_The_Heat_Is_On_How_Climate_Change_Can_Impact_Sovereign_Ratings_25-11-2015.pdf
[25]Global Footprint Network, UNEP FI. 2016. ERISC Phase 2: How Food Prices Link Environmental Constraints to Sovereign Credit Risk. http://www.footprintfinance.org/portfolio/erisc2-report/.

8. APPLYING INSIGHTS TO INVESTMENT DECISIONS

Carbon footprint and intensity measurements represent important tools for understanding and managing the exposure of investment portfolios to carbon and energy transition risks. While such data provides a foundation for benchmarking carbon performance against other portfolios, the financial industry needs to develop more robust tools to assess investment risks. The industry also needs to develop innovative ways to incorporate those risks into investment decision-making, portfolio management, and climate risk-managed solutions for clients.

Because there is significant uncertainty as to the timing of physical climate change, governments' policy response, and the pace of technological breakthroughs on energy systems, accurate risk analysis may be challenging. Therefore, using risk exposure metrics, as outlined in this paper, is a prudent approach until more robust methods are developed.

From a practical perspective, robust carbon intensity analysis provides the basis for a range of investment management solutions including:

- Portfolio decarbonization;
- Exclusionary screening, divestment, and best-in-class selection;
- Tilt strategies with or without optimization for tracking error;
- Low-carbon indices and financial products based on them;
- Incorporation of green investments (such as green bonds);
- Carbon offsetting measures;
- Enhanced ESG (environmental, social and governance) integration strategies.

Portfolio carbon intensity metrics also could play a more visible role in fund selection and monitoring as demand for responsible, sustainable, and impact investments grows worldwide. Moreover, investors are looking at ESG and sustainability considerations across all types of funds, not just within the universe of responsible investment funds. In response, financial information providers such as Morningstar and MSCI have introduced fund ratings based on ESG factors. As these sustainability rating methodologies evolve, they will incorporate a greater range of more sophisticated carbon footprint, climate risk, and stranded asset metrics.

Carbon and climate risks should also be considered more carefully by an investment management industry that is placing greater emphasis on risk-managed products. Many of the key trends in fund management–including the growth of multi-asset allocation products and liquid alternatives–center around diversification to reduce risk and volatility. The proportion of fund assets in multi-asset allocation products continues to rise, in part reflecting the growth of risk-based and risk-target products within defined contribution retirement plans. These products consider various investment risks, but few if any of them account for carbon, climate, or transition risks. However, in the timeframe of many long-term retirement-oriented investors, such risks may prove material.

Some providers have laid the groundwork for incorporating carbon, climate, and transition risks into the portfolio management process. Investment consultant Mercer estimated the potential impact of climate change on returns for portfolios, asset classes, and industry sectors between 2015 and 2050, based on four climate change scenarios.[26] Their analysis suggests that industry sector impacts will be the most significant, and that asset class return impacts could be material, varying by scenario. A 2-degree scenario may benefit emerging market equities, infrastructure, real estate, timber, and agriculture. But a 4-degree scenario could negatively affect most of those segments.

> **"We recommend that investors conduct a thorough analysis of carbon risks and that the discussion be broadened beyond ESG professionals to include a firm's top portfolio managers, risk management executives, CIOs, and other senior members within an organization."**

Downside risks are expected to materialize either from structural change during the transition to a low-carbon economy, where investors are unprepared for change, or from higher physical damages. Mercer's analysis suggests that investors need to view climate change as a new return variable that will "inevitably" affect outcomes.

As the investment industry further explores these issues, we recommend that more investment managers, consultants, and asset owners conduct a thorough carbon intensity and climate/transition risk analysis of their portfolios, and share their findings with the industry. We also recommend that such analysis and discussion be broadened beyond ESG professionals to include a firm's top portfolio managers, risk management executives, chief investment officers, and other senior members within an organization.

[26] Mercer. June 2015. Investing in a Time of Climate Change. http://www.mercer.com/our-thinking/investing-in-a-time-of-climate-change.html.

9. SOVEREIGN GREEN BONDS: AN EMERGING INVESTMENT STRATEGY

Green bonds are poised to offer investors a new fixed-income opportunity for investing in a low-carbon future, as well as countries a new way to fund their commitments under the Paris Climate Agreement.

Issuance of green bonds has soared in recent years, with over USD 147 billion of green bonds issued to date, according to Climate Bonds Initiative. Even with rapid growth, total green bonds issuance today represents a fraction of the USD 21 trillion of sovereign bonds outstanding.[27] Multilateral Development Banks, corporates, municipalities, cities, state banks, and some export-import banks comprise the majority of issuers, but to date, there have been no sovereign green bonds issued.

Following the commitments made at COP21 through individual country Intended Nationally Determined Contributions (INDCs), "the green bond market is now poised for issuance by sovereign issuers," according to Sean Kidney, CEO of Climate Bonds Initiative.

In August, France announced plans to issue EUR 3 billion in sovereign bonds for three years, for a total of EUR 9 billion, starting in 2017.

Much of the visible pipeline for prospective issuance will come from developing and emerging economies. Kenya announced plans to issue green bonds to finance investment in its renewable energy sector. Nigeria's Ministry of Environment indicated that is considering green bond issuance. Additional prospective sovereign issuers include Morocco and China, according to Climate Bonds Initiative, which advises governments on setting up policy and regulatory frameworks to support market development.

In terms of scale, by far the most promising prospective sovereign issuer will be China, which recently issued Guidelines for a Green Financial System. Green bonds also figured prominently in the G20 Green Finance Synthesis Report issued at the 2016 meeting hosted by China in Hangzhou.[28] According to research at the Commercial Bank of China Co. Ltd. (CBC), "In the first half of 2016, China issued about 58 billion yuan of green bonds domestically, accounting for 30% of the total worldwide. Starting from the second half, the growth of the Chinese green bond market further accelerated. (CBC estimates) that the domestic green bond market will reach 300 billion yuan by the end of this year, or half of the global market."[29]

– Darius Nassiry, ClimateBonds Initiative

Nascent Opportunities

"Identifying investments to support the low-carbon transition can be a challenge for sovereign investors. For example, the green bond market is still very small, with many bonds at the high end of the credit spectrum relatively short-dated, while many institutional investors favor longer-dated paper that better matches their liabilities. Still, momentum is clearly building for this market, and we believe it should be a key component of any ESG investment strategy."

– Aegon Asset Management

[27]See http://www.bis.org/statistics/c1.pdf
[28]G20. 2016. G20 Green Finance Synthesis Report. http://unepinquiry.org/wp-content/uploads/2016/09/Synthesis_Report_Full_EN.pdf
[29]Xueqing Jiang. 2016. CBRC Pushes Green Finance. http://www.chinadaily.com.cn/business/2016-09/06/content_26710132.htm

APPENDIX A: DATA SOURCES

Depending on the analysis chosen, there are two leading sources for national carbon emissions data. The first is World Resources Institute (WRI), which maintains the CAIT Database. The second source is Global Footprint Network (GFN), which maintains two databases: The National Footprint Accounts (NFA) and its Environmentally Extended Multi-Regional Input-Output (EE-MRIO) model database.[30] Both organizations draw on standard public datasets.[31]

Table 8: Comparison of Global Footprint Network and WRI Databases

Database(s)	Geographic Coverage	Coverage	Primary Sources	Highlights
World Resources Institute's **CAIT Database**	185 countries + EU	GHG Emissions **1990-2012** *(CO_2equivalents)* CO_2 emissions **1850-2012**	CDIAC, IEA 2014 *(based on IPCC 1996)*, UNFCCC 2014, EIA 2014	Production data by country
Global Footprint Network's **National Footprint Accounts (NFAs)**	215 countries/ territories including world	CO_2 emissions **1961-2012**	IEA 2014 *(based on IPCC 1996)*, CDIAC	Production, Consumption*, Trade by country
Global Footprint Network's **Environmentally Extended Multi-Regional Input-Output Database**	140 regions of which about 110 are countries	CO_2 emissions **2004, 2007, 2011**		Production, Consumption*, Trade by country and economic sector

**Can be provided with detailed breakdown by economic sector for selected years after 2000.*

[30]National Footprint Account Database. http://www.footprintnetwork.org/en/index.php/GFN/page/footprint_data_and_results/
[31]Primary data sources include International Energy Agency (IEA), Emission Database for Global Atmospheric Research (EDGAR), Carbon Dioxide Information Analysis Center (CDIAC), U.S. Energy Information Administration (EIA), U.S. Environmental Protection Agency (EPA), and the United Nations Framework Convention on Climate Change (UNFCCC).

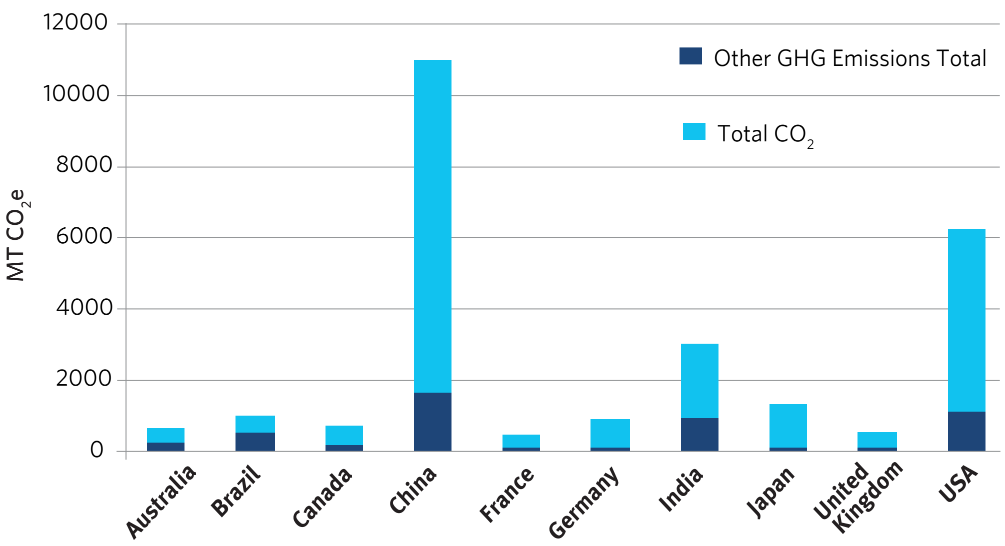
WRI's CAIT Database (CO_2 versus GHG)

The CAIT Database[32] provides total GHG emissions data on a production basis, from 1990 to 2012 expressed as CO_2e (CO_2 equivalents). Because climate change is driven not only by CO_2 but by all GHGs (greenhouse gasses), and many GHGs like methane have a high global warming potential, the fact that the CAIT database provides data on the basis of CO_2e, is a strength.

In general, non-CO_2 GHGs can be more difficult to estimate as they are not point sources (for instance in the case of methane) or they depend on the quality of burning processes (in the case of NOx). It is also more difficult to allocate non-CO_2 gases to final goods and services.

One of the limitations of the CAIT database is that the data covers only production emissions. Users are therefore presented with a tradeoff between measuring GHG emissions on the one hand and measuring consumption and trade flows on the other. The case studies presented in this report have used data from the National Footprint Accounts, which provide consumption, production, and trade flows for CO_2 only. Figure 17 shows the difference between CO_2 and total GHGs for selected countries.

Figure 17: CO_2 and GHG for Selected Countries ($MtCO_2e$)



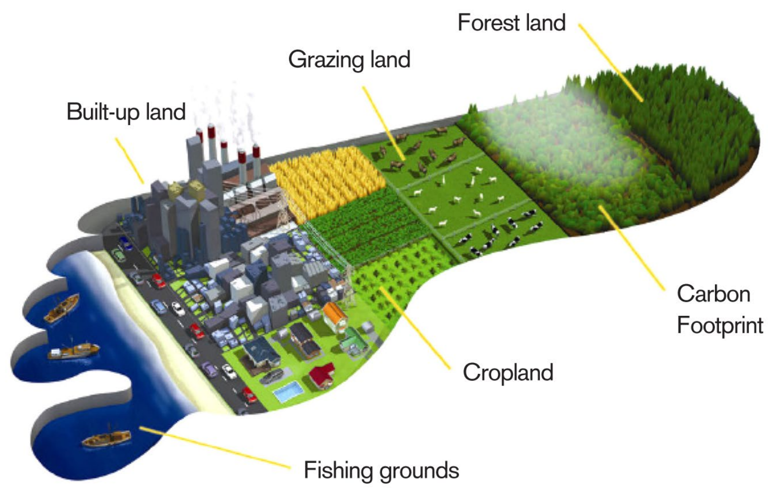
Source: World Resources Institute, 2012

National Footprint Accounts

The National Footprint Accounts track CO_2 emissions as a country's "carbon footprint," which is one of six Ecological Footprint subcomponents. As one of the world's most extensively used natural resource accounting frameworks, the NFAs provide accounts of the Ecological Footprint and biocapacity for more than 215 countries and territories. The Ecological Footprint represents a country's demand for natural resources and services, while biocapacity represents the ability of a country's ecosystems to provide them.

The NFAs are a physical resource accounting system calculated by starting with production-based resource flows, then calculating consumption by adding imports and subtracting exports. The NFAs provide annual data, with time trends dating back to the 1960s, with high product level resolution (625 products).

Figure 18: The Six Land-Types of the Ecological Footprint



[32]WRI CAIT Climate Data Explorer. http://cait.wri.org/

Net Carbon Footprint

As discussed in Section 5, investors can consider whether to take into account the carbon absorption of a country's forests to balance their emissions, resulting in a country's "net carbon footprint."

In theory, net carbon emissions are calculated as the total CO_2 emissions (production approach) from a given area minus the total CO_2 sequestration within that area. Data on emission and ecosystem sequestration is difficult to measure and calculate, and therefore a reliable global dataset does not currently exist. However, the NFAs can provide a first approximation of net CO_2 sequestration by country based on forest sequestration.

CO_2 can be sequestered naturally by ecosystems through the process of photosynthesis or, in some cases, by carbon capture/sequestration (CCS) techniques. Most natural ecosystems are in relative balance, that is, both emission and sequestration from non-forest ecosystems are generally very low compared to CO_2 sequestration in forest ecosystems. Therefore, globally, forests have been shown to be the primary ecosystem of significance when it comes to carbon sequestration.

Net forest sequestration can be approximated as gross forest sequestration minus ecosystem loss of carbon, either as natural CO_2 emission, or CO_2 embodied in harvested forest products. Net CO_2 sequestration can then be calculated as the difference between country CO_2 emissions and net forest sequestration.

For country$_i$

Net CO_2 Sequestration$_i$ = $ET_i - NFS_i$

Where *ET_i = CO_2 Emissions, total*

NFS_i = Net forest sequestration of CO_2

and *Net forest sequestration of CO_2 $(NFS_i) = GFS_i - (EE_i + EH_i)$*

Where *GFS_i = Gross forest sequestration of CO_2*

EE_i = Ecosystem emission of CO_2

EH_i = Ecosystem harvest of embodied CO_2

Global Footprint Network's MRIO Model

Multi-Regional Input-Output Models use financial data on the purchases between economic sectors and by final consumers across regions of the world. MRIO modeling can be used to proxy the flows of embodied CO_2 by applying an environmental extension to the economic based model.

Global Footprint Network's MRIO Footprint accounts provide consumption based CO_2 emissions data as calculated by an Environmentally Extended Multi-Regional Input Output (EE-MRIO) model. The underlying economic data comes from the Global Trade Analysis Project (GTAP 9.0) and allows users to identify the CO_2 emissions of all steps in the supply chains of 57 economic sectors for 140 world regions. This data provides disaggregation of CO_2 emissions as a result of final demand by households, government, and gross fixed capital formation.

Several other MRIO databases exist, including EORA, WIOD, EXIOBASE, OpenEU (GTAP-Based), and OECD. Global Footprint Network's EE-MRIO model differs from others because it incorporates all NFA land types, therefore, in addition to tracking flows of CO_2, it also expresses the embodied demand placed upon forest land, grazing land, cropland, fisheries and land utilized for infrastructure.

APPENDIX B: EXAMPLE: OWNERSHIP APPROACH

We applied the ownership-based approach to the Powershares Emerging Markets Sovereign Debt ETF (Ticker: PCY), a US exchange-traded fund with over $3 billion in assets. The fund invests in the debt of 30 emerging market countries in roughly similar proportions.

This approach attributes emissions to an investor based on ownership of a country's debt outstanding. It is calculated using:

$$\text{Carbon Footprint} = \sum_{n}^{i} \frac{\text{Investment}_i}{\text{debt outstanding}_i} \times \text{Country Emissions}$$

Using this approach, the Powershares Emerging Markets Sovereign Debt ETF has 4.2 million tonnes CO_2 of financed emissions. In standardized terms allowing for comparability across portfolios, this represents 1,381 tonnes CO_2 per $1 million of AUM.

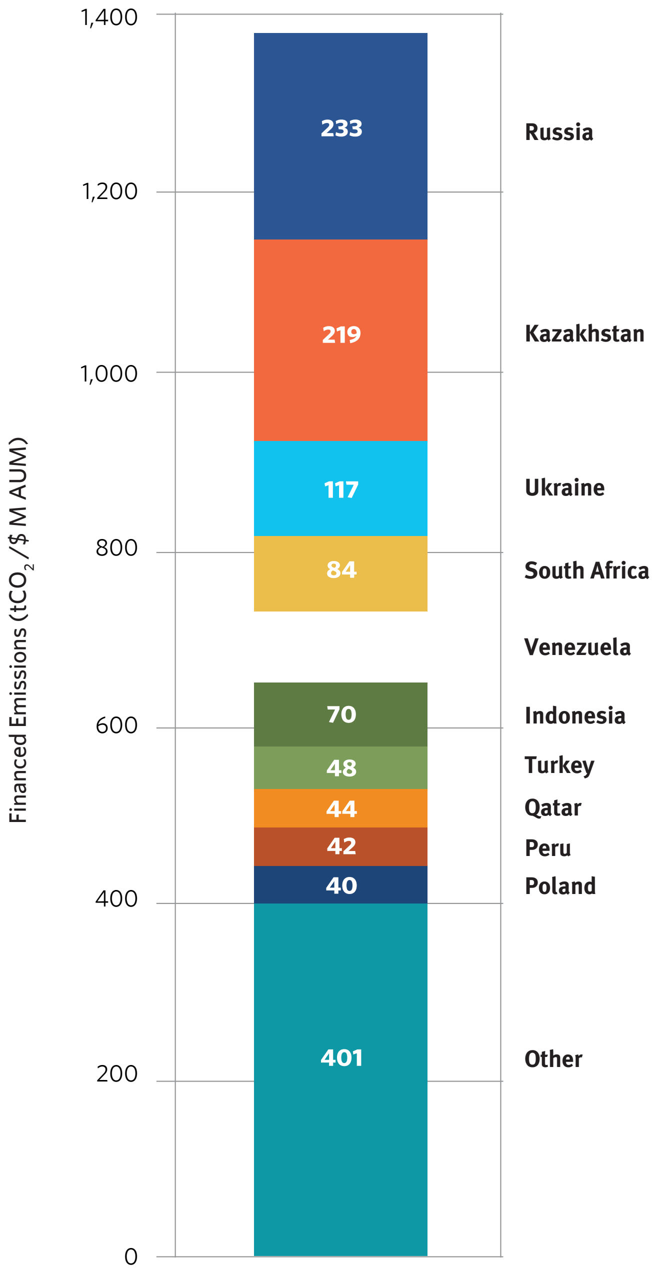
Breaking down the headline numbers into their underlying drivers helps investors better understand a portfolio's carbon footprint and financed emissions. For example, reporting the top five countries that contribute the most and the least towards financed emissions provides useful additional information to investors and fund managers.

In the Powershares ETF, investment allocations allocations to Russia, Kazakhstan, and Ukraine are similar to other countries, but the contribution of these three countries to financed emissions is several times higher than Brazil, Sri Lanka, or Uruguay. In the case of Brazil, the country's high level of debt outstanding drives this result.

Table 9: Powershares Emerging Markets Sovereign Debt ETF Ownership-based Carbon Footprint

Country	CO_2 (Production) tonnes 2012	Country Debt 2015 $ Bil	Mkt Val of Debt Held $ Mil	Weight in Portfolio	Financed Emissions tonnes CO_2	Carbon Contribution in Portfolio
5 LARGEST CONTRIBUTORS TO FINANCED EMISSIONS						
Russia	1,731,554,852	252	104	3.4%	714,668	17%
Kazakhstan	233,988,983	36	102	3.3%	671,650	16%
Ukraine	302,008,114	85	101	3.3%	359,474	8%
South Africa	388,431,772	154	102	3.3%	257,481	6%
Venezuela	184,495,894	70	96	3.1%	252,857	6%
5 SMALLEST CONTRIBUTORS TO FINANCED EMISSIONS						
El Salvador	6,809,719	15	105	3.4%	46,763	1%
Panama	10,504,398	23	100	3.3%	46,556	1%
Brazil	477,140,853	1,258	111	3.6%	41,936	1%
Sri Lanka	17,059,721	61	103	3.4%	28,915	1%
Uruguay	8,819,997	35	101	3.3%	25,280	1%
TOTAL PORTFOLIO AUM AND FINANCED EMISSIONS			**3,070**		**4,239,059**	
NORMALIZED FINANCED EMISSIONS TONNES CO_2/$MIL					**1,381**	

Figure 19: Powershares Emerging Markets Sovereign Debt ETF–Financed Emissions by Country (tonnes CO_2/ $M AUM)



Practical considerations and challenges involved in calculating ownership-based carbon footprints include:

- Country emissions data is generally reported with a lag of approximately three years. Ownership-based footprints however require reporting on current portfolio holdings and assets managed. Current or recent debt outstanding data aligned with the reporting date of portfolio holdings should typically be used. Modeling current emissions ("now-casting") may be helpful to align reporting with current ownership and debt outstanding data. The methodology used for estimating current emissions should be disclosed, with standards developed over time.
- Emissions data may not be readily available for a few countries (e.g. Lebanon and Serbia for this portfolio).
- Portfolios with derivatives (futures, swaps) related to sovereign debt, short positions, or fund-of-funds may present additional methodological challenges.

Issues Related to Debt Outstanding

The results are highly dependent on debt outstanding denominator of the calculation. Variability of results will be driven by changes in debt outstanding, with exchange rate movements potentially having the greatest impact on debt.

Countries with significantly higher debt outstanding would typically contribute less to financed emissions, per dollar invested, than countries with low debt levels. If a country significantly increases its debt outstanding, while the amount allocated to that country remains unchanged in an investment portfolio, that country's contribution to portfolio financed emissions would decrease.

In practice, however, allocations within most bond portfolios are typically correlated with country weightings in commonly used indices, which are usually based on debt outstanding. Thus if a country increases its debt outstanding, the allocation to that country in an index portfolio will increase and overall financed emissions would decrease proportionately across all countries, assuming assets in the portfolio do not change.

The two-country example in Table 10 illustrates how debt outstanding changes the financed emissions in tonnes, even though from a structural standpoint the emissions of each country and an investor's holding in the portfolio in dollars are unchanged. In addition, the country allocations of actively managed portfolios often, but not always, are similar to those in their benchmark indices. Thus a similar dynamic may be observed in active strategies.

Table 10: Two-Country Example of Debt Outstanding Effects on Financed Emissions

Country	CO_2	Debt	Country Allocation in Index	Index Fund $ Invested	Financed Emissions
Country A	50	1000	91%	45.5	2.27
Country B	50	100	9%	4.5	2.27
Total	**100**	**1,100**	**100%**	**50.0**	**4.55**
Country	**CO_2**	**Debt**	**Country Allocation in Index**	**Index Fund $ Invested**	**Financed Emissions**
COUNTRY B INCREASES DEBT OUTSTANDING BY 5 TIMES:					
Country A	50	1000	67%	33.3	1.67
Country B	50	500	33%	16.7	1.67
Total	**100**	**1,500**	**100%**	**50.0**	**3.33**

PROJECT PARTNERS:

Finance for Change
A Project of Global Footprint Network

Global Footprint Network is a research organization that is changing how the world manages its natural resources and responds to climate change. Since 2003, the organization has engaged with more than 50 nations, 30 cities, and 70 global partners to deliver scientific insights that have driven high-impact policy and investment decisions.

Global Footprint Network's Finance for Change Initiative was launched to more deeply analyze and expose the links between climate change, resource constraints, economic performance, and sovereign credit ratings. Our methodology taps the national and trade resource accounting metrics that Global Footprint Network has been calculating for more than a decade.

www.footprintfinance.org

south pole group

The South Pole Group is one of the world's leading climate action solution providers, measuring and reducing climate impact for its clients. Headquartered in Zurich, Switzerland, with 17 offices around the globe and over 130 climate change professionals, the company has achieved savings of over 50 million tonnes of CO_2 since being incorporated in 2006.

With the largest and deepest coverage of high quality company GHG information in its proprietary database, South Pole Group has screened over EUR 500 bn assets under management for their climate impact. The company pioneered high volume portfolio carbon screening that is now available on Bloomberg terminals (APPS CARBON), YourSRI.com and CleanCapitalist.com. South Pole Group has been a strong contributor to the Montreal Carbon Pledge.

www.thesouthpolegroup.com

Disclaimer

This report is for information purposes only. It is not intended to be relied upon as a forecast or investment advice and is not a recommendation, offer or solicitation to buy or sell any securities or to adopt any investment strategy. Any recommendations are solely for the reader's consideration, do not take into account the particular investment objectives, financial situations, or needs of individual investors, and are not to be relied upon as investment advice. Any references to specific investments are for illustrative purposes only.

The information herein has been obtained from sources that Global Footprint Network believes to be reliable; however, Global Footprint Network does not guarantee its accuracy, timeliness or completeness, and it is subject to change without notice. The opinions expressed in this report are as of November 2016 and may change as a result of subsequent events or additional knowledge becomes available. Reliance upon information in this paper is at the sole discretion of the reader.