impact cubed

Measuring the economic impact of environmental externalities in large investment universes: **The case of water**

2019

Investment Week Winner:
Best Thought Leadership Paper

INVESTMENT WEEK
SUSTAINABLE & ESG INVESTMENT AWARDS 2019

About us

We collate and create outcome-based impact data for all listed companies globally. From examining board diversity to evaluating water scarcity, our in-depth analysis of revenue streams across thousands of business activities equips investors with the tangible data necessary for effective reporting, regulation, and portfolio optimization, enabling them to fully understand their impact on the world.

If you would like to get in touch, we would be happy to hear from you at info@impactcubed.com.

You can find out more about our data and portfolio models at www.impactcubed.com.

About the Authors

Antti Savilaakso has over 15 years experience in sustainable investment, holding leadership positions in Nordea Asset Management, MSCI ESG Research, GRI, UN PRI, acting as member and chairman of the FinSIF board 2011-2015, author of multiple publications and widely featured speaker on sustainable investment.

Larry Abele has spent over 20 years building and running quantitative strategies at Deutsche Asset Management (Global Head of Quantitiatve Strategies 2000-2004), Barclays Global Investors, First Quadrant, named among Institutional Investor's 20 rising stars in Hedge Funds.

Introduction

This paper presents a framework to measure and manage environmental externalities in a large investment portfolio of publicly listed equities. The approach and related financial modelling can be used to estimate the economic and investment impact of any environmental externality such as:

carbon emissions
water use
air emissions
solid waste
hazardous waste
soil quality
land use
combination of biodiversity

or other ecosystem services that large corporations use or impact, but may not properly account or pay for.

Similar frameworks exist commercially, but are costly and depend on the quality of data input, and eventually on the margins of error that commercial actors are less willing to make available. This paper argues that given the current level of data quality and the lack of a commonly adopted water accounting protocol, the type of approximation investors are able to make in-house following this proposed framework is entirely sufficient and adequate. The paper outlines the sourcing and organization of data, and in-house estimation methods to build a water dataset. The proposed approach has the additional advantage of enabling externality measurement to passively become more accurate over time as reported externality data quality improves.

In economics, an externality is defined as a cost or benefit that affects a third party who did not choose to incur that cost or benefit. Negative externalities occur when the consumption or production of a good causes a harmful effect to a third party and where the effect is not reflected in the price of the product or service.

Unaccounted for environmental externalities can affect shareholder value because they lead to a more uncertain, rapidly changing economic environment and greater systemic risks. While most individual investments have (at times negligible) environmental risk, for universal owners[1] environmental costs are unavoidable as they come back into the portfolio over time in the form of insurance premiums, taxes, inflated input prices, and the physical costs associated with disasters, reducing cash flow, and eventually earnings and dividends. Furthermore, eventual pricing of highly polluting activities can cause a decline in asset values over time. In other words, one company's externalities can damage the profitability of other portfolio companies, and adversely affect other investments, and hence the overall portfolio and market return (Urwin, 2011).

Financial markets do not properly price environmental externalities (UNEP, 2016; PRI, 2016). The economic cost of these externalities has been estimated to be around USD 6.6 trillion, out of which the 3,000 largest companies account for around USD 2.15 trillion (Trucost, 2011). This suggests that financial metrics (cash flows, earnings, etc.) would turn out to be inflated in large investable universes should the externalities be reflected in them. There have been studies published that focused on establishing more accurate examples of how environmental externalities impact narrowly defined industries (Dowell, Hart, & Yeung, 2000; Owen, 2006). However, we are not aware of studies that focus on present and future impacts on investment metrics, such as stock prices in large investment universes.

Despite the harsh top down estimates, financial markets have not shown signs of attempting to address environmental externalities as a whole. This is to a certain extent understandable. These externalities manifest themselves very differently in different industries and different parts of the world.

However, environmental externalities as a general concept with their common characteristics are starting to be recognized for their importance. In September 2015, world leaders adopted the UN 17 Sustainable Development Goals (SDGs) to end poverty and fight inequality and climate change.

[1] Universal owners are typically large institutional investors, who often have highly-diversified and long-term portfolios that are representative of global capital markets.

The following 10 SDGs directly link to environmental externalities, including ones produced by companies:

Zero Hunger – 70% of fresh water globally is used for agriculture (FAO AQUASTAT).

Good Health and Well-being – pollution related diseases should be substantially reduced.

Clean Water and Sanitation – companies compete with local communities for fresh water.

Affordable Clean Energy – Clean Energy uses a fraction of the water used by fossil fuels.

Industry, Innovation and Infrastructure – calls for increased industrial efficiency in the use of raw materials.

Sustainable Cities and Communities – refers to reduction of local air emissions.

Responsible Consumption and Production – refers to solid waste recycling and efficiency.

Climate Action – greenhouse gases are one of the externalities.

Life Below Water – links to adverse biodiversity impact of marine pollution.

Life on Land – links to biodiversity on land.

To summarise, this paper presents a framework for measuring and managing environmental externalities in large investable universes. The framework can be applied cost effectively with publicly available data. Doing so enables investors to address the majority of the SDGs in their portfolios and therefore steer their investments towards sustainable development.

In the next section, the paper expands on why externality data is difficult to interpret and source, before introducing four steps needed to estimate water externality data in-house.

A word about externality data

The word externality might provoke a negative reaction in people not familiar with economics. This is unsurprising as it describes an abstract concept and as a word has traditionally had very little meaning outside economics. In this paper, it means the environmental costs associated with producing a good or a service, which the producing company is not paying for. It also should be understood as an umbrella term for costs that in real life manifest itself very differently compared to one another in different industries and different regions.

Company reporting is inconsistent

Company specific externality data is needed to measure and manage externalities at portfolio level. The challenge is that the data needs to be high enough quality to do so, and company specific externalities are difficult to define and measure for individual companies, let alone large investable universes of companies. This is understandable and characteristic to many environmental, social and governance (ESG) data sets.

With few exceptions (*Environmental reporting guidelines*, 2013; EPA 2012), companies are not regulated to report on the externalities they produce. Externalities manifest themselves differently in different sectors and different regions, therefore reporting practices vary between them. Externalities impact a wide range of stakeholders – including companies, regulators, civil society from different parts of the world – and the relevant accounting frameworks are time consuming and costly to establish. Thus, the accounting frameworks required to report companies' externality impact are far from standardised. Supported by th Global Reporting Initiative (Global Reporting Initiative, n.d.) and few other similar initiatives, mandatory ESG reporting frameworks have grown from 35 in 2006 to 248 in 2016 (Carrots & Sticks, 2016, p. 9). The volume of sustainability reporting has mushroomed on the back of that. The amount of companies publishing something sustainability related in a global sample of the largest one hundred companies from 34 countries has grown from 18% in 1996 to 73% in 2015 giving plenty of material to work with.

As a result of this rapid proliferation of standards and reporters, externality data sets are young, messy and generally not available for very large investment universes, which makes it difficult to accurately establish the price of an externality for an individual company and investor. Therefore, statistical methods (sometimes involving heroic assumptions) are required, supplemented by trust and transparency between companies, investors, and the relevant third parties.

Measuring externalities in investment portfolios

Externality Footprinting is in its infancy within the investment community. Carbon footprinting is the most advanced where tools have been commercially available for a few years now. The Greenhouse Gas Protocol has developed metrics to compare different commercial approaches and has published a summary of the differences between major players (WRI, UNEP-FI, & 2° Investment Initiative, 2015, p. 45).

The recent popularity of carbon footprinting has been undoubtedly fuelled by investor initiatives. One example is the Montreal Pledge ("Montreal Pledge," n.d.), in which signatories commit to measure and publicly disclose the carbon footprint of their investment portfolios on an annual basis. Overseen by the Principles of Responsible Investment, it has attracted commitment from more than 120 investors with over US$10 trillion in assets under management, as of the United Nations Climate Change Conference (COP21) in December 2015 in Paris. It has wide ranging support from investors across Europe, the USA, Canada, Australia, Japan, Singapore and South Africa. Similar initiatives will drive not only carbon, but various other externality footprinting approaches in the future as well.

In light of the challenges discussed in the previous chapter, the paper presents a method to measure environmental externalities based exclusively on companies' self-reported data. This enables investors to produce externality footprints in-house without any external (commercial) inputs.

The method we have developed balances out companies' self reported biases as well as any subjective errors there might be in third party data. We believe that externality reporting by companies has improved greatly in the past decade, and is already accurate enough for the purposes of this method. Furthermore, we expect company reported data to substantially improve over time as the reporting frameworks develop and become more regulated and more accepted. Therefore we expect the results produced by this method to substantially improve over time. Finally, the method does not require any inputs that need to be obtained commercially, thereby reducing its application costs and therefore barrier to entry substantially.

The method is illustrated using water as an example. It consists of 4 steps:

Step 1: Get the externality data

As part of their sustainability and financial reporting, companies generally provide information on how their operations interact with a particular externality. Typically, this disclosure is qualitative and expressed in a form that is valid and needed to inform investment decision making. For externality measurement purposes, however, the quantified externality data points (tons of carbon emitted, litres of water withdrawn etc.) are the only ones that matter. As described before, the quantity and quality of this data varies greatly for understandable reasons. Company sustainability reporting is rarely audited, with regional differences in accounting conventions, definitions and even in units (gallons vs. litres in the case of water for example). Out of all externalities, carbon accounting frameworks tend to be the best ("Greenhouse Gas Protocol," n.d.), however, even carbon emissions reported by companies contain unfortunate amounts of errors.

It can also be suggested that companies have a considerable amount of flexibility to make assumptions that work in their favour when reporting. These companies may enjoy an advantage that goes beyond their commendable intention to report. As a result, anecdotally, large and well resourced companies tend to report better than smaller, resource scarce companies.

The first step in any portfolio externality measurement is to establish a high quality company specific externality dataset. The company specific data can be collected from companies themselves, or more practically via 3rd party data platforms, such as Bloomberg and Thomson Reuters. There are also various ESG service providers offering collected and estimated externality footprints for large investable universes. Multiple samples of the same externality indicator strengthen the data quality in later stages. The objective here is to gather a sample of a few thousand companies from various sources.

To illustrate the complexity of this task, Bloomberg has water data for around 2,200 companies, waste data for about 2,100 and carbon data for about 2,300 companies. The list below contains three different ways how this data might be erroneous or misleading:

1. Company reporting includes various different definitions. As there is no widely accepted water accounting protocols, companies use definitions like *water*

consumption, *water use*, and *water withdrawal* quite liberally, as exemplified in the screenshot below:

	Ticker		Short Name	Tot Wtr Use:Y	Tot Wtr Wthdrl	Salt Wtr Wthdrl
1)	ENEL	IM	ENEL SPA	22.70M	22.70M	13.39M
2)	ENGI	FP	ENGIE	--	13.74M	8.23M
3)	EXC	US	EXELON CORP	50.88M	22.28M	7.24M

Source: Bloomberg

We can see here that Exelon corp. report three different water numbers. One is for Total Water Use, including presumably every litre of water used, including recycled water; Total Water Withdrawal, which describes only the amount they have withdrawn externally to be used in their operations; and Saltwater Withdrawal that describes how much of that water is withdrawn from the ocean for cooling purposes and thus not competing with other industrial, residential, or agricultural uses.

The question is which number is the most accurate? The answer (unfortunately) is not clear-cut, as it all depends on the specific company and data under analysis.

2. Companies at times report data only for part of their operations. They might disclose ex. a water number in their sustainability report that only represents a fraction of the company's total operations. The example below describes a typical case:

A company reports how many cubic metres of groundwater they have withdrawn. This number is then replicated by 3rd party data platforms and research providers. The footnote in the original reporting suggests that there is something a reader should pay attention to.

WATER	
Freshwater withdrawal[4]	
Surface water (m^3)	0
Ground water (m^3)	3,756
Rainwater (m^3)	100
Produced water (m^3)	1,841,535

Source: Company reporting

The referred footnote located two pages away suggests that the reported water withdrawal represents company operations only in one country, in this case France.

[4] Quantities of freshwater utilised during onshore operations (France), excluding municipal water consumption for offices.

Source: Company reporting

Only further investigation from different sources, in this case Bloomberg, reveals that less than 10% of company operations are in France, rendering the company reported groundwater withdrawal number not fit for use.

In Millions of USD except Per Share	FY 2012		FY 2013		FY 2014		FY 2015	
12 Months Ending	12/31/2012		12/31/2013		12/31/2014		12/31/2015	
Revenue	1,319.5	100.0%	1,132.0	100.0%	785.2	100.0%	569.3	100.0%
Norway	1,050.6	79.6%	987.1	84.8%	591.0	79.1%	347.6	66.5%
Malaysia	–		–		0.0		71.2	13.6%
France	115.0	8.7%	110.2	9.5%	96.8	13.0%	50.6	9.7%

Source: Bloomberg

While these issues would be unfathomable in audited financial accounting information, reporting like this is acceptable for companies when providing ESG related information.

From the investor's point of view some data might be better than no data at all, as investors can use information like this to estimate a company's total emissions across all operations. It would benefit the company to have their numbers enter the investment processes accurately, but even best estimates can help.

3. Research provider error

ESG information including water information is often published in PDF files that are not easily searched and categorized. For example, in the table below, both machines and humans might read that the company used 5611 million cubic metres (cbm) of process water in 2015, while the actual unit of the table refers to energy use related to processing water, not water use per se.

Energy source	2012	2013	2014	2015
Storage capacity (in million cbm)	0.8	0.8	0.8	0.8
Process water	1,184	1,626	5,412	5,611
Electricity (TJ)	318	328	346	362
Total indirect energy (TJ)	**1,502**	**1,954**	**5,758**	**5,973**
Total relative indirect energy (MJ/cbm)	**1,789**	**2,327**	**6,855**	**7,111**

The energy source process water for 2014 is restated as our Altamira - TLA Terminal did not report on its process water.

Source: Sample company reporting

All of the three examples above show how company specific data points are often inaccurate and how this potentially makes investment universe wide externality datasets misleading. From this we conclude that the errors, including but not limited to the examples mentioned above, have to be controlled for.

One intuitive and accessible way to do this is to check the universe for outliers using sample standard deviations across different company groups using industry classification levels (depending on amount of data disclosed) and countries. Companies that report 1000x more or less emissions than their peers fox example should be fixed or omitted from the sample.

Finally, we suggest this dataset should be normalised by company size whilst controlling for different reporting currencies, as well as for different units and reporting years with the following format when gathering and merging data from various data sources. The final table may differ in details depending on the use case (for example for a US only universe it may be more practical to retain gallons as unit if it is the most commonly reported), but we propose a general format as an example in the table below. Using a format with specific units and time stamps for data points promotes the consistency and reliability of the resulting dataset. We suggest using a major currency as the unifying currency and SI units (grams, tons, litres etc.) as accounting unit as this usually guarantees the least amount of, potentially erroneous, conversions.

Table 1. Company specific externality dataset structure

Company name	Externality emitted	Matching revenue	Externality intensity
Company A	x litres… in year z	y USD… in year Z	x/y litres/USD in year z
Company B	...	...	...
...			

The final dataset should have several thousand companies with exact count depending on the externality, each with one specific, accurate emissions per revenue datapoint per company. This final dataset can be further quality controlled. Do the largest and smallest emitters per country for example broadly line up with intuition on their industry classifications? Thermal utilities use a lot of cooling water, so their water use should be higher than most other industrial activities. Breweriers and soft drinks manufacturers require fresh water to run their production, so their water use should be higher than other consumer goods companies.

Step 2: Company exposure per business model

Mapping companies' potential exposure via their revenue or assets is the second independent step in establishing an externality dataset for a large investment universe.

It would be intuitive to assume that most investors are well aware of what products and services companies in their portfolios offer. In practice however, it is surprisingly difficult to establish this accurately for large investment universes. The easiest and most intuitive option is simply to use one of the existing commercially controlled industry classification systems like the Global Industry Classification System (GICS) controlled by MSCI, or Industry Classification Benchmark (ICB) controlled by FTSE Russell. However, industry and company classification systems tend to serve a commercial purpose and are not designed to be particularly accurate.

Furthermore, all industry classification systems have one fundamental flaw. Companies, especially large listed companies, might have a very diverse set of operations, and most companies strive to differentiate themselves from one another to gain competitive advantage. Some might acquire equity stakes in their key suppliers in order to ensure a sustainable supply of an important raw material or a component. Some companies might diversify into other completely unrelated businesses in order to diversify the cyclicality of their core businesses. Most industry classification systems do not take this into account and simply categorise companies into industries and sectors where the companies make the majority of their revenue, i.e. if the company makes 60% revenue in oil exploration and 40% in renewable energy technologies, it will be classified as an oil exploration company among those companies that make 100% of their revenue from oil exploration. Needless to say, this completely skews the bases to estimate the companies' externality exposure. Renewable energies have a fraction of the environmental externality impact (ex. GHG, water) of fossil fuels – omitting this in the previous example will significantly distort the final outcome.

A more laborious but much more accurate option is to use a more granular revenue breakdown of companies' products and services. For our example from the previous paragraph, the difference would be using a weighted 60% estimate from oil exploration companies and 40% from renewable energy companies vs. simply an oil exploration one and ignoring 40% of the company's diversified revenues. We may then want to set a threshold for the inclusion of companies' reported data into the regression estimate sample, for example a minimum of 70% or 80% revenues from the product or service. The ability to set high thresholds will depend on how well or how thinly disclosed the data is in the industry and may lead to a trade-off with the sample size. Despite these additional considerations and challenges, as a rule of thumb, the more granular the system, the more accurate the estimate is as an output. Obtaining granular inputs in-house may be resource intensive, as publicly available revenue data provided by companies tend to be complex to parse. There are commercial solutions available from various data providers like Bloomberg and Factset. Naturally the commercial solutions have their own strengths and weaknesses that have to be taken into account when assessing the practicality and usefulness of one commercial dataset over another.

The outcome of step two is to have data on how different companies are exposed to a particular externality via different business activities. We argue that one should have a data set that is as granular as it is meaningful when describing companies' exposure to different products and services expressed in revenue to accurately estimate their contribution to the externality at hand.

Step 3: Run regression model with the exposure and externality data

The externality intensity figures from Step 1 together with the business model, i.e. product/service revenue breakdown from Step 2 can be set up as a large set of linear equations. These equations are then optimised using relatively simple and well established statistical tools provided by Excel, Matlab or R. Note that there are several choices to be made when using statistical modelling which might affect the end results.

The regression results give an estimate of how many units of an externality (e.g. liters of water) companies create to generate one unit of activity (e.g. US dollars of revenue).

Step 4: Final outcome – combining measured values with regression results

The estimates can be used on their own, but can also be combined with the actual reported numbers by reporting companies. Externality accounting tends to be asymmetric, meaning that companies themselves are usually better positioned to estimate their own externality impact, and therefore using (reliable) company reported numbers to establish portfolio level externalities usually leads to more accurate results.

Table 2. The final outcome of company specific externalities

Company	Domicile/Sector/…	Intensity	Reported/estimated
Company A	…	X units of externality/revenue	R/E
Company B	…	…	R/E
…	…	…	…

The end results show how much of an environmental externality a product/service creates for each unit of revenue in the reference universe. This establishes the basis for any externality based action an investor might take. Some examples are listed below:

Footprint any portfolio against any benchmark or other reference point.

Establish industry averages and monitor individual company performance over time and against selected peers.

Optimise existing portfolio against certain investment constraints (like tracking error).

Heat mapping an investable universe to identify problematic areas.

Identify the problematic sectors, regions and companies for engagement programs.

Externalities and materiality in an investment context

As we touch upon applying the externality dataset in an investment context, the issue of materiality deserves a final mention. Assigning some materiality values to an externality dataset will inherently be an exercise in managing risk and/or seeking alpha and as such is up to each individual investor to develop their own view or choose an external framework they are comfortable applying. For those investors looking to develop one themselves, we propose a base framework for doing this. The table below describes the similarities and differences between different environmental externalities from a materiality point of view. We characterize each externality with the following materiality drivers:

SPATIAL refers to how local the externality impact is

TEMPORAL refers to how much a particular externality varies over time, ex. through the seasons

GLOBAL PRESSURE refers to how much global organisations and governance pay attention to and impact the issue at hand

LOCAL PRESSURE points out how organised local communities and local NGOs are around the issue

LINK TO LISTED COMPANIES refers to how much a particular externality can be linked to listed companies

MATERIALITY hypothesizes different ways for the issue to materialise

The table on the following page summarizes the basics of this as applied to the main externality types and can be used as a base structure to help guide investors in establishing their own materiality matrix.

Table 3. Various externalities and their materiality drivers

	Spatial	Temporal	Global Pressure	Local Pressure	Link to listed companies	Materiality
Greenhouse gases	Global concern and impact	No meaningful seasonal variation from investor point of view	Yes, under the UN umbrella	Several local pressure groups pushing the global GHG	Strong, large corporations emit lot of GHG's	Societal pressure, regulation, substitution
Water	Local impact linked to water basins, precipitation and water tables	Substantial	Various global pressure groups	Yes	Yes, large corporations might use large quantities of water	Scarcity, substitution, local pressure
Local Air emissions	Yes revolves around cities and industrial zones and infrastructure	Some variation	No with few notable exceptions like ozone.	Yes particularly around most affected cities	Yes, certain production processes emit a lot of nitrogen and sulphur dioxides for example.	Local pressure, substitution, regulation
Solid Waste	Yes, very local	No	Few notable exceptions like plastic in oceans	Yes, particularly around most affected areas	Yes, depending on a business model	Regulation, local pressure, substitution
Chemicals	Yes	No	Yes, depending on a chemical.	Yes	Yes, listed corporations use a lot of chemicals defined to be hazardous	Stakeholder pressure, regulation
Land use/soil erosion	Yes, some regions are more vulnerable than others.	No	Not much outside academia	Sometimes	Sometimes, although mostly indirectly.	Stakeholder pressure, scarcity
Biodiversity	Yes, the biodiversity hotspots are very concentrated	No	Not much outside academia	Sometimes	Sometimes	Stakeholder pressure
Other Ecosystem services (recreational, cultural)	Yes	Sometimes	No	Yes	Sometimes	Stakeholder pressure

Conclusion

Externality footprinting is in its infancy within the investment community with only carbon footprinting done systematically. Yet, we believe this is precisely where (sustainable) investment should be headed. Measuring carbon, water, or any other externality footprints lays the groundwork for any kind of management of the externality in question, from engagement to optimisation, and even divestment. Furthermore, various environmental externalities directly link to sustainable development as we understand it today, and managing environmental externalities well takes investors more than halfway towards aligning investment portfolios with the SDGs.

The quality of externality data reported by companies has traditionally been a barrier to entry for investors to working with externalities. Its quality and quantity has substantially improved during the past few years, and will continue to improve going forward. Because of this, externality footprinting for investors generally tends to require (costly) commercial services from external parties. To counter that, this paper has discussed how a water footprint, just like any other externality footprint, can be established in-house by any investor, using only publicly available material, thus not only keeping the sometimes heroic assumptions under investor control, but also making it considerably more affordable.

We believe that externality footprinting is an important tool of (sustainable) investment and should be part of the toolkit of large and small investors alike. We hope that the approach explained in this paper makes this easier to achieve.

Key Takeaways

- Environmental externalities are an increasingly important metric for investors to employ across their entire investment universes, not only because of their huge sustainability impact but also on materiality grounds
- Both consistency and quanitity are lacking in reported externality data. Datasets cleaned, normalized, and filled in with estimates are available commercially, but their cost and the lack of transparency and control over assumptions and errors made in the process of creating them can be unattractive to investors
- We present an alternative in the form of a 4 step framework investors can follow to build their own externality datasets in-house. The quality of the resulting dataset will be equivalent to commercially available ones, and fully sufficient for investment purposes, but with the added advantage of the investor being aware and in charge of the methodological choices, and introduced assumptions or biases

Step 1 – Data collection

The starting point for building a large investment universe externality data is to obtain a sample of a couple thousand reported numbers to act as the estimation sample. A practical source of this is 3rd party platforms. We recommend using more than one source for the same universe.

We identify 4 things the investor should be mindful of as they approach this task:

(i) There is a variety of externality measures reported – when gathering data and triangulating between sources we must pay attention to their consistency

(ii) Reporting may be incomplete, for example covering only part of a company’s operations

(iii) Data obtained via third party platforms may contain errors such as incorrectly interpreted units

A meaningful proportion of these errors can be eliminated by triangulating between sources and checking for outliers within industries and over time.

The resulting dataset should be consistent and normalized to eliminate company size and currency as factors in externality figures.

Step 2 – Structuring the dataset by product & service exposure

Environmental externalities are very much driven by the type of products & services the company offers. To come up with robust estimates, we suggest choosing an industry classification system to group companies into granular enough estimation samples to yield reliable results.

Step 3 – Regression estimates

Based on the reported data sample built in Step 1, and the industry classification applied in Step 2 to group it into estimation samples, the investor can calculate regression estimates for each product & service category, to then be applied to the non-reporting companies' industry exposures mix and come up with their estimated externality figures.

Step 4 – Combine the estimated and reported datasets

The reported data sample and the estimated universe can be combined into the full investment universe externality dataset and applied to measure and manage investment portfolio's externality exposure and impact.

References

Carrots & Sticks. (2016). Retrieved from KPMG website: https://home.kpmg.com/xx/en/home/insights/2016/05/carrots-and-sticks-global-trends-in-sustainability-reporting-regulation-and-policy.html

Currents of change. (2016). Retrieved from KPMG website: https://assets.kpmg.com/content/dam/kpmg/pdf/2015/11/kpmg-international-survey-of-corporate-responsibility-reporting-2015.pdf

The KPMG survey of corporate responsibility reporting 2015

Dowell, G., Hart, S., & Yeung, B. (2000). Do corporate global environmental standards create or destroy market value? *Management Science*, *46*(8), 1059-1074. Retrieved from http://www.stuartlhart.com/sites/stuartlhart.com/files/Dowell%20Hart%20%20Yeung%20Mgt%20Sci%202000.pdf

Environmental reporting guidelines. (2013). Retrieved from Department of Environment, Food and Rural Affairs website: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/206392/pb13944-env-reporting-guidance.pdf

FAO AQUASTAT. (2016). Retrieved from Food and Agriculture Organization of the United Nations (FAO) website: http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

Global Reporting Initiative. (n.d.). GRI's History. Retrieved September 23, 2016, from https://www.globalreporting.org/information/about-gri/gri-history/Pages/GRI's%20history.aspx

Greenhouse Gas Protocol. (n.d.). Retrieved from http://www.ghgprotocol.org/

Learn About the Greenhouse Gas Reporting Program (GHGRP) | Greenhouse Gas Reporting Program (GHGRP) | US EPA. (2012). Retrieved from EPA website: https://www.epa.gov/ghgreporting/learn-about-greenhouse-gas-reporting-program-ghgrp

Montreal Pledge. (n.d.). Retrieved from http://montrealpledge.org/

Owen, A. D. (2006). Renewable energy: Externality costs as market barriers. *Energy Policy*, *34*, 632-634. Retrieved from http://www.ceem.unsw.edu.au/sites/default/files/uploads/publications/MarketBarriers.pdf

Robins, N., & Zadek, S. (2016). *Imagining a sustainable financial system*. Retrieved from UNEP website: http://unepinquiry.org/wp-content/uploads/2016/02/Imagining_a_Sustainable_Financial_System.pdfcontent/uploads/2016/02/Imagining_a_Sustainable_Financial_System.pdf

Sustainable financial system, PRI formal consultation. (2016). Retrieved from Principles of Responsible Investment website: https://www.unpri.org/download_report/17906

Trucost. (2011). *Universal ownership: Why environmental externalities matter to institutional investors*. Retrieved from UNEP Finance Initiative & Principles of Responsible Investment website: http://www.unepfi.org/fileadmin/documents/universal_ownership_full.pdf

Urwin, R. (2011). Pension funds as universal owners: Opportunity beckons and leadership calls. *Rotman International Journal of Pension Management*, *4*(1), 27. Retrieved from http://rijpm.com/admin/article_files/fulltext_(5).pdf

WRI, UNEP-FI, & 2° Investment Initiative. (2015). *Climate strategies and metrics: Exploring Options for Institutional Investors*. Retrieved from http://ghgprotocol.org/sites/default/files/ghgp/Climate%20targets_FINAL_med.pdf