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Analysis

Understanding the shadow impacts of investment and divestment decisions: Adapting economic input–output models to calculate biophysical factors of financial returns

J. Ritchie *, H. Dowlatabadi

Institute for Resources, Environment and Sustainability, University of British Columbia, 2202 Main Mall, Vancouver, BC V6T 1Z4, Canada

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ABSTRACT

In recognition of the cumulative effects resulting from financial decisions, a growing number of campaigns are advocating for the removal of investment funds from companies responsible for high levels of carbon emissions. A systematic approach can aid in examining the social, economic and environmental impacts that extend beyond political motivations to divest from fossil fuel companies.

We have adapted publicly available economic input–output life cycle assessment models (EIO-LCA) to develop a Shadow Impact Calculator (SIC) for examining the potential environmental impacts of investment decisions. An investment portfolio's shadow impacts represent the economic, social and environmental effects underlying an investor's decision to place their funds in particular financial instruments. In this study, we focus on greenhouse gas emissions to show which sectors of the United States economy have particularly large or small carbon shadows and place those results in the context of volatility and earnings. To demonstrate how SIC may be used, we examine the endowment investments of a Canadian university in the context of divesting from fossil fuel companies. Our analysis suggests that large pooled funds choosing to direct their investments away from heavy carbon emitters may have less of an impact than would otherwise be expected.

1. Introduction

Financial investments are inherently a multi-attribute decision. Traditionally, an investor seeks to balance risks and rewards by allocating a portfolio across ranges of sectors and asset classes. We suggest that conventional financial metrics can be augmented to frame the effects of portfolio allocation decisions on climate and energy systems. For this study, we have extended economic-input output models for use with decisions on financial investments. This approach is used to model the potential results of choosing to divest a university endowment from fossil fuel companies.

Recent campaigns advocating for divestment have focused on pressuring institutional investors to remove funds from carbon intensive financial holdings because of their long-term association with greenhouse gas emissions. While the fossil fuel divestment campaign has raised important questions through an active social movement around the moral and political viability of continually obtaining investment income from holdings of fossil fuel companies, this study seeks to understand the potential reliance of investment funds on whole-economy contributions to climate change through applying a Shadow Impact Calculator (SIC), built on the economic input–output life cycle assessment (EIO-LCA) framework[1] (Matthews and Small, 2000).

Because no company operates in isolation from the whole economy, measurements of an investment's *shadow impact* use EIO-LCA to reflect the chain of interactions that make it a desirable financial instrument. We define the shadow impact of an investment as the patterns of resource mobilization that support the value of a financial instrument.

The following work is focused on examining the carbon emission shadow of equity investments. Divestment is modeled in its ability to move money from one sector to another, potentially reducing the size of the carbon shadow needed to support the returns received by a particular investor. Reductions of a carbon shadow in this context should not be perceived as inevitably leading to an absolute reduction in greenhouse gases across the whole economy. Further development of SIC as an extension to the EIO-LCA methodology opens the possibility of exploring many additional environmental, material and social impacts of investment decisions for a broader range of asset classes across ranges of time.

* Corresponding author. Tel.: +1 919 701 9872.
E-mail address: emailjustinritchie@gmail.com (J. Ritchie).

[1] Environmentally extended input–output (EE-IO) adds to monetary input–output (IO) tables developed through a national economic census with information on environmental impacts for each sector (Hendrickson et al., 2006; Miller and Blair, 2009; Victor, 1972). EE-IO models form the basis of the EIO-LCA foundation of SIC.

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Table 1
Available methodologies for calculating financed emissions.
2° Investing Initiative (2013).

Model name	Methodology	Scope	First availability
Trucost	Extensive database of carbon data reported by companies + proprietary EE-IO model for non-reporting companies	More than 4500 listed companies	2006
INRATE	EE-IO model supplemented with LCA data of products	More than 2800 listed companies	2006
Profundo	Tracking fossil-fuel company transactions using Bloomberg and public data	Bank ratings based on financing provided to fossil-fuel extraction	2011
Cross-asset footprint	Based on Inrate data extrapolated to include financial instruments beyond equities	Listed non-financial companies and financial institutions, sovereign bond, loans, mortgages and green projects	2012
South Pole carbon screener	Extrapolation for each sector based on reported carbon data	Every listed company	2012
Camrdata Carbon Screener® Model	Carbon disclosure project data	Roughly 8000 listed companies	2013
ASN Bank	Based on Trucost for equities along with reported data and national statistics for other products	Methodology applied to its own balance sheet to reach carbon neutral by 2030 goal	2013

Table 1 contents adapted from 2°C Investing Initiative comprehensive review.

When compared to alternative approaches for measuring the greenhouse gas implications of financial holdings, SIC provides the advantage of being applicable on a range of economic scales by using readily available public information. Once the per-sector composition of a portfolio's investments is known, we can apply EIO-LCA to understand the broader economy-wide effects. In the context of movements advocating divestment from large-scale contributors to climate change, this approach is useful for examining the life cycle impacts of decisions to move money from one sector to another. If data are available on the specific companies held by an investor, the SIC model may be adapted to reflect the precision of funds transferred between specific equities.

As reflected in Table 1, SIC is only one methodology in a growing toolbox of assessments attempting to understand the environmental impacts of financial investments (2° Investing Initiative, 2013). It is our opinion that no single methodology is currently able to deliver a comprehensive picture of biophysical impacts associated with an investment.

Leading tools for estimating the emissions associated with an investment use a range of methodologies, as summarized in Table 1. At the smallest scale, directly reported data (often based on process-based LCA) from companies may be used to calculate financed emissions. This micro-scale approach can be combined with data on macroeconomic and cross-sector transactions to obtain a more comprehensive calculation. An example of a multi-scale approach to calculate financed emissions is exhibited by Trucost[2] which uses a comprehensive database of company reports combined with environmentally extended input–output models (EE-IO) and LCA data on products (van Ast and Dell'Aringa, 2009).

It is difficult to determine how closely the proprietary methodologies listed in Table 1 would resemble the outputs we obtain with SIC. The process by which EIO-LCA calculates biophysical impacts associated with economic activities relies on EE-IO data, as do several of the currently available methodologies. Where it appears Trucost, Inrate and SIC may differ in applying these EE-IO matrices and in the range of outputs that may be obtained: the EIO-LCA data used by SIC is traced through economic activity in the entire supply chain and data are available for a range of impacts.

To demonstrate how SIC may be applied toward the question of divestment, the endowment investments of a leading Canadian university are analyzed for their carbon shadow using statements issued from the campus' Treasury department.

2. Methodology

SIC's framework is based on EIO-LCA which is developed from input–output tables of a national economy. These IO tables reflect the cost of goods purchased and sold. EIO-LCA is publicly available for use, and may be accessed online at http://www.eiolca.net. We apply the EIO-LCA 2002 United States Benchmark Producer Price model to US and international equity holdings and the 2002 Canada Industry Account Model for Canadian equity holdings (Carnegie Mellon University Green Design Institute, 2013a, 2013b).

The economic prospects of a company (i.e., exposure, expected growth and earnings for investors) are primary factors in determining its financial valuation. Thus, different sectors and companies exhibit wide variations in their price–earnings (P–E) ratios: a metric that suggests how much a particular investor is willing to pay for equity for one dollar of earnings. Conventional capital asset pricing models aim to calculate the appropriate rate of return of an asset but have no understanding of returns on natural capital. We suggest that biophysical factors may also potentially play a role in determining a security's price and can be expressed as the shadow impacts of an investment.

The SIC approach for modeling the shadow impact of an equity investment begins with gathering revenue data reported by companies and the market price for their shares at a given date. This relationship is commonly expressed as the price–sales (P–S) ratio: a formulation of how much an investor will pay for a dollar of sales generated by the company to consumers or producers. SIC uses an equity's P–S ratio as the link between activities in the financial sector and activities in the broader economy. This process is shown in Fig. 1. Where P–S ratios aren't readily available, they may be calculated by dividing the market capitalization for a company (the total market value of the company's outstanding shares) by the total annual revenues of the company.

Once a relationship is established between an equity share's price and a corresponding amount of economic activity in a specific sector, EIO-LCA models provide the corresponding environmental or social impacts for which an investor is willing to pay. This adaptation of EIO-LCA for use with financial instruments allows SIC to model the environmental, social and resource impacts that deliver returns to a specific investor.

EIO-LCA calculates the greenhouse gas outputs from flows of purchases between sectors as a vector ($\Delta \boldsymbol{b}_{CO2e}$) which is a function of the greenhouse gas emissions released by economic activity per dollar of output ($\boldsymbol{R}_{CO2e}$). This is shown in Eq. (1) which was adapted from Hendrickson et al., 2006.

$$\Delta \mathbf{b}_{CO2e} = \mathbf{R}_{CO2e}(I-A)^{-1}y \tag{1}$$

where: $\Delta \boldsymbol{b}_{CO2e}$ is a vector of the greenhouse gas outputs resulting from the supply chain of a purchase; $\boldsymbol{R}_{CO2e}$ is a matrix of the GHG impact per dollar of output at each stage of economic activity; $(\boldsymbol{I}-\boldsymbol{A})^{-1}$ represents the series of the supply chain engaged by a purchase (Hendrickson et al., 1998; Lave et al., 1995; Leontief, 1970); and $\boldsymbol{y}$ is the final demand, measured with SIC as the revenues generated for a particular company that sells products or services to a producer or consumer.

[2] Trucost is considered the industry leader in calculating financed emissions; their commercial activity generates roughly £2 million each year of which approximately 50% is devoted to investor related studies.