DBS Impact Measurement Project

TECHNICAL REPORT
MARCH 9, 2020

SMU
SINGAPORE MANAGEMENT UNIVERSITY

SIM KEE BOON INSTITUTE FOR FINANCIAL ECONOMICS

LEE KONG CHIAN SCHOOL OF BUSINESS

About this report

This report work was commissioned by DBS and SMU's Sim Kee Boon Institute and serves as an evaluation of the Pilot Study on DBS Impact Measurement conducted by Impact Institute. This report was written by Professor Hao LIANG and Dr. Phuong T.B. NGUYEN of Singapore Management University (SMU). Professor David Fernandez and Dr. Junho PARK from SMU also made significant inputs into the report.

ACKNOWLEDGEMENTS

This report has benefited from important inputs of Mikkel Larsen and Eunice Tan (DBS), Florian Reuter, Adrian De Groot Ruiz, and Valerius Vandru Hartanto (Impact Institute), as well as insights from a variety of thought leaders working in the Sustainable Finance field. Priscilla Cheng and Eugene Chiu (SMU-SKBI) have provided excellent assistance in drafting the report. All opinions and errors remain the sole responsibility of the authors.

Contents

Executive Summary

- The measurement of ESG and its impact is becoming one of the more important and debated issues in sustainable business practice, with the significant challenges being the subjectivity of scope, criteria, as well as lack of consistency across different rating agencies and data providers
    - Impact measurement goes beyond ESG measurement. Apart from qualitative and input-based approach, it encapsulates a more outcome/impact-based approach, supported with quantitative methods
- Impact measurement and valuation are still at the infant stage, with limited research and guidelines, thus II's approach has significant novelty and is among the first to measure and value impact
    - II works with partners to continuously improve its approach, and helps the development of the field by providing a proof of principle that some of the challenges can be tackled
- The data compiled through Impact Institute's (II) Global Impact Database (GID) are generally in line with what has been used in the mainstream academic literature; however, some data sources used by II focus more on Europe (e.g., Exiobase, European Social Survey), which may not be suitably adapted for the Asian context, and the inclusion of non-English sources can be improved
- The methodologies employed by II (Integrated Profit and Loss Assessment) are based on straightforward and acceptable assumptions; however, there is room for improvement with regard to (i) the attributions along the global value chains; (ii) the rigid weights between direct and indirect impact distribution; (iii) consideration of higher order indirect impact along value chains; (iv) use of interest rate in impact attribution to the loans made by financial institutions
- The two case studies on Palm Oil sector and Automotive (electric vehicles (EV) versus combustion engine vehicles (CEV)) sector both utilise the methodologies and the data developed by II, but embody different approaches reflecting different characteristics of these two sectors
    - The analyses of the palm oil industry involve the combination of the top-down assessment on global demand and supply and bottom-up country- and industry-specific data
    - The Automotive sector is analysed through the bottom-up approach since the production of EVs is composed of several stages assembling a multitude of parts from various sectors
    - Caveats in II's case studies of the two sectors include insufficient higher order impact assessment (i.e. the indirect impact from the education of farmers' children), and leaving the indirect impact of electronic disposals at the end-of-life phase of EVs out of scope
- Overall, the methodologies and the data utilised by II are broadly consistent in comparison with the recent academic literature on the assessment of ESG impact, but may not be fully generalized to other countries and sectors

1 Introduction

1.1 DBS past efforts in sustainable & responsible finance

DBS builds its sustainability framework on three pillars: responsible banking, responsible business practices, and creating social impact. The bank strongly promotes responsible and sustainable finance by offering multiple products and services that target sustainable development of businesses. Green loans and sustainable bonds finance/re-finance social and green projects, with an aim of advancing environmental sustainability. ESG funds factor in environmental, social, and governance (ESG) considerations into the investment process. DBS continuously explores opportunities to incentivise sustainable practices of its customers. Sustainability-linked loans integrate ESG performance metrics in their interest rate assessment, motivating companies to achieve sustainability targets for a better interest rate. In addition, the ESG risk assessment process incorporating Group Core Credit Risk Policy, Group Responsible Financing Standard, and Sector Guides enables DBS to obtain an overall understanding of the customers' approach to managing projects in terms of environment, society, and governance. It demonstrates the institution's commitment to sustainability in making lending decisions as well as its expectations of customers to uphold responsible business practices.

With this project collaboration with Impact Institute and Singapore Management University, DBS is taking a step further in ensuring their loans are creating significant positive impact on the environment and communities in which they operate. The Bank has explored many models for "Impact Measurement", including Integrated P/L, Impact Weighted Accounts, IMP and UNEP FI's Positive Impact Initiative. The project is expected to provide a consolidated approach with a comprehensive and insightful presentation for the loans' impact assessment purpose of DBS.

Other sustainability initiatives taken by DBS include managing its environmental footprints, adopting environmentally friendly technologies, and encouraging its employees to adopt sustainable behaviours through raising awareness and engagement on sustainable lifestyles. In addition, DBS has been producing integrated reports in accordance with the Integrated Reporting <IR> Framework and Global Reporting Initiative (GRI) Standards since 2015. These actions ensure all stakeholders are well-aware and up-to-date with DBS's ongoing efforts in adopting sustainable and responsible financing practices.

1.2 SMU's past efforts in sustainable finance

SMU is a pioneer in Singapore and in the whole Asia-Pacific region in promoting research and education around sustainable finance. Over the past few years, SMU has put significant efforts in building up its capacity in this area. Faculty members at SMU have published numerous research articles on the topics of ESG/sustainable finance in top-tier journals including *Journal of Finance*, *Journal of Financial*

Economics, *Academy of Management Journal*, *Management Science*, *Organization Science*, *Management Science*, *Oxford Review of Economic Policy*, *Journal of Corporate Finance*, *Journal of Econometrics*, among others. The team leader of this project, Prof. LIANG Hao, holds the DBS Sustainability Fellowship and has won several international awards, including twice the prestigious Moskowtiz Prize on Socially Responsible Investing, Alliance for Research on Corporate Sustainability Emerging Scholar Award, FIR-PRI Finance and Sustainability Award, Sustainable Finance Geneva Prize, Zephyr Prize for Best Corporate Finance Paper, Mirae Asset Daewoo Co., Ltd. Outstanding Paper Award, among others.

In terms of education, SMU has launched the Sustainability major (as the second major) at both the undergraduate and postgraduate levels. As part of the initiative, a course on Sustainable Finance has been taught at both levels starting from 2019. A short-term course on Sustainable Finance and Impact Investing is also offered to the public via SMU Academy. Faculty members have developed original teaching cases on sustainability issues in China and Asia via SMU's Center of Management Practice.

With regard to knowledge dissemination, SMU has been actively holding conferences, workshops and roundtables to facilitate deep dialogues between academics and the industry. These efforts include the SKBI Conference on Green and Ethical Finance (September 16-17, 2020; co-organised with Asian Development Bank Institute and Journal of Banking and Finance) at SMU, 9th Annual SKBI Conference on Sustainable Finance (November 7-8, 2019; co-organised with TBLI Group) at SMU, Sustainable Finance Forum (July 13-14, 2019; co-organised with CUHK Shenzhen and Shanghai Advanced Institute, SJTU) in Shenzhen, the Influential Impact Lunch – Sustainability (May 21, 2019) at SMU, among others.

1.3 DBS-SMU collaborations

DBS has established strong collaborations with SMU on various projects. The recent DBS-SMU Sustainability Initiative in February 2019 supports academics, businesses, and students passionate about tackling real world sustainability challenges. The program introduces Singapore's first sustainability major, and funds sustainability research, fellowships as well as community engagement projects. There are many other collaborations made through SMU's Sim Kee Boon Institute (SKBI), which include a research project on DBS' online banking data ("Physical Frictions and Digital Banking Adoption" by Hyun-soo Choi and Roger Loh), a project on "Sustainable Digital Finance in Asia: Creating environmental impact through bank transformation" (joint with Sustainable Digital Finance Alliance and UN Environment). An ongoing project is investigating credit decisions that involve tradeoffs between sustainability goals and developing dashboard/rubric for making loans.

1.4 Impact Institute's (II) previous works

Impact Institute (II) is a social enterprise, with a mission to "empower organisations and individuals to realise the impact economy by creating a common language for impact and providing the tools to use it." (Impact Institute) Impact Institute has been developing open-source standards for measuring and valuing impact, as well as providing training and services to organisations. The organisation recently circulated the beta version of "Framework for Impact Statements", which serves as a guide for impact statements. This is a progressive effort as more organisations and companies adopt ESG data reporting and produce integrated reports, in which impacts are measured and integrated in accounting statements to illustrate their value implications. II has been working with multiple clients (ABN-AMRO, DSM, Akzo Nobel, etc.) on quantitatively measuring impact of their businesses and/or their investments, as well as on delivering the valuation on annual reports to stakeholders. They have successfully developed integrated profit and loss reports for the bank ABN AMRO. II also works with organisations such as The Economics of Ecosystems and Biodiversity (TEEB) by United Nations Environment Programme (UNEP), Fairtrade International, and Ministry of Economic Affairs of the Netherlands on a variety of sectoral case studies, analysing environmental, societal and human impact of production systems and products.

Impact Institute has been working with European, Latin American, and African organisations. This project with DBS is one of the first of their efforts in extending their expertise to Asian context. Asian and European economies bear many discrepancies in terms of economic and social standards. Therefore, this project offers an opportunity to observe how the Integrated Profit and Loss Assessment methodology as well as the integrated reporting framework that Impact Institute has developed adapt in a more diverse condition.

2 Literature Review

2.1 ESG: definition and implication for firm value and investor return

ESG is the broad umbrella term that refers to the incorporation of environmental, social, and governance considerations into corporate management and investor's portfolio decisions. Managers and investors typically assess these ESG factors using non-financial data on environmental impact (e.g., carbon emissions), social impact (e.g., employee satisfaction) and governance attributes (e.g., board structure). As the definition of the term evolves, researchers and practitioners are beginning to include more indirect factors into consideration, and have singled out the E&S components from the G component, as the latter refers to the traditional governance issues which have been discussed and studied for decades.

Table 1 below highlights some of the major ESG issues that companies are typically exposed. There is no consensus on the exact list of issues and their related materiality, but the concern is that some of these may affect the value creation by a firm. These issues are increasingly topical as a growing portion of firm value lies in intangible assets. While such intangibles as the value of a brand and intellectual property are increasingly reported on firm financials (even if reasonable estimates of their value vary widely), many ESG issues relating to intangibles, are most often, not reflected in traditional financial accounting statements.

Table 1. Main ESG Issues

Environmental (E)	Social (S)	Governance (G)
○ Climate change and carbon emission ○ Natural resources use and energy and water management ○ Pollution and waste ○ Eco-design and innovation	○ Workforce health and safety, diversity and training ○ Customer and product responsibility ○ Community relations and charitable activities	○ Shareholder rights ○ Composition of board of directors (independence and diversity) ○ Management compensation policy ○ Fraud and bribery

The environmental (E) dimension measures a company's impact on the natural ecosystem. This comprises emissions (e.g., greenhouse gases), the efficient use of natural resources in the production process (e.g., in terms of energy, water or materials), pollution and waste (e.g., oil spills), as well as innovation efforts to eco-design its products. The social (S) dimension covers a company's relation with its workforce, customers and society. It includes its efforts to maintain loyal workers (e.g., employment quality, health and safety, training and development), satisfied customers (e.g., producing quality goods and services that keep costumers safe) and being a good citizen within the communities it operates. The governance (G) dimension captures the systems in place for management to act in the best interest of its long-term shareholders. This includes safeguarding shareholder rights (e.g., limiting anti-takeover devices), a well-functioning board (e.g., with an experienced, diverse and independent composition), well-designed executive compensation policies and avoiding illegal practices such as fraud and bribery. There is a vast literature on ESG and CSR in finance, accounting, and management. In this section we only review the most representative ones in each field that are pertinent to this project.

The common explanation for why companies engage in ESG is that doing so enhances profitability and firm value, a relationship often referred to as "doing well by doing good" (e.g., Orlitzky, Schmidt, and Rynes, 2003; Flammer, 2015). Conceptually, ESG engagement can enhance firm value through signalling the company's product quality (Cao, Liang, and Zhan, 2019), building up social capital (Lins,

Servaes, Tamayo, 2017) and stakeholder support (Deng, Kang, and Low, 2013), playing a role of insurance and risk management (Koh, Qian, and Wang, 2014), motivating employees (Edmans, 2011), etc. Other studies consider the inverse, that is, "doing good by doing well," by examining whether it is only well-performing firms that can afford to invest in CSR (e.g., Hong, Kubik, and Scheinkman, 2012). The rationale behind this is that total firm value should include the welfare of various stakeholders besides shareholders, thus those with higher profitability for shareholders should also take care of other stakeholders. However, some scholars argue that ESG engagement may be motivated by managers' personal tastes which do not always align with shareholder value maximisation, thus signifies an agency problem (Cheng, Hong, Shue, 2013; Masulis & Reza, 2015; Krueger, 2015).

Empirical evidence of a positive link between corporate ESG (or E&S) engagement and long-term firm value also abounds. Earlier studies mostly examine only one perspective, such as employee welfare (Edmans, 2011), environmental protection (e.g., Dowell, Hart, and Yeung, 2000; Konar and Cohen, 2001), corporate philanthropy (e.g., Seifert, Morris, and Bartkus, 2004), or consumer satisfaction (e.g., Luo and Bhattacharya, 2006; Servaes and Tamayo, 2013). More recent studies looking at ESG as a whole find similar patterns. A meta-analysis of 60 review studies that combine more than 2200 unique primary studies conducted by Friede, Busch and Bassen (2015) documents that 90% of academic studies find a non-negative relationship between ESG and financial performance, of which 48% in vote-counting studies and 63% in meta-analysis show a positive correlation. This positive effect of high ESG on firm value is likely through the channels of lower cost of capital (e.g., El Ghoul, Guedhami, Kwok, and Mishra, 2011; Albuquerque, Durnev, and Koskinen, 2013), lower idiosyncratic risk and a lower probability of financial distress (Lee and Faff, 2009), more positive sell-side analysts' recommendations (Bushee and Noe, 2001), and more resilience to volatile market conditions such as during the global financial crisis (Lins, Servaes, Tamayo, 2017). It is worth noting that in the context of bank lending which is more relevant to DBS, studies find that firms with high environmental and social concerns face higher interest rates of their bank loans (e.g., Chava, 2014; Hoepner, Oikonomou, Scholtens and Schroder, 2016).

Another large and growing literature takes the investor perspective by studying sustainable, responsible and impact investing (SRI), especially those made through institutional investors. The Global Sustainable Investment Review (2019) reports that over US$ 30 trillion were managed according to responsible investment criteria across the world in 2018. There is an active debate around this topic in the academic literature. On one hand, if SRI creates a binding constrain on portfolio optimisation, we should expect a cost to performance. One the other hand, ESG advocates claim that SRI can enhance returns due to markets under-pricing of ESG information. Studies find that many investors accept lower expected returns on socially responsible investments and are willing to pay higher management fees.

The overall evidence suggests that investors value sustainability criteria and are willing to forgo financial performance in order to invest in accordance with their social preferences.

Several studies investigate the role of institutional investors' ESG preferences and their impact on portfolio companies ESG practice. The impact of institutional investors' ESG preference on portfolio firms' ESG is achieved mostly through engagement and proxy voting. In addition, collaboration among activists ("coordinated engagement") played an instrumental role in increasing the success rate of the engagements (Dimson, Karakas, Li, 2015 & 2019).

2.2 ESG measurement: current practices and challenges

One major challenge is that it is very difficult to measure ESG performance. This challenge may be why people usually focus on short-term financial metrics when evaluating a company. For that reason, ESG rating agencies can play a major positive role. They painstakingly collect and aggregate a range of information on a company's ESG performance – its own disclosures, third-party reports (e.g. from NGOs), news items, and proprietary research through company interviews and questionnaires. They derive an overall ESG score, as well as scores for the individual components (E, S, and G) separately. These ESG ratings are mostly given to publicly listed equities that are included in major global equity indices, are industry-adjusted (e.g., only comparing the ESG performance of companies within the same business sector) and utilise different methodologies. Some widely used ratings include KLD (now MSCI ESG STAT, with 3,000+ US companies), MSCI Intangible Value Assessment (now MSCI ESG, with 7,500+ global companies), Thomson Reuters ASSET4 ESG (now Refinitiv ESG, with 7,000+ global companies), Sustainalytics Company Ratings (with 11,000+ global companies), Dow Jones Sustainability Index (RobecoSAM), FTSE4Good, ISS ESG (Ethix), Oekom Corporate Ratings, GES International, Vigeo Eiris, S&P ESG Index and Trucost (including data from Carbon Disclosure Project), Bloomberg, Morningstar, FTSE Russell, Vigeo Eiris, etc. However, many have pointed to potential biases in ESG ratings, such as larger companies may receive better ESG reviews because they can dedicate greater resources to prepare and publish ESG disclosures, and control reputational risk, higher ESG assessments for companies domiciled in regions with higher reporting requirements, and normalizing ESG ratings by industry can be oversimplified.

An emerging literature deals with ESG disclosure and sustainability reporting (including integrated reporting). The common belief underlying this literature is that increased quantity and quality of ESG information can generate benefits to capital markets through greater liquidity, lower cost of capital and better capital allocation. Christensen, Hail and Leuz (2019) offer a comprehensive literature review of accounting and finance research showing that there currently exists substantial variation in ESG

disclosures across firms. This makes an objective comparison of two companies' ESG practices quite difficult, and posts challenges to a regulator in creating and enforcing reporting standards. However, prior literature also shows that corporate disclosures involve proprietary and litigation costs. For example, With regard to policy prescriptions, mandatory ESG reporting would have implementation issues in terms of ESG standard setting process, the materiality of ESG disclosures, the use of boilerplate language and difficulties in enforcement.

2.3 Impact measurement in impact investing

Another emerging trend of ESG is impact investing, in which investors intentionally seek to create both financial return and positive social impact that is actively measured. According to Global Impact Investing Network (GIIN), the global impact investing market has sized to over $500 billion by April 2019, more than doubled from the estimated 228 billion in 2018 and quadrupled the estimated $114 billion in 2017. In an article published on Harvard Business Review, Cole, Ghandhi and Brumme (2018) provide a background note on impact investing. Barber, Morse and Yasuda (2019) find that venture capital funds that aim not only for financial return but also for social impact earn lower returns than traditional funds, suggesting investors derive nonpecuniary utility from investing in dual-objective funds. However, the topic area still remains under-researched.

An important part of impact investing is the measurement of social and environmental impact. To the best our knowledge, there's no formal academic study on how to scientifically measure impact. Nevertheless, some approaches are adopted in practice by impact investors. For example, an HBS report identifies four methods of impact measurement in impact investing:

- **Expected return** takes into account the anticipated social benefits of an investment against its costs, discounted to the value of today's value, and can take various forms, including Social Return on Investment (SROI), Benefit Cost Ratio (BCR), and Economic Rate of Return (ERR).

- **Theory of change and logic model** explain the process of intended social impact. Specifically, logic model is a common tool used to map a theory of change of an organisation, intervention, or program by outlining the linkage from input, to activities, to output, to outcomes, and ultimately to impact.

- **Mission alignment methods** measure the execution of strategy against mission and end goals over time; examples include social value criteria and scorecards used to monitor and manage key performance metrics.

- **Experimental & quasi-experimental methods** are after-the-fact evaluations that use a randomised control trial or other counterfactual to determine the impact of the intervention compared to the status quo.

Similarly, in a Harvard Business Review article, Addy, Chorengel, Collins, Etzel (2019) propose a framework for calculating the value of impact investing and also a new metric of the *impact multiple of money* (IMM): (1) Assess the Relevance and Scale; (2) Identify Target Social or Environmental Outcomes; (3) Estimate the Economic Value of Those Outcomes to Society; (4) Adjust for Risks; (5) Estimate Terminal Value; (6) Calculate Social Return on Every Dollar Spent.

Other frameworks for impact measurement have been developed. For example, the Equator Principles (EPs) were developed by the World Bank's International Financial Corporation (IFC) as a risk management framework for determining, assessing and managing environmental and social risk when funding new projects by financial institutions. EPs apply globally, to all industry sectors and to four financial products: (1) project finance advisory services, (2) project finance, (3) project-related corporate loans, and (4) bridge loans. It is primarily intended to provide a minimum standard for due diligence and monitoring to support responsible decision-making in risk management.[1] The IFC has also reviewed several different impact measurement frameworks in its recent report titled "The Promise of Impact Investing". Notably, a monetisation framework is developed by TPG's RISE Fund, which is based on the calculation of an impact money multiple (IMM) in the spirit of Addy et al. (2019) that quantifies and monetises an investment's net social and environmental impact (p. 53), as shown in the figure below.

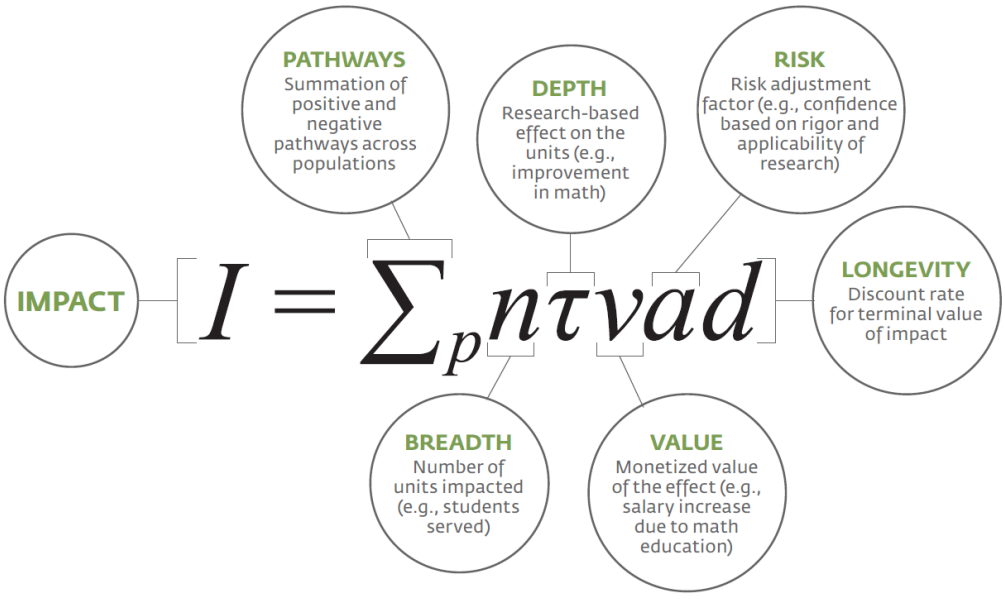

Figure 1. Impact Monetisation Formula used by TPG (RISE Fund). Source: IFC Report "The Promise of Impact Investing"

[1] EPs include ten principles: 1. Review and Categorisation; 2. Environmental and Social Assessment; 3. Applicable Environmental and Social Standards; 4. Environmental and Social Management System and Equator Principles Action Plan; 5. Stakeholder Engagement; 6. Grievance Mechanism; 7. Independent Review; 8. Covenants; 9. Independent Monitoring and Reporting; 10. Reporting and Transparency

Harvard Business School has also being developing the Impact Weighted Accounts Report. Impact-weighted accounts are line items on a financial statement, such as an income statement or a balance sheet, which are added to supplement the statement of financial health and performance by reflecting a company's positive and negative impacts on various stakeholders. Central to impact-weighted accounts is the monetary valuation of the social and environmental impacts. The aim of such monetisation is to (1) translate all types of social and environmental impacts into comparable units that business managers and investors intuitively understand; (2) make these units meaningfully aggregated and compared without obscuring important details needed for decision-making; (3) display financial and impact performance in the same accounts that are compatible to existing financial and business analysis tools. The project is still ongoing, and currently more than 56 companies have experimented with monetary impact valuation, producing environmental or total profit and loss accounts. 86% of them are measuring environmental impacts, 50% are estimating employment/social impacts, and 20% are estimating product impacts.

Other major impact measurement frameworks include the "Six Capitals" defined by International Integrated Reporting Council (IIRC): financial capital, manufacturing capital, intellectual capital, human capital, natural capital, social and relationship capital (which is also the framework that II adopts in this impact measurement project), the Global Reporting Initiative (GRI), Task Force on Climate-related Financial Disclosures (TCFD), and Sustainability Accounting Standards Board (SASB).

2.4 Global value chain with a focus on environmental extensions

Another stream of relevant literature is that on global value chain, which is used in II's methodology for impact attribution. As economies become more integrated and the production of one good spreads out across multiple countries, value chain analysis has been recognised as an important tool in development and environmental research. Value chain concepts revolve around the fact that companies can create value by breaking down their activities (Porter, 1985), and the governance structure embedded in the fragmented but interlinked production systems (Gerrefi et al., 2005). These early concepts, however, refer to pure economic structure of value chains. In the last decade, integration of natural resource consumption, chain-related emissions, and societal impacts has received growing attention. Therefore, terms like "greening the value chain" or "environmental value chain" have been coined to indicate the importance of integrating other impact factors, especially environmental factor, in the value chain framework.

Value chains are typically characterised by input-output tables (IOTs). These tables describe how industries (and even countries) interact with one another in the production process. IOTs are typically in monetary terms, so Input-Output Analysis (IOA) carried out on IOTs allows tracing monetary flows of goods and services across all sectors within an economy or across different economies. IOA has become an important tool in value chain analysis to assess impacts using a wide variety of indicators, ranging from economic and financial to environmental and societal. There are other methods used in value chains analysis such as Life Cycle Assessment (LCA), Material Flow Analysis (MFA), Computable General Equilibrium (CGE) models, and Social Life Cycle Assessment. Each approach has its own limitations in terms of assumptions and applications. For instance, IOA assumes one single production technology for each product, so it is rigid when considering a chains of various production processes. MFA is not an impact assessment tool as it is applied to build indicators assessing natural resource extraction. CGE, due to its complex functional forms, is more suitable for ad-hoc analysis. Thus, depending on the nature of the study, researchers should adopt a suitable approach to value impacts along the production value chains.

A large body of literature utilises value chains analysis to study the effects that a certain sector and/or policy has on natural resources and the environment, especially in tracing and pricing carbon dioxide emissions (e.g., Hertwich & Peter, 2009; Perese, 2010; Zhang et al., 2015). Besides carbon footprints, many studies use IOA to assess impacts on environment. Lenzen et al. (2003) calculate the indirect effects of a development proposal in terms of land disturbance, water use, emissions of NO_x and SO_2. Notably, Lammerant et al (2014) assess the negative impacts of EU demand for certain commodities on biodiversity condition in third countries. Ewing et al. (2012) introduce an improved method to link multi-regional input-output (MRIO) framework and the footprint datasets to calculate carbon, ecological, and water footprints. Kucukva et al. (2014) identify and outline economic, social and environmental impacts, termed as Triple Bottom Line, of US residential and commercial buildings through integrating several social and economic indicators into Life Cycle Assessment approach of IOA. Compared to environmental issues, assessments on human and social impact are still limited. A number of studies focusing on pressing issues such as poverty alleviation (Nadvi, 2004; Mitchell, 2012), employment (Chen et al., 2013), and social hotspots identification (Zamani et al., 2018) also adopt input-output analysis to identify value-chain impacts.

3 Evaluation of II's Data and Methodology

Impact Institute uses both a bottom-up approach and a top-down approach in assembling and analysing data and measuring impact. The Global Impact Database (GID) described below mainly applies to top-down analysis. This approach provides a broad analysis of multiple countries and sectors altogether.

Output from this model can be then supplemented with bottom-up data from DBS and other sources in the overall impact analysis for more granular results. This is the hybrid approach that II proposed in one of their pilot assessments.

3.1 Data

II's approach on impact data. II has developed its proprietary Global Impact Database (GID) Model to quantitatively describe the global economy and estimate economic, social and environmental impacts of investments. The GID Model generally uses a top-down approach, though II also supplements it with bottom-up data in its analysis. The model uses multiple secondary data to estimate and attribute global value chain impacts on a country-sector level. For input-output analysis, GID model uses the Eora Multi-Region Input-Output Table (MRIO) to identify the interdependency across different countries and sectors.[2] To extend the supplement input-output tables, the model utilises other global datasets to back out indicators for country-sector activities in social and environmental issues, including air pollution, land usage, labour productivity, wage information, child labour, health & safety incidents, among others. Lastly, the GID makes use of impact factors – such as ReCiPe Impact Assessment method – to convert extensions into the standard set of impacts under the six capitals (financial, natural, social, human, manufacturing, and intellectual) of the International Integrated Reporting Council (IIRC). Because impacts typically are measured in various natural units, monetisation factors compiled from CE Delft Environmental Prices Handbook are utilised to express impacts in monetary values.

The strength of II's approach. The data sources utilised in producing GID database for impact assessment are highly reliable and commonly used in academic research as well as industrial reports. Firstly, Eora-26 is a multi-region input-output table covering 4,916 sectors across 189 countries for the time period from 1990 to 2015. It is a sub-database among Eora's global supply chain database that has uniform sector classifications across all countries. As production processes become increasingly fragmented in stages and integrated across countries, Inter-Country Input-Output (ICIO) tables have been developed with a purpose of documenting inter-sectoral transfers across countries. These tables link harmonised national input-output tables with bilateral trade data in goods and services by end-use category. Currently, there are six major sources of data on global input-output linkages[3], and Eora is

[2] The Eora global supply chain database consists of a MRIO table model that provides a time series of high-resolution IO tables with matching environmental and social satellite accounts for 190 countries. See more description of the database in Appendix.

[3] Six major ICIO tables include Global Trade Analysis Project (GTAP) [www.gtap.agecon.purdue.edu], World Input-Output Database (WIOD) [www.wiod.org], OECD-WTO TiVA Database [oe.cd/tiva], Eora Multi-Region Input-Output Table (MRIO) [www.worldmrio.com], IDE-JETRO Asian Input-Output Table. [www.ide.go.jp/English/Data/Io], EXIOBASE Multi-Regional Environmentally Extended Supply and Use/Input Output Database (MR EE SUT/IOT) [www.exiobase.eu].

one of them. Compared to other ICIO tables such as IDE-JETRO Asian IOTs and World Input-Output Database (WIOD), Eora provides a wider country and sector coverage with a larger number of Asian economies, as well as a longer time series (e.g. IDE-JETRO Asian IOTs provides tables only for benchmark years 1985, 1990, 1995, 2000, 2005.) In addition, Eora database has been used by multiple organisations such as Deloitte, KPMG, McKinsey Global Institute, the European Commission, the World Bank, the United Nations (UN) as well as by academic institutes and universities. For impact assessment, especially with regard to environmental aspects, Eora is highly recommended resource when it comes to value chain analysis (see Lammerant et al., 2014, and UK's Carbon Footprint 1997-2016). That being said, OECD-WTO TiVA Database would be able to serve as a reference for the results generated from the Eora tables. In addition, II deploys a wide variety of resources - Exiobase, Social Hotspot Database, Wageindicator, OECDstat, etc. – for social, environmental, and economic extensions. These databases are also conventional in academic research and provide extensive information that can serve as impact indicators.

The caveats to II's approach. There are two caveats with regards to the extensions and the impact factors. Firstly, as the model compiles data from a wide variety of resources, discrepancies in terms of granularity, currency and base year are unavoidable. Dealing with this issue, Impact Institute conducted data cleaning via normalisation through inflation and purchasing power parity (PPP) correction, currency conversion, as well as data (dis)aggregation. Such data cleaning process is common in research. However, caution should be taken when dealing with conversion around PPP as it may significantly alter the final impact estimates, despite limited changes in impact per se. Second, according to the document on GID model provided by II, impact factors are taken from the ReCiPe Impact Assessment method, and the monetary factors are from the CE Delft Environmental Prices Handbook, European Social Service, and TEEB. Some of these data sources focus on European economies (such as Exiobase and European Social Survey) and may not be suitably adapted for the Asian context. Although many of the databases do provide global coverage (e.g., Eora is from Australia, Edgar is from the U.S., and ILO, World Bank, OECD, TEEB are international institutions), the perspective is still heavily European- or OECD-based, especially when dealing with social and human aspects.[4] Therefore, we advocate for further references and customisation. For instance, the model can refer to World Bank's World Development Indicators, and utilise national reports on social welfare and labour conditions

[4] It is worth noting that ReCiPe and Wageindicator are European databases but they include granular data from all countries and have a global coverage. CE Delft monetisation factors are developed for the Netherlands but from sources from various countries and adjusted on a country basis.

whenever possible. Please see Appendix for a detailed assessment of the database. In addition, the focus of the data source is on English language literature, and the inclusion of non-English sources can be improved.

Suggestion. An additional data source for global value chain is Factset Revere, which offers a unique dataset of supply chain relationships (firm-level networks of customers and suppliers) that identifies companies' interrelationships and their comprehensive geographic revenue exposures, starting from April 2003. It covers about 30,000 global companies, whose information is culled from company regulatory filings, websites, and daily updates based on new filings, press releases, and corporate actions releases. One advantage of Revere data is that they contain information of both major and minor private and publicly listed customers. This helps to identify who are the corporate customers of the clients (borrowers) of DBS so as to more accurately trace the impact pathway. However, it should be noted that given its coverage is mostly limited to listed companies as suppliers, whereas there are much more companies in the world, Factset Revere is only an additional rather than alternative dataset to MRIO tables.

3.2 Methodology

This section reviews II's methodology in combining top-down and bottom-up approaches to measure impact. It is worth noting that impact measurement and valuation are still a "young science", with limited research and guidelines. Therefore, despite the caveats identified below, in many cases, II's approach has significant novelty and is among the first to measure and value impact. II has been working with partners to continuously refine its methodology and helps the development of the field by providing a proof of principle that some of the challenges can be tackled.

3.2.1 GID's Attribution Methodology

II's approach on value-added attribution. As production becomes more interdependent across countries and sectors, investments in one specific sector create effects throughout the economy and even the world. It is thus essential to take into consideration the impact of investment beyond the first order. The GID model uses value-added analysis to attribute the impact of investment along the value chains productions of goods and services. This methodology analyses both upstream and downstream linkages of a sector in a country, identifying the value added within trade volumes and trade relations across countries and across sectors. Extensions beyond economic factors are also included in the value chain analysis. This process allocates direct impact, which is the impact of the activity in the country/sector itself, to value chain impact of sectors both upstream and downstream.

After measuring value chain impact, the model then conducts attribution of impact to investments, using the value added of the investment as the main driver. As DBS is interested in assessing how much impact their loans create throughout the economy, the model specifically attributes the total impact to the investment of one dollar in specific country and sector. Interest rate is proposed as a potential proxy for value-added provided by the lenders. There are two options under consideration: the net interest income (representing the bank effective interest) and a representative industrial rate. The impact attributed to an investment is calculated as the ratio of the interest of the investment to the impact per unit of value added. The current results in this pilot are derived using 2% interest rate per dollar investment.

The strength of II's approach. Attribution along the global value chains is necessary in the context of current globalisation trend, and the input-output analysis approach is suitably applied in this model. There is a rising number of academic research extending the input-output analysis to account for impacts on environmental issues (e.g. Hertwich & Peter, 2009; Lenzen et al., 2003; Ewing et al., 2012; Zhang et al., 2015) and social issues (e.g. Nadvi, 2004; Mitchell, 2012; Chen et al., 2013). Hence, the GID model does incorporate the key ideas in the current literature. In addition to tracking the trade relations, the attribution method also assigns the magnitude of impact proportionately to the added value following the input-output tables. Sectors that add more value in the chain would get a larger share of overall impact. This assumption is reasonable for distributing the impacts of investment over interdependent sectors along the same value chain.

The caveat to II's approach. Firstly, the current model does not consider the "multiplier effect" of a loan. The current value chain analysis focuses mainly on the external effects related to production process of all the sectors within the chains, yet it does not give much insight on implicit effects such as job creation, education advocacy for employee, or political voice. This issue is reflected also through the limited number of extensions related to social and human impacts, but is not systematically incorporate in the analysis, probably due to data limitation and the difficulty in capturing all indirect impact. This may potentially underestimate the true impact on society. As more comprehensive data sources become available for social, human and natural capitals, the model can be updated to reflect these updates, so that it can provide a more comprehensive impact analysis of investments. Furthermore, spill-over effects (i.e. education of employees' children) are not covered.

Second, attribution to investment using interest rate can have two shortcomings. First, interest rate does not embody all the indirect effects the investment creates along the value chains. It only captures the direct lending effects based on financial values. Second, it can create bias as the counterfactual

scenarios[5] in which another bank provides the loan instead of DBS are not observable, and can have many possibilities. That is, the "marginal impact" of a DBS loan is hard to attribute.[6] Further robustness check using other proxies (i.e. industry average) as attribution factor to investment are encouraged to provide a more comprehensive understanding to the investors. Despite the caveat, it is again worth noting that this approach is one of the first attempt to quantify and value impact.

3.2.2 Integrated Profit and Loss Assessment Methodology (IAM)

II's approach on identifying impact pathway. The integrated profit and loss assessment methodology (IAM) is developed by Impact Institute in order to quantify and assess the values that an organisation contributes to the welfare of its stakeholders and the society within a given timeframe. It mostly uses a bottom-up analysis. The assessment first identifies various stakeholder groups of an organisation, and categorises the organisation's assets into financial, natural, social, human, manufacturing, and intellectual capitals following the IR-framework (IIRC, 2013). The next step is to draw all potential impact pathways as a quantifiable chain of effects and counterfactual effects that an activity of the organisation has on its stakeholders. Along each impact pathway, IAM assesses how much impact the organisation can contribute, whether directly or indirectly through another entity. The assessment also identifies reference scenarios in which the organisation did not realise its activity, and consequently the impacts this might cause.

The strength of II's approach. Identifying impact pathways gives insights into all the stages involved in the value chains of products and services. All the entities that contribute to the production and delivery of a good or service can be captured through such impact pathways. This process helps organisations track all impact contributions. On top of impact pathways, the use of reference scenarios shed light on the impacts of adopting or not adopting a certain activity of the organisation, both immediate effects as well as potential long run effects on other entities along the chain. II's approach provides a comprehensive measurement of total contribution an organisation creates.

The caveat to II's approach. Identifying counterfactual scenario is an intricate process, and it is even tougher when they are placed within a value chain. Also, it is important to acknowledge which reference scenarios are quantifiable and worth assessing, since analysing every single scenario is not practical.

[5] Statistically, a counterfactual is a result one would expect if the intervention had not been implemented. A counterfactual can be developed using a control group, i.e., a group created through random assignment which do not receive an intervention or receive the usual intervention when a new version is being evaluated. In the context of this project, a counterfactual can be the impact without any loan granted ("absolute impact"), or the impact of loans provided by other banks or financing by other means.

[6] A "marginal impact" refers to the impact of DBS loans relative to loans by other banks or financing by other means. It is relative to an "absolute impact" that refers to the impact of loans given by DBS compared to that without any loan.

Another potential caveat in the methodology is that value chain network in practice is much more complex than a simple horizontal sequential link of different actors. There are possible overlapping procedures, interconnection between different value chains, and double counting values as input-output travel across numerous country borders. The methodology should provide instructions on how it deals with such complications.

II's approach on measuring impact contribution. Integrated Assessment Methodology (IAM) distinguishes between direct and indirect impacts, as well as between absolute and marginal impacts. Altogether, they form four types of impact: direct absolute impact, direct marginal, indirect absolute, and indirect marginal. After identifying four types of impact, total impact contribution of the organisation is then a (linear) combination of these impacts. A generic formula for total impact contribution that II has developed is as follows:

$$\begin{aligned}&\boldsymbol{Impact\ contribution}\\&\quad=\boldsymbol{\alpha}[\boldsymbol{\gamma}\times\boldsymbol{Direct\ Absolute\ Impact}+(\mathbf{1}-\boldsymbol{\gamma})\times\boldsymbol{\delta}\\&\quad\times\boldsymbol{Indirect\ Absolute\ Impact}]+\boldsymbol{\beta}[\boldsymbol{\gamma}\\&\quad\times\boldsymbol{Direct\ Marginal\ Impact}+(\mathbf{1}-\boldsymbol{\gamma})\times\boldsymbol{\delta}\\&\quad\times\boldsymbol{Indirect\ Marginal\ Impact}]\end{aligned}$$

For the formula above, II acknowledges that not all parameters can be fixed from first principles. In order to be able to proceed, II provides a parameter choice that enables calculations.

The strength of II's approach. This is a well-articulated general formula for organisations to apply when valuing impacts, and is in line with other methods of impact measurement utilised in the impact investing field (see Section 2.3 of this report). It takes into account different effects an activity may bring. Each impact is followed by a distinct weight parameter so that users can implement different distributions depending on the context and analysis. Furthermore, guidance on certain principles to be implemented while combining multiple types of impacts is provided. Five principles are applied when attributing impact to an organisation: (1) conservation of impact, (2) additivity, (3) sensitivity, (4) sufficient resolution, and (5) co-responsibility. These principles ensure impact contribution is correctly stated and comparable across organisations. For the calculation of total impact contribution, IAM recommends adopting "impact equivalence." This recommendation suggests that when two types of impacts are to be included and there is no strong argument that one is significantly more important than the other, both impacts should be included with equal weight in the total impact contribution.

The caveat to II's approach.

One caveat is the approach towards distinguishing between direct and indirect impacts, and between absolute and marginal impacts. The distinction provided in IAM are to some extent unclear. First, the scope of direct impact crucially depends on the definition of stakeholders that are directly affected. For example, for a loan given to a palm oil planation, who should be included in the analysis of impact on the community? Should family members of an employee of the plantation (i.e., a farmer) be considered as direct stakeholders? Second, the absolute impact refers to the impact of loans given by DBS compared to that without any loan, whereas the marginal impact refers to the impact of DBS loans relative to loans by other banks or financing by other means. Understandably, it is infeasible to measure marginal impact accurately due to the lack of counterfactual. That is, estimating the baseline situation of not having DBS loans but having financing from other financial institutions is extremely difficult, as there are many alternative scenarios.

Another caveat is related to the choice of parameters for pilot measurement calculation. Not all the parameters can be derived from the first principle ("conservation of impact"), so in order to proceed with the calculation, II assumed absolute impact and marginal impact are equally weighted. This means $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are both $\mathbf{50}\%$. This is a strong but understandable assumption as it is not easy to assign exact weights on reference scenarios. II does allow users to modify the parameters as a sensitivity check. With regard to direct and indirect impacts, the methodology provides specific implementation to attribute impacts based on level of the organisation's responsibility along the value chain. If an activity has predominantly internal effects within the organisation only (i.e. salary paid to employees, dividends paid out to shareholders, etc.), then total impact contribution are equally weighted between direct absolute impact and direct marginal impact. This makes sense as the activity's impact does not spread out along the impact pathway. Otherwise, total impact contribution is composed of direct impacts and value chain impacts.

Furthermore, applying fixed parameters to those impacts often does not take into account the true intention of an action, such as when a borrowing company intends to avoid their responsibilities for negative impact by letting their suppliers bear more of such responsibilities. There is some empirical evidence for the case of GHG emissions due to regulatory arbitrage and financial constraints (e.g., Bartram, Hou, Kim, 2019). In the case of electricity emission from driving electric vehicles, Holland, Mansur, Muller and Yates (2016) find that electric vehicles generate negative environmental benefits of 0.73 cents per mile on average relative to comparable gasoline vehicles, after accounting for both global and local pollutions, which is largely due to emissions from charging EVs. About 90% of local environmental externalities from driving EVs in one state in the U.S. are exported to other states, implying that although they may be subsidized locally, the environmental benefits are negative overall.

The weight of value chain impact is calculated as the ratio of value added of the organisation relative to that of the whole value chain. This is standard for value chain analysis as an organisation's impact contribution is proportional to how much added value it contributes to the whole value chain. However, as we look closely at the value chain, the link that organisations should take the most responsibility would be the direct upstream and downstream linkages, and less so as we move further along the value chain. The organisation has little say on what its partners choose as suppliers, meaning it should not take responsibility for other actors' actions. This is a caveat of IAM that Impact Institute also acknowledges. So far, there is no standard method to quantify this weight for responsibility along the value chain, so utilising the value-added ratio is still the most acceptable proxy.

In short, the Integrated Profit and Loss Assessment Methodology provides a comprehensive impact assessment of an organisation's activity. It includes the value chain effects and connections, the various scenarios as well as types of impacts. However, there is room for further research with regard to complex value chain networks as well as impact attribution assumptions along the chains.

3.2.3 Monetisation Methodology

II's approach on monetisation. Integrated reporting has long advocated for the importance of distilling impact into monetary units rather than using the natural units. Reasons include the intrinsic value of currency, the wide usage of currency in financial reports, and the ease of handling for firms and managers, particularly when they need to carry out comparative studies and make strategic investment decisions. Since social, human and natural data often come in natural units (e.g. kg of CO2 emissions, hectare of land usage, number of workplace safety incidents, etc.), the GID model uses monetisation factors to convert impact data into monetary units. The conversion methodology is based on remediation of external costs and on valuating well-being effects. Data sources utilised include OECD, the European Social Survey, and the World Bank.

The caveat of II's approach. Monetisation of impact is a complex procedure, but is favoured in research. In the literature of labour economics, several studies have been conducted to assess the earning outcomes in association with years of schoolings (Mincer, 1974), job locations (Moretti, 2004), firm age (Brown & Medoff, 2003), experience and gender (Munasinghe et al., 2008), etc. These studies, in a sense, "monetise" the impact that different variables have on labour outcomes. However, not every impact can be represented through changes in income. In the development economics literature, field experiments are usually conducted to assess the impact a specific incentive has on social welfare such as education, gender equality, health, labour conditions etc. In these studies, impact indices are likely

to be expressed in their natural values, which are not necessarily dollar values.[7] Therefore, not all impacts can be monetised: for some it is by nature not possible to assign a dollar value, and for others the data are often not available.

For investors and industrial practitioners, monetary expression is encouraged as they provide straightforward values and make comparative analysis easier. However, as there has not been a standardised procedure for the monetisation process (besides the ISO14008 "Monetary valuation of environmental impact and related environmental aspects"), analysts should take great caution when conducting impact monetisation. This lacking of standardised metrics may also explain why not many social and human impact are covered, as they may not be able to express in monetary terms.

Another caveat with II's approach is the geographical context of their monetarisation factors. As the True Price methodology is mainly based on European's data sources, it may not be ideal to apply the same standards to non-European's economies. The concept of social welfare (i.e. minimum wage, labour rights, political awareness, etc.) in many developing countries vary significantly from that in the European counterparts. Thus, it is essential to look into specific country's laws and conditions, obtain national dataset if possible, to ensure the conversion factors are sensible. Furthermore, there are potential risks attaching to the monetisation process, such as discounting issues, or putting a cap on the perceived value of a social or environmental outcome (Serafeim et al., 2019). The model should identify these risks and include them in the report as a robustness check for a more comprehensive analysis.

4 Evaluation on Case Studies: Palm Oil and Electric Vehicles

4.1 Overview of II's studies

Impact Institute conducted two pilot measurement case studies on the Palm Oil industry and the Automotive industry utilising the IAM methodology and the data compiled through their GID model.

[7] For instance, Banerjee et al. (2015) reported the long-run impact of an anti-poverty program in India. The evaluation covered a variety of social aspects ranging from income level, consumption, financial stability to labour supply, human well-being, political involvement and women's empowerment. Indicators such as consumption, income level and financial stability were apparently presented through dollar amounts, while other social outcomes were denominated in their natural values: labour supply was represented by minutes spent on paid labour, political engagement reflected through election participation as well as women's contribution in household's decisions. Linking these natural values to monetary values is challenging, as it will likely overlook the indirect impact of empowered women and political engagement on overall household income and local GDP growth. So far, there is no consensus in the literature on quantifying these values. Another study by Mbiti et al. (2019), examining the impact of providing grants and teacher incentives to schools, uses students' test performance as impact index. It is extremely difficult to link students' test performance to their future career and family choices, thus their household incomes and tax contributions. Again, there is no commonly agreeable method in the literature to quantify such higher-order indirect impact.

These two cases embody different approaches due to the nature of the sector as well as data availability. Specifically, the study on Automotive industry uses bottom-up approach, which requires specific sectoral information and analysis for every stage along the value chains, whereas the Palm Oil study uses a hybrid approach which combines bottom-up data (field-level information) with top-down data of countries and sectors across the world. The choice of approaches for these two industries is appropriate considering the nature of their production and use. Production of electric vehicles are composed of several stages, each of which may belong to different sectors and take place in different countries. Therefore, granular analysis along each step of the production chain following the bottom-up approach will provide a comprehensive impact assessment of the whole industry. Palm oil, on the other hand, is an input material with high demand from various industries and countries across the globe. Thus, a top-down approach can provide a broad analysis of palm oil industry across a range of countries and sectors. Then, by combining top-down results with bottom-up industry-specific data, the final detailed assessment will cover impact generated from crude palm oil production in a specific country to all potential use of palm oil along different value chains.

The impact scope of these case studies was chosen according to the Impact Institute Standard Impact List 2019, covering 5 out of 6 IIRC's capitals (IIRC, 2008): natural, financial, social, human and manufactured. Within each capital, multiple impact categories were identified based on materiality and feasibility assessment of the dataset. The studies cover a wide variety of impact, and provides a comprehensive understanding of how the production process of palm oil and automotive vehicles can influence multiple factors beyond the normal economic context. Finally, results of impact valuation were expressed in monetary terms – impact of lending 1 SGD to a specific sector (SGD-eq/SGD-lent). Since data for different impacts are represented by different units, expressing these impacts in the same language (i.e., monetary value) will allow for consolidating all possible factors in the report and making easier comparison. This will be useful for investors and businesses to make strategic decisions regarding their lending portfolio to a specific industry.

4.2 Evaluation

Not only do the reports identify which capitals among the five get the highest impact from the industry, but they also provide a breakdown of impact on each capital category as well as the source of impact contribution. Consequently, readers are able to understand whether the impact originate from the direct production of the goods, or from the use of the goods along the value chains. In the case that the value chain impact is higher, the analysis also identifies which phases/stages are likely to contribute more impact. This is highly informative, especially for investors when making their decisions on whether to invest in a production plant of a specific sector in a country.

There might be a potential issue of over-attribution due to multiple stakeholders involved in the assessment process. However, Impact Institute has addressed this and confirmed that by identifying specific capital involved with the specific stakeholders, impact are duly attributed to the stakeholders. Total impact by capitals are the same as the total impact via the stakeholders. Nevertheless, there are a few issues worth mentioning.

First, one assumption made in the analysis is to consider only top 10 export countries and domestic sales. This is acceptable since the top 10 exporters tend to make up for the majority of total exports of the sector. However, it is important to run a check on this assumption for the sector under study to ensure no value is overlooked. In addition, data limitation is unavoidable, especially since the study covers a wide range of data sources and countries/sectors. In addition, not all countries and sectors provide data on production and export/import, so missing values and estimations are inevitable. When such issues occur, it is advisable that the report informs readers of such shortcomings so that they could analyse the results with sufficient understanding.

Second, the two case studies do not consider second order indirect effects in terms of human and social aspects particularly. For instance, when DBS provides a loan to a palm oil plantation, they are interested in not only the impact the loan creates on the working conditions and education of the workers in this specific plantation, but also the ripple effects the loan may have on the workers' family. For instance, does the loan makes any impact on improving education of the workers' children? Does it help with job creation within the sector/region? This chain of impact assessment also applies to other actors along the value chains of palm oil sector. Quantifying such higher order impact requires a more complex framework with appropriate weights and attribution factors in place. Further research along this line in the future will enhance the scope of impact measurement.

Third, the current electric vehicles case study does not consider the end-of-life phase. When electric vehicles are disposed, the process of handling body parts of the car (metals, tires, plastic dashboard, etc.) and especially the ion-lithium batteries can create long-lasting impact on the environment and the working condition of employees at the disposal centres. Considering it is only one phase along the production chains, the final value may not change significantly. Besides, more efforts have been made to recycle and reuse car parts. For example, Singapore is building a new lithium-ion battery recycle facility to ensure metals from the batteries to be reused to make new batteries (article here). Similarly and as II has properly acknowledged, research from IEA (2019a), Hawkins et al. (2013), and Kukreja (2018) shows that end-of-life only contributes to a small share of the total impact of the whole life cycle of electric vehicles. However, other countries may adopt different methods of handling disposal. If the

location for the majority of Singapore EVs' disposal is known, it will be more informative if the report could consider this phase's impact. Otherwise, the report can provide reasons for excluding it in the first place for a more complete picture.

Lastly, different approaches are employed in the two pilot studies based on the characteristics of the industries. This was possible because these pilot studies focus on two distinctive sectors. Thus, it could significantly improve the applicability and comprehensiveness if specific rules, guidelines, or matrices are provided on how to choose methodologies for each case, or if a universally applicable method is available to analyse the impact on loan applicants across different sectors.

5 Future Extensions and Conclusions

The data sources and methodology for measuring social and environmental impact are in line with the IIRC's framework and other frameworks such as HBS Impact-Weighted Accounts and IFC guidelines that aim to monetise impact. The methodology proposed by the GID model is tractable and has been used widely in global value chains literature. It considers all possible linkages on the supply chains, attributes reasonable effects of investments on interdependent sectors and players. Nevertheless, a study at sector and country level may provide outdated and noisy results. As more detailed and granular data become available, it is advisable to consider modifying the model to utilise these firm-level supply chain data. Being able to track trading partners of a company will enhance the accuracy of identifying the impact a loan creates.

With regard to the generalisability of the approach, the data and methodology used by II can also be useful for monetising (in the form of valuation) social and environmental impact and integrating them into financial statements, especially for multinational corporations. This is consistent with IIRC's integrated reporting framework and Harvard Business School's Impact Weighted Accounts initiative. Therefore, II's approach can be potentially integrated with other existing and developing frameworks and be applied to a much broader context of impact measurement.

However, there are also several caveats on the generalisability of the results. First, the study is conducted in the banking sector with the geographical focus in Asia. When applying the methodology and results to other economies and sectors, an important consideration is the difference in social norms and regulations, which can be extremely large across different jurisdictions and legal systems (Liang and Renneboog, 2017). In addition, the generalisability will also be affected by the difference in ESG standards and practices across industries and sectors. The accounting principles differ significantly between the financial sector and the other sectors, so as the "distance" and sensitivity to environmental

and social impact. For example, the environmental impact of the oil and gas sector can be much bigger and more direct than that of the banking sector, which implies much greater impact attribution to the former. Such cross-country and cross-sector differences will also affect the aggregation of bottom-up and top-down data when assigning the weightage of each country and industry when aggregating the impact.

This project also sheds some light on the regulatory framework in the region and across the world. Different regions are proceeding at different speeds on ESG regulation. Notably, the European Union (EU) currently has a more ambitious regulatory agenda backed by strong political support for a transition to a low-carbon economy. In 2018, the European Commission released an Action Plan for Financing Sustainable Growth with several policy initiatives aimed to re-orient private capital towards sustainable projects so as to meet the 2030 targets that the EU committed to as part of the Paris Agreement. Following the recommendations from the EU High-Level Expert Group on Sustainable Finance, the package included a taxonomy to classify sustainability activities, standards and labels for green financial products and developing sustainability benchmarks. Other non-mandatory international and national frameworks and initiatives are being developed, including the Sustainable Stock Exchange Initiative, UNEP Finance Initiative and other UN SDG-related initiatives, Carbon Disclosure Project; EU Energy and Climate Package; US Clear Air Act; China's Renewable Energy Law (2006); India's National Actin Plan on Climate Change (2008), etc. A key issue of these regulatory frameworks is to quantify and monetise environmental and social impact that can be actioned on. Therefore, the methodology and results of this project, given their consistency with the international practices and academic studies, can have important implications for policymakers in Singapore and in the region to join the global efforts in standardising ESG and impact measurement and regulations.

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Appendix

Usage	Main sources	Period coverage	Country/ Industry coverage	Website	Description	Comments/Notes
Input-Output Analysis	EORA	1990 - 2015	190 / 26	https://worldmrio.com/	Time series of high-resolution IO tables with matching environmental and social satellite accounts; Environmental indicators covering GHG emissions, labour inputs, air pollution, energy use, water requirements, land occupation, N and P emissions, primary inputs to agriculture	Reliable economic representation of global economy; Widely used for IOA in international trade studies
	IDE-JETRO Asian IOTs	1985, 1990, 1995, 2000, 2005	10 / 76	https://www.ide.go.jp/English/Data/Io	Other international Input-Output Tables that are frequently used in literature Can be used as references for global value chains analysis in GID model	Limited countries and time period covered
	WIOD 2016	2000 - 2014	44 / 56	http://www.wiod.org/home		Limited coverage for Asian countries
	OECD ICIOs	1995 - 2015	64 / 36	https://www.oecd.org/sti/ind/inter-country-input-output-tables.htm		Not regularly used for research with environmental extensions
Environmental, social and human extensions	Exiobase Version 1 Version 2 Version 3 Monetary form Hybrid form	 2000 2007 1995 - 2011 2011	 44 / 163 44 / 163 45 / 163 44/ 164	https://www.exiobase.eu	Provide data on air pollution, labour, land use impact indicators	Widely used for IOA in international trade studies
	Social hotspot database (SHDB)		113 / 57	https://www.socialhotspot.org/	An extended input-output Life Cycle Inventory database; IO model is based on GTAP7. Provides data on labour productivity, child labour impact and health & safe incidents	Reasonable data source for human rights, social life cycle assessment, supply chain transparency, social footprint, etc.
	ILOSTAT	Varied	234 / -	https://ilostat.ilo.org/	Average wage data	
	Eora				Rest of extensions	

	Wageindicator		167 / 350	https://wageindicator.org https://glabor.org/platform/wageindicator/	Provides data on real wages, salary check, minimum wage, living wage, wage in context, labour law, etc Use in the methodology as living wage benchmark.	Reliable data source
	OECDstat		OECD countries and selected non-members	https://stats.oecd.org/	Mainly used to calculate mean to median ratio (wages)	Good source for GDP, FDI, Health, unemployment, income distribution, population, labour, education, trade, finance, prices, Economic Outlook, Government Debt, Social expenditure, etc. But unclear whether the coverage is good enough for Asia (where most countries are not OECD members).
Impact factors	ReCiPe Impact Assessment method			https://www.springerprofessional.de/en/recipe2016-a-harmonised-life-cycle-impact-assessment-method-at-m/11919942	A life cycle impact assessment (LCIA) methodology. The primary objective of the ReCiPe method is to transform the long list of life cycle inventory results into a limited number of indicator scores. ReCiPe was developed in 2008 by RIVM National Institute for Public Health and the Environment (https://www.rivm.nl/en), CML, PRé Consultants and the Radboud University Nijmegen on behalf of the Dutch Ministry of Infrastructure and the Environment.	This methodology mainly covers environmental impact factor. It is unclear whether social/human impact factors are taken into account.
	World Development Indicators	Varied by data	217 / -	http://datatopics.worldbank.org/world-development-indicators/	Time series statistics on global development and the fight against poverty	These databases can serve as reference for impact factors, especially with regard to social welfare and humanity aspects
	World Governance Indicators	1996 – 2018	200+ / -	https://info.worldbank.org/governance/wgi/	Reports aggregate and individual governance indicators according six dimensions of governance	
Monetisation factors	CE Delft Environmental Prices Handbook			https://www.cedelft.eu/en/environmental-prices https://www.cedelft.eu/en/publications/download/2622	The prices are per kilo emission in 2015 Euros and differ per country and region; used as a source for environmental monetisation factors	One caveat is whether it can be suitably adapted for Asian economies, and how social and human factors are taken into account. If True Price framework is used, more discussion in terms of geographical context is recommended
	European Social Service				Source for social capital monetisation	May not be suitable for Asia? Maybe it's more appropriate to access individual national database for more accurate information.

	TEEB (The Economics of Ecosystems and Biodiversity)			http://www.teebweb.org/	Based in Geneva, Switzerland; hosted by the United Nations Environment Programme (UNEP) A source for monetisation of natural capitals in True Price Methodology	It is not entirely clear how macro-level numbers are extracted from their reports, or whether there is any other database owned by TEEB
Financial data	World Bank			https://data.worldbank.org/	Provides data for inflation factor, exchange rate, PPP rate in the GID model	Good source for country-level data
	IMF			https://www.imf.org/en/Data	Time series data on IMF lending, exchange rates and other economic and financial indicators	Another good source for country-level data, can be used as reference for financial data