Sustainable Finance and the Global Health Crisis

Edited by Pasquale Marcello Falcone and Edgardo Sica

First published 2024

ISBN: 978-1-032-25722-8 (hbk)
ISBN: 978-1-032-25723-5 (pbk)
ISBN: 978-1-003-28470-3 (ebk)

12 Social dimension of green finance

Covid-19 shines spotlight on companies' vulnerable employment in supply chains

Claudia Hitaj, Ioana-Stefania Popescu, Thomas Schaubroeck, and Thomas Gibon

DOI: 10.4324/9781003284703-14

The funder for this chapter is Luxembourg Institute of Science and Technology (LIST)

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

12 Social dimension of green finance

Covid-19 shines spotlight on companies' vulnerable employment in supply chains

Claudia Hitaj, Ioana-Stefania Popescu, Thomas Schaubroeck, and Thomas Gibon

Introduction

SF has moved from niche to mainstream, accounting for 36% or US$35.3 trillion of total assets under management in capital markets, according to the Global Sustainable Investment Alliance (GSIA, 2021). There is an increasing risk of greenwashing in the market, as investors and regulators alike seek the best tools for measuring the sustainability of ESG investment products. With the threat of climate change and, more recently, health crises like the global Covid-19 pandemic, investors look for resilient companies that create long-term value. For this, investors need reliable metrics, able to capture both environmental and social factors affecting and affected by publicly listed companies.

While ESG ratings were developed to cover all sustainability aspects, there is large criticism regarding their reliability (Berg et al., 2020). Quantitative tools are needed to measure the real impact of investment decisions. However, there is an over-concentration on methods measuring carbon-related emissions for both investment funds and green bonds (Gibon et al., 2020; Popescu et al., 2021). In the EU taxonomy, the European Commission (EC) defined four other environmental-related goals, in addition to climate change, to tackle the complexity of environmental sustainably (EC, 2019). At the same time, the taxonomy extended impact measurement to social aspects, as financial products need to meet "minimum social safeguards" to be eligible for the sustainability label. Finally, the recently drafted EU social taxonomy (EU, 2022) discusses the importance of setting social objectives to consider in investment decisions.

Aside from the regulatory push to include the social dimension in sustainability claims of investment products, the Covid-19 pandemic brought social impacts of companies and their supply chains to the fore and elevated the issue in the collective conscience. The pandemic negatively affected countries' ability to advance on the Agenda 2030 and the Sustainable Development Goals (UN, 2021). Aside from this more general effect, the pandemic shined a spotlight on how different companies were treating their workers, such as for example workers' access to measures to prevent the spread of the virus or pay during pandemic-related lockdowns and factory closings. With the renewed scrutiny, poor treatment of workers has risen

DOI: 10.4324/9781003284703-14

in terms of the reputational risk it poses to companies (O'Connor-Willis, 2021), which is reflected in their stock market performance and ability to raise capital.

Despite this increased interest in social impacts, social indicators in the finance field are still largely under development. The ESAs were appointed to draft, inter alia, a set of indicators on which financial institutions will have to report. One example indicator is "Violations of UN Global Compact (UNGC) principles and OECD Guidelines for Multinational Enterprises" (ESAs, 2021). The UNGC includes, for example, Principle 3 (Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining) and Principle 4 (the elimination of all forms of forced and compulsory labour). These kinds of binary indicators (participant or not a participant in the UNGC), however, yield little information on how well a company is doing in terms of social impacts, in particular as regards their supply chain.

For this reason, life-cycle assessment (LCA) methods are taking hold in SF impact measurement. LCA implies considering upstream and downstream processes of a company's activity, such as the production of an electric vehicle or a T-shirt from resource extraction, manufacturing, transportation, and distribution through to end-of-life. A recent study analysed the social risks associated with trade-based consumption in the EU27 (Pelletier et al., 2018). The authors found that using LCA gives a more complete picture of the global social risks of economic activities within the EU, as opposed to a simpler "country-of-origin" approach, in which indicators for the country of origin are considered without accounting for the flow of inputs from other countries to the country-of-origin. Finance scholars are also increasingly discussing the importance of looking beyond direct sustainably impacts and addressing value chain social well-being (Landier and Lovo, 2020).

In practice, few environmental assessment methods include the life-cycle perspective when evaluating investment funds (Popescu et al., 2021) or green bonds (Gibon et al., 2020). Social LCA (S-LCA) is a more nascent field and has not, to our knowledge, been applied to investment funds, though some studies conduct S-LCA of certain sectors or global supply chains (Simas et al., 2014, 2015; Lèbre et al., 2020). Recently, UNEP (2020) published updated guidelines on S-LCA with the goal of furthering the application of S-LCA to the assessment of companies. Our study fills this gap in the literature. The main aim and novelty of this work is the application of S-LCA to the evaluation of public equities and investment funds, focusing on the social issue of "vulnerable employment".

We show the role that S-LCA can play in measuring the social impacts of investments. The advantage of metrics based on S-LCA is that impacts along the whole supply chain of companies are considered. In the context of social impacts, we differentiate between direct and indirect or supply-chain impacts. When evaluating public equities or investment funds, S-LCA relies on matching social life-cycle inventories with a financial database, so a company's performance on a social indicator can be tracked along their supply chain. In this study, we use the FactSet database for information on investments in publicly traded companies and the multi-regional input-output (MRIO) database EXIOBASE for information on life-cycle impacts. EXIOBASE is an environmentally extended MRIO database, but it contains several indicators that are relevant to S-LCA, such as “vulnerable employment”. By linking the two databases, we can determine the hours of labour in vulnerable employment compared to total employment per €1 million invested in a particular company and separate the vulnerable employment into the direct or indirect (supply-chain) stages.

Previous S-LCA studies have been applied to economic sectors but they have not focused on the explicit link with financial investments. Some discussed the social risks embodied in global supply chains (Simas et al., 2014, 2015). Others looked at social trade-offs associated with the material needs of the climate transition (Lèbre et al., 2020). We aim, in particular, to advance this literature by further linking social impacts to capital markets, through publicly listed companies and their reach. As a first objective, we identify the sectors that are most affected by vulnerable employment, and, as a second objective, assess vulnerable employment and GHG emissions in publicly listed companies and study the apparel and mining sectors in greater detail. We assess the extent to which social and environmental impacts are negatively or positively correlated, as some sectors have low climate impacts but greater vulnerable employment risks, while risks are reversed for other sectors or are high/low across both dimensions. Cobalt and lithium mining, for example, play a key role for lithium-ion batteries and the ability of the global economy to transition away from fossil fuels and towards electrification of transportation, but are also known hotspots for poor working conditions (World Economic Forum, 2020).

The ILO finds that vulnerable workers were hit hardest by the Covid-19 pandemic, which has worsened pre-existing inequalities (ILO, 2021). Going forward, corporations and their investors will have to reconcile social and environmental aspects in order to attract funding, in particular as the pandemic put renewed focus on working conditions across the globe.

Data and methods

Input-output databases for social and environmental life-cycle inventories

Large-scale LCA relies on life-cycle inventory (LCI) databases. These databases are environmentally extended or socially extended input-output databases of economic activities. They are capable of linking an economic activity to its underlying suppliers and associate those production activities with environmental or social impacts. Whereas conventional input-output tables of economic accounts track the flow of goods and services through the economy in monetary units (euros), an environmentally extended LCI, such as EXIOBASE (Stadler et al., 2018), contains additional information in physical units of the environmental impact of these activities. EXIOBASE’s input-output based LCIs are multiregional, which means they contain information specific to economic subsectors across various countries or regions.

Table 12.1 EXIOBASE version 3

Property	*Description*
Base-years	1995–2011/16
Products	200
Industries	163
Countries	44 (EU28 plus 16 major economies)
Rest of the world regions	5 (Europe, Asia, Africa, America, Middle East)
Water accounts	194 (water blue and green per source, including final demand)
Material accounts	189 (energy products, including final demand) 222 (used extractions) 222 (unused extractions)
Land accounts	14 (including build up land for final demand)
Social accounts	14 (employment per skill level and gender, vulnerable employment)
Emissions	28 (from combustion including final demand) 410 (non-combustions) 3 (HFC, PFC, SF_6)

While EXIOBASE contains a few indicators on social impacts, such as vulnerable employment or low/medium/high-skilled employment by gender, its main purpose is to measure environmental impacts. It is therefore used primarily in environmental LCA or e-LCA. The most recent version of EXIOBASE (Stadler et al., 2018) covers 44 countries and 5 Rest of World regions (Table 12.8 in the Appendix), 200 products, 163 industries, 3 employment skill levels per gender, 417 emission categories, and 662 material and resources categories (Table 12.1). For example, the emission categories cover the combustion emissions of CO_2, CH_4, N_2O, SO_x, NO_x, NH_3, CO, and other pollutants.[1] Non-combustion emissions of chemicals from various processes are also covered, as are agriculture-related air, soil, and water emissions, land use, extraction of minerals, and blue and green water consumption.

The two most comprehensive social life-cycle inventories are the Product Social Impact Life Cycle Assessment database (PSILCA) (Ciroth and Eisfeldt, 2022; Mancini et al., 2018) and Social Hotspot Database (SHDB) (Benoit-Norris et al., 2012). PSILCA is developed by Green Delta, based in Germany, while SHDB is developed by New Earth, a non-profit based in the US.

SHDB contains social risk and opportunity information that can be used to quantify the social performance of a product supply chain and life cycle. To model global supply chains, SHDB uses the Global Trade Analysis Project, a global economic equilibrium model. SHDB contains data on 57 sectors across 113 countries and regions. Next to the inputs for each sector and the trade flows between countries expressed in monetary units, SHDB contains information on working hours by sector and region, which serve as the weights for the social issues examined. The social issues of labour rights and decent work, health and safety, human rights, governance, and community infrastructure are grouped into 22 social themes, which are measured by one or more indicators (Table 12.9). These include, for example, child labour, excessive working time, poverty, labour laws, toxics and hazards, gender equity, drinking water, sanitation, and children out of school.

Similar to SHDB, PSILCA covers 14,838 sectors for almost 189 countries, though for one-third of those countries only a basic set of 26 broad sectors is available. The 90 indicators in PSILCA are grouped into 23 sub-categories (Table 12.10) in the PSILCA Life Cycle Inventory Database, such as child labour, forced labour, fair salary, workers' rights, health and safety, migration, and corruption. PSILCA is based on the multi-regional input-output model of the Eora database.

EXIOBASE is available free of charge, while both SHDB and PSILCA require the purchase of a licence. For this study, we use EXIOBASE to compare companies' and funds' performance on GHG emissions and vulnerable employment, since it allows for comparison of environmental and social performance using a single database and since it has a higher resolution of sectors and is more up-to-date on the economic transactions side. A broader, multi-indicator analysis of social impacts along supply chains would benefit from using a dedicated social life-cycle inventory, such as SHDB or PSILCA. Linking the inventories to a financial database can be more cumbersome than for EXIOBASE, since PSILCA uses different industry classifications depending on the country or region. For the UK and the US, for example, the industry classification of demand is very detailed. However, these industries do not match the industries used to classify demand in other countries. Any matching of the hundreds of sectors/industries with those in a financial database would need to be performed separately for the different classification systems available in PSILCA. Thus, PSILCA retains granularity in favour of a unified sector/industry classification across all countries. PSILCA does well for specific case studies but requires more work when looking across all countries and sectors. As we need to link the entire database (all country-sector/industry combinations) to a financial database, we use EXIOBASE, which also allows us to include environmental impacts.

One important drawback of using input-output-based databases to track life-cycle or supply-chain social and environmental impacts is that the data in the inventory are not company specific and represent the average performance of companies in the same sector and country. The advantage of conducting an LCA of a company or investment fund is, first and foremost, that detailed information on supply-chain impacts can be tied to each company and that the data are external, independent and transparent, and are not self-reported. These gains in information stand opposite the non-negligible drawback of losing information on impacts that is specific to companies. Until a hybrid methodology is developed the relative merits of one or the other approach is a topic of debate. Currently, though, most rating agencies rely on information provided by the companies themselves that can only be verified to a certain extent. As such, our study provides a necessary robustness check to the information on company- and fund-level performance on social and environmental impacts.

Financial database: FactSet

FactSet provides absolute revenue information for the full universe of publicly listed companies, as well as company revenue breakdown (FactSet, 2021). We use the FactSet Databases Revere Business Industry Classifications System (RBICS) and Geographic Revenue Exposure (GeoRev) for a detailed revenue breakdown for each company, by industry (FactSet RBICS database) and country (FactSet GeoRev database). The FactSet RBICS database is very detailed, with 1,603 separate sub-industries. This level of detail allows us to build a rather unique company profile, which we further link with environmental and social indicators available at the country-industry level.

Linking the input-output database EXIOBASE to the financial database FactSet

To estimate the environmental and social impact of public companies, we need, first, information on the economic activities undertaken by the company (from FactSet) and, second, impact factors by economic sector that we extract from the environmentally extended multi regional input-output database EXIOBASE.

To define the correspondence link between the two databases, we established concordance tables. For the regional classification the FactSet to EXIOBASE correspondence was a n:1 relationship. FactSet has a 250 countries classification and EXIOBASE has 49 geographical categories: 45 countries and 5 rest of the world (RoW) regions. For the sectorial classification, the matching was more cumbersome. In some cases, FactSet had a more detailed sectorial breakdown (e.g. for financial sector) and for others, EXIOBASE (e.g. a separate category for each renewable source of production of electricity for each renewable sources). Thus, the sectorial matching was either a 1:1 relationship, 1:n, n:1 or n:n.

We build on the methodology proposed by Koellner et al. (2007) and improved in Popescu et al. (2022). A concordance matrix is established between different industry-level classifications in EXIOBASE and FactSet (Figure 12.1), allowing us to make a regionalized profile of all economic activities of a company and to allocate respective impact factors, thus building company-level estimates for the chosen sustainability indicators. At the company level, we extracted the revenue breakdown for the year 2020. This was then linked with the adjusted impact factors from EXIOBASE.

Choice of social and environmental indicators

Measuring social impact is more challenging than environmental impact, as measures tend to be qualitative rather than quantitative and the choice of measurement unit is not straightforward. EXIOBASE uses hours and number of persons (1,000 persons), to measure the number of people affected by the respective social stressor. PSILCA uses working hours as the default method. However, the activity variable has its limitations and does not cover all stakeholders. In the literature other units are proposed, such as "biophysical pressure" (Zimdars et al., 2018).

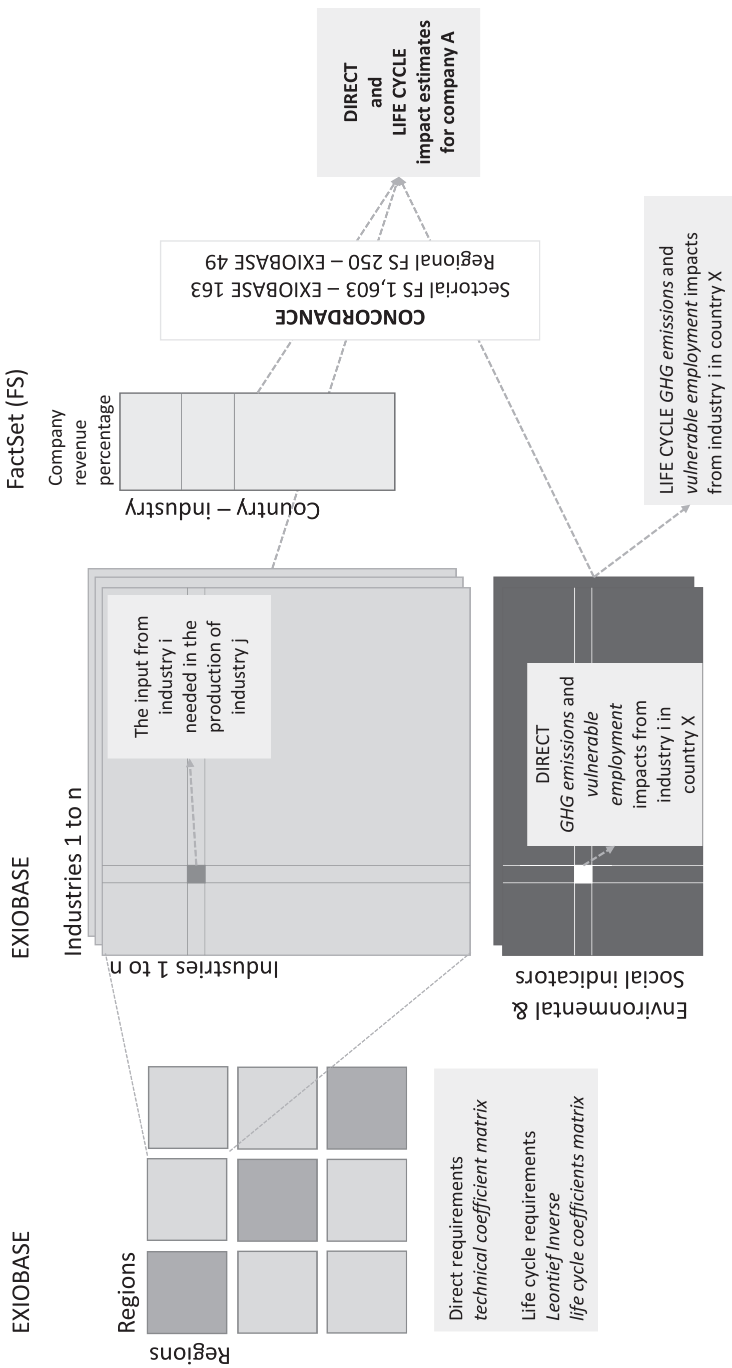

Figure 12.1 Linking input–output database EXIOBASE to the financial database FactSet.

For this study, we use the vulnerable employment indicator, measured in 1,000 persons. The choice of our indicator is strongly supported by the draft EU social taxonomy (EU, 2022), as "decent work (including for value-chain workers)" is the first of three objectives under the taxonomy.

Vulnerable employment is defined by the ILO (2013) as workers without employee status, as explained in the Supplementary Information of Stadler et al. (2018). People in vulnerable employment are classified as own-account workers and contributing family workers, that is, workers without formal employment bonds. The measure is indicative of informal employment – workers not covered by social security or without access to paid leave and work stability or security (Simas et al., 2014).

The labour accounts extension in EXIOBASE is based on data sourced from the ILO, Eurostat, and OECD Statistics, as detailed in the database seminal paper (Stadler et al., 2018). The labour data is updated to year 2011, and we use the 2018 economic accounts from EXIOBASE, the latest available year of data aside from extrapolations to 2019 and 2020, as using the 2018 data ensures higher reliability of data based on collected rather than extrapolated data.

For comparison and as proxy for green indicators, we also use GHG emissions, measured with the indicator "GHG emissions (GWP100) | Problem oriented approach: baseline (CML, 2001)[2] | GWP100 (IPCC, 2007)", accounting for CO_2 and other GHGs based on the global warming potential (GWP) over 100 years.

Social scores from rating agencies

We retrieve ESG indicators related to social and environmental issues from the Bloomberg database. Specifically, we retrieve, at company level, the MSCI ESG rating, Social Disclosure Score (developed by Bloomberg) and Social and Environmental dimensions rank score, from the Corporate Sustainability Assessment (CSA) methodology of RobecoSAM. The latter was acquired by S&P Global (S&P Global, 2020) and is available in Bloomberg. The description of each of the fields are presented in Table 12.2. The different measures did not cover all companies.

Company-level: sample of public companies and market indices

Capital markets are increasingly looking at the sustainability profiles of investable companies. Over 40,000 companies are listed on stock exchanges around the world, where they attract investments by different actors, such as insurance companies, pension funds, and asset managers. We select the full sample of available public companies in FactSet for 2020, the year of the pandemic. Choosing the year 2020 may lead to a reduced sample, as revenue collection in FactSet is not complete. However, analysing specifically year 2020 allows us to understand the real exposure of companies in the year of the Covid-19 outbreak. The selection leads to a final sample of 17,529 companies, with combined estimated revenues of over 30 trillion EUR.

Table 12.2 Selection of ESG indicators available on Bloomberg

Indicator	*Source*	*Scale*	*Description*	*Data availability*
Social Disclosure Score	Bloomberg	0.1–100 (100 is the best)	Proprietary indicator from Bloomberg, based on the extent of a company's social disclosure.	541/673 (80%)
ESG rating	MSCI	AAA–CCC (AAA is the best)	Considers different social issues, like "Supply Chain Labour Standards" or "Access to Health Care" and it is calculated for each company, based on position relative to industry peers.	187/673 (28%)
ROBECOSAM ENV Dimension Rank	RobecoSAM (S&P Global)	1–100 (100 is the best)	Covering up to 10 environmental (social, respectively) material themes, based on data collected from the RobecoSAM CSA survey.	573/673 (85%)
ROBECOSAM Social Dimension Rank				574/673 (85%)

Note: In the "Data availability" column we show for how many of the sampled companies we find a valid score/rating. Retrieved in January 2022.

Table 12.3 Sample of companies and investment funds

Sample	*Description*	*Number of listed companies*	*Year*
Full	All publicly listed companies in FactSet, with available revenue information	17,529	2020
Apparel	All publicly listed companies in FactSet in this sector	486	2020
Chemicals	All publicly listed companies in FactSet in this sector	1,514	2020
Food manufacturing	All publicly listed companies in FactSet in this sector	534	2020
IT&C	All publicly listed companies in FactSet in this sector	354	2020
Mining metals	All publicly listed companies in FactSet in this sector	253	2020
Climate Transition Index fund	Amundi MSCI World Climate Transition CTB UCITS ETF DR USD (C) (LU1602144492)	1,281	2018, 2019, 2020

Next to this full sample of companies, we consider subsamples of companies engaged in specific industries as well as companies held by a climate transition market index (Table 12.3). The five sectors of interest due to high shares of direct or indirect vulnerable employment include apparel (486 companies), chemicals (1,514 companies), food manufacturing (534 companies), IT&C (354 companies), and mining metals (253 companies). In a second step, we focus on the apparel and mining metals sectors, as they have received particular media attention after recent disasters, such as the 2012 Dhaka garment factory fire in Bangladesh or the 2019 collapse of a cobalt and copper mine in Kolwezi in the Democratic Republic of Congo. Both sectors are labour-intensive and have a high share of vulnerable employment – indirect (supply chain) in the case of apparel and more direct in the case of mining metals.

Another sub-sample we consider includes the 1,281 companies that comprise the MSCI Climate Transition Index and we analyse the related investable exchange-traded fund (ETF) Amundi MSCI World Climate Transition CTB UCITS ETF. The Climate Transition ETF invests in companies compatible with the below 2°C warming scenario, companies that would be positively affected by the climate transition. We look at how the fund evolved from 2018 to 2020, both in terms of GHG emissions and vulnerable employment.

Results and discussion

Vulnerable employment by sector

Today, the total number of vulnerable workers worldwide is estimated at around 1.48 billion – around half of the total global workforce (ILO, 2018). According to EXIOBASE, for which the most recent vulnerable employment estimates are from 2011, the values are a bit higher than the up-to-date statistics, at 2.14 billion people in vulnerable employment across the globe, with 800 million people in China alone.

The sectors with the highest intensity in terms of workers in vulnerable employment per €1 million (MEUR) of output include agriculture and farming, mining, and services (e.g. sales). Intensity values in the top 100 sectors exposed to vulnerable employment range from 100 to over 6,000 persons per MEUR of industry output generated. As intensity values are highly influenced by different pricing across sectors, we also analyse values for absolute vulnerable employment exposure from direct operations of all sectors.

"Agriculture and farming" has the highest vulnerable employment exposure at the global level with 60% of total employment (Table 12.4). "Retail and trade" and "Services" sectors come next with by-country values between 5% and 30%. Manufacturing industries, such as "Apparel" and "Computers and communication equipment" have on average more than 5% of total employment classified as vulnerable. While these values represent global averages at sector level, regional variation is a larger driver of differences in vulnerable employment.

Indirect, supply-chain vulnerable employment contributes, on average, more than 70% to total exposure to vulnerable employment for sectors related to processing of raw materials (food processing or metals production), but also textiles manufacturing, chemicals, and computers and equipment manufacturing.

Table 12.4 Total vulnerable employment in absolute values

Industry classification	*Vulnerable employment (in 1,000 persons)*	*As a percentage of all sectorial employment*
Agriculture and farming	1,012,041	59.6
Services	365,527	14.4
Retail and trade activities	168,704	17.9
Construction	152,836	24.5
Processing of agricultural and meat products	63,015	11.0
Other transport	56,923	13.3
Mining	53,893	3.4
Other manufacturing	49,539	7.2
Computers and communication equipment	39,217	8.2
Apparel manufacturing	38,709	8.0
Metal production	36,438	7.7
Chemical manufacturing	17,625	7.3
Automobile manufacturing	17,197	8.4
Plastic manufacturing	14,027	7.4
Utilities	11,799	2.6

Note: The industry classification is a manual regrouping, by larger industry group, of EXIOBASE 163-industry classification.

Table 12.5 Total vulnerable employment, direct (scope 1), across countries and regions

Ranking from highest to lowest direct *exposure to vulnerable employment*	*EXIOBASE Country/ Region*	*Direct vulnerable employment (in 1,000 persons)*	*Direct vulnerable share of total employment*
1	China	799,479	42
2	India	616,645	89
3	RoW Asia and Pacific	317,302	41
4	Indonesia	85,124	40
5	RoW Africa	78,937	19
6	RoW Europe	42,004	18
7	RoW America	41,732	32
8	Brazil	24,769	23
8	Mexico	19,852	24
10	RoW Middle East	14,189	27
40	Croatia	359	17
41	Denmark	229	9
42	Slovenia	210	14
43	Lithuania	199	11
44	Norway	182	10
45	Latvia	112	10
46	Estonia	77	7
47	Cyprus	75	20
48	Malta	49	18
49	Luxembourg	32	14

Note: We sum all the sectors in a country. The first 10 countries/regions have the highest direct exposure to vulnerable employment, while the last 10 countries/regions presented have the lowest direct exposure. The table is a sample from the full 49-region EXIOBASE classification. Values are based on data extracted from EXIOBASE v3.8, year 2018.

Vulnerable employment across countries and regions

The countries with the highest proportion of vulnerable employment out of total employment, averaged across sectors, are mostly in Asia (Table 12.5). India is the country with the highest mean – 89% of workers are classified as under vulnerable employment. China has the largest exposure to vulnerable employment mainly in the Agricultural sector as well as Construction and Hotels and Restaurants (336 million workers).

Company-level analysis: vulnerable employment and GHG emissions of publicly listed companies

We computed vulnerable employment accounts for the complete universe of publicly held companies with revenue breakdown available in FactSet. Summary statistics for the sample are shown in Table 12.6. All companies are responsible for more than 295 million people in vulnerable employment, only from direct operations (about 14% of global vulnerable employment, according to the ILO

Table 12.6 Summary statistics for absolute and intensity measures for the sample of 17,529 public companies

Vulnerable employment (in number of persons)	*Absolute (total)*			*intensity (per MEUR)*		
	Scope 1	*scope 3 upstream*	*Life cycle*	*Scope 1*	*Scope 3 upstream*	*Life cycle*
mean	17,055	21,210	38,288	10.71	17.18	27.91
std	325,688	121,006	400,412	52.07	31.76	66.71
min	0	0	0	0	0.026	0.034
10%	4	31	45	0.11	0.84	1.23
25%	42	187	280	0.41	1.92	3.15
50%	361	1,208	1,846	1.81	6.37	9.10
75%	2,823	7,304	11,186	7.17	17.77	27.20
90%	14,618	32,392	50,776	27.57	42.91	76.88
99%	214,596	366,528	588,061	95.11	165.34	262.73
max	35,254,804	5,055,269	40,314,679	4,385.86	384.05	4,429.80

statistics presented above). The number more than doubles when adding scope 3 upstream (supply-chain) exposure to vulnerable employment. The share of vulnerable employment across companies is highly skewed. The top 50 companies (0.2% of sampled companies) generate 50.05% of the direct vulnerable employment. Scope 1 GHG emissions for the same sample account for almost 8 $GtCO_2$-eq (roughly 20% of the global total GHG emissions). The average direct intensity of vulnerable employment for the sample of 17,529 public companies is 10.7 persons per MEUR of revenue output, while supply-chain vulnerable employment is an additional 17.8 persons per MEUR for a total of 27.9 persons per MEUR (Table 12.6). The distribution is skewed to the right, as the median total (direct and indirect) vulnerable employment intensity is 9.10 persons per MEUR.

In Figure 12.2, we plot the top 25 companies by vulnerable employment (those with the greatest absolute number of vulnerable workers) from the total sample of companies alongside their revenues in million euros.

A look at the list of top 25 companies shows that the problem of vulnerable employment is not a side issue, but one affecting global companies, many of which most consumers in developed economies have come into direct or indirect contact with. Petrochina based in China tops the list, followed by Jardine Matheson, a British multinational conglomerate based in Hong-Kong and domiciled in Bermuda, whose holding companies are active mainly in Asia in construction, transportation, automotive, hotels, restaurants, and real estate. China Petroleum & Chemical Corporation or Sinopec, engaged in oil and gas exploration, refining, and the production and sales of petrochemicals, fibres, and fertilizers, rounds out the top three. Three mining companies, Glencore, an Anglo-Swiss commodity trading and mining company, Vedanta, a global mining company headquartered in London, and Hindustan Zinc, an Indian mining company and subsidiary of Vedanta, take up the next three spots.

Aside from these oil, gas, and mining companies, food manufacturers (Charoen Pokphan Foods, JBS), automotive companies (SAIC, Toyota, Mitsubishi), e-commerce and retail giants (Walmart, Amazon, Alibaba), and electronics (Apple, Samsung) figure prominently in the top 25 companies.

Six companies most exposed to life-cycle vulnerable employment are also in the top 25 for GHG emissions (PetroChina Co., Ltd., China Petroleum & Chemical Corp., China Railway Construction Corp., China Communications Construction Co., Glencore, and Toyota Motor Corp.). However, we observed that companies often included in environmentally-friendly investment funds (e.g. IT&C companies like Apple) and leading in sustainability rankings (e.g. Unilever), do have a significant involvement in vulnerable employment, while they are considered leaders in terms of climate change management.

Impacts along supply chains: direct and indirect vulnerable employment and GHG emissions

The reason SRI and sustainability labels exist is because consumers themselves cannot verify how something has been produced. This is particularly true for

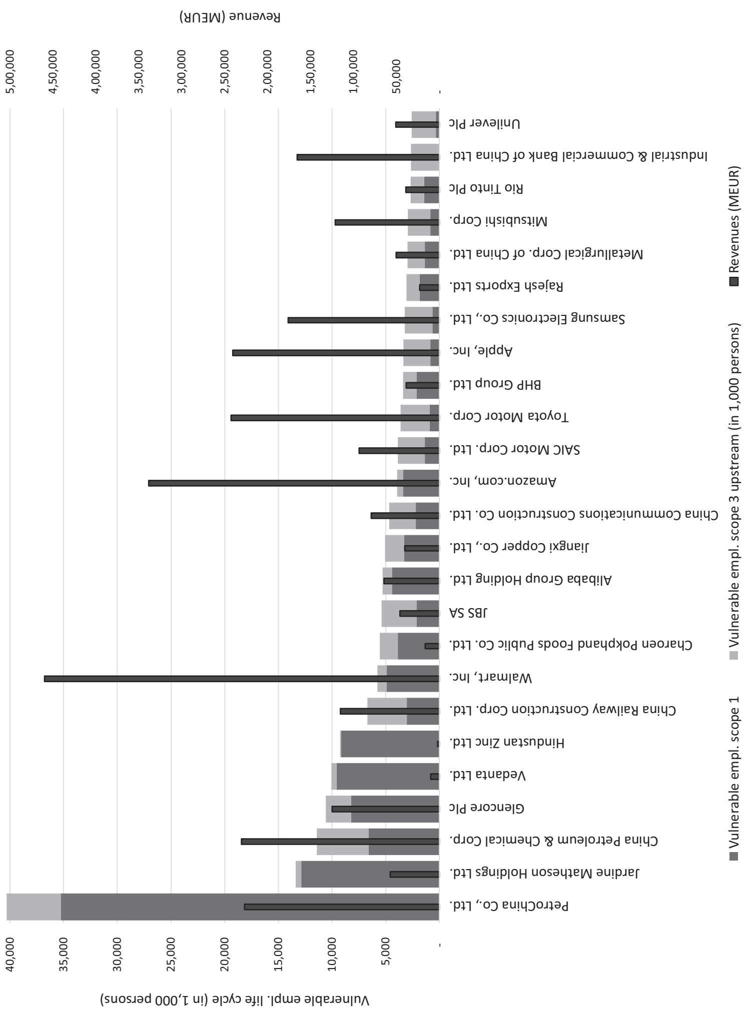

Figure 12.2 Top 25 public companies by life-cycle vulnerable employment exposure, for year 2020. Results are estimated using the EXIOBASE vulnerable employment impact factors and FactSet revenue breakdown.

products that have been produced abroad, as labour and environmental protection laws can vary substantially across countries. Labour-intensive industries tend to concentrate in regions with low cost of labour, in part due to lax labour laws compared to OECD countries. Similarly, energy-intensive industries concentrate in regions with low-cost electricity, oil, or natural gas supplies. Metrics that track supply-chain impacts are important, since for most global, public companies, vulnerable employment, if any, is more likely to occur indirectly in the supply chain rather than directly in the main operations of the companies.

Figure 12.3 shows the mean indirect and direct impacts on vulnerable employment and GHG emissions for the selected sample of companies belonging to one of the five sectors (apparel, chemicals, food manufacturing, IT&C, and mining metals) chosen for their relatively high or low impact on the two indicators. Mining metals has the highest life-cycle impacts, both social and environmental, while for the social impacts, namely vulnerable employment, more than 80% of the impact is from direct operations. Apparel and IT&C are similar for social impacts, while apparel has lower environmental impacts. The difference between sectors for the different indicators is mostly visible for the scope 3 upstream impact: we observe that IT&C has the second-highest supply-chain GHG emissions, but the lowest supply-chain vulnerable employment.

We present the same result in terms of absolute numbers (rather than averages) in Figure 12.9 and as intensities in Figure 12.10 in the Appendix. When normalizing mean vulnerable employment by revenue, the apparel and food manufacturing sectors have higher vulnerable employment per €1 million in revenue than the mining metals sector, with the majority of these impacts occur indirectly in the supply chain (Figure 12.10).

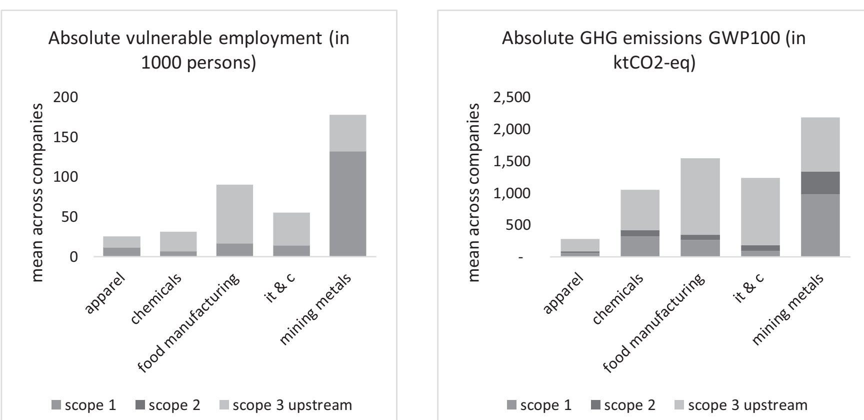

Figure 12.3 Mean vulnerable employment and GHG emissions across listed companies, by sector, estimated for year 2020, using EXIOBASE for impact factors and FactSet for the revenue data.

Correlation of social life cycle with available social scores from rating agencies

Our life-cycle measure of vulnerable employment has the benefit of taking into account impacts in both the direct and indirect (supply chain) stages but comes with the drawback of using industry/country-averages without taking into account company-specific information. Social scores from rating agencies, in contrast, have the advantage of being company-specific. However, they often rely on self-reported data from companies and the coverage is not as complete. In theory, some elements of the social scores of rating agencies are based on impacts that occur in the supply chain, for example "supply chain labour standards" in MSCI's ESG score. However, MSCI's ESG score had only 28% coverage.

RobecoSAM's Social Dimension Rank score had a higher coverage of our sample at 85%. It is a composite score of labour practices indicators, human rights, human capital development, talent attraction & retention, corporate citizenship & philanthropy, and some industry-specific indicators (S&P Global, 2021).[3] The indicators are based on a company's responses to a Corporate Sustainability Assessment questionnaire. Most of the questions are measured mainly at the level of the company rather than its supply chain. This includes questions about whether the company has a non-discrimination and anti-harassment policy in place, the gender balance of the workforce, what share of the workforce is represented by an independent trade union or covered by a collective bargaining agreement, and whether the workforce has access to training. Only the human rights questions delve into the supply chain, as they focus on whether the company has a human rights policy in place and ask whether Tier I suppliers have been assessed for human rights issues in the last three years. Social issues in the supply chain are thus but one component of a larger social score that is mainly determined by activities at the level of the direct company operations.

It is thus of interest to assess how well our life-cycle measure of vulnerable employment correlates with the Social Disclosure Score of Bloomberg (80% coverage) and the RobecoSAM social dimension rank, for the two sectors of interest, apparel and mining (Table 12.7). A higher Social Rank indicates a better performance.

We observe that the selected market ESG measures are poorly correlated with our vulnerable employment estimates. Higher values in both the Social Disclosure Score and Social Dimension Rank indicate better performance, while for our measures higher values indicate worse performance, a negative correlation is expected. Instead, we find almost no correlation, or if any, then a positive correlation. A positive, albeit not very strong correlation of 0.58 and 0.64 is observed between the two social ESG scores of the rating agencies for the mining metals and apparel sectors, respectively.

There are several possible reasons for the poor correlation. As our S-LCA methodology uses industry-country-average impact factors instead of company-specific factors, some degree of effort at the company level to do better than the industry-country average is lost. Another more disconcerting explanation for this incongruity is that larger companies have more resources at their disposal

Table 12.7 Correlation coefficient between our vulnerable employment estimates and Bloomberg's Social Disclosure Score and ROBECOSAM Social Dimension Rank

Apparel	*Social Disclosure Score*	*ROBECOSAM Social Dimension Rank*
Number of companies	114	122
Scope 1 absolute	0.37	0.50
Scope 2 absolute	0.32	0.33
Scope 3 upstream absolute	0.32	0.33
Life-cycle absolute	0.36	0.45
Scope 1 intensity	0.24	0.41
Scope 2 intensity	0.09	0.15
Scope 3 upstream intensity	0.02	0.18
Life-cycle intensity	0.09	0.28
Social Disclosure Score	1	0.64
ROBECOSAM Social Dimension Rank	0.64	1
Mining metals	*Social Disclosure Score*	*ROBECOSAM Social Dimension Rank*
Number of companies	75	83
Scope 1 absolute	0.11	0.19
Scope 2 absolute	0.12	0.18
Scope 3 upstream absolute	0.09	0.17
Life cycle absolute	0.11	0.20
Scope 1 intensity	0.08	0.13
Scope 2 intensity	0.25	0.27
Scope 3 upstream intensity	-0.01	0.11
Life cycle intensity	0.07	0.14
Social Disclosure Score	1	0.58
ROBECOSAM Social Dimension Rank	0.58	1

for sustainability marketing, which can lead to a false conception that the company actually does better on social issues. The Social Dimension Rank score of RobecoSAM is a weighted composite of different indicators, most of which focus on direct operations of the company and only one of which considered the assessment of human rights issues in Tier I suppliers without considering Tier II and III suppliers. The final score thus provides little insight into a company's social impacts along its supply chain.

Focus on the apparel, clothing, and textile sector

We selected the top ten companies from the apparel sector with the largest amount of direct and indirect vulnerable employment and plotted the direct and indirect vulnerable employment as well as the remaining employment, for reference (Figure 12.4). For apparel companies, we find that LVMH Louis Vuitton Moët Hennessy directly and indirectly employs the most vulnerable workers, with supply-chain impacts three times as large as direct (scope 1) impacts. Fiber producing companies, like Toray Industries or Texhong Textile Group also show high indirect vulnerable employment, due to the importance of raw materials (cotton and synthetic fibre production) in their supply chains. Industria de Diseño Textil SA (Inditex), known for its brands Zara and Massimo Dutti and often criticized for its fast-fashion philosophy (Aftab et al., 2018), has high vulnerable employment exposure.

The apparel sector has a long history of opaque supply chains and the use of vulnerable employment. The recent outbreak of the coronavirus disease (Covid-19) has in fact exposed the vulnerable employment of the clothing supply chain operating in South Asian countries, with millions becoming jobless (Majumdar et al., 2020). Specific S-LCA case studies confirm the general issue of poor job conditions, and this also for the same region, even for clothing delivered in Europe (Herrera Almanza and Corona, 2020; Van Der Velden et al., 2017). Initiatives and labels exist to counter these issues, such as the "Goodweave" label (GoodWeave, 2022).[4]

Focus on the mining metals sector

We conduct a similar analysis for the mining metals sector. We observe that direct vulnerable employment is higher than indirect, for all companies (Figure 12.5). Companies that are often held by climate-transition investment funds, such as Rio Tinto, Glencore, or BHP Group are associated with high vulnerable employment.

The mining sector is booming but is particularly susceptible to vulnerable employment, especially in certain developing countries where "women and sometimes children often work in or around mines for less pay or status than their male and adult counterparts, without basic safety equipment" (Sovacool et al., 2020). Yet, even in the EU28, among raw material industries, mining and quarrying displays the worst social performance (Di Noi et al., 2020). The Covid-19 crisis, in particular, may have caused job losses in the mining sector. The crisis disproportionately affected lower-income countries that tend to have a larger share of workers in the informal sector (Ramdoo, 2020), which is related with vulnerable employment. Moreover, as the products of the mining sector are used to manufacture electronics, electric vehicles, solar panels, and wind turbines (Sovacool et al., 2020), the issue of vulnerable employment in mining needs to be addressed to ensure that the products we need for the climate transition are produced in a socially just way. Fortunately, there are certain initiatives that aim to counter types of vulnerable employment, such as the "Fairmined" initiative for gold (Fairmined, 2022).

Focus on climate transition indices investable universe: trade-offs between social and environmental impacts

Climate-focused financial market indices seek to build portfolios aligned with the climate transition, following, for example, the guidelines of the EU Climate

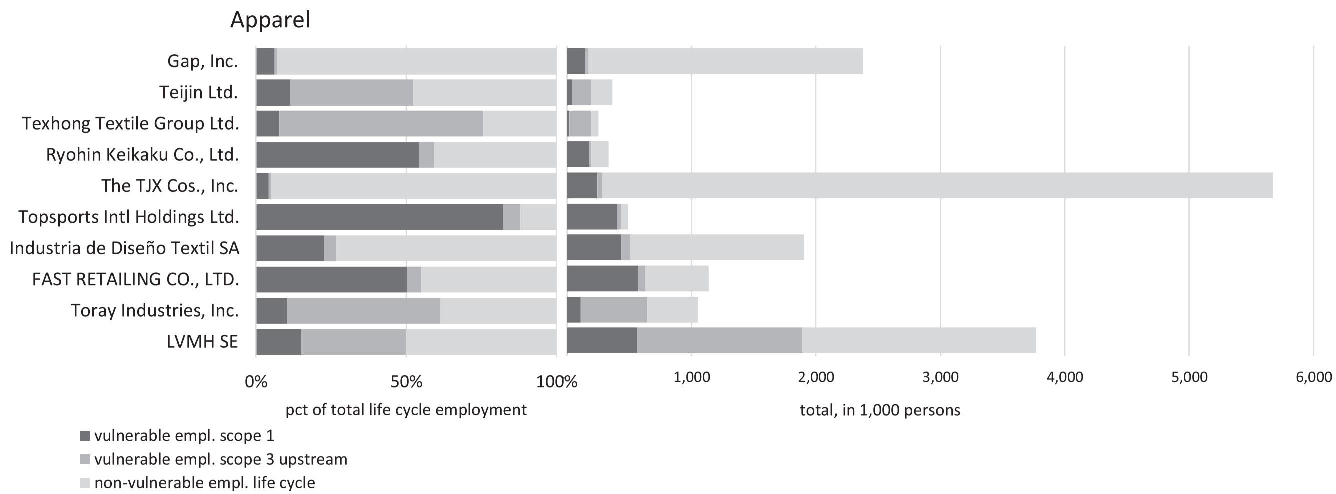

Figure 12.4 Tep ten companies most exposed to life-cycle vulnerable employment, in the apparel sector.

Note: The first graph shows the percentage share of vulnerable employment in total employment, and the relationship between direct and indirect impacts. The second graph plots the total number of workers for a company.

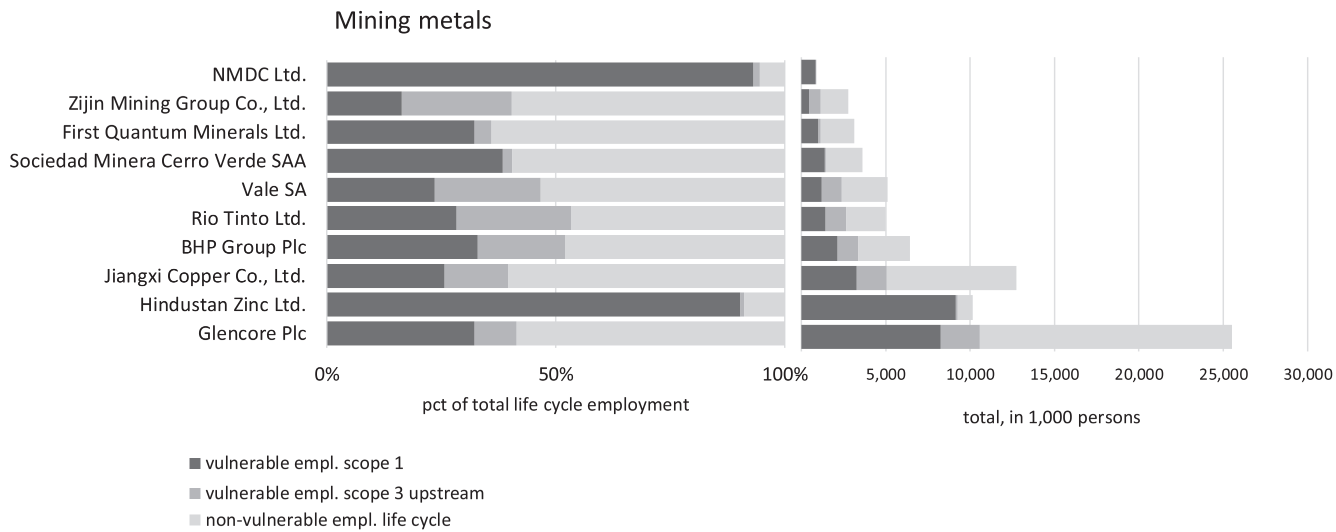

Figure 12.5 Tep ten companies most exposed to life-cycle vulnerable employment, in the mining metals sector.

Note: The left graph shows the percentage of vulnerable employment in total employment, and the relationship between direct and indirect impacts. The second graph plots the total number of workers for a company.

Transition Benchmark. However, the selection methodology for companies in such an index is not straightforward and social impacts may be overlooked when the focus is solely on climate. Figure 12.6 shows the life-cycle GHG emissions and vulnerable employment attributable to the sample of 1,281 companies in the MSCI World Climate Transition Index. We extract detailed revenue information for the constituents of the Index and compare their exposure to GHG emissions and vulnerable employment, in order to understand which companies show a positive or negative correlation between social and environmental impacts.

Companies in different regions are exposed to vulnerable employment to varying degrees. For the regions of Asia/Pacific and Africa & Middle East, the vulnerable employment tends to be generally higher, as expected from the information we have at country-industry level from EXIOBASE.

Trade-offs between social and environmental impacts can be clearly identified for some companies and industries. For example, utility companies have very low vulnerable employment impact factors but high GHG emissions (especially those companies generating electricity from fossil fuels). The same is valid for the Oil & Gas Extraction companies. The inverse relation holds for companies in the services sector: health and social work companies have high vulnerable employment but low emissions, due to the type of activity performed.

There are high trade-offs across companies in particular sectors. For example, retail companies like Walmart, AEON Co., or FAST RETAILING CO. rank high for direct, scope 1 intensity for vulnerable employment. In general, for scope 3 upstream, vulnerable employment is more closely correlated with GHG emissions. When looking at the intensity of vulnerable employment in the supply chain, we find companies producing electronic equipment as ranking high, while having low indirect GHG emissions. For example, QUALCOMM, producing communication equipment, or Nitto Denko Corp. from Japan, involved in manufacturing of semiconductors, have high supply-chain exposure to vulnerable employment – between 20 and 30 workers per €1 million of output produced, or about 200,000 workers in total.

For other sectors, such as chemicals, we see that environmental and social impacts are correlated, when looking at the impact over the life cycle. In the Appendix (Figure 12.11 and Figure 12.12), we show the same scatter plot, separately for direct and indirect impacts.

Companies with high values for vulnerable employment can pass as good environmental investments. For example, food giants like Danone or Unilever and automobile manufacturers like Daimler and Toyota are often included in the portfolios of sustainable investment funds, like the MSCI World Climate Transition Index. However, their supply-chain impacts in terms of vulnerable employment are very high. It is unlikely that social standards for supply-chain workers will improve unless these companies are scrutinized by investors for allowing poor working conditions in their value chain.

The difference in social versus environmental impact implies that green investment is not necessarily socially responsible investment and special attention needs to be placed on green sectors associated with negative social impacts.

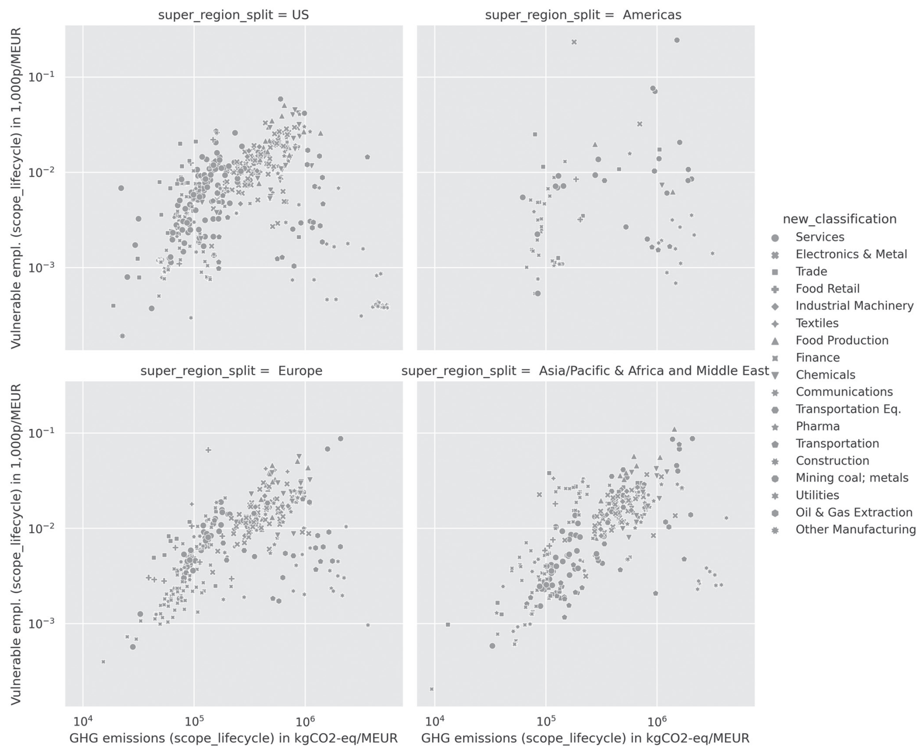

Figure 12.6 Scatter plot showing the trade-off between vulnerable employment and GHG emissions (GWP100) for companies in the MSCI Climate Transition Index.

Note: Each scatter plot illustrates companies domiciled in different regions (US, Americas, Europe and Asia/Pacific & Africa and Middle East). The symbols represent the main industry class of each company. There are a total of 1,281 companies composing the index in year 2020.

Policymakers need to design different solutions to target both social and environmental improvements.

Investment in mutual funds

As a case study related to the mutual fund industry, we compare how the investable MSCI Climate Transition ETF performs on vulnerable employment (Figure 12.7) and GHG emissions (Figure 12.8), over three different years – since its inception in 2018 to the year of the Covid-19 pandemic, 2020. In order to have holdings amount information, we select an investment fund available to retail clients, offered by Amundi, an asset manager.

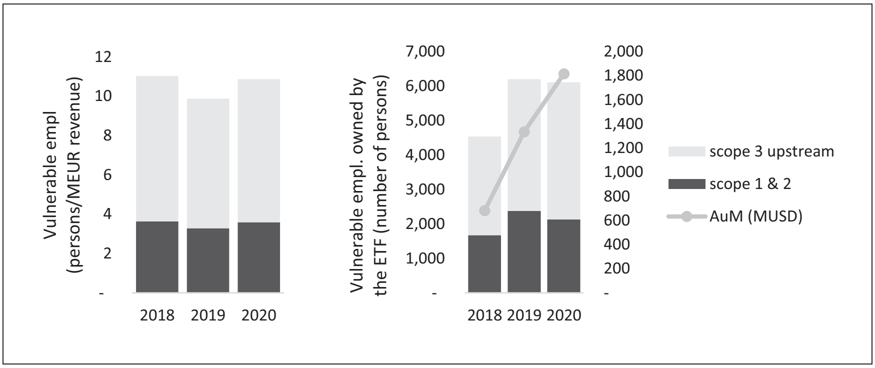

Figure 12.7 Vulnerable employment as intensity and absolute, attributable to the Climate Transition Index, for 2018, 2019, and 2020.

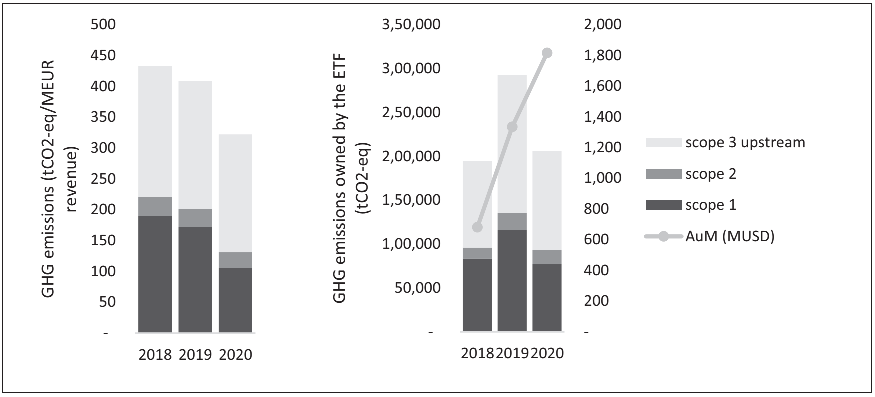

Figure 12.8 GHG emissions as intensity and absolute, attributable to the Climate Transition Index, for 2018, 2019 and 2020.

Worryingly, the Climate Transition fund, despite significantly decreasing its carbon emissions exposure from 2018 to 2020 (from almost 450 to 320 tCO_2-eq per million euros in output generated (MEUR)), has a stable exposure to vulnerable employment (11 persons/MEUR the mean value for the entire sample of companies but still three times larger than the median, as the distribution is skewed). This finding is critical for the development of the SF field. Investors cannot focus solely on carbon emissions as the main sustainability performance proxy. The climate transition cannot be achieved at the expense of worsening working conditions for persons more exposed to vulnerable employment. We can attribute more than 6,000 workers in vulnerable employment to this fund (and 200 $ktCO_2$-eq of GHG emissions).

Moreover, being included in a Climate Transition fund can serve as an endorsement of the fund for the sustainability practices of the company, assuming that no shareholder activism is conducted by the asset manager in order to change company practices. Holdings in the fund that show high supply-chain vulnerable employment can be traced back to blue chip companies that tend to be held in any major mutual fund. For example, Apple, Daimler, and BASF each have estimated vulnerable employment exposure in the supply chain of more than 1 million workers. If investment managers start demanding more action and more reporting on supply-chain social standards, they can trigger change in company practices.

Conclusion

The social dimension of green finance is of critical importance, despite being mostly overlooked in current sustainability assessments of green financial instruments. Recent regulations have put a renewed focus on social impacts, including the EU sustainable finance taxonomy and national legislation, such as Germany's Supply Chain Due Diligence Law (*Lieferkettensorgfaltspflichtengesetz*), which was passed in 2021, taking effect in 2023 and will hold large companies accountable for human rights in their supply chains. These efforts have gained particular traction after news stories highlighted the plight of workers without work protections during the Covid-19 pandemic. With our study, we aim to highlight the importance of considering social impacts when making investment decisions for the climate transition.

Sustainability assessment tools like LCA offer a basis for defining measurable social indicators for SF stakeholders. We introduced a first application of an environmentally extended multi regional input-output database, EXIOBASE, to the assessment of social impacts of corporations and investment instruments by linking it the financial database FactSet. We focus on the indicators of GHG emissions and vulnerable employment as a proxy for both the environmental and social dimension of sustainability. Vulnerable employment is defined as workers without employee status and is indicative of informal employment and thus correlated with other social indicators, such as whether workers are covered by social security, have access to paid leave, or work stability.

We find that the agriculture and construction sectors have high shares of vulnerable employment, globally, at 60% and 25%, respectively. Vulnerable employment occurs mainly in the supply chain. Indirect, supply-chain vulnerable employment contributes, on average, more than 70% to total exposure to vulnerable employment for sectors related to processing of raw materials (food processing or metals production), but also textiles manufacturing, chemicals, and computers and equipment manufacturing.

For the complete universe of publicly held companies with revenue breakdown available in FactSet vulnerable employment amounts to 10.7 persons per MEUR of revenue output on average, while supply-chain vulnerable employment is an additional 17.8 persons per MEUR for a total of 27.9 persons per MEUR. This distribution includes companies with much higher shares of vulnerable employment in their own operations and their supply chain. Across all sectors, however, vulnerable employment is often hidden in the supply chain, and this finding is particular true for the apparel and food manufacturing sectors.

In the apparel sector, we find that for seven out of the top ten publicly listed companies in our sample in terms of vulnerable employment the total direct and indirect (supply-chain) vulnerable employment made up more than 50% of their total employment. In the mining metals sector, the share was above 40% in all of the top ten companies. Even when considering companies across all sectors, the top 25 companies in terms of vulnerable employment included many companies consumers in developed economies are likely familiar with, such as Walmart, Amazon, Apple, Toyota, Samsung, Mitsubishi, and Unilever.

In general, we find that social impacts show a higher variation between regions than within the same region across different industries, while for environmental impacts the opposite is generally valid. Environmental impacts are technology and process-driven, while social impacts are rather a factor of societal norms. Nonetheless, there are sectors, such as agriculture and farming, which are more exposed to social issues like vulnerable employment, across more regions, independent of the development status of the country, just as there are sectors where environmental impact can be country-dependent, when, for example, one country has more restrictive regulations in terms of GHG emissions.

Our assessment of companies included in the MSCI World Climate Transition Index showed that companies selected the good performance on climate change do not necessarily do well on vulnerable employment. While some companies exhibit both high GHG emissions and high vulnerable employment, we also found companies with low GHG emissions and high vulnerable employment, particularly in the food retail, services, and trade sectors. This result is particularly concerning when it comes to industries that will likely see greater investment flows in the future, as they are necessary for the climate transition, such as electric vehicles and solar panels. Manufacturing in these two sectors requires metals, such as cobalt and lithium, which are susceptible to human rights violations in their mining. While the Climate Transition fund decreased its carbon emissions exposure from 2018 to 2020, its exposure to vulnerable employment remained unchanged and was three times larger than the median for the entire sample of companies.

The advantage of the LCA methodology as applied to publicly listed companies and funds lies in quantifying impacts along their supply chain. While rating agencies, such as Sustainalytics and RobecoSAM, do consider social impacts along supply chains, only Tier I suppliers are considered and the indicator is but one of several others that focus on the main operations of companies rather than on the extent of human rights issues in their supply chain. Our measure of vulnerable employment was poorly correlated with the Social Score of RobecoSAM and the Social Disclosure Score of Bloomberg for companies in the apparel and mining metals sectors. Our measure has the added advantage of offering 100% coverage, while the social scores of RobecoSAM, Bloomberg, and MSCI had lower coverage of 85%, 80%, and 28%, respectively.

Social-centred life-cycle inventories, such as PSILCA and the SHDB, are dedicated to measuring social impacts across multiple indicators. However, they cannot be readily linked to financial databases, because industry classifications differ across regions within PSILCA and SHDB. More work is needed in harmonizing these databases and facilitating the correspondence to financial investment products. Future research could focus on facilitating this correspondence, since the results would serve to validate our present results on vulnerable employment using EXIOBASE and would expand the measurement of social impacts along supply chains beyond the single measure of vulnerable employment.

Notes

1 Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd) pyrene, polychlorinated biphenyls, dioxins (PCDD and PCDDF), hexachlorobenzene, non-methane volatile organic compounds, particulate matter (PM_{10} and $PM_{2.5}$), total suspended particulate, and heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, and Zn).

2 CML 2001 (baseline) method was adopted for the impact assessment stage. CML was developed at Leiden University and follows guidelines established by ISO 14044 (2006b) and by the International Life Cycle Data System (ILCD), developed by the European Commission Joint Research Centre (2010).

3 www.spglobal.com/en/annual-reports/2021/

4 https://goodweave.org/goodweave-certification-label-builds-partnerships-in-rug-and-home-textile-sector-to-eradicate-child-forced-and-bonded-labour-in-supply-chains/

References

Aftab, M.A., Yuanjian, Q., Kabir, N., Barua, Z., 2018. Super Responsive Supply Chain: The Case of Spanish Fast Fashion Retailer Inditex-Zara. *Int. J. Bus. Manag.* 13, 212. https://doi.org/10.5539/IJBM.V13N5P212

Benoit-Norris, C., Cavan, D.A., Norris, G., 2012. Identifying Social Impacts in Product Supply Chains: Overview and Application of the Social Hotspot Database. *Sustainability* 4, 1946–1965. https://doi.org/10.3390/su4091946

Berg, F., Kölbel, J., Rigobon, R., 2020. Aggregate Confusion: The Divergence of ESG Ratings. *SSRN Electron. J.* https://doi.org/10.2139/ssrn.3438533

Ciroth, A., Eisfeldt, F., 2022. A New, Comprehensive Database for Social LCA: PSILCA.

Di Noi, C., Ciroth, A., Mancini, L., Eynard, U., Pennington, D., Blengini, G.A., 2020. Can S-LCA Methodology Support Responsible Sourcing of Raw Materials in

EU Policy Context? *Int. J. Life Cycle Assess.* 25, 332–349. https://doi.org/10.1007/s11367-019-01678-8

EC, 2019. *Taxonomy Technical Report.*

ESAs, 2021. *Final Report on Draft Regulatory Technical Standards.*

EU, 2022. Final Report on Social Taxonomy.

FactSet, 2021. FactSet Data Solutions – FactSet Ownership and FactSet Fundamentals [WWW Document]. FactSet. URL www.factset.com/solutions/business-needs/data-solutions (accessed 4.2.21).

Fairmined [WWW Document], 2022. URL https://fairmined.org/ (accessed 3 March 2022).

Gibon, T., Popescu, I.-Ş., Hitaj, C., Petucco, C., Benetto, E., 2020. Shades of Green: Life Cycle Assessment of Renewable Energy Projects Financed through Green Bonds. *Environ. Res. Lett.* 15, 104045. https://doi.org/10.1088/1748-9326/abaa0c

GSIA, 2021. *Global Sustainable Investment Review 2020.*

Herrera Almanza, A.M., Corona, B., 2020. Using Social Life Cycle Assessment to Analyze the Contribution of Products to the Sustainable Development Goals: A Case Study in the Textile Sector. *Int. J. Life Cycle Assess.* 25, 1833–1845. https://doi.org/10.1007/S11367-020-01789-7/TABLES/4

ILO, 2013. Guide to the Millennium Development Goals Employment Indicators Second edition.

ILO, 2018. World Employment Social Outlook: Trends 2018.

ILO, 2021. *World Employment and Social Outlook: Trends 2021*, International Labour Organization: Geneva.

IPCC, 2007, Climate Change 2007: The Scientific Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, edited by S. Solomon et al., Cambridge University Press: New York.

Koellner, T., Suh, S., Weber, O., Moser, C., Scholz, R.W., 2007. Environmental Impacts of Conventional and Sustainable Investment Funds Compared using Input-Output Life-Cycle Assessment. *J. Ind. Ecol.* https://doi.org/10.1111/j.1530-9290.2008.00077.x

Landier, A., Lovo, S., 2020. ESG Investing: How to Optimize Impact? *SSRN Electron. J.* https://doi.org/10.2139/SSRN.3508938

Lèbre, É., Stringer, M., Svobodova, K., Owen, J.R., Kemp, D., Côte, C., Arratia-Solar, A., Valenta, R.K., 2020. The Social and Environmental Complexities of Extracting Energy Transition Metals. *Nat. Commun.* 11, 1–8. https://doi.org/10.1038/s41467-020-18661-9

Majumdar, A., Shaw, M., Sinha, S.K., 2020. Covid-19 Debunks the Myth of Socially Sustainable Supply Chain: A Case of the Clothing Industry in South Asian Countries. *Sustain. Prod. Consum.* 24, 150–155. https://doi.org/10.1016/J.SPC.2020.07.001

Mancini, L., Eynard, U., Eisfeldt, F., Ciroth, A., Blengini, G.A., Pennington, D.W., 2018. Social Assessment of Raw Materials Supply Chains: A Life-Cycle-Based Analysis. Publications Office of the European Union. https://doi.org/10.2760/470881

O'Connor-Willis, C., 2021. *Making ESG Work: How Investors Can Help Improve Low-Wage Labor and Ease Income Inequality.* NYU Stern White Paper, Center for Business and Humand Rights.

Pelletier, N., Ustaoglu, E., Benoit, C., Norris, G., Rosenbaum, E., Vasta, A., Sala, S. 2018. Social sustainability in trade and development policy. The International Journal of Life Cycle Assessment, 23, 629–639.

Popescu, I.S., Gibon, T., Hitaj, C., Rubin, M., Benetto, E., 2022. Are SRI Funds Financing Carbon Emissions? An Input-Output Life Cycle Assessment of Investment

Funds [WWW Document]. *SSRN Electron. J.* URL https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4047292 (accessed 3 March 2022).

Popescu, I.-S., Hitaj, C., Benetto, E., 2021. Measuring the Sustainability of Investment Funds: A Critical Review of Methods and Frameworks in Sustainable Finance. *J. Clean. Prod.* 314, 128016. https://doi.org/10.1016/j.jclepro.2021.128016

Ramdoo, I., 2020. The Impact of Covid-19 on Employment in Mining [WWW Document]. *Int. Inst. Sustain. Dev.* URL www.iisd.org/publications/impact-covid-19-employment-mining (accessed 3 March 2022).

S&P Global, 2020. CSA to Become the Pillar of ESG Data Collection at S&P Global – Benefits for Corporates | S&P Global [WWW Document]. URL www.spglobal.com/esg/csa/insights/csa-benefits-for-corporates (accessed 28 February 2022).

Simas, M., Wood, R., Hertwich, E., 2015. Labor Embodied in Trade: The Role of Labor and Energy Productivity and Implications for Greenhouse Gas Emissions. *J. Ind. Ecol.* 19, 343–356. https://doi.org/10.1111/jiec.12187

Simas, M.S., Golsteijn, L., Huijbregts, M.A.J., Wood, R., Hertwich, E.G., 2014. The "Bad Labor" Footprint: Quantifying the Social Impacts of Globalization. *Sustain.* 6, 7514–7540. https://doi.org/10.3390/su6117514

Sovacool, B.K., Ali, S.H., Bazilian, M., Radley, B., Nemery, B., Okatz, J., Mulvaney, D., 2020. Sustainable Minerals and Metals for a Low-Carbon Future. *Science* (80-.), 367, 30–33. https://doi.org/10.1126/SCIENCE.AAZ6003/SUPPL_FILE/AAZ6003_SOVACOOL_SM.PDF

Stadler, K., Wood, R., Bulavskaya, T., et al., 2018. EXIOBASE 3: Developing a Time Series of Detailed Environmentally Extended Multi-Regional Input-Output Tables. *J. Ind. Ecol.* 22, 502–515. https://doi.org/10.1111/jiec.12715

UN, 2021. The Sustainable Development Goals Report 2021 [WWW Document]. URL https://unstats.un.org/sdgs/report/2021/

UNEP, 2020. Guidelines for Social Life Cycle Assessment of Products and Organisations 2020 [WWW Document]. URL https://wedocs.unep.org/handle/20.500.11822/34554 (accessed 3.1.22).

Van Der Velden, N.M., Vogtl, J.G., 2017. Monetisation of External Socio-Economic Costs of Industrial Production: A Social-LCA-Based Case of Clothing Production. https://doi.org/10.1016/j.jclepro.2017.03.161

World Economic Forum, 2020. Making Mining Safe and Fair: Artisanal Cobalt Extraction in the Democratic Republic of the Congo | World Economic Forum [WWW Document]. URL www.weforum.org/whitepapers/making-mining-safe-and-fair-artisanal-cobalt-extraction-in-the-democratic-republic-of-the-congo (accessed 1 March 2022).

Zimdars, C., Haas, A., Pfister, S., 2018. Enhancing Comprehensive Measurement of Social Impacts in S-LCA by Including Environmental and Economic Aspects. *Int. J. Life Cycle Assess.* 23, 133–146. https://doi.org/10.1007/s11367-017-1305-z

Appendix

Table 12.8 EXIOBASE country and region list and abbreviations

Code	*Country/region*	*Code*	*Country/region*
AT	Austria	SI	Slovenia
BE	Belgium	SK	Slovakia
BG	Bulgaria	GB	UK
CY	Cyprus	US	US
CZ	Czech Republic	JP	Japan
DE	Germany	CN	China
DK	Denmark	CA	Canada
EE	Estonia	KR	South Korea
ES	Spain	BR	Brazil
FI	Finland	IN	India
FR	France	MX	Mexico
GR	Greece	RU	Russia
HR	Croatia	AU	Australia
HU	Hungary	CH	Switzerland
IE	Ireland	TR	Turkey
IT	Italy	TW	Taiwan
LT	Lithuania	NO	Norway
LU	Luxembourg	ID	Indonesia
LV	Latvia	ZA	South Africa
MT	Malta	WA	RoW Asia and Pacific
NL	The Netherlands	WL	RoW America
PL	Poland	WE	RoW Europe
PT	Portugal	WF	RoW Africa
RO	Romania	WM	RoW Middle East
SE	Sweden		

Table 12.9 Social categories and themes in the SHDB

Social category	*Social theme*
Labour rights and decent work	Child labour
	Forced labour
	Excessive working time
	Wage assessment
	Poverty
	Migrant labour
	Freedom of association, collective bargaining rights
	Unemployment
	Labour laws
Health and safety	Injuries and fatalities
	Toxics and hazards
Human rights	Indigenous rights
	Gender equity

Table 12.9 (Continued)

Social category	*Social theme*
	High conflicts
	Human health issues
Governance	Legal systems
	Corruption
Community infrastructure	Hospital beds
	Drinking water
	Sanitation
	Children out of school
	Smallholder vs. commercial farms

Table 12.10 Indicators in the PSILCA life-cycle inventory database

Stakeholder	*Subcategory*	*Indicator*	*Unit of measurement*	*Index*
WORKERS	Child labour	Children in employment, male	% of male children ages 7–14	W1.1
		Children in employment, female	% of female children ages 7–14	W1.2
		Children in employment, total	% of all children ages 7–14	W1.3
	Forced labour	Goods produced by forced labour	Number of goods in the sector	W2.1
		Frequency of forced labour	Cases per 1,000 inhabitants in the country	W2.2
		Tier placement referring to trafficking in persons	Tier placement	W2.3
	Fair salary	Living wage, per month	US$	W3.1
		Minimum wage, per month	US$	W3.2
		Sector average wage, per month	US$	W3.3
	Working time	Hours of work per employee, per day	h	W4.1
		Hours of work per employee, per week	h	W4.2
		Standard weekly hours	h	W4.3
		Standard daily hours	h	W4.4
	Discrimination	Occurrence of discrimination	Text	W5.1
		Women in the labour force	% of economically active female population	W5.2
		Men in the labour force	% of economically active male population	W5.3
		Gender wage gap	%	W5.4
	Health and Safety	Accident rate at workplace	#/yr	W6.1
		Fatal accidents at workplace	#/yr	W6.2

		Occupational risks	Text	W6.3
		DALYs due to indoor and outdoor air and water pollution	DALYs per 1,000 inhabitants in the country	W6.4
		Presence of sufficient safety measures	OSHA cases per 1,0000 employees in the sector	W6.5
		Workers affected by natural disasters	%	W6.6
	Social benefits, legal issues	Social security expenditures	Social security expenditures as a % of GDP	W7.1
		Evidence of violations of laws and employment regulations	#	W7.2
	Workers' rights	Freedom of association rights	text	W8.1
		Trade union density as a % of paid employment total	%	W8.1.1
		Right of association	ordinal 0–3	W8.1.2
		Right of collective bargaining	ordinal 0–3	W8.1.3
		Right to strike	ordinal 0–3	W8.1.4
VALUE-CHAIN ACTORS	Fair competition	Presence of anti-competitive behaviour or violation of anti-trust and monopoly legislation	Cases per 10,000 employees in the sector	V1.1
		Presence of policies to prevent anti-competitive behaviour	Y/N	V1.2
	Corruption	Corruption index of country	index value	V2.1
		Evidence of an active involvement of the enterprises in corruption and bribery	Text	V2.2
	Promoting social responsibility	Presence of codes of conduct that protect human rights of workers among suppliers	Y/N	V3.1
		Membership in an initiative that promotes social responsibility along the supply chain	%	V3.2

(Continued)

Table 12.10 (Continued)

Stakeholder	*Subcategory*	*Indicator*	*Unit of measurement*	*Index*
	Supplier relationships	Interaction of the companies with suppliers	Text	V4.1
SOCIETY	Contribution to economic development	Economic situation of the country	Text	S1.1
		Contribution of the sector to economic development	%	S1.2
		Public expenditure on education	US$/yr	S1.3
		Illiteracy rate, male	%	S1.4.1
		Youth illiteracy rate, male	%	S1.4.2
		Illiteracy rate, female	%	S1.5.1
		Youth illiteracy rate, female	%	S1.5.2
		Illiteracy rate, total	%	S1.6.1
		Youth illiteracy rate, total	%	S1.6.2
	Health and safety	Health expenditure, Total	%	S2.1.1
		Health expenditure, Public	%	S2.1.2
		Health expenditure, out of pocket	%	S2.1.3
		Health expenditure, external resources	%	S2.1.4
		Health expenditure out of the total GDP of the country	%	S3.1
		Life expectancy at birth	Years	S3.2
	Prevention and mitigation of conflicts	Risk of conflicts with regard to the sector	Text	S4.1
LOCAL COMMUNITY	Access to material resources	Level of industrial water use	Text	L1.1
		Level of industrial water use, out of total withdrawal	%	L1.1.1
		Level of industrial water use, out of total actual renewable	%	L1.1.2

	Extraction of material resources (other than industrial water)	Text	L1.2
	Extraction (total) of fossil fuels	t/cap	L1.2.1
	Extraction (total) of biomass	t/cap	L1.2.2
	Extraction (total) of ores	t/cap	L1.2.3
	Extraction (total) of biomass	t/km2	L1.2.4
	Extraction (total) of industrial & const. minerals	t/cap	L1.2.5
	Presence of certified environmental management systems	# of CEMS per 10,0000 employees	L1.3
	Description of (potential) material resource conflicts	Text	L1.4
Respect of indigenous rights	Presence of indigenous population	Y/N	L2.1
	Human rights issues faced by indigenous people	text	L2.2
	(Company's) respect of indigenous rights	Text	L2.3
Safe and healthy living conditions	Pollution level of the country	Text	L3.1
	Contribution of the sector to environmental load	Text	L3.2
	Drinking water coverage	%	L3.3
	Sanitation coverage	%	L3.4
	Management effort to improve environmental performance	Text	L3.5
Local employment	Unemployment rate in the country	%	L4.1
	Work force hired locally	%	L4.2
	Percentage of spending on locally based suppliers	%	L4.3
Migration	International migrant workers in the sector	%	L5.1
	International Migrant Stock	%	L5.2
	Net migration rate	Net migration per 1,000 persons	L5.3
	Emigration rate	%	L5.4
	Immigration rate	%	L5.5
	Human rights issues faced by migrants	Text	L5.6

(Continued)

Table 12.10 (Continued)

Stakeholder	*Subcategory*	*Indicator*	*Unit of measurement*	*Index*
CONSUMERS	Health and Safety	Violations of mandatory health and safety standards	#	C1.1
		Presence of commissions/institutions to detect violations of standards and protect consumers	Y/N	C1.2
		Presence of management measures to assess consumer health and safety	Y/N	C1.3
	Transparency	Presence of business practices that are deceptive or unfair to consumers	#	C2.1
		Presence of certifications or labels for the product/sites sector	#	C2.2
		Presence of a law or norm regarding transparency (by country and/or sector)	Y/N	C2.3
	End of life responsibility	Strength of national legislation covering product disposal and recycling	Text	C3.1

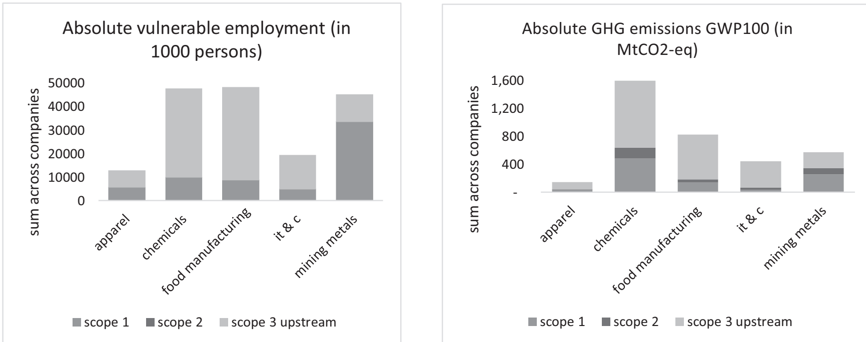

Figure 12.9 Total vulnerable employment and GHG emissions, by sector in 2020.

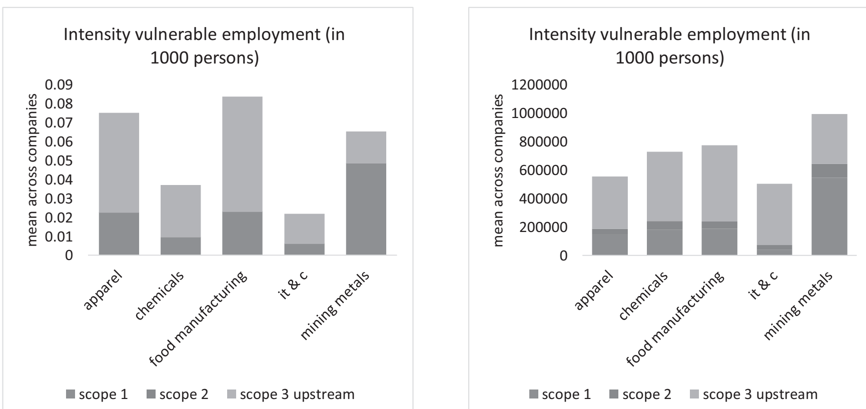

Figure 12.10 Mean vulnerable employment and GHG emissions, expressed as intensity (per MEUR of revenue), by sector in 2020.

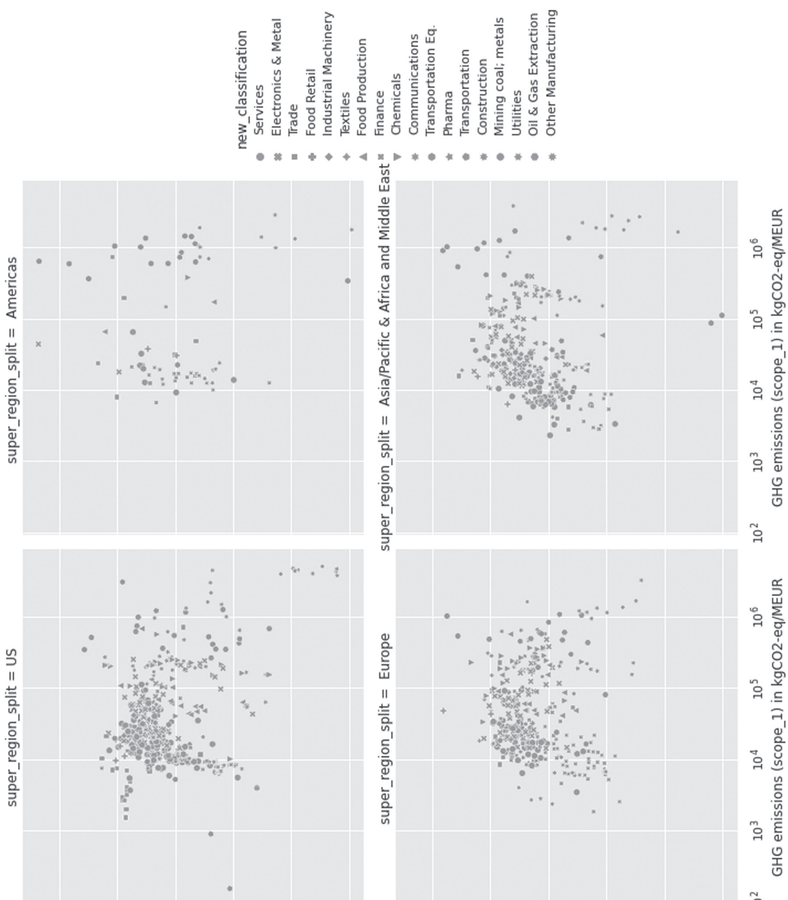

Figure 12.11 Companies from the climate transition index, scope 1 intensity.

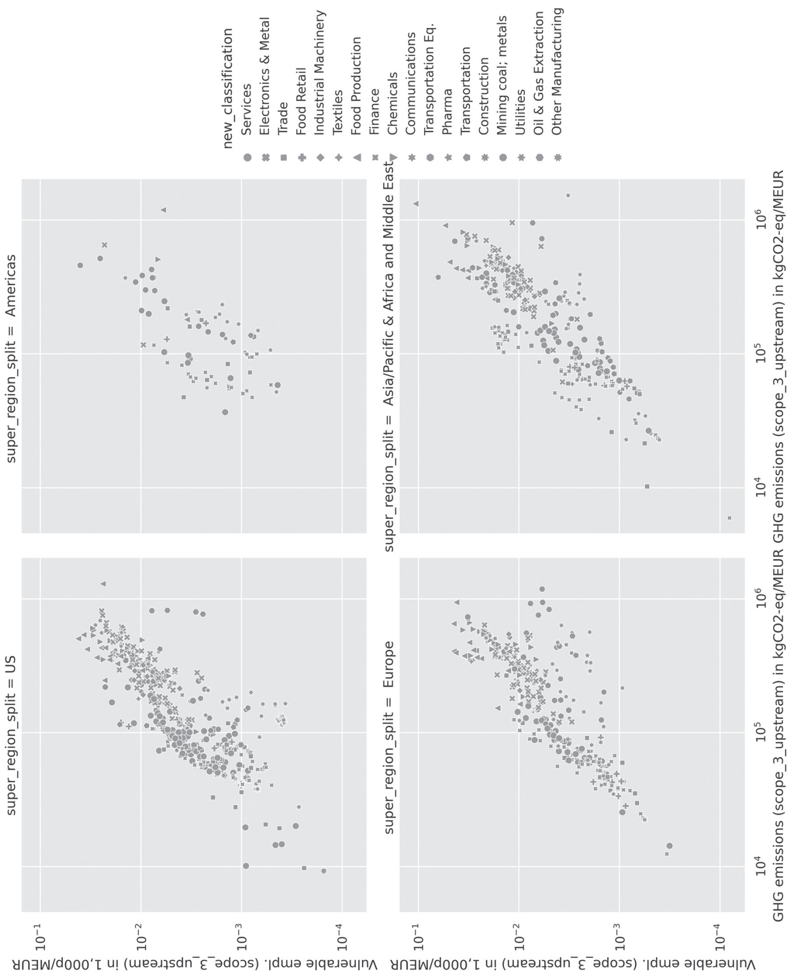

Figure 12.12 Companies from the climate transition index, scope 3 upstream intensity.