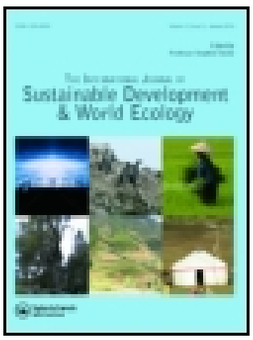

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# Towards nexus-based governance: defining interactions between economic activities and Sustainable Development Goals (SDGs)

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# Towards nexus-based governance: defining interactions between economic activities and Sustainable Development Goals (SDGs)

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**ABSTRACT**

The success of the Sustainable Development Goals (SDGs) depends on solving the 'nexus' challenge: how can positive interactions between SDGs be optimised, and negative interactions minimised, in order to create co-benefits and reduce trade-offs? Due to their varying impacts on the SDGs, the economic activities undertaken by organisations present a key lever for operationalising this SDG-nexus. Yet the interactions between individual economic activities and the economic, social, and environmental dimensions of sustainable development have not been systematically assessed, thus creating a vital operational bottleneck to achieving the SDGs. This paper conducts a systematic review of 876 articles published between 2005 and 2019 to study the nexus between individual economic activities, sustainable development in general, and the SDGs in specific. It finds that studies on agricultural, industrial, and manufacturing activities predominantly report negative impacts on environmental development, while literature on services activities highlight economic and social contributions. Overall, most economic activities are expected to positively impact industrialization, infrastructure, and innovation [SDG 9] and economic productivity [SDG 8], while many help meet basic needs [SDGs 2, 3, 4, 6, 7, 11]. However, negative impacts are widespread, afflicting ecosystems [SDGs 14 and 15], climate change [SDG 13] and human health [SDG 3]. We synthesise positive and negative interactions between individual economic activities and SDG targets and discuss implications for: integrated (nexus) governance approaches to the SDGs; the role of the private sector in promoting sustainable development; and for improving statistical classifications to monitor economic activities' SDG impacts.

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Economic activities; Sustainable Development Goals (SDG); Sustainability; Nexus approach; Systematic review; Sustainable development; 2030 Agenda; Interlinkages

*"The desire to engross the whole surface of the earth in the mere production of the greatest possible quantity of food and the materials of manufacture, I consider to be founded on a mischievously narrow conception of the requirements of human nature." – J. S. Mill 1866*

## 1. Introduction

In 2015, the world's leaders adopted 17 Sustainable Development Goals (SDGs) that aim to '*free humanity from poverty, secure a healthy planet for future generations, and build peaceful, inclusive societies as a foundation for ensuring lives of dignity for all*' (UN 2017, p. 4). These 17 goals are supported by 169 targets with over 200 indicators. All countries, regardless of their income-levels, agreed to aim to achieve the SDGs by the year 2030. However, five years in, the outlook on the SDGs is bleak: recent assessments show that inequality is widening, hunger is on the rise, ecosystems are eroding at an alarming rate, and climate change threatens the entire SDG agenda (Sachs et al. 2019; UN 2019).

A major challenge is the priority given to SDGs that drive economic growth compared to SDGs that promote social inclusion and ecological sustainability (Gupta and Vegelin 2016). Economic growth is a double-edged sword for sustainable development. Growth is critical for improving living standards, and it typically is good for the poor (Dollar et al. 2013), as witnessed by the role economic growth played in helping lift more than one billion people out of poverty since 1990 (World Bank 2018). However, economic growth may promote inequality within and between countries (Ravallion 2001; Stiglitz 2019). Moreover, our impacts on the planet have become so profound that we entered the Anthropocene – an epoch in which human activity is the dominant cause of environmental change, which will likely be observable for millions of years to come (Crutzen 2006; Lewis and Maslin 2015). These 'limits to growth' (Meadows et al. 1972) also jeopardise the SDGs. The dominant focus on economic growth and consumption – organised in vulnerable international systems (e.g. Mintzberg 2015) – conflicts with SDGs addressing the natural environment (Kopnina 2016; Spaiser et al. 2017). Environmental destruction may consequently harm public health, both through pollution and by encouraging the spread

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of diseases passed from animals to humans, which is a likely cause of the current coronavirus pandemic (UN Environment 2020). Such inconsistencies could cause the SDG agenda to fail.

Moving forward requires integrated governance approaches (Boas et al. 2016) that treat the SDGs as they are: entwined and indivisible (UN 2015). One such approach is the 'nexus approach', which induces policymakers to act on the interactions between individual SDGs in order to reap co-benefits and reduce the risk of trade-offs (Weitz et al. 2014; Boas et al. 2016; Liu et al. 2018). Different methods are emerging for exploring interactions between the SDGs. One method quantifies interactions between SDGs using public statistics (e.g. Spaiser et al. 2017; Allen et al. 2019; Bali Swain and Yang-Wallentin 2020). Another method qualitatively maps and scores the strength of positive, neutral, and negative SDG interactions in different contexts (e.g. Nilsson et al. 2016). Understanding the range of positive and negative interactions between the SDGs is critical for unlocking their potential and supports creating coherent, nexus-based, policies for the SDGs (Griggs et al. 2017). This need for integrated governance for the SDGs resonates with policymakers: the 2018 UN High Level Policy Forum prioritised SDGs 6, 7, 11, 12 and 15 for governing linkages amongst the SDGs, and the 2019 Global Sustainable Development Review (GSDR) advised the UN to act on the interactions between the SDGs by targeting six 'entry points' to the SDG agenda (Independent Group of Scientists appointed by the Secretary-General 2019).

In this context, the critical role of the economy in the broader notion of sustainable development (i.e. the integration of economic, social, and environmental development in resilient, inclusive and balanced societies) merits further exploration. To date most efforts examined the consequences of *economic growth* on sustainable development in general (e.g. Meadows et al. 1972; Redclift 2005) and the SDGs more specifically (e.g. Spaiser et al. 2017). A complementary lens zooms in on the nature of *economic activities*. Numerous, highly heterogeneous types of economic activities may be undertaken by organisations in a society. Economic activities can be any kind of activity that an organisation engages in that aims to make, provide, purchase, or sell goods or services. Examples include specific types of agriculture, manufacturing, or services activities, whereby international organisations such as the UN and the European Union have classified hundreds of individual economic activities. These economic activities generate diverse economic, social, and environmental impacts. A growing number of studies analyse the sustainable development impacts of individual types of economic activities, helping shed light on their positive and negative SDG impacts. Yet as far as we are aware, no studies have yet provided an overarching perspective on how the diverse economic activities that organisations engage in impact different sustainable development dimensions, and how these impacts can be governed in an integrated manner.

This paper helps to fill this gap by synthesising the literature on the interface between economic activities and sustainable development impacts. We systematically review 876 articles published between 2005 and 2019 that cover 420 economic activities (defined by the ISIC Rev. 4 classification[1]). Following a methodological explanation (section 2), we provide an overview of the key features of sustainable development characteristics reported in articles on individual economic activities. This includes whether the articles report an economic activity to have positive or negative sustainable development impacts, the sustainable development dimensions (i.e. economic, social and/or environmental) that are discussed, the geographic scope of the study, and what types of solutions are deemed necessary to improve the economic activity's impacts on sustainable development (section 3). Then, we identify the SDGs that are central to the reviewed literature, and summarise the identified positive and negative interactions between individual economic activities and SDG targets (section 4). Finally, we discuss the implications for the governance of sustainable development, for the role of the private sector in managing the sustainable development impacts of the economic activities they undertake or invest in, and for the ability of statistical classifications to monitor and evaluate economic activities' sustainable development impacts (section 5).

## 2. Methodology

In order to yield comprehensive and reproducible findings, published literature related to the interactions between individual economic activities and sustainable development themes (i.e. economic, social and environmental) was analysed using standardised techniques (e.g. Moher et al. 2009; Higgins and Green 2019).

Peer-reviewed scientific papers were retrieved through two online databases (Science Direct and Google Scholar) using different combinations of search terms. The Boolean operators AND and OR were used to combine these terms. The following keywords and combinations thereof were used: [economic activity$(X)$] AND ('economic impact' OR 'economic growth' OR 'societal impact' OR 'social inclusion' OR 'environmental impact' OR 'pollution'). Search terms inserted for [economic activity ($X$)] were derived from the ISIC Rev. 4 classification of economic activities. ISIC Rev. 4 classifies economic activities into 21 sections (level 1); 88 divisions (level 2); 238 groups (level 3); and 420 classes (level 4). The 88 divisions of this classification (level 2) were used as search terms for individual economic activities ($X$).[2,3] Combining these terms

with two keywords for each of the three main dimensions of sustainable development ensures a broad and inclusive scope. To enhance the precision of the searches, the search terms were directed at articles' titles and abstracts.

In addition, nongovernmental organisations (NGOs) and intergovernmental organisations (IGOs) publish literature on the interface between economic activities and sustainable development. Including grey literature in addition to peer-reviewed academic literature allows for gaining a more complete perspective on the relations between economic activities and the SDGs, avoiding publication bias, and comparing debates in both streams of literature. Therefore, the websites of international NGOs and leading IGOs that have a focus on the economy-development interface were accessed to identify relevant reports. Reports were retrieved, in alphabetical order, from: Asian Development Bank (ADB); Carbon Disclosure Project (CDP); Centre for Disease Control and Prevention (CDC); European Union; Food and Agriculture Organization (FAO); International Finance Corporation (IFC); Organisation for Economic Co-operation and Development (OECD); UK Government Office for Science; UN Economic Commission for Africa; UN Development Programme (UNDP); UN Environment Programme (UNEP); World Bank; World Health Organization (WHO).

The retrieved articles were screened for their suitability for inclusion in the review and were included if they matched the following criteria: (1) the article discusses intersections between an economic activity and aspects of sustainable development; (2) the causality that is discussed runs from economic activities to aspects of sustainable development; (3) the discussed interactions are caused by the economic activity itself rather than by the managerial policies that govern the economic activity; (4) the effects of economic activities on sustainable development are discussed at the level of economies, societies, and the environment, rather than individuals and organisations. Additionally, inclusion of articles was confined to those published between 2005 and 2019. As our search terms were diverse and many, our intention was to offer a comprehensive and representative, but not exhaustive, overview of the literature on the effects of economic activities on sustainable development themes.[4] To this end, we adopted an inclusive and liberal approach in including articles in the review. In total, 876 articles were included (847 academic and 29 grey articles). Figure 1 reports our search and inclusion strategy.

Key features related to the nexus between economic activities and sustainable development were recorded for each article, including: (1) the economic activity discussed by the article, at the most detailed ISIC Rev. 4 level (minimally at the 2-digit division level); (2) the geographic scope discussed in the article; (3) which sustainable development dimensions (i.e. the economic, social, environmental, or a mix of these) the article discusses; (4) which specific sustainable development themes are discussed (e.g. poverty reduction, air pollution, climate change, health, etc.); (5) whether the economic activity is expected to have positive, negative, or mixed impacts on sustainable development; and (6) whether the article mentions solutions for improving the contributions of the economic activity to the sustainable development aspects, and if so, what types of actions are deemed necessary.

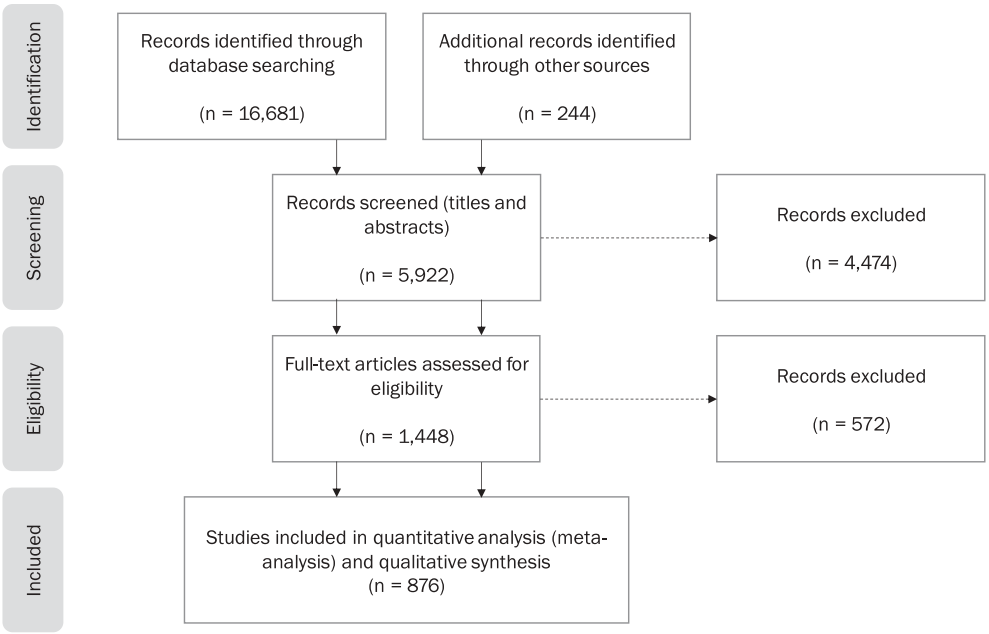


**Figure 1.** Systematic review process – flow of information*

**Adapted from* Moher et al. (2009)

The data collected through the literature review were analysed using SPSS version 26. The analyses focused on descriptive indicators of the data to determine the significance of the relations between key features of the articles. Significances in differences of count variables between different groups of articles were tested using Chi-Squared tests.

## 3. Key features: economic activities and sustainable development

Figure 2 summarises the key features of the reviewed articles. It lists the number of reviewed articles per each of the 18 sections of the ISIC Rev. 4 classification. The majority of articles included in the review relate to agriculture, forestry and fishing (212 articles; 24% of total), mining (145 articles; 17% of total) and manufacturing (143 articles; 16% of total). No articles were retrieved for sections 'N – Administrative and support services activities' and 'S – Other service activities'. The articles can be further aggregated into four overarching economic groups: agriculture (section A; 212 articles; 24% of total), manufacturing (section C; 143 articles; 16% of total), other industries (sections B, C – F; 303 articles; 35% of total), and services (sections G – S; 218 articles; 25% of total). This reveals that the reviewed articles are relatively evenly distributed across major economic groups.

Most articles (553 articles; 63% of total) centre on the negative interactions of economic activities on sustainable development. 203 articles (23% of total) discuss positive interactions and the remaining 120 articles (14% of total) refer to a combination of positive and negative interactions. As shown in Figure 2, more than 80% of the articles on 'manufacturing', 'wholesale and retail trade; repair of motor vehicles and motorcycles', 'mining and quarrying', and 'accommodation and food services', discuss these sectors' negative interactions with sustainable development. Around two-thirds of the literature on 'construction', 'agriculture, forestry and fishing', 'transportation and storage', 'real estate activities', and 'electricity, gas, steam and air conditioning', also focus on negative effects of these activities on societies and the environment. Economic activities related to 'finance and insurance', 'information and communication', and 'water supply; sewerage, waste management and remediation', are more positively focused: 93%, 81%, and 61% of articles discussing these activities talk about their contributions to sustainable development. The types of interactions discussed by the articles (i.e. positive, negative, or a combination) is significantly associated with types of (grouped) economic activities (i.e. agriculture, manufacturing, other industries, and services) ($X^2(6) = 126.14, p < .001$).

The articles vary according to the dimensions of sustainable development they discuss. Half of the articles (52%) discuss effects of economic activities on the environment, 14% discuss effects on the economy, 8% discuss social effects, and the remaining 25% discuss effects on multiple of these three dimensions. Figure 2 shows that the environment is, respectively, central to 77%, 64%, 63% and 60% of the literature on 'manufacturing', 'agriculture, forestry and fishing', 'construction', and 'electricity, gas, steam and air conditioning'. Effects on the economy are mostly discussed in literature on 'finance and insurance' (78% of articles), and 'information and communication' (78% of articles). Social effects are primarily discussed in articles on 'education' (71% of articles), and 'human health and social work activities' (67% of articles). Literature on 'water supply; sewerage, waste management and remediation' (68% of articles) particularly adopts an integrated perspective by discussing multiple sustainable development dimensions. The dimensions of sustainable development discussed in the articles is significantly associated with types of (grouped) economic activities ($X^2(9) = 177.21, p < .001$) .

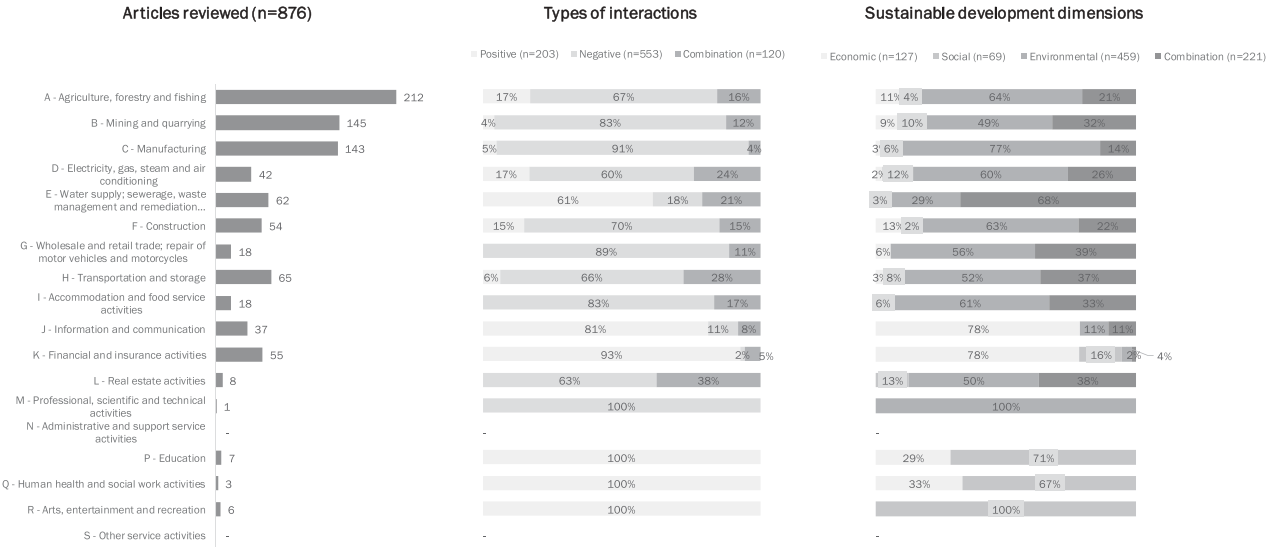


**Figure 2.** Number of articles, types of interactions, and sustainable development dimensions, per economic sector.

Specific sustainable development dimensions (i.e. economic, social, environmental, or a combination) are also significantly associated with the types of interactions discussed in articles (i.e. positive, negative, or a combination) ($X^2(6) = 702.84, p < .001$). Respectively 88% and 57% of the articles talking about economic and social development emphasize the positive role of specific economic activities. Literature focused on the environment has a different focus: 93% of these articles emphasise the negative impacts of economic activities on our planet.

The literature is spread across geographies. Asia and Europe respectively host 30% and 23% of the articles, with a further 27% of studies focusing on countries in multiple regions (global). Africa, the Americas, and Oceania attract between 2% and 8% of research on interactions between economic activities and sustainable development. Figure 3 offers a more detailed breakdown of the geographic aspects of the literature. It shows that research with a global reach, as well as studies focusing on Europe and North America, is evenly distributed across the four (aggregated) economic sectors, focuses mainly on negative interactions between economic activities and sustainable development, and mostly assesses the environmental dimension of sustainable development. Asian and Latin American studies place more emphasis on manufacturing (42% and 59%), underscore negative sustainable development interactions (67% and 65%), while mainly focusing on the environment (54% and 52%). Manufacturing also accounts for most Africa-focused studies (43%). However, studies taking place on this continent tend to assess positive interactions between economic activities and sustainable development (53%), having a primary focus on economic development (31%) or on combinations of sustainability dimensions (30%). Statistical tests show these differences to be significant: geographical scope and (aggregated) economic sector ($X^2(18) = 64.59, p < .001$), geographical scope and types of interactions ($X^2(12) = 59.90, p < .001$), and geographical scope and types of sustainable development dimensions ($X^2(18) = 64.40, p < .001$).

75% of the reviewed articles offered suggestions for improving the impacts of economic activities on sustainable development. The proposed solutions varied and, at an aggregated level, called for public policy and regulation (54%), for business policies that influence the impacts of companies on sustainable development (26%), for technological innovation (5%) and for multiple of these potential solutions (15%). These four types of solutions are significantly associated with the grouped economic activities that the articles centre on ($X^2(9) = 59.03, p < .001$), with the types of sustainable development interactions discussed in the articles ($X^2(6) = 87.15, p < .001$), and with the sustainable development dimensions that the articles focus on ($X^2(9) = 86.14, p < .001$).

Figure 4 summarises the proportion of articles – per aggregated economic sector, per type of sustainable development interaction, and per type of sustainable development dimension – suggesting each category of solutions. Public policy is recommended in articles on agricultural activities (accounting for 41% of solutions offered in literature on this sector), in other industries (64%) and in services (66%). Business policy is, relatively, the most frequently offered suggestion for making manufacturing activities more sustainable (accounting for 36% of articles centred on this sector that offer solutions). At 13%, innovative technologies are also relatively frequently called upon in the literature on


**Figure 3.** Economic sectors, types of interactions, and sustainable development dimensions per region.

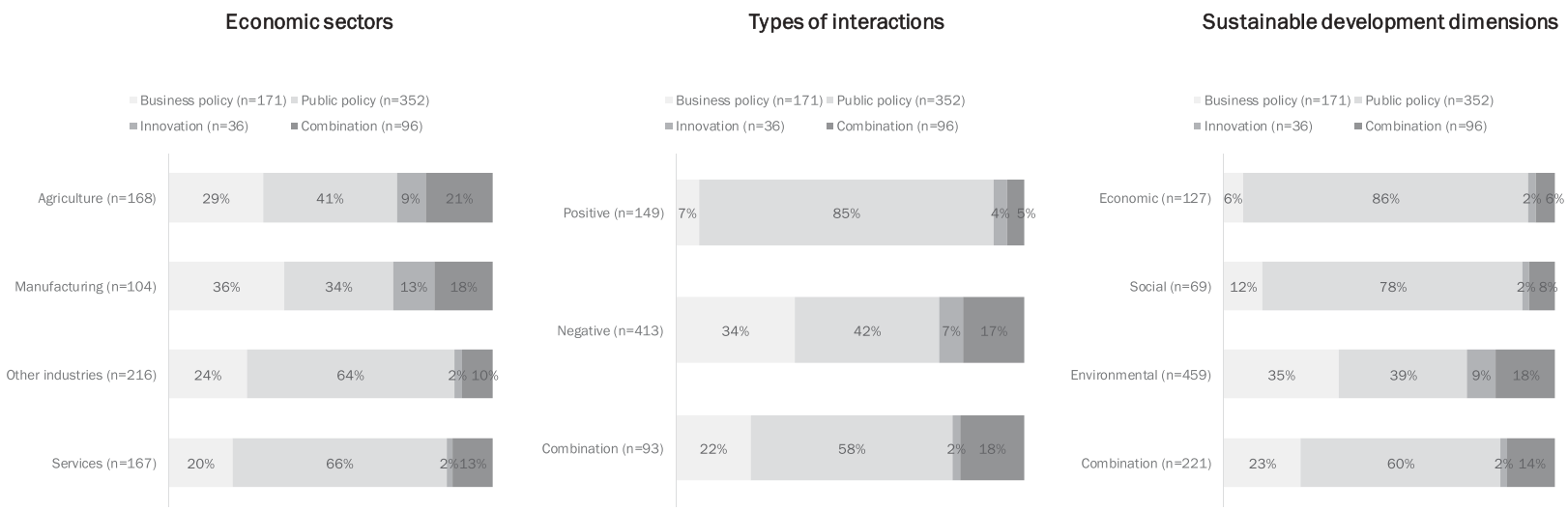


**Figure 4.** Suggested solutions, per economic sector, types of interactions, and sustainable development dimensions.

manufacturing activities. Articles that, respectively, centre on positive, negative, or a combination of both types of interactions between economic activities and sustainable development all mostly call for public policies (at 85%, 42%, and 58%). At 34%, a significant share of articles discussing negative interactions also call for improved business policies. A somewhat similar picture is found when looking at the sustainable development dimensions: across the four categories, public policies are deemed most desirable. Yet particularly when looking at the literature focused on the environment, many articles (35%) also call for better business policies.

## 4. Synthesis: interactions between economic activities and SDGs

### 4.1. SDG topics in literature on economic activities

In addition to sustainable development dimensions, we recorded the specific sustainable development topics each article discusses (e.g. air pollution, water use, labour productivity etc.). These themes could then be 'translated' to relevant SDGs by assessing the wording of the SDGs' 169 targets.

It is found that the 876 articles made a total of 1,959 references to the themes of the 17 SDGs. 1,480 (76%) of these references were made in the context of a negative interaction between economic activities and SDG themes. 479 (24%) references indicated positive interactions. Figure 5 shows the proportion of references made to the SDGs' themes, considering both negative (left) and positive (right) interactions.

### 4.2. Synthesising interactions between economic activities and SDG targets

This section summarises positive and negative interactions between economic activities and SDG targets – referred to between square brackets.[5]

**Agriculture, forestry and fishing** Economic classes related to crop and animal production, and fishing and aquaculture may help end hunger by improving people's access to safe, nutritious and sufficient food [2.1], in enhancing the productivity of agriculture, particularly concerning small-scale farmers [2.3], and in ensuring sustainable food production systems [2.4] (FAO 2017; Rasmussen et al. 2018). Additionally, economic classes focused on aquaculture can reduce overfishing and end destructive fishing practices [14.4] (FAO 2017). And by being a renewable material, wood produced by logging and silviculture activities can help sustainably manage natural resources [12.2] (Michelsen et al. 2008). Finally, crop production and forestry deliver biomass that may support renewable energy generation [7.2], enhancing people's access to power [7.1] (Muller 2009).

However, agricultural intensification rarely leads to positive ecosystem impacts (Davis et al. 2016; German et al. 2017). Agriculture accounts for some 70% of water withdrawals globally, raising concerns about water scarcity [6.4] (FAO 2011). Moreover, farmers apply fertilizers and pesticides, whose (over)use causes leaching of chemicals (e.g. nitrogen, phosphorus and potassium) into the soil and groundwater [12.4] (Fischer et al. 2010), constituting water pollution [6.3], harm to freshwater ecosystems [15.1] (Evans et al. 2019) and to biodiversity [15.5] (Krief et al. 2017). Agriculture's extensive land use also drives biodiversity loss (Lanz et al. 2018), as well as land degradation [15.3] (Nowak and Schneider 2017). Deforestation and habitat loss are furthermore associated with forestry activities [15.2] (Michelsen et al. 2008). Fisheries, in turn, contribute to the depletion of fish stocks through overfishing [14.4] (Roberts 2007) and, like the aquaculture sector (Islam 2005), are a cause of marine pollution [14.1] (Good et al. 2010). At an overarching level, climate change [13.2] is worsened through agriculture and forestry's land use, their roles in deforestation, agriculture's production

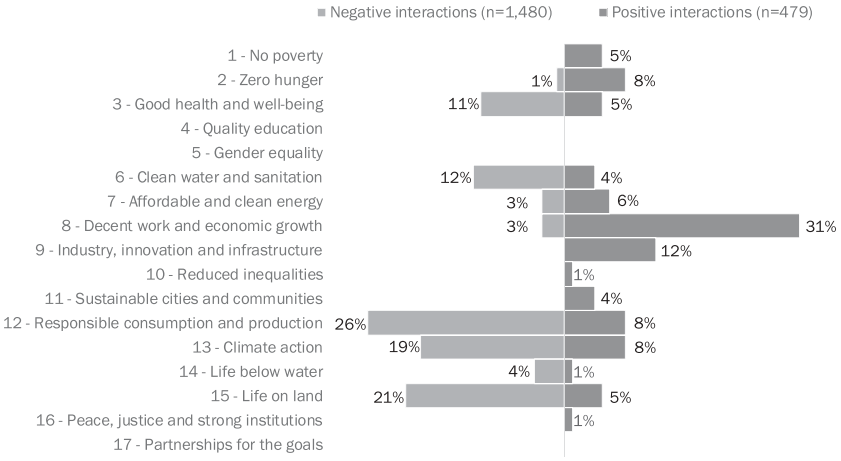


Figure 5. References to SDGs made in a negative (left) and positive (right) context.

of livestock (IPCC 2014; Paolotti et al. 2016), as well as through the fuel combustion of fishing fleets (Greer et al. 2019).

**Mining and quarrying** Mining coal, lignite and uranium and extracting petroleum and gas contribute to current systems of energy provision [7.1]. Quarrying stone, gravel and sand contributes to developing infrastructure [9.1]. Mining of iron ores and other metals delivers inputs for industrialisation [9.2].

But mining's excavation and extraction degrades natural habitats, which frequently leads to loss of biodiversity [15.5] (Castilla-Gómez and Herrera-Herbert 2015; UNDP 2016). Mining activities also cause water pollution [6.3] (Martínez et al. 2019) and generate large volumes of waste, such as heavy metals and tailings [12.4], that compound effects on natural habitats [15.5] (Fashola et al. 2016). Significant air pollution, including via particulate and gas emissions, is also associated with mining and quarrying activities, posing a threat to human health [3.9] (Fugiel et al. 2017), especially to those living near mining areas (Fernández-Navarro et al. 2012; Hendryx 2015; von der Goltz and Barnwal 2019). GHGs are one type of air pollutant emitted by mining activities [13.2] (IPCC 2014).

**Manufacturing** drives industrialisation and contributes to raising industry's share of employment and incomes [9.2]. Manufacturing classes that produce complex goods, such as electronics, motor vehicles, and transport equipment, can be drivers of economic productivity, technological upgrading and innovation, and sources of higher value added [8.2] (H.-J. Chang 2010; Hausmann et al. 2013). Sub-classes of the manufacturing sector may bring more unique contributions to the SDGs. Manufacturing of: food products may spread access to food [2.1]; agrochemicals and fertilizers can increase agricultural productivity [2.3]; soaps and detergent can help halt communicable diseases [3.3]; pharmaceutical products may contribute to the latter target, as well as to increasing people's access to medicines and vaccines [3.8]; coke and petroleum products could contribute to access to energy [7.1]; construction and building materials can contribute to ensuring access to adequate, safe and affordable housing [11.1]; motor vehicles, bicycles, and railway locomotives may support accessibility of safe, affordable, accessible and sustainable transport systems [11.2]; repair activities can prolong the life of machinery and equipment, thereby preventing waste [12.5]; and computers and communication equipment can spread access to information [16.10].

Being industrial activities, these manufacturing classes have negative impact potential on climate change [13.2] (IPCC 2014). Many manufacturing classes, such as producing food products, textiles, paper products, and steel products, consume large amounts of freshwater, thereby causing concerns over water scarcity [6.4] (Saleh 2016). Water pollution is a related issue, being associated with the textile, paper, metals and chemical manufacturing classes [6.3] due to their effluents containing chemicals and waste [12.4 and 12.5] (Pérez et al. 2017; Toczyłowska-Mamińska 2017). For instance, China's pulp and paper industry, contributing to 25% of global production, accounts for 18% of the country's wastewater emissions (Yu et al. 2016). Similarly, the textile industry represents around 20% of global industrial water pollution (Colin et al. 2016). Such water pollution reaches rivers [15.1] (Madikizela et al. 2017) and marine ecosystems [14.1] (Čelić et al. 2019). Solid waste [12.5] is furthermore generated by the manufacturing of construction and building materials, metals, paper, plastics, and electronics ('e-waste') (Monte et al. 2009; R. Wang and Xu 2014) which, when ending up in the environment, may pollute natural habitats and harm biodiversity [15.5]. Forests are also at risk [15.2], particularly from wood, paper, and rubber manufacturing classes (FAO 2008; Ahrends et al. 2015). Finally, manufacturing of alcohol and tobacco products may cause substance abuse [3.5] while manufacturing of weapons and ammunition and military fighting vehicles could be associated with violence [16.1].

**Electricity, gas steam and air conditioning supply** classes have the potential to help ensure access to affordable, reliable and modern energy services [7.1]. When derived from renewable sources (which is not included in ISIC Rev. 4) it helps increase the share of renewable energy in the energy mix [7.2]. Access to power is a necessary condition for promoting industrialisation [9.2] (Aliyu et al. 2013).

However, the non-renewable energy sources that are the dominant source in most countries' electricity production (Abas et al. 2015), are the principal cause of GHG emissions [13.2] (Höök and Tang 2013). This section's combustion of energy furthermore drives air pollution [3.9]. For instance, estimates suggest that in China 15 million and in India 11 million years of life lost can be avoided by eliminating power generation emissions (Gao et al. 2018).

**Water supply. sewerage, waste management and remediation activities** can advance diverse SDG targets. Water collection, treatment and supply activities can spread access to safe and affordable drinking water [6.1], for instance through water distribution (Li et al. 2016) and desalination (Al-Agha & Mortaja, 2005), and contribute to water quality by treating wastewater [6.3]. Sewerage activities may improve access to adequate and equitable sanitation and hygiene [6.2] (Tortajada and Biswas 2018). Together, water and sewerage activities form important components of infrastructure [9.1] and promote housing with basic services [11.1]. In turn, waste collection, treatment and disposal activities, materials recovery, and remediation activities contribute to waste management [11.6 and 12.4] and may accelerate recycling [12.5]

(Andreasi Bassi et al. 2017). By treating water and waste, and by providing sewerage, these economic classes may also reduce deaths and illnesses from hazardous chemicals and water and soil pollution and contamination [3.9] (Oyoo et al. 2014). Waste can furthermore be used as an energy source [7.1].

Trade-offs mainly concern climate change [13.2] due to the energy used in distributing water – estimated to account for some 7% of global energy consumption (Coelho and Andrade-Campos 2014) – but also caused by economic classes focused on dismantling wrecks (Dodds 2007). Waste incineration causes air pollution [3.9] (D. S. Chang and Yang 2011).

**Construction** of buildings may positively impact access to housing and urbanisation [11.1] (Castells-Quintana 2017). Construction of roads, railways, motorways, bridges, but also of utility, water, and telecommunication projects, can contribute to developing quality, reliable, sustainable and resilient infrastructure [9.1] (L. Wang et al. 2018). More specific positive relations between construction of infrastructure and sustainable development targets can also be defined: water projects support access to water, access to sanitation, water quality, and water resources management [6.1, 6.2, 6.3 and 6.5], utility projects spread access to energy [7.1], and telecommunications help provide access to information [16.10].

Yet construction emits GHGs [13.2] (IPCC 2014; Arıoğlu Akan et al. 2017), particulate matter air pollutants and dust [3.9] (Zuo et al. 2017; Ahmed and Arocho 2019). It consumes vast amounts of natural resources [12.2] (Dong and Ng 2015) and generates waste [12.5] (Badi and Murtagh 2019). To illustrate, construction is estimated to account for 25–30% of the European Union's solid waste (European Union 2019). Fragmentation of natural habitats, for instance through roads that cut through ecosystems, are additional threats [15.5] (Koemle et al. 2018).

**Wholesale and retail trade; repair of motor vehicles and motorcycles** is a broad section that delivers goods and services that can benefit specific SDG targets. Wholesale and retail trade of agricultural and food products and of agricultural machinery can support access to food [2.1] and improve farmers' productivity [2.3 and 2.4]; pharmaceutical and medical goods contribute to ending communicable and non-communicable diseases, ensuring access to sexual and reproductive health-care services, as well as to health-care services and medicines more generally [3.3; 3.4; 3.7; 3.8]; plumbing devices support sanitation [6.2]; gaseous fuels enhance access to energy [7.1]; waste can be a source of clean energy and links to recycling [7.2 and 12.5]; metals, wood, and construction materials may develop infrastructure [9.1]; industrial machinery drives industrialisation [9.2]; timber and building materials support access to housing [11.1]; sale and repair of motor vehicles support access to transport [11.2]; and information and communication equipment can spread access to information [16.10].

Wholesale and retail trade activities transport goods to customers, emitting GHGs [13.2] (Wiese et al. 2012). Trading motor vehicles, fuels, and chemicals spreads release of air pollutants [12.4 and 3.9]. Selling textiles and clothing produces significant waste, including of microplastics that end up in the environment [11.6; 12.5; 14.1 and 15.5] (Belzagui et al. 2019). Risks of substance abuse are linked to trading alcohol and tobacco [3.5]. And food waste is associated with distributing and selling food products [12.3] (Albizzati et al. 2019).

**Transportation and storage** activities may support industrialisation [9.2] through freight transport and warehousing. Passenger transport supports mobility [11.2] while public transport helps mitigate GHG emissions and air pollution [13.2 and 3.9]. To illustrate, on days during which Barcelona's metro, train, and/or bus systems are striking, inducing people to take private vehicle trips, air pollutants rise by 4.1% to 7.7% (Basagaña et al. 2018). Additionally, pipeline transport may support countries' access to energy [7.1], whereas space transport's research and development activities help upgrade countries' technological capabilities [9.5].

Yet road, water, and air transport activities are a leading cause of climate change [13.2] (IPCC 2014; Shi 2016), and release air pollutants [12.4] that cause health risks [3.9] (Gujba et al. 2013; Zhang et al. 2017). Furthermore, road and rail transport threaten land-based ecosystems [15.5], inland water transport afflicts rivers [15.1] and sea and coastal transport disrupt marine ecosystems through generating pollution, waste, disturbance, and introducing aquatic invasive species [14.1] (Halpern et al. 2008; O'Brien et al. 2017).

**Accommodation and food service activities** can, via hotels and camping grounds, contribute to sustainable tourism [8.9] and, through restaurants and mobile food services, spread access to food [2.1]. However, hotels and restaurants are associated with high water consumption [6.3] (Deyà Tortella and Tirado 2011), GHG emissions [13.2] (Chan 2005; L.-F. Chen 2019), food waste [12.3] (Sandaruwani and Gnanapala 2016; Sakaguchi et al. 2018; Yang et al. 2019), and municipal waste [11.6 and 12.5] (Singh et al. 2014).

**Information and communication** activities provide access to information [16.10]. Software development, computer programming, and telecommunications activities may enhance market efficiencies and thereby promote economic productivity [8.2], and could also diffuse technology supporting research that upgrades industrial sectors' technological capabilities [9.5] (Vu 2011). Empirical research confirms a positive link between information and communication activities and economic development, applying among countries at different income levels (Niebel 2018). An illustration is

the African continent, where a 1% increase in access to mobile networks is estimated to lead to a 0.5% increase in real GDP per capita (Djiofack-Zebaze and Keck 2009).

Negative externalities primarily concern GHG emissions from energy consumption [13.2] (Asongu et al. 2017). This relationship is hypothesised to follow an inverted-U shape: over time, smarter cities, transportation systems, electrical grids, industrial processes and energy saving gains may be realised (Añón Higón et al. 2017).

**Finance and insurance** activities are called for by various SDG targets, most notably 8.10: to strengthen the capacity of financial institutions to expand access to banking, insurance and financial services. Monetary intermediation may help micro-, small- and medium-sized (industrial) enterprises access financing [8.3 and 9.3], and, together with insurance classes, could help people, including the poor, gain access to financial services [1.4]. Financial intermediation and insurance activities are also conducive to economic productivity [8.2], although this is a complex non-linear relationship (Lee et al. 2017; Benczúr et al. 2018) that is mediated by countries' institutions (Law et al. 2018) and income levels, with low- and middle-income countries displaying no short-run growth effects (Bangake and Eggoh 2011). Furthermore, past a certain threshold financial development can hamper growth (Law and Singh 2014) and although financial development could reduce poverty, the financial instability that typically follows is detrimental to the poor (Akhter and Daly 2009).

**Real estate activities** can spread access to adequate, safe and affordable housing [11.1]. But the built environment emits GHGs through energy use [13.2], consumes large volumes of water [6.4] and generates waste [12.4] (Zheng et al. 2012). For example, out of 159,000 rental properties in 10 U.S. cities just 5.3% to 21.6% had energy efficiency features, though these drive up the rent by 6% to 14% (Im et al. 2017).

**Professional, scientific and technical activities** contains classes related to scientific R&D and engineering activities, which support scientific research and upgrading of technological capabilities [9.5]. This section also incorporates architectural activities, aligning with sustainable cities [11.1], and legal activities, which help protect fundamental freedoms in accordance with national and international institutions [16.10].

**Administrative and support service activities** comprises rental and leasing activities, including of agricultural machinery and equipment, which drive agricultural productivity [2.3 and 2.4], of construction and civil engineering equipment, which contribute to infrastructure development [9.1], and of motor vehicles, water, and air transport equipment, that contribute to access to transport [11.2]. Other services in this section include employment placement, which can match supply and demand of decent jobs [8.3], building and landscape related services, which support the quality of housing [11.1], travel agency services, which play a role in advancing sustainable tourism [8.9], and security and investigation activities, which may reduce violence [16.1].

GHG emissions [13.2], air pollutants [3.9], and negative impacts on land- and marine-based ecosystems [15.5 and 14.1] are associated with the rental and leasing of motor vehicles, water transport equipment, and agriculture and construction machinery.

**Education** directly supports SDG 4 – Quality Education. Pre-primary, primary, secondary, tertiary, technical and vocational, and other education are classes that enable girls and boys to complete primary and secondary education [4.1], provide access to pre-primary education [4.2], and ensure that people can access technical, vocational and tertiary education [4.3].

**Human health and social work activities** directly supports SDG 3 – Good Health and Wellbeing, and spreads access to health-care services [3.8]. Hospital, medical and dental activities can help end the spread of communicable diseases, promote prevention and treatment in general, and of substance abuse in specific, help reduce deaths and injuries from road traffic accidents, and ensure access to sexual and reproductive health-care services [3.3; 3.4; 3.5; 3.6; and 3.7]. Child day-care activities can help ensure that girls and boys have access to early childhood development, care, and pre-primary education [4.2].

**Arts, entertainment and recreation** includes performing arts, libraries, and museums, which safeguard cultural and natural heritage [11.4]. This may foster the appreciation of cultural diversity, which relates to disseminating knowledge and skills for promoting sustainable development [SDG 4.7]. Moreover, these classes may help empower the social, economic and political inclusion of all (Hodgetts et al. 2008; Azmat et al. 2018).

**Other service activities** is an aggregation of economic classes, many of which are so broad that their interactions with SDGs are hard to define. The repair of computers and personal and household goods, however, can contribute to reducing waste generation through prevention [12.5].

## 5. Implications and future research

### 5.1. Towards nexus-based governance

This paper made it clear that the SDGs cannot be viewed in isolation of the economic structures in which they are to be achieved. Economic activities drive positive and negative impacts on the SDGs which are themselves entwined. Our review informs how this nexus may be governed. Whereas economic activities may contribute to diverse socio-economic topics, they are simultaneously linked to environmental degradation and negative health impacts. More specifically, economic activities can promote industrialisation, infrastructure and innovation [SDG 9], economic productivity [SDG 8], housing and transport

[SDG 11], production and distribution of food [SDG 2], generation and distribution of energy [SDG 7], managing waste [SDG 12], providing access to health [SDG 3], education [SDG 4] and to information [SDG 16]. But negative externalities abound and afflict the environment as well as people's health. Nearly all types of economic activities emit GHGs [SDG 13], many use vast amounts of water and/or are related to water pollution [SDG 6], cause pollution and waste more generally [SDG 12], which erodes the natural environment [SDGs 14 and 15], and harms people's health [SDG 3], directly, due to pollution, and indirectly as degradation of habitats may spread diseases from animals to humans – which is the likely origin of the current coronavirus pandemic.

Hence, economic activities' impacts on sustainable development must be managed in an integrated – nexus-based – manner that promotes co-benefits of economic activities on SDGs, and mitigates trade-offs (c.f. Weitz et al. 2014; Boas et al. 2016; Allen et al. 2019). There are ample opportunities for furthering research on this nexus:

On the one hand, scholars studying individual economic activities may expand their notions of sustainable development. Of the reviewed articles, just 25% discuss effects on more than one sustainable development dimension and only 14% simultaneously examine positive and negative effects. Analysing an economic activity's positive as well as its negative impacts on multiple sustainable development dimensions helps inform integrated approaches for the SDGs. On the other hand, sustainable development scholars could build on this paper's analysis by: (i) defining networks between economic activities and SDGs; (ii) empirically assessing the correlation (and causality) of economic activities in specific countries, and these countries' performance on the SDGs; and (iii) exploring the conditions that enable policymakers to govern this economy-SDG nexus, including their ability to mobilise collective action, publicly, as well as by bringing companies along in the SDG agenda, for instance through cross-sector partnerships.

### 5.2. Solutions for improving economic activities' sustainable development impacts and the role of the private sector

The reviewed articles proposed diverse solutions for improving the sustainable development impacts of economic activities. These were grouped into four categories: business policy, public policy, innovation, or a combination of these types. Improving sustainable development requires polycentric approaches (Ostrom 2010). Yet just 15% of articles propose combinations of solutions. Most articles call for *public policy*, particularly as a means to enhance potential positive impacts on social and economic development. Over a quarter of articles invite *business policies*, especially to mitigate negative impacts on the environment. Indeed, in addition to integrated governance (5.1), we note three points concerning businesses, the main agents undertaking economic activities.

First, early insights reveal that although companies supportively embraced the SDGs, there are many gaps in their engagement with SDGs that aim to 'avoid harm' but are 'externally actionable', such as environmental degradation (van Zanten and van Tulder 2018). This is concerning: this study showed that environmentally centred SDGs are among the biggest victims of the economic activities that companies undertake, whereas scholars call on companies to improve their environmental footprint. This provides an opportunity for corporate sustainability scholars to study what the conditions and antecedents are for companies to manage their impact on the SDGs in an integrated manner, both to make positive contributions and to reduce negative externalities.

Second, economic activities undertaken by firms form global value chains (GVCs): globally dispersed chains of production and consumption. By integrating different economic activities, GVCs also spread and connect SDG impacts. For instance, agricultural value chains integrate activities such as crop production, processing, packaging, transport, wholesale and retail trade, and marketing, each impacting different SDGs in different locations of the world (Kastner et al. 2011). Furthermore, some firms *'undertake the functional integration and coordination of internationally dispersed activities'* (Gereffi 1994, p. 41), rendering them to be 'lead firms' that determine what is produced, how this is produced, and by whom (Gereffi et al. 2001). Future studies can help investigate how the governance of GVCs influences SDG impacts, and how lead firms' ability to decide which countries host what types of economic activities help explain countries' performance on the SDGs.

Thirdly, financial institutions finance economic activities. Financial assets (e.g. loans, equities, credits) thereby impact SDGs. The synthesised interactions between economic activities and SDG targets presented in this paper can map financial portfolios to the SDGs and deliver insights on the impacts financial institutions support. Another research avenue would survey financial services providers' opportunities for balancing their loan portfolios' SDG interactions. For instance, financing a water treatment facility may mitigate the water pollution of a textile manufacturer. A related approach can study the incentives (e.g. reduced interest rates, improved terms) that financial institutions can offer their clients for improving SDG impacts.

### 5.3. Embedding local sustainable development priorities

In assessing the interface between economic activities and sustainable development scholars appear to take

local needs into account. For instance, studies on the African continent tend to examine the manufacturing sector's positive impacts on economic development, whereas European and North American focused studies are more likely to investigate the negative environmental impacts of diverse economic activities. Countries report to the UN on their progress towards the SDGs and various institutions conduct cross-country assessments (e.g. Sachs et al. 2019; UN 2019). Correlating countries' performance on the SDGs with the economic activities undertaken within their boundaries may explain progress and deteriorations, and offer advice on which economic activities may help close the gap towards 2030. However, data availability is a next challenge.

### 5.4. Impact measurement

Measuring the impacts of economic activities on the SDGs is a step that follows logically from this study's synthesis. Three issues deserve attention.

First, concerning the independent variable, there is a need to refine and update classifications of economic activities. ISIC Rev. 4, used by this study and one of the most commonly used classification systems, was most recently updated in 2008. Statistical classifications have thereby not kept abreast with the changing nature of the economy. Various classes of economic activities were found to be either missing, or worthy of an expansion, in a sustainable development context. Alphabetically, this includes the need to add new or differentiate existing economic classes related to: biomass and biofuels; conservation of natural habitats; renewable energy generation and distribution (e.g. hydro, solar, wind); health and climate insurance; microfinance and SME lending; organic agriculture; public versus private transport; sustainable – or green – finance; waste incineration, landfills, recycling and other waste management options.

Second, concerning the dependent variable, measuring progress towards achievement of the SDGs and their targets remains a challenge (Hák et al. 2016). Aside from general data unavailability and incoherency at the national level, another issue is the lack of sub-national data. Although national-level SDG indicators are increasingly available, including through the UN Statistics Division and the World Bank, this study shows that the literature frequently reports economic activities to impact SDGs at local (municipal) levels. For instance, mining pollution was found to mostly afflict the health of those living in the mining area. Such impacts may easily be obscured in macro-level statistics. Hence, collecting sub-national data for certain SDG targets is imperative, towards which creative solutions could contribute (in the above example, it might be possible to measure health impacts by surveying doctor reports).

Third, at a meta-level, our findings provide food for thought concerning the measurement and conceptualisation of 'development'. Although GDP is commonly used as an indication of a country's level of development, many commented on its deficiencies and the limited insights the metric provides into 'sustainable development' as an integration of economic, social and environmental development (e.g. Stiglitz et al. 2019). Alternatives have been developed (e.g. UNDP's Human Development Index and the OECD's Better Life Index), yet these apply to countries at a macroeconomic level and are unable to quantify impacts at the level of companies and the economic activities they undertake. Then, the challenge arising from this paper is that although many benefits of economic activities at the company-level can be quantified in terms of GDP (i.e. the value added delivered by an economic activity), its externalities typically are not priced. And this is particularly problematic in terms of negative externalities, such as the adverse effects on climate, ecosystems, and human health that are associated with numerous economic activities. The big question is, what can replace GDP and provide quantifications of the positive and negative impacts of economic activities at the level of companies?

### 5.5. Limitations

Although the quantity, types, and geographic distribution of the articles included in this review are likely to paint a representative picture of the interactions between economic activities and the SDGs, we note four limitations. First, with 29 grey and 847 academic articles included in the study, publication bias is a risk. We suspect this risk to be low: academic articles were found to have a much more confined scope than grey articles. Academics inclined to provide detailed insights into the sustainable development impacts of highly specific economic activities, using life-cycle analyses, modelling, experiments, or other comprehensive methods. In contrast, grey literature tended to synthesise the effects reported in academic research. Consequently, grey articles provided overarching perspectives that had been fleshed out in detail in academia. Second, the review only included articles written in English, which may overlook valuable insights published in other languages. Third, our scope was confined to the sustainable development effects inherent in the nature of economic activities. Management of these economic activities is relevant too, for instance concerning human rights, gender equality, and occupational health and safety. Corporate sustainability research can contribute to understanding why and how companies manage the interactions between their economic activities and the SDGs. Fourth, in order to systematically survey the interface between diverse types of economic activities and the wildly

varied concept of sustainable development, we inevitably faced a compromise between breadth and depth. The sustainable development challenges we are facing and the numerous ways in which economic activities contribute to them, led us to choose for synthesising breadth, rather than going into depth.

## 6. Conclusion

The world is not on track to achieve the 17 SDGs by 2030. A dominant emphasis on economic development threatens achievement of social, and especially environmental SDGs. Economies are aggregations of numerous, widely diverse economic activities. And individual economic activities vary widely in terms of the SDGs that they impact, both positively and negatively. This study conducted a systematic literature review in order to map the nexus between unique economic activities and sustainable development.

In terms of key indicators, the findings show that studies on agricultural, industrial, and manufacturing activities predominantly assess their negative impacts on environmental development. In contrast, literature on services activities emphasises contributions to economic and social development. These findings vary across geographies, taking local sustainable development abilities and constraints into account. Solutions for improving economic activities' sustainable development impacts were categorised into a number of specific governance areas: public policies, business policies, and technological innovation. Public policies are most called upon followed by business policy. Mitigating negative impacts is particularly seen to require combinations of these policies.

The review's findings allowed us to map positive and negative interactions between economic activities and SDGs. Through their inherent nature, economic activities have the potential to advance diverse SDGs, particularly those related to industrialisation and the development of infrastructure, economic productivity, urbanization and transport, and power generation and distribution. Yet trade-offs with other, primarily environment- and health-related SDGs, will inevitably arise and are not just related to economic activities that are the usual suspects. Rather, we show that virtually all types of economic activities are associated with negative externalities. The positive and negative interactions between detailed economic activities and SDG targets were summarised per activity.

We conclude that integrated, nexus-based, governance for the SDGs will benefit from accounting for economic activities. Because they impact SDGs economic activities can be a force for good, although their negative impacts must be curtailed. This invites involvement of companies. As the primary agents undertaking economic activities, companies can make valuable contributions towards ensuring that positive interactions materialise and negative interactions are mitigated.

## Notes

1. According to the UN Statistics Division (UNSTATS), ISIC Rev. 4 is *'a basic tool for studying economic phenomena, fostering international comparability of data, providing guidance for the development of national classifications'* (UNSTATS 2007).
2. In case ISIC Rev. 4's groups (level 3) and classes (level 4) strongly differed from its divisions (level 2), we included these in the search terms, with the purpose of adding specificity to the analysis.
3. Search terms related to the governance of the public sector and the activities of households were excluded. This includes the following sections (level 1): 'Public administration and defense; compulsory social security'; 'Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use'; and 'Activities of extraterritorial organisations and bodies'.
4. Systematic reviews use systematic and explicit methods to identify, select, and critically appraise relevant studies, and to collect and analyse secondary data from them, in order to answer a research question and synthesise the literature. Systematic reviews are often used in medicine and health care studies to provide an exhaustive summary of the current evidence. Many, particularly in these sectors, therefore advise to use the systematic review methodology for specific, narrow, and well-confined research questions (e.g. Higgins and Green 2019). In this paper, we create a systematic-type review to synthesise a broad range of literature whereby our principle is to do so in a representative, albeit non-exhaustive manner.
5. For an overview of SDG targets see: https://sustainabledevelopment.un.org/.

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Since 1 April 2020, the first author is employed by Robeco, an asset management firm with its headquarters in Rotterdam, the Netherlands. The insights from this research may, but do not need to be, reflected in the investment products or services that the firm offers. The views expressed in this paper are not necessarily shared by Robeco.

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