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# Frontiers in Service Science: Integrating ESG Measures and Supply Chain Management: Research Opportunities in the Postpandemic Era

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**Abstract.** The COVID-19 pandemic has highlighted the instrumental role of supply chains in delivering economic, human, and societal value. At the same time, the pandemic has intensified interest among businesses, governments, and academics to examine environmental, social, and governance (ESG) issues. In today's hyper-globalized economy, ESG measures are futile unless they explicitly incorporate a firm's *end-to-end operations* throughout its entire supply chain. On the other hand, well-calibrated ESG measures should play a central role in guiding a firms' day-to-day supply chain management practices. To illustrate the value of unifying ESG and end-to-end supply chain thinking, we present three supply chain cases that arose amid the COVID-19 pandemic, involving online platforms; public health supply chains; and vaccine development, manufacturing, and distribution, respectively. Drawn from these three cases, we spotlight some new research opportunities in both ESG and supply chain management.

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**Keywords:** supply chain management • environmental, social, and governance (ESG) • COVID-19 pandemic • operations management

## 1. Introduction

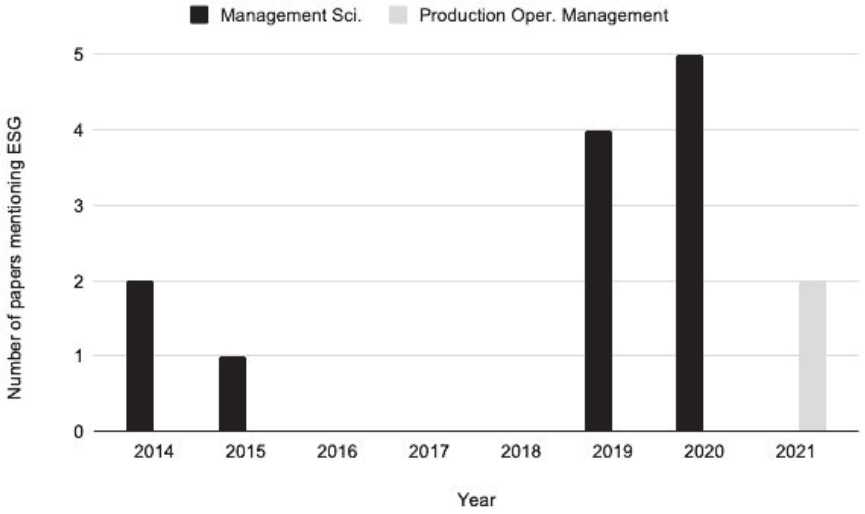
Since its debut in a United Nations report in 2006, *environmental*, *social*, and *governance* issues (ESG) have captivated the attention of businesses, governments, and academics (Atkins 2020). To appreciate the impact of ESG, one needs to look no further than the size of assets managed under ESG-themed portfolios, which is approximately $40 trillion by 2021 and expected to reach $53 trillion by 2025 (Bloomberg Intelligence 2021). Today, ESG is the most widely accepted measure of firms' sustainability and social impact; the U.S. Securities and Exchange Commission (SEC) has set up an ESG subcommittee, which recommended in 2020 that all the publicly traded firms disclose material ESG information (Securities and Exchange Commission 2020b). Similarly, the European Commission unveiled an action plan in 2018 that incorporates ESG issues into financial advice, ratings, and market research (European Commission 2018).

ESG issues influence supply chain operations, and supply chain operations affect ESG performance. By 2019, most Fortune 250 firms in the United States established various ESG goals, ranging from greenhouse gas emissions to worker safety, transparency, and responsible procurement. In June 2021, the German parliament passed a new Supply Chain Due Diligence Act that comes into effect in 2023 for large Germany-based companies with more than 3,000 employees. Under this new law, large companies are responsible for identifying, preventing, and addressing social and environmental issues arising throughout their supply chain networks (Koppmann and Lechner 2021).[1]

The importance of ESG in managing supply chains among corporate leaders is unequivocal. Yet, the interplay between ESG and operations management (OM) remains understudied in the research literature. Even within a vibrant subfield that studies sustainable operations (see Atasu et al. 2020 for a recent review), research formally addressing ESG issues remains rare. Based on our search in five OM-focused journals (*Management Science*, *Manufacturing & Service Operations Management*, *Operations Research*, *Production and Operations Management*, and *Service Science*),[2] we identified 15 such papers with the majority published during the past three years (Figure 1), focusing on issues arising from voluntary/mandatory disclosure of ESG (especially environmental) measures. However, none of these papers examines the synergistic relationship between ESG and end-to-end supply chain operations.

Whereas the "E" (environmental) and "G" (governance) pillars are relatively well defined and well understood, the "S" (social) pillar is ambiguous. Thus,

**Figure 1.** OM-Focused Journal Papers Containing the Term "ESG" (or "Environmental, Social, and Governance")




*Note.* Manufacturing Service Operations Management, Operations Research, and Service Science have not published any papers mentioning ESG between 2014 and 2021.

our focus in this paper is on how the "S" pillar of ESG considerations interacts with end-to-end supply chain operations. Specifically, we argue that, for firms to incorporate various "S" measures (e.g., fair labor, worker safety, and fair pay) into their end-to-end supply chain operations in a meaningful way, it is imperative to address at least five gaps that involve ESG measures. These gaps include (1) supply chain opacity, (2) ambiguous relationship between ESG supply chain measures and firm performance, (3) supply chain ESG measurement complexity, (4) biased ESG supply chain measures, and (5) inconsistent supply chain law and enforcement. These gaps present research opportunities for postpandemic supply chain management and ESG researchers.

This paper is organized as follows. In Sections 2 and 3, we argue that postpandemic supply chain management research should incorporate ESG measures and contribute to ESG performance. Next, in Sections 4–6, we present three cases emerging from the COVID-19 pandemic to illustrate the importance and value of unifying ESG and supply chain thinking. Based on the aforementioned gaps and the three case studies in Sections 4–6, we next identify gaps that connect ESG measures and end-to-end supply chain operations and pose five important research questions for further examination in Section 7. We conclude in Section 8.

## 2. Background: From Corporate Social Responsibility (CSR) to ESG

The COVID-19 pandemic created a pivotal change for business leaders to rethink the role of business in society. Friedman (1970) argues that a firm's goal is to serve the shareholders' interests using a company's resources to increase profits by staying within the rules of the game. This shareholder paradigm incentivizes firms to focus on profit. Notably, the total market capitalization of the top 50 global companies increased by $4.5 trillion amid the pandemic in 2020. By 2021, the combined worth of these 50 global giants is equivalent to 28% of global gross domestic product (Orlik et al. 2021).[3] This striking revelation has two implications. First, these top global companies have stronger economic power than many governments around the world. Second, the global supply chain operations of these global companies have outsized societal-level environmental and sustainability impacts across many countries.

Whereas the notion of CSR was officially coined in 1953 by the economist Howard Bowen (Thomas 2019), the precise definition of CSR remains thorny: the reader is referred to Dahlsrud (2008) for an analysis of 37 definitions of CSR. Even without a clear definition, the intent of CSR was to make companies *accountable* for their actions that affect health, safety, and the environment. For example, a public outcry met the milk formula scandal in China that damaged the kidneys of 54,000 babies (Yardley 2008), the recall of Mattel's toys tainted with lead paint in 2007 (Story and Barboza 2007), the extreme air and water pollution in China caused by unethical manufacturers (Buckley 2015), the collapse of Rana Plaza in Bangladesh in 2013 with a death toll of more than 1,000 factory workers (Dai 2020), and unsafe and fake products sold by Amazon's third-party sellers in 2020 (Dai and Tang 2020e). Even when these multinational corporations did not directly

commit these unethical acts, there is public pressure to hold these giant firms indirectly responsible.

In addition to the public pressure, investment strategy is changing as the millennial generation cares about environmental sustainability and social responsibility more than baby boomers. Specifically, millennial investors contributed $51 billion to sustainable funds in 2020 compared with $5 billion in 2015 (Adamczyk 2021). These sustainable funds are based on ESG investing—an investment strategy in which shareholders invest in firms with good environmental, social, and governance performance measures. Globally, ESG investing has experienced snowballing growth in recent years. Global ESG assets are projected to total $53 trillion by 2025, representing more than a third of the $140.5 trillion in projected total assets under management (Bloomberg Intelligence 2021). In 2021, Larry Fink, chairman and CEO of Blackrock, the largest asset manager in the world, argued in a letter to CEOs that 2021 marked "the beginning of a long but rapidly accelerating transition" to ESG investing and that CEOs must move on to address issues from public health to the climate to social justice, not just quarterly earnings (Fink 2021, p. 1).

Unlike CSR, which pressures a company to be accountable for its actions, ESG is aimed at making a company's actions and their outcomes *measurable* so that investors can make informed investment decisions. The ESG movement is creating a new incentive for companies to collect and disclose information about their financial, environmental sustainability, and social responsibility performance. However, one major challenge exists: the lack of agreement on what to measure and what to report because ESG is very broad and its definition is the subject of an ongoing debate. The first set of ESG standards traced back to the early 1990s by Amy Domini, one of the founders of KLD Research & Analytics, who created the Domini 400 Social Index, which is a stock market index selected according to a set of social and environmental standards.[4]

ESG ratings can influence investment strategy. Ioannou and Serafeim (2015) examined analysts' recommendations from the Institutional Brokers' Estimate System between 1993 and 2007 and found empirical evidence that analysts issued stronger recommendations toward firms with high ESG ratings over time. Their research findings help explain why the number of ESG rating agencies has mushroomed in recent years.[5] For example, the MSCI ESG Rating Index rates a company based on (1) data disclosed by the firm voluntarily according to different reporting standards[6] and (2) data collected from independent sources, such as news media, governmental databases, and nongovernmental organization (NGO) reports.[7] (Figure A.1 in the Appendix illustrates how MSCI's ESG rating is determined.[8] Other ESG ratings use similar approaches except for different weights on various ESG measures.)

Currently, a unifying reporting standard for ESG ratings does not exist, and the SEC opined that ESG disclosures are likely to be "adaptive and innovative" (Coates 2021). Aside from the common ESG standard, it remains unclear how ESG ratings would influence a firm's supply chain operations in the post-COVID-19 era.

## 3. The Missing Link: ESG and Supply Chain Thinking

ESG investing is intended to nudge corporate leaders to pay attention to their companies' sustainability and social commitments. In particular, among the three pillars captured by ESG, both the "E" and "G" pillars have widely accepted measures, whereas the "S" pillar does not (Lee and Tang 2018). According to the *ESG Global Survey 2019* conducted a year prior to the pandemic, a "middle-child predicament" is associated with the "S" pillar of ESG (BNP Paribas 2019).[9] The "S" pillar is ambiguous in part because of a lack of consensus about the scope of social issues upon which it touches.[10] Another—and often overlooked—reason that the "S" pillar is ambiguous to measure is the extensive supply chain networks on and with which almost every company depends and operates. Several major ESG index providers incorporate supply chains as a criterion for the "S" pillar. Yet they tend to treat supply chains *separately* from other components of the pillar. For example, in the "S" pillar of the Bloomberg ESG index, "supply chains" are considered independent of other measures, such as discrimination, human rights, and community relations (Boffo and Patalano 2020). In reality, however, measuring discrimination, human rights, and community relations without accounting for a firm's extensive supply chain networks can mislead and misinform the public (Dai 2020).

In today's hyper-globalized economy, ESG measures are of little value if they do not incorporate a firm's operations throughout its entire supply chain. For example, ExxonMobil indicated it was reducing greenhouse gas emissions when it was actually increasing them, shifting dirty operations to its supply chain partners (Henn 2016). In addition, the current measures for the "S" pillar do not properly incorporate how a focal firm deals with the downstream (e.g., customers) and upstream (i.e., suppliers). For example, "customer protection" may sound like issues between a company and its customers. Yet today's ubiquitous platform economy means customers frequently interact with third-party sellers (or service providers), and customers have very little, if any, legal

protection from the platform (Dai and Tang 2020e). Thus, accounting for the entire supply chain operations is necessary for measuring the "S" pillar.

On the flip side, putting ESG risk at the heart of supply chain management is emerging as an essential business practice. To sustain its supply chain operations and to improve its performance pertaining to the "S" pillar in 2021, Unilever announced its plan to pay a living wage to "all of its supply-chain workers" by 2030 (Bowman 2021). Yet implementing this plan is challenging because Unilever's global supply chain operations entail more than 400 brands of consumer goods in 190 countries.[11] ESG is not merely about moral values; it measures real risks that threaten the functioning of firms' supply chains, especially in times of crises. As an example emerging from the pandemic, the U.S. medical supply chains were severely disrupted for much of 2020 in large part because few medical supply manufacturers and distributors have incorporated public health and national security risks into their design of supply chain networks, leading to over-reliance on foreign suppliers for essential medical supplies and, hence, the inability to ramp up production during the initial months of the COVID-19 pandemic (Bai et al. 2020; Dai and Tang 2020d, f).

To illustrate the importance of ESG risks (especially in the context of ESG investing) and the lack of consistent and appropriate ESG supply chain measures (especially in the context of supply chain risks), we next present three separate supply chain case studies that occurred during the COVID-19 pandemic. These case studies serve to expose the need to develop appropriate ESG measures that incorporate a firm's operations throughout the entire supply chain.

## 4. Case 1: Consumer Protection Arising from Online Retail Platforms

Amid the COVID-19 pandemic, prolonged closures of many brick-and-mortar stores and safety protocols accelerated the dominance of online retail platforms.[12] To meet the growing consumer demand with supply, online retail platforms, such as Amazon, need to expand their global supply chain operations by facilitating the sales transactions between independent third-party merchants and consumers and charging a 15% sales commission on average (Brophy 2020).[13] However, getting more third-party merchants to sell on these online platforms exposes consumers to increased risks with little protection. Using Amazon as an example, we now describe two aspects in which firms' ESG risk is not well defined and cannot be easily measured unless ESG measures take the operations of the entire supply chain into consideration.

### 4.1. Third-Party Product Transparency

Online retail platforms expose consumers to direct (online) sales from foreign sellers on an unprecedented scale, yet identity information about these third-party sellers is often hidden from consumers.[14] Without authenticated identity, fake reviews grow unchecked. Both the academic literature and journalistic investigations show how some foreign sellers fabricate orders that make a listing appear more popular than it actually is and lead to fake reviews from "verified purchases" (Ovide 2020). In certain cases, third-party sellers reportedly contacted dissatisfied customers, asking them to revise or delete their negative reviews in exchange for refunds or gift cards (Nguyen 2021). Through this manipulation, these unethical sellers can boost their overall average star ratings.

When an online retail platform allows unidentifiable third-party sellers to operate on the platform, it exposes consumers to risks of purchasing counterfeit or unsafe products. In addition, fake reviews increase the "search friction" for consumers to find the product they can trust (Chen et al. 2020, Xiao et al. 2022). Therefore, without properly managing its third-party sellers, fake reviews and counterfeits can destroy the value proposition of online platforms, creating reputational risks. For this reason, ESG measures must incorporate the *entire* supply chain operations into consideration: these measures should include the extent to which a platform collects and verifies third-party sellers' identities and its track records (i.e., genuine and safe products, sales records, quality assurance record, customer satisfaction) and the extent to which the platform discloses this information on its product page in a transparent manner (Dai and Tang 2020a).

### 4.2. Third-Party Product Liability

Besides fake reviews, product liability associated with unsafe products sold by a third-party seller can be a thorny issue. A high-profile court decision by the San Diego Superior Court on August 13, 2020, highlighting the lack of consumer protection in online platforms (*Bolger v. Amazon.com, LLC* 2020). The decision involved Angela Bolger, who purchased a replacement laptop battery from Amazon and subsequently suffered from severe burns when the battery exploded. Amazon argued it should be not liable for the damage because it was simply an "online marketplace" facilitating the transaction between Bolger and Lenoge, a China-based third-party seller that did not respond to the court. In a departure from other court rulings, the San Diego Superior Court ruled that Amazon is responsible because of its role as a facilitator that was pivotal in bringing the product to the consumer.

Legal efforts aimed at holding online platforms accountable can have unintended consequences. For

example, in February 2020, the California State Assembly introduced a law, coded AB-3262, titled "Product Liability: Electronic Retail Marketplaces" (Stone 2020). Under this law, all the online marketplaces will be held strictly liable for harm caused to consumers as a result of defective products sold through them. Whereas Amazon issued a statement voicing its "conditional support" of AB-3262, arguing that "this legislation aimed at protecting consumers should apply equally to all stores, including all online marketplaces," others warned such legislations can kill off smaller competitors so that Amazon can gain a bigger market share. More targeted efforts, such as pressure from ESG investors, can be more effective. Specifically, besides supply chain transparency as a measure for ESG risk (Sodhi and Tang 2019), we believe supply chain–wide ESG measures should include the process the platform puts in place to keep consumers out of harm's way.

## 5. Case 2: Resilience of Public Health Supply Chains

The COVID-19 pandemic exposed the risk in public health supply chains in the United States. In March 2020, hospitals, nursing homes, and other essential facilities across the United States experienced severe shortages of personal protective equipment (PPE) such as N95 masks (Artenstein 2020). Such severe shortages are associated with unnecessary infections and mortality, especially among healthcare workers and nursing home residents (Dai et al. 2020). By contrast, countries and regions with ample PPE supply, including Taiwan, New Zealand, and Singapore, experienced nearly zero COVID-19-related deaths at nursing homes and healthcare facilities during the same period (Dai et al. 2021). This stark contrast stunned the public, especially because, in 2019, the United States was ranked the first among 195 countries in the Global Health Security Index, which measures a country's ability to prevent, detect, and respond to pandemics (Nuclear Threat Initiative 2019a). Upon a close examination, we note that the index did not take the supply chain operations into consideration,[15] and it focuses on documentation with a binary measure.[16]

Currently, comprehensive measurements of pandemic readiness are neither considered nor collected. The majority of the essential medical supplies, such as PPE, used in the United States are provided by multinational manufacturers, such as 3M and Honeywell (Dai et al. 2020). Yet these companies are only required to report the locations of their manufacturing plants to the Food and Drug Administration, and the exact PPE production capacity in domestic versus overseas facilities of these U.S.-based manufacturers is kept unknown (Dai and Tang 2020f). Most global firms treat this kind of supply chain data as trade secrets to gain a competitive edge. Hence, regulators, public health agencies, healthcare providers, and researchers cannot assess the vulnerabilities of the public health supply chains caused by these essential medical supply manufacturers (Fiore 2020).

To our best knowledge, ESG indexes have not formally incorporated public health risk as a consideration when evaluating a firm. For example, consider the case in which ESG rating agencies include a "supply chain resilience" measure based on the simulated performance associated with some standardized "stress tests" of a company's supply chain (Dai et al. 2020, Simchi-Levi and Simchi-Levi 2020). In this case, this resilient measure can be ranked across different firms within the same sector, creating incentives for companies to develop plans to mitigate the risk associated with various supply chain disruptions. Amid calls to include public health and national security implications as part of ESG metrics (Bai et al. 2020), ESG rating agencies must ensure they incorporate trustworthy and up-to-date supply chain information in evaluating various companies' ESG risk, especially in the medical supply sector.

## 6. Case 3: COVID-19 Vaccine Development, Manufacturing, and Distribution

To get the COVID-19 pandemic under control, the record-breaking pace of vaccine development and manufacturing by AstraZeneca, Johnson & Johnson, Moderna, and Pfizer helped reduce the number of infections, hospitalization, and deaths significantly (Dai and Song 2021, Mak et al. 2021). Yet the instrumental role these manufacturers played has not been reflected in their ESG ratings. For example, Pfizer, the vaccine maker receiving the first emergency use authorization for its mRNA vaccine, currently has an ESG rating of B,[17] according to MSCI, far below ExxonMobil's BBB rating.[18] To provide incentives to the pharmaceutical industry for developing and manufacturing vaccines successfully in times of public health crises, ESG measures need to properly reflect the "S" pillar across global supply chains.

First, developing new vaccines is a risky business because of uncertainty in efficacy, yield, and demand for vaccines (Dai and Tang 2020c).[19] In view of the risk in developing and producing vaccines, Dai and Tang (2020b) propose that manufacturers can benefit from horizontal *coopetition* schemes through which pharmaceutical manufacturers compete on the development of COVID-19 vaccines while cooperating by building shared production capacity. Such coopetition schemes help reduce the risks in vaccine development and incentivize the companies to expand their production capacity. ESG ratings should accurately and properly incorporate manufacturers' participation in

such efforts. For instance, in the "S" pillar, ESG measures should incorporate the extent to which a firm is willing to cooperate and coordinate with other firms to create societal value.

Second, most pharmaceutical firms design their clinical trials by focusing on safety and efficacy, yet few would take the pace of *vaccination* into consideration. For example, each dose of the Moderna vaccine in use contains 100 μg although half a dose (50 μg) can provide nearly the same level of protection (Chu et al. 2021). Given the same raw-material constraints, producing half-dose vaccines can double the vaccine coverage. The challenge, however, is that vaccines are authorized based on the way randomized controlled trials were designed in the first place. Therefore, there is a "disconnect between individually and socially optimal doses" (Strohbehn et al. 2021, p. e1049). To maximize population benefits, incentivizing vaccine manufacturers to choose "socially optimal pandemic drug dosing" is essential (Strohbehn et al. 2021, p. e1049). Therefore, ESG agencies should measure manufacturers' "S" pillar according to their supply chain impacts so that the "S" measure can provide a strong incentive for firms to design their vaccine regimens with social benefits in mind.

## 7. Closing the Gap: Research Challenges and Opportunities

Upon reflecting on those three cases presented in Sections 4–6, we recognize that it is imperative for ESG rating agencies to adopt supply chain thinking in measuring firms' commitments to the "S" pillar by taking the operations along the entire supply chain into consideration. However, a variety of challenges exist for unifying ESG and supply chain thinking, which, in turn, present research opportunities for OM researchers. Table 1 summarizes various challenges and research opportunities.

We now elaborate on these challenges and research opportunities with real examples.

1. Lack of supply chain visibility and transparency: As noted in Section 4, supply chain operations are traditionally opaque, and firms often do not have visibility beyond their immediate suppliers (Dai and Tang 2020f, Dai et al. 2020, Fiore 2020). Sodhi and Tang (2019) argue that supply chain visibility and transparency can enable firms to reduce supply chain risks and improve supply chain efficiency. By making its supply chain transparent to the public, a company can enlist consumers, NGOs, and even suppliers' own employees to expose suppliers' unethical activities (Tang and Babich 2014). Therefore, it is of interest to examine the implications of using emerging technologies, such as sensors and blockchain technology, to improve supply chain visibility (Babich and Hilary 2020). More importantly, conducting research to examine whether supply chain visibility and transparency can indeed reduce supply chain risks and improve supply chain efficiency is certainly of interest.

Beyond the potential benefits of supply chain visibility and transparency, ESG rating agencies should consider establishing a "supply chain transparency index" that can be ranked similarly as the fashion transparency index for the fashion industry (Dai 2020).[20] Doing so can create a new line of empirical and behavioral research to examine the impact of this supply chain transparency ranking on financial and other ESG performances. For instance, will a firm's supply chain ESG performance and its financial performance (sales and stock returns) improve because of its public exposure of supply chain data?

2. Ambiguous relationship between supply chain ESG measures and firm's performance: Currently, ESG measures do not incorporate a firm's operations in the entire supply chain explicitly. Before executives invest in more cost and efforts in gathering, verifying, and reporting supply chain ESG data, it is important to take a step back to examine the underlying issues and fundamental value of ESG reporting itself.

Currently, ESG ratings have several issues. First, ESG ratings of a company can be highly inconsistent across different rating agencies because they use different opaque proprietary methodologies: some agencies weigh more heavily toward ESG risks, whereas other agencies weigh more heavily on ESG impact.[21] Second, ESG

**Table 1.** Challenges and Research Opportunities for Embedding ESG Measures in Supply Chain Management

| Challenges | Research opportunities |
|---|---|
| Supply chain opacity | Will a firm perform better by including supply chain transparency as a measure of ESG? |
| Unclear relationship between ESG supply chain measures and firm performance | Do firms with stronger ESG measures receive strong market response? |
| Supply chain ESG measurement complexity | To avoid measurement fatigue, which ESG supply chain measures are most meaningful? |
| Biased ESG supply chain measures | What are the mechanisms to ensure unbiased ESG supply chain measures? |
| Inconsistent supply chain law and enforcement | What are the mechanisms that can ensure all parties along the supply chain comply with local and global regulations? |

ratings offer mixed results in terms of stock returns. Shifflett (2021) reports that top-ranked ESG stocks (rated by MSCI ESG rating, Sustainalytics ESG rating[22] and Refinitiv ESG rating[23] agencies) can beat or lag the S&P 500 or the Dow Index. Correspondingly, it is of interest for future research to examine whether a specific ESG rating (or a weighted measure of different ESG ratings) can offer predictive power for the stock returns.

Besides ESG ratings, one can use empirical and behavioral research to examine the investors' decision-making process. Specifically, do they really believe in ESG investing as a long-term commitment to nudge companies to do good?[24] If investors tolerate ESG misdeeds, then the linkage between ESG ranking and financial performance can be weak. In the absence of a clear association between ESG rankings and stock performance, the need to examine the market response to firms with strong supply chain ESG measures is even stronger.

3. Complexity of supply chain ESG measurement: Because the supply chain structure and operations are often highly complex for many multinational firms, the number of ESG measures can be overwhelming. Putting supply chain issues aside, the lack of a common ESG reporting standard has afforded companies different ways to measure and report their data.[25] To overcome this challenge, Fink (2021) calls for a uniform ESG information disclosure standard for developing consistent measures and conducting proper ranking of all companies.[26] Having a uniform standard is appreciated, but Li and Wu (2020) argue one-size-fits-all ESG mandates may not lead to better societal outcomes.

Instead of standardizing ESG supply chain measures for all firms, one possibility is for each industry sector to take proactive control of ESG metrics.[27] For example, food companies (e.g., Nestle, Mondelez, and Mars) source their ingredients (e.g., cocoa, sugar, and coffee) globally, and paying farmers a "fair price" through Fair Trade Certification would be seen as socially responsible (Chen et al. 2021). Therefore, establishing just a few key meaningful supply chain measures and examining which measures would yield better overall ESG performance is of interest.

4. Unbiased supply chain ESG measures and reporting: Left to their own devices, companies within an industry sector have incentives to collude by cherry-picking supply chain ESG measures or by agreeing jointly to report only certain supply chain ESG measures. To avoid conflicts of interest, it is of interest to examine the role and implications of establishing an industry-based consortium with an independent and diverse board membership to govern the selection process of supply chain ESG measures for a particular industry sector. For example, after the collapse of Rana Plaza in Bangladesh that killed more than 1,000 apparel factory workers in 2013, apparel corporations, Bangladeshi unions, and NGOs formed an independent consortium to develop safety measures, audit mechanisms, and penalty incentives to ensure contract factories comply with fire and building safety (Caro et al. 2018). Therefore, it is of interest to examine—both theoretically and empirically—how the membership of such a consortium can affect the supply chain ESG performance in addition to the traditional financial performance.

Once a set of ESG measures for an industry sector is established, a potential issue of "selective reporting" arises. For example, Shi et al. (2021) find empirical evidence that firms tend to "greenwash" their supply chain ESG image by reporting environmentally responsible suppliers and concealing "bad" suppliers. Therefore, it is of interest to develop an independent audit mechanism to reduce selective reporting biases. Because companies often rely on NGOs to conduct on-the-ground inspections, it creates incentives for some unethical suppliers to offer bribes to those NGO inspectors. As such, there is a need to develop an innovative approach to tackle corruption in the NGO world (Larché 1999).

5. Supply chain law and enforcement: As discussed in Section 1, Germany is pushing for the Supply Chain Due Diligence Act (Koppmann and Lechner 2021), and the Biden administration issued a supply chain advisory in 2021, which warns U.S. companies that they will be running afoul of U.S. law if forced labor is involved in any link of their supply chain operations (Hayashi 2021). In a similar vein, the European Commission issued a guidance in 2021 asking EU businesses to address the risk of forced labor in their supply chain operations (European Commission 2021).[28] These measures are intended to nudge companies to develop and execute plans to improve their ESG measures. Therefore, it is of interest to examine the implications of these new regulations in future empirical work. We propose two specific research questions. First, how would these regulations and penalties affect a (German) firm's supply chain operations (including sourcing, contracting, monitoring, auditing)? Second, how should a (German) firm develop a "trickle up" mechanism to incentivize its direct supplier to offer incentives to upstream suppliers to comply with the new regulations? The "trickle up" mechanism has yet to be modeled and analyzed in the supply chain contracting literature (Tang 2006).

## 8. Concluding Remarks

Whereas ESG investing is gathering momentum around the globe, complex and inconsistent ESG measurements and reporting standards have created major problems even for investment firms to develop various ESG index funds.[29] At the same time, ESG measures associated with the operations of the entire supply chain have not been fully captured. Hence, such disconnection can induce firms to shift various dirty and unethical operations to their supply chain partners overseas to boost their ESG ratings.

In this paper, we argue the importance of incorporating supply chain processes and operations into ESG measures to capture the performance of all three "E," "S," and "G" pillars along a firm's supply chain. Specifically, we present three cases from the COVID-19 pandemic to illustrate how the "S" pillar of ESG considerations interacts with supply chain management and why establishing supply chain ESG measures is important. We also propose various research questions to address some ongoing challenges for establishing supply chain ESG measures. Once a set of meaningful supply chain ESG measures is developed for each sector, ESG rating agencies can then develop a new methodology to rate a firm's entire supply chain operations in a more transparent manner.[30] With transparent supply chain ESG reporting and ESG rating methodologies, companies are more likely to pivot their supply chain operations to a more environmentally sustainable and socially responsible future.

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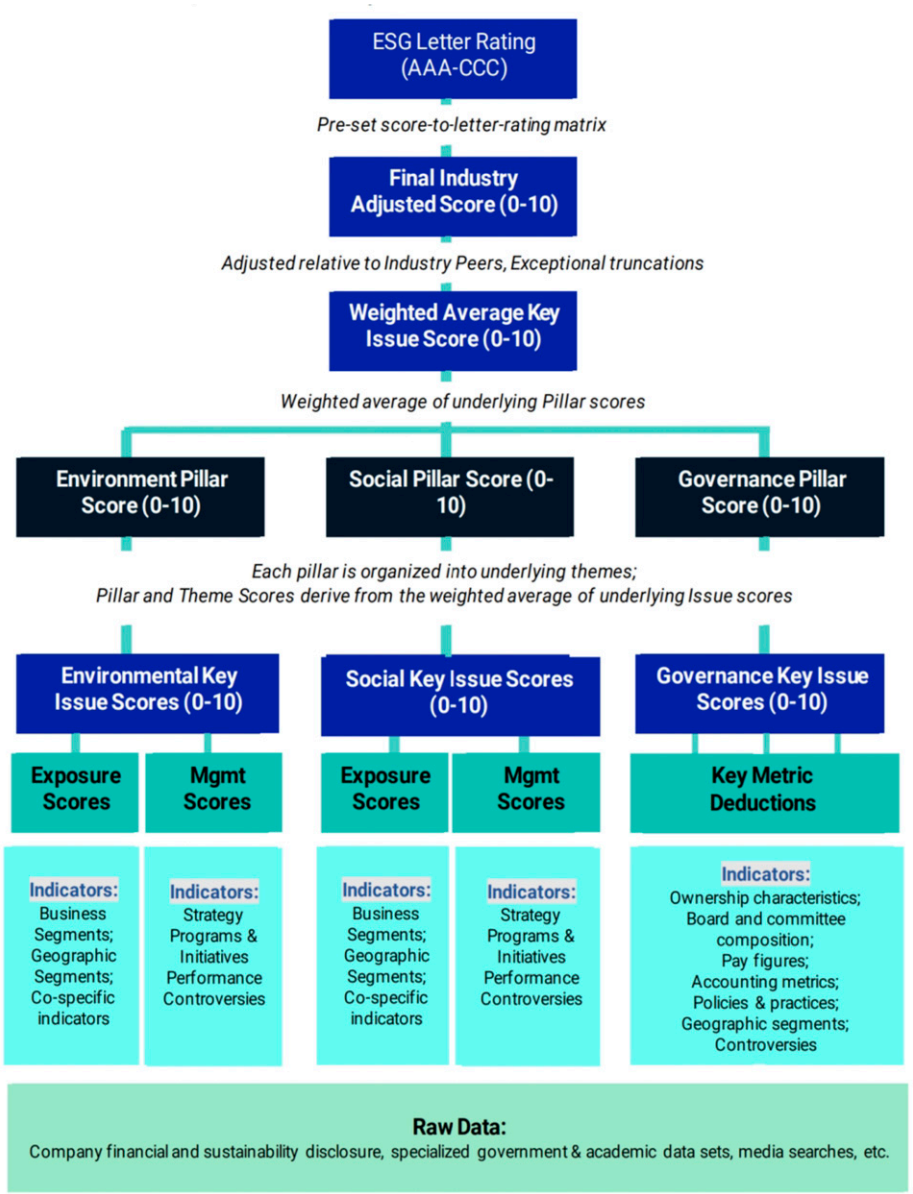
## Appendix

**Figure A.1.** A Schematic View of How MSCI ESG Scores Are Computed




*Source:* MSCI (https://bit.ly/msciesgmethod).

## Endnotes

[1] This new law also requires each large company to provide ways for employees of direct suppliers and indirect suppliers (i.e., suppliers further upstream) to alert the company regarding human rights or environmental violations.

[2] We conducted our search in INFORMS Pubs Online (https://pubsonline.informs.org) and Wiley Online Library (https://onlinelibrary.wiley.com/journal/19375956) to identify papers published in five OM-focused journals (*Management Science*, *Manufacturing and Service Operations Management*, *Operations Research*, *Production and Operations Management*, and *Service Science*) containing the phrase "environmental, social, and governance" as of August 2, 2021.

[3] By contrast, the total market capitalization of the top 50 global companies was approximately 5% of global gross domestic product in 1990 (Orlik et al. 2021).

[4] Through a series of acquisitions by MSCI, a global provider of equity, fixed income, hedge fund stock market indexes, multiasset portfolio analysis tools, and ESG products, the FTSE KLD 400 Social Index was renamed the MSCI KLD 400 Social Index in 2010.

[5] ESG rating agencies include (i) Bloomberg ESG Data Services, (ii) Dow Jones Sustainability Index, (iii) MSCI ESG Research, (iv) Sustainalytics, (v) Thomson Reuters ESG Research Data, (vi) S&P Global, (v) ISS ESG, (vi) Vigeo/EIRIS, (vi) Fitch Ratings, and (vii) Moody's Investors Service.

[6] These standards were established by the Global Reporting Institute (GRI), Sustainability Accounting Standards Board (SASB), and Task Force on Climate-related Financial Disclosures (TCFD).

[7] For details, see https://www.msci.com/what-if-esg-disclosures-become-standardized, accessed on July 30. 2021.

[8] For details, see https://www.msci.com/documents/1296102/21901542/MSCI+ESG+Ratings+Methodology+-+Exec+Summary+Nov+2020.pdf, accessed on September 29, 2021.

[9] Whereas experts are getting to grips with the "E" pillar in ESG, the "S" pillar remains elusive. BNP Paribus' 2019 survey found the "S" pillar to be the most difficult element to incorporate into investment analysis. Nearly half (46%) of respondents feel that this is the case. Investors are grappling with the complexity of integrating social factors into their investment analysis and decision making. A lack of consensus in the industry surrounding what constitutes the "S" pillar makes it harder to incorporate into investment strategies compared with both the "E" and "G" pillars. As such, it often acts as an interaction point between these two pillars.

[10] For example, the CFA Institute (2015) lists the following as examples of social issues: customer satisfaction, data protection and privacy, gender and diversity, employee engagement, community relations, human rights, and labor standards. By contrast, the SEC's ESG subcommittee proposes that the "S" pillar covers issues such as weapons, alcohol, gambling, support for organized labor, human rights practices, supply chain labor standards, consumer protection, and animal welfare (Securities and Exchange Commission 2020a).

[11] According to Unilever's website (https://www.unilever.com/brands/, accessed August 10, 2021), its product categories include food, ice cream, tea, coffee, cleaning agents, pet food, beauty products, and personal care, among others.

[12] In 2020, Amazon's U.S. sales increased by 44% to $318.41 billion, accounting for nearly 40% of the U.S. e-commerce market (Droesch 2021).

[13] By 2020, Amazon's third-party sales accounted for nearly 60% of the company's physical sales (Dai and Tang 2020a).

[14] Beginning in September 2020, after significant media attention about Amazon's business model (Berzon et al. 2019), the company's third-party sellers are now required to disclose their names and addresses (Greene 2020).

[15] As simplistic as this criterion may look, the Global Health Security Index was actually "a massive undertaking involving millions of dollars and hundreds of researchers" (Lewis 2021, p. xiv).

[16] In particular, the component concerning PPE availability (Nuclear Threat Initiative 2019b, p. 101, section 4.5.1: Infection control equipment availability) has a single documentation-based criterion as follows: "Has the country published a publicly available plan, strategy, or similar document to address personal protective equipment (PPE) supply issues for both routine national use and during a public health emergency? Yes = 1, No = 0."

[17] See https://bit.ly/mscipfe, accessed November 4, 2021.

[18] See https://bit.ly/mscixom, accessed November 4, 2021.

[19] Among the 145 vaccine candidates under development by July 2020 (Dai and Tang 2020c), only 20 were authorized for use by August 2021 (Zimmer et al. 2021). Even for the lucky few manufacturers whose vaccines were authorized—most notably, AstraZeneca, Johnson & Johnson, Moderna, and Pfizer—producing billions of doses based on novel technologies requires significant investments and does not guarantee profitability. As a case in point, the AstraZeneca vaccine has been distributed in more than 170 countries yet is expected to deliver a $13 million loss to the manufacturer in the second quarter of 2021 (Strasburg and Butini 2021).

[20] The fashion transparency index is developed by an independent organization called Fashion Revolution; see https://www.fashionrevolution.org/about/transparency/.

[21] For example, Chevron Corp. earned the best rating from Refinitiv and yet got the worst rating from Morningstar's Sustainalytics (Eaglesham and Shifflett 2021). To overcome this challenge, the SEC is weighing a common ESG disclosure standard for publicly traded companies along the lines of the Financial Standards Board.

[22] Suystainalytics was acquired by Morningstar, Inc., in 2020.

[23] Refinitive is a data provider owned by the London Stock Exchange Group.

[24] This research question is motivated by the fact that most consumers do consume products produced by unethical companies. Eckhardt et al. (2010) conducted in-depth interviews in 11 cities over 8 countries and found that consumers tend to "rationalize" their consumption of products produced by companies with weak ESG measures. Their rationalizations are due to economical rationalization (i.e., getting most value for their money), institutional dependency (i.e., the government is responsible to regulate ESG issues), and developmental realism (i.e., some unethical acts are necessary for economic development).

[25] For example, Kotsantonis and Serafeim (2019) illustrate 20 different ways for companies to report their employee health and safety data. In addition, when ESG rating agencies use the reported data to compute different ESG metrics by using their proprietary systems, inconsistent metrics across different rating agencies ensue, which can create public mistrust.

[26] Currently, many ESG measurements are established by GRI, SASB, and TCFD, among others.

[27] Business schools missed the opportunity to take control of metrics, and they are now overwhelmed by many survey requests to participate in numerous business school rankings.

[28] Germany's parliament proposed a penalty (up to 2% of a company's annual global revenue) if its supply chain partners at any level violate human rights and environment regulations, whereas the European Union and the United States are issuing warnings that a firm could run a high risk of violating U.S. law.

[29] For example, the DWS Group, the asset management arm of Deutsche Bank AG, claimed $540 billion (more than half of its assets under management) have been run through a process (ESG integration) ensuring the investment faces lower ESG risks than the industry average. However, Kowsmann and Brown (2021) report that no quantifiable or verifiable ESG integration for key asset classes exists at DWS. This scandal heightened the need to streamline various ESG measures and reporting standards.

[30] Currently, many ESG rating agencies use data reported by the firm to compute different ESG metrics using their proprietary systems without disclosing their underlying methodologies. This fact may explain why various ESG ratings can be inconsistent and unreliable (Mackintosh 2021). Moreover, when institutional investors face so many inconsistent ESG metrics across firms and so many ratings across agencies, analysts/investors may suffer from "metrics and ratings fatigue" (Thompson et al. 2005) and end up with inconsistent recommendation/investment decisions.

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