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Why academics should study the supply chains of individual corporations

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Abstract

Although fields such as industrial ecology have advanced our understanding of how cleaner technologies, recycling, and lifestyle changes can reduce the impacts of production and consumption on people and planet, environmental deterioration and social injustices stubbornly persist. New strategies are needed to achieve change in an era of increasing urgency. This paper proposes that academics study the supply chains of individual corporations and link them to environmental and social impacts in geographically specific areas. Nongovernmental organizations (NGOs) have used this approach successfully, issuing reports about corporate activity related to deforestation, sweatshops, and other issues of social concern. But academics, by and large, have studied generic products, industries, and sectors. To verify this, after reviewing approximately 11,000 studies on supply chains, we identified just 27 academic papers that focused on individual corporations. These were primarily by NGOs and social scientists, with no studies by industrial ecologists meeting our review criteria. To uncover corporate supply chains, researchers used two distinct methodological approaches: *in situ* (interviews, surveys, and surveillance) and *ex situ* (trade data, document analysis, and maps). In this paper, we explain why and how academics should study the supply chains of individual corporations. This is done by combining approaches from industrial ecology, with those from geography, sociology, and other social sciences to develop a political-industrial ecology of supply chains. This both physically links actual product flows with their environmental impacts, and explores how they affect justice, equity, and welfare. The work we propose offers clear collaborative linkages with NGOs, industry, and the media.

KEYWORDS

environmental justice, global value chain, nongovernmental organization, political ecology, political-industrial ecology, sustainable business

1 | INTRODUCTION

We live in an age of corporate giants. A total of 69 of the world's largest 100 economic entities—companies, nation-states and the like—are in fact corporations. The revenue of Walmart Corp. ranks 10th globally, just slightly less than that of the Canadian government (Global Justice Now, 2016). Walmart's revenue is even larger than the agriculture, forestry, and fishing industries of North America and the European Union combined[1]. A mere 100 companies account for 25% of global trade (Bartley, 2018). Coca-Cola is the world's largest consumer of sugarcane and aluminum, the second biggest consumer of glass, and the fourth largest consumer of coffee (Houpt, 2011). Just 100 corporations are linked to almost three fourths of global greenhouse gas (GHG) emissions (Griffin, 2017). Collectively, the 20 largest meat and dairy companies generate more GHGs than Germany (GRAIN & IATP, 2018).

Corporate activities are both immense in scale and global in geographic scope. Processes of globalization shuffle material, energy, information, money, and people across borders, oceans, and industries at increasing volumes and rates. Corporations produce, manage, tap into and lobby for the

[1] When comparing Walmart's revenue in 2015 ($482 billion) to the total added value of the agriculture, fishing and forestry industries of the European Union ($233 billion) and North America ($220 billion) for the same year (The World Bank, 2019)

free movement of these flows. As a result, supply chains cross the globe and along the way they distribute environmental degradation and social upheaval unevenly (Dicken, 2011).

For these reasons, changing corporate behavior must be part of any sustainable transition. Nongovernmental organizations (NGOs) have known this since the 1990s when they began investigating the supply chains of individual corporations. NGOs will often select a sector that faces social and environmental challenges, targeting brands in that sector (Bloomfield, 2014; Gereffi, Garcia-Johnson, & Sasser, 2001). This has included Nike and Zara and the use of child labor to produce their apparel (Center for Research on Multinational Corporations, 2016; Schanberg 1996) and how oil palm production for the likes of Cargill, Musim Mas, and Wilmar has led to illegal logging in the rainforests of Indonesia (WWF, 2016).

NGOs target well-known brands to gain leverage over corporations (Bloomfield, 2014; Chrun, Dolsak, & Prakash, 2016). This strategy is effective since brands—carefully cultivated over time and valued in the hundreds of billions of dollars—are valuable corporate assets (Interbrand, 2018). NGOs strategically identify sensitive corporate actors and their brands in problematic sectors (Bloomfield, 2014, 2017). For instance, NGOs linked Nike, a brand associated with notions of freedom and empowerment, to child labor and sweatshops (Bartley, 2018). NGOs will organize protests and boycotts and sway public opinion through the media (Bloomfield, 2014; Dauvergne, 2017; Spar & La Mure, 2003). NGOs will also compare sustainability laggards against sustainability leaders (Bloomfield, 2014). Using these "media politics," NGOs maximize limited budgets and nudge corporations and entire sectors toward sustainability (Klooster, 2005, 2006). As these campaigns can devalue brands, reduce sales, and result in stock market penalties (O'Rourke, 2014; Spar & La Mure, 2003), corporations will often commit to "cleaning up" their supply chains. These campaigns can also influence voting shareholders, such as ethical investment funds, with influence over corporate decision making (Bartley, 2018). By linking palm-oil to deforestation in Southeast Asia, for instance, Greenpeace pushed McDonald's, Unilever, and Proctor & Gamble to introduce "zero deforestation" pledges (Dauvergne, 2017). Proactive companies will sometimes collaborate with stakeholders to develop sustainability standards. Recalcitrant companies may risk legal action by NGOs and regulatory agencies (Gibson & Warren, 2016; Spar & La Mure, 2003).

Given the scale of corporate operations, targeting a few key actors in key sectors can have a profound impact. As such, corporate supply chains represent a potent and much needed research area. For O'Rourke (2005), academics (including industrial ecologists) should not only study corporate supply chains but also collaborate with NGOs. Academics, after all, enjoy much greater confidence and trust among the public than do those in business, government or media (Edelman, 2017). This puts sustainability scholars in an enviable position with respect to research on the environmental and social impacts of the supply chains of individual corporate actors.

So how often have academics taken up O'Rourke's call to study supply chains in this way? What segments of academia are doing this research and what data and methods are they using? We answer these questions through an inventory of approximately 11,000 publications on supply chains from the academic and "gray" literature. Our findings indicate just 57 papers on corporate specific supply chains, with little activity by industrial ecologists. To advance research in this area, we briefly present a methodological framework to link corporate supply actors across space and time by combining *ex situ* and *in situ* data gathering techniques with methods in industrial ecology. This builds on work by NGOs and social scientists to effectively form a *political-industrial ecology of corporate supply chains.* To bring about concrete change, we note how academics can publish results, build websites, and partner with NGOs to communicate findings to the broader public in order to encourage more sustainable behavior by individual corporations and entire sectors.

2 | IDENTIFYING THE RELEVANT LITERATURE

We used Scopus to search for relevant literature in the social sciences, engineering, and natural sciences over a fifty-year period (1966–2017) (Table S1 in Supporting Information S1). Queries covered the various academic terms for supply chains, such as "global value chains," "global commodity chains," "global production networks," and "supply chain management." We began with broad search terms (e.g., "supply chain management" and "case study"), refining them iteratively based on the results of the query. Scanning literature on supply chain management, for instance, revealed "value stream analysis" and "value stream mapping" as necessary search strings.

Studies had to fulfill four criteria:

1. Studies needed to identify companies or brands.
2. Studies had to cover multiple companies coordinating different tasks and operating together to form a supply chain (e.g., Company A manufacturing batteries and Company B assembling cellphones).
3. Studies had to reveal previously unknown connections between different companies. For instance, we would not include a study reiterating company links from a corporate report (e.g., Company A reports selling to Company B), but we would include a study capturing additional links (e.g., Company B reports selling to Company C, who is then indirectly linked to Company A).
4. Studies could not be based on collaborations with companies (e.g., supplier audits).

These criteria excluded work that might seem relevant at first glance, such as LCAs that map a company's supply chain but do not identify their suppliers (Smith et al., 2017). For similar reasons, we omitted LCAs only covering a company's direct operations (Meinrenken, Sauerhaft, Garvan,

& Lackner, 2014). Moreover, corporations often conceal problematic suppliers (Lebaron & Lister, 2015) or are unaware of whom their suppliers source from (O'Rourke, 2014). Thus, we excluded supplier audits and work using published information on suppliers, as these are rare instances when corporations know and are willing to share these data. In sum, we included studies that linked individual companies to their specific suppliers *without* the benefit of pre-existing mapping of the supply chain. Illuminating how researchers can do this is a primary goal of this review.

We applied these criteria for the Scopus search in the keywords, highlights, title, and abstract. Despite potential omissions, we found enough candidate texts using this method to feel confident that the findings are representative of the academic literature on individual corporate supply chains. Having identified promising studies, we then skimmed the text, followed by a full reading of the paper once we were certain that it met our criteria.

To identify the "gray" literature we conducted unstructured Google queries and searched NGO websites (as of December 2017), including those of: *Amnesty International*, *Greenpeace*, *Environmental Investigative Agency*, *World Wildlife Fund*, *Environmental Defense Fund*, *Center for Research on Multinational Corporations (SOMO)*, *Amazon Watch*, *Sierra Club*, and *International Labour Organization*. We skimmed press releases and executive summaries of NGO reports, followed by a full reading of the reports themselves.

3 | SCANT ATTENTION TO INDIVIDUAL CORPORATIONS

Scopus yielded 10,830 publications related to supply chains. These crossed multiple disciplines and thought-traditions. Supply chain management scholarship featured prominently (3,427 results), particularly value stream analysis (980 results). This is expected given the work focuses on how to optimize information and material exchanges across a supply chain. Industrial ecology methods were also prevalent, with thousands of results for searches containing "life cycle assessment" and "supply chains" (1,340 results) or "companies" (1,213 results), and case studies of industrial symbiosis (195 results). Another key collection of literature used theories and approaches from geography and sociology, namely, work in the area of *global value chains* (1,306 studies), *global commodity chains* (261 studies), and *global production networks* (677 studies).

Despite this voluminous literature, we identified just 57 studies (approximately 0.5%) that fulfilled the four criteria (Tables 1 and 2). A total of 30 alone came from NGOs, with 27 from academics, primarily the literature on global value chains (GCC), global commodity chains (GVC), and global production networks (GPN). GCC analyses focus on the historical reconstruction of "chains" that produce consumables, including identifying geographic configuration and unequal divisions of labor and value in the various production processes (Hopkins & Wallerstein, 1977). In essence, this "world-systems" approach focuses on: (a) physical input-output structure of interlinked processes producing goods; (b) territorial configurations of commodity chains; and (c) buyer-driven versus producer-driven governance modes (Gereffi, 1994). GVC analyses expand on the inter-firm governance structures identified in global commodity chain work, with particular emphasis on the institutional context and unequal value capture across the chain (Gereffi, Humphrey, & Sturgeon, 2005). GPN analyses prioritize the spatiality of production systems, particularly how they embed within different institutional and environmental contexts, and how these in turn influence firm behavior and inter-firm relations (Coe, Dicken, & Hess, 2008).

Of the 57 identified papers, 24 addressed environmental and resource issues, 19 addressed supply chain governance and economic development, and 14 studied labor and social issues. Agriculture (18 studies) and forestry (10 studies) dominated the environmental research; other represented sectors were mining, fishing, oil and gas, and waste. Studies that focused on labor and social issues included the clothing (seven studies) and electronics (six studies) sectors. The 19 studies related to governance and economic development covered a wide variety of sectors, with agriculture and electronics prominently figured. Overlap in academic and NGO concerns existed for the environmental and social issues, but governance and economic development were solely areas of academic interest.

Tables 1 and 2 show the portion of the supply chain each study covered, according to the conventional life cycle stages (resource extraction, manufacture, use, and end-of-life) plus retail. Manufacture received the most attention (55 studies), followed by retail (36 studies), and resource extraction (26 studies). End-of-life saw little attention (two studies), and no studies included the use stage. Emerging ownership models, such as product-service systems, will necessitate inclusion of the use stage. NGOs displayed broad supply chain coverage (16 studies covering 3 stages), with comparable concern for extraction (22 studies), manufacture (29 studies), and retail (23 studies). This stems from their goal of changing industry by linking brands and retailers to upstream issues in extractive zones and factories. Only 8 academic studies covered 3 stages and manufacture received the most academic attention with 26 studies. The emphasis on manufacturing in the academic literature relates to governance and economic development studies, a focus of GCC, GVC, and GPN scholars. These scholars focus especially on upgrading in the manufacture stage (Bloomfield, 2017). Just 5 of 19 governance and economic development studies considered extraction to retail; the remainder focused on manufacturing.

The geography of the supply chains also varied across the studies (Figure 1A–C and Tables S2, S3). Studies of resource extraction focused ion resource-rich regions (equatorial regions and boreal forests), often areas with human rights or environmental issues, with Brazil and Indonesia as hotspots. Studies on manufacturing centered on the United States and China, and, to a lesser degree, Western Europe, India, and Brazil. There was a notable "south-north" direction of the investigated supply chains, with the bulk of retailers in wealthy, western countries. The transition economies

TABLE 1 Selected corporate actor tracking research in NGO literature. Shading indicates the life-cycle stages covered by the study

Sector	Topic	Author, year	Life cycle stage				
			Extraction	Manufacture	Retail	Use	End-of-life
		Environmental focus					
Forestry	Illegal logging	Environmental Investigation Agency (2009)	■	■			
		Greenpeace (2010)	■	■	■		
		Environmental Investigation Agency (2011a)	■	■			
		WWF (2012)	■	■	■		
		Environmental Investigation Agency (2012)	■	■			
		Environmental Investigation Agency (2013)	■	■	■		
		Greenpeace (2017a)	■	■	■		
	Deforestation	Greenpeace (2006)	■	■	■		
		Greenpeace (2007)	■	■	■		
		Greenpeace (2017b)	■	■	■		
Agriculture	Deforestation	Greenpeace (2008)	■	■	■		
		Greenpeace (2009)	■	■	■		
		Forest Heroes (2016)	■	■	■		
		Mighty Earth (2016)	■	■	■		
		WWF (2016)	■	■			
Oil and gas	Deforestation	Amazon Watch (2016)	■	■	■		
		Sierra Club (2014)	■	■			
Mining	Illegal logging	Greenpeace (2013)	■	■	■		
Pharmaceuticals	Wastewater	Changing Markets (2016)		■	■		
Waste	Illegal dumping	Environmental Investigation Agency (2011b)					■
		Labor or social focus					
Clothing	Labor rights	Maquila Solidarity Network (2003)		■	■		
		SOMO (2015)		■	■		
		International Labour Organization (2016)		■	■		
	Child labor	National Labor Committee (2006)		■	■		
		SOMO[a] (2013)		■	■		
Agriculture	Labor rights	Amnesty International (2016a)	■	■	■		
Electronics	Labor rights	SSACM[b] (2013)		■	■		
Forestry	Land conflicts	Greenpeace (2017c)	■	■			
Fishing	Labor rights	Greenpeace (2015)	■	■	■		
Mining	Child labor	Amnesty International (2016b)	■	■	■		

Note. Cells with shading represent the portions of the supply chain covered by the study.
[a]Center for Research on Multinational Corporations.
[b]Students & Scholars Against Corporate Misbehavior.

and their burgeoning consumer class were underrepresented as final markets, echoing Bloomfield's (2017, 2014) observations of GCC, GVC, and GPN scholarship and criticism of NGO campaigns.

3.1 | No identified studies in industrial ecology

We found no industrial ecology studies that met our four criteria. The bulk of the research analyzed generic products or sectors to highlight how environmental and resource intensity differ between functional units, production methods, and consumption regimes. This work can help inform policy and design "greener" products but does not explicitly contribute to a political-industrial ecology of corporate supply chains. Industrial ecologists have assessed the environmental performance of corporations and brands, including Motorola (Rock, Angel, & Pao, 2006), PepsiCo Inc. (Meinrenken et al., 2014), Mars Inc. (Ridoutt, Eady, Sellahewa, Simons, & Bektash, 2009), Tyson (Smith et al., 2017), and Yale University (Thurston & Eckelman, 2011). Many of these were industry collaborations (failed criterion 4) that avoided the critical perspectives we propose. It was also common to not identify upstream suppliers (failed criterion 2), though this did not stop some researchers from taking a more adversarial tact by

TABLE 2 Corporate actor tracking research in academic literature. Shading indicates the life-cycle stages covered by the study

Sector	Topic	Author, year	GCC, GVC, or GPN	Life cycle stage				
				Extraction	Manufacture	Retail	Use	End-of-life
Supply chain governance or economic development focus								
Agriculture	Governance	Fold (2002)	GCC	■	■			
		Fold and Gough (2008)	GVC	■	■	■		
		Tipples (2008)	—	■	■	■		
		Wilson (1996)	—	■	■	■		
	Upgrading	Ponte and Ewert (2009)	GVC		■			
		Franz and Hassler (2010)	GPN	■	■	■		
		Vagneron et al. (2011)	GVC	■	■	■		
Electronics	Upgrading	Yeung (2007)	GPN		■	■		
		Hsu et al. (2008)	GPN		■			
		Yang et al. (2009)	GPN		■			
		Liu and Yang (2013)	GPN		■			
Ceramics	Governance	Hervas-Oliver and Boix-Domenech (2013)	GPN		■			
Automobile	Governance	Hall and Olivier (2005)	GVC		■			
Hygiene	Upgrading	Li (2014)	GVC		■	■		
Clothing	Governance	Bair and Gereffi (2001)	GCC		■	■		
Fishing	Governance	Engelseth and Sandvik (2017)	GPN		■			
Waste	Governance	Brooks (2013)	GPN					■
Forestry	Upgrading	Gellert (2003)	GCC	■	■			
Energy	Governance	Gregg et al. (2017)	GVC		■			
Environmental focus								
Agriculture	Deforestation	Godar et al. (2016)	—	■	■			
		SEI[a] (2017)	—	■	■			
		SEI (2017)	—	■	■	■		
	Greenhouse gases	Soosay et al. (2012)	—	■	■	■		
Labor or social focus								
Agriculture	Fairtrade	Loconto and Simbua (2012)	GVC	■	■	■		
	Land tenure	Ferrando (2017)	GVC	■	■			
Clothing	Gender relations	de Neve (2005)	GVC		■	■		
Electronics	Working conditions	Lepawsky and Billah (2011)	GPN		■	■		

Note. Cells with shading represent the portions of the supply chain covered by the study.
[a]Stockholm Environment Institute.

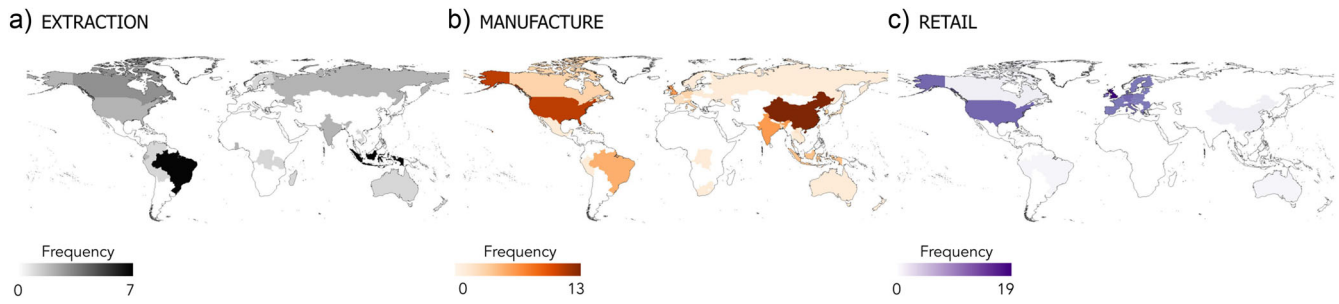

FIGURE 1 Geographic distribution of (A) extraction, (B) manufacturing, and (C) retail corporate actors in the literature based on frequency of occurrence. End-of-life not shown here due to limited coverage in reviewed literature, but is available in Table S1 in Supporting Information S1. Underlying data used to create this figure can be found in Supporting Information S2

ranking company environmental performance (e.g., Smith et al., 2017). Numerous studies analyzed industrial symbiosis between firms (e.g., Krones, 2017), but these relied on previously published work (failed criterion 3) or industry collaboration.

Three suitable studies did relate loosely to industrial ecology. Two of them, one by Godar, Suavet, Gardner, Dawkins, and Meyfroidt (2016) and a related one by the Stockholm Environmental Institute (2017), were a criticism of process-based LCA, especially its perceived vague policy implications and onerous data demands. The third paper used carbon footprint to complement an analysis of the management of wine supply chains (Soosay, Fearne, & Dent, 2012).

Of the thousands of industrial ecology studies in Scopus, only a few analyzed particular corporations, often in ways that avoided tough questions about their supply chains and business practices. Why industrial ecologists have focused so little on individual corporations is unclear. Much like NGOs, industrial ecologists view companies as fulcrums of environmental and social change (Dauvergne & Lebaron, 2014; Lifset & Graedel, 2002). Both promote market mechanisms to move producers and consumers toward sustainability (Bloomfield, 2014). One reason might be the prominent belief held by industrial ecologists in the ability of technology address resource scarcity and global environmental collapse (O'Rourke et al., 1996). Industry is the favored vehicle to reduce its environmental impacts (Boons & Roome, 2000) and there is preference for "light" regulation, using taxation to incentivize corporate environmentalism (Deutz, 2009; O'Rourke et al., 1996). Moreover, early industrial ecologists suggested avoiding normative opinions, sticking to the science and eschewing activism (Boons & Roome, 2000).

3.2 | Corporate actor tracking methods: *Ex situ*, *in situ*, and hybrid

In the 57 studies we identified, researchers used two distinct approaches; *ex situ* and *in situ*. *Ex situ* approaches use secondary data sourced from customs datasets, annual stockholder reports, corporate sustainability reports, company websites, media reports, and confidential internal memos. *In situ* approaches generate primary data through interviews, site visits, surveys, surveillance, and other fieldwork.

One *ex situ* approach entailed reading documents to identify suppliers, corporate subsidiaries, and customers. Internal company reports enabled Greenpeace to track illegal timber flows from forests to Chinese paper mills (2010). Amnesty International (2016a, 2016b) used investor documents to connect African exporters of cobalt to Chinese electronics firms and used corporate websites to link palm-oil refinery operators with parent companies. Hsu et al. (2008) mined media reports and other sources to build linkages between electronic component producers to global brand-name manufacturers. This type of document review is labor intensive, which can limit its scalability when applied to complex supply chains that may include dozens of firms.

Researchers also identify supply chains using semi-structured and structured data. These data have standard forms, syntaxes, and characteristics that facilitate and expedite their combination, manipulation, and retrieval, particularly using computer automation. Commonly used datasets include customs data of cross-border shipments ("bill-of-lading" data), remote-sensing data, national input-output tables, and agricultural production statistics. A good example of this is the Godar et al. (2016) study, which linked Indonesian palm oil to global commodity markets. Using bilateral customs datasets of waterborne palm oil trade, they identified Indonesian exporters and foreign importers alongside their respective trade volumes for thousands of palm oil shipments. They then combined district-level production data, transport network data, and port locations to build a minimum transport cost model that linked palm from municipalities to likely locations of export or storage. Global bilateral trade data from United Nations FAOSTAT of national-level agricultural commodity exchange supported a quasi-input-output model capturing transshipments from countries that imported and then re-exported Indonesian palm oil.

In situ research typically entails interacting directly with supply chain actors through interviews, surveys, and site visits. Time and labor-intensive, this research focuses on one or a few actors or study sites. Multiple academic studies have relied on interviews to link suppliers and customers (see Bair & Gereffi, 2001; Fold & Gough, 2008; Gellert, 2003) and surveys (Vagneron & Roquigny, 2011). NGOs have interviewed garment factory and agricultural workers to document labor infractions (Amnesty International, 2016a; Greenpeace, 2015; National Labor Committee, 2006). Site visits can also include direct observations. The brands produced at factories can be determined by visual inspection (Environmental Investigation Agency, 2013) or packaging labels can reveal the origin of an item sold at a market (Brooks, 2013). During site visits, researchers will also document local impacts, such as deforestation in Brazil (Mighty Earth, 2016) or Madagascar (Global Witness and Environmental Investigation Agency, 2009).

In situ research can also involve the use of surveillance, in which researchers clandestinely observe and document activities along the supply chain. The Environmental Investigation Agency (EIA) is one NGO that has pioneered surveillance methods, often going undercover by posing as buyers. To document the use of illegal Laotian timber in Vietnamese furniture factories, they surreptitiously recorded conversations with factory managers (Environmental Investigation Agency, 2011a). Surveillance can also include in-person or remotely tracking a supply chain, often without prior consent. McDowell, Mason, and Mendoza (2015) followed trucks from ports to factories to link U.S. consumers of tuna to Thai fishing vessels suspected of human trafficking. Similarly, WWF (2016) followed trucks carrying palm-fruit from Indonesian national parks to mills. To follow illegal waste dumping in Nigeria, EIA (2011b) investigators planted GPS tracking devices inside defective computer monitors. Although *in situ* methods often provide key details when *ex situ* data are lacking or companies are unwilling to cooperate with investigators, we did not find any academics using these tactics since gathering information under false pretenses, failing to anonymize interviewees, and surveilling firms all contravene academic codes of conduct.

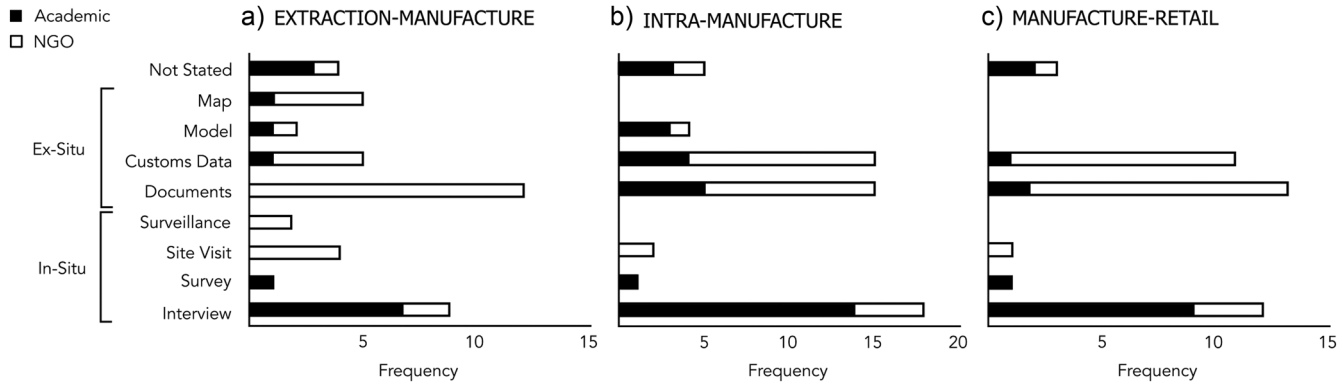

FIGURE 2 Application of different data sources to make (A) extraction-manufacturing, (B) intra-manufacturing, and (C) manufacturing-retail corporate actor linkages in the reviewed literature. Underlying data used to create this figure can be found in Supporting Information S2

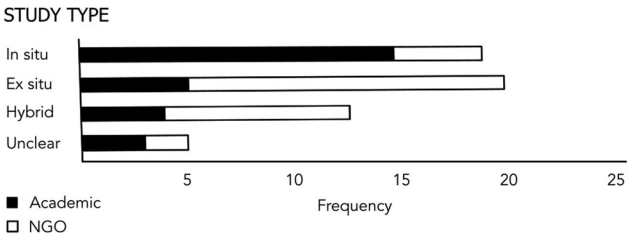

FIGURE 3 Each study based on the methods applied, where hybrid describes a mix of *in* and *ex situ* methods. Underlying data used to create this figure can be found in Supporting Information S2

Academics and NGOs use both *in situ* and *ex situ* approaches (Figure 2A–C and Tables S4, S5). However, NGOs tended to rely more on *ex situ*, whereas academics used more of a blend. Interviews were especially prominent in the academic studies. Particular *ex situ* or *in situ* methods were not associated with specific supply chain stages, with one exception: Land parcel maps were often useful in identifying firms involved in raw material extraction. Of the 57 studies, 13 used a hybrid approach, combining *in situ* and *ex situ* methods (Figure 3). For example, to illustrate how the Burger King supply chain is connected to rainforest degradation, NGO Mighty Earth (2016), used customs data and models (*ex situ*) to identify exact Amazonian rainforest tracts likely cleared for soy plantations. Investigators then used aerial drones to document rainforest clearing at these sites (*in situ*). Hybrid studies illuminate the complementary strengths of *ex situ* and *in situ* approaches. *Ex situ* approaches can make large numbers of interfirm linkages, sketch the territoriality of a supply chain, and identify potentially problematic companies using secondary data. *In situ* approaches can perform in-depth analysis of particular companies, capture "leakage" of illicit goods into supply chains, and document environmental and social change at specific sites.

4 | WHY AND HOW SHOULD ACADEMICS STUDY INDIVIDUAL CORPORATIONS AND THEIR SUPPLY CHAINS

We have provided multiple reasons for why academics should study the supply chains of individual corporations. First, we have noted their enormous size and geographic reach, some are larger than the GDP of entire countries. Second, as NGOs have demonstrated, focusing on individual corporate brands can lead to significant improvements in terms of supply chain transparency and sustainable sourcing. Third, academics enjoy high levels of public trust and have the methodological toolkit that can build off these approaches to systematically link corporate actors together across the supply chain and evaluate the environmental and social impacts.

Although our review found a burgeoning collection of research on corporate supply chains, the work remains to be done. Just 57 papers out of approximately 11,000 identified studies focused on the corporate scale. This nascent work on corporate supply chains encompasses three research streams: (a) "brand activism" campaigns by NGOs to compel companies and sectors to produce more sustainably; (b) social scientists who formulate, validate, and refine theories on global commodity chains (GCC), global value chains (GVC), and global production networks (GPN); and (c) other academics who analyze the environmental impacts of global commodity trade, focusing on precise locations of resource extraction and the companies importing and exporting these commodities. This research uses *ex situ* and *in situ* approaches to map out the supply chain structures of corporations. Conspicuously, we found no relevant studies by industrial ecologists.

In the remainder of this paper, we summarize a methodological framework to systematically track these corporate supply chains across space and time, noting data challenges and societal linkages. This involves combining LCA procedures with *in situ* and *ex situ* data gathering techniques.

Then, we conclude by calling for a broader *political-industrial ecology of corporate supply chains and brands*. This combines the methodological toolkit of industrial ecology with the theoretical and methodological expertise found in the social sciences, especially the work by sociologists, geographers, and political economists. To indicate how this can occur, we briefly illustrate how LCA and *in situ* and *ex situ* data gathering can be used to track corporate actors across space and time.

4.1 | Tracking corporate actors and fostering sustainability

In a related paper (Goldstein & Newell, 2019), we provide a detailed methodological framework—Tracking Corporations Across Space and Time (TRACAST)—for how to map out the supply chains of individual corporations. This method has four steps: (i) scope study, (ii) collect data, (iii) identify and verify corporate actor linkages, and (iv) evaluate environmental and socioeconomic impacts. Here we briefly summarize the TRACAST method.

Akin to an LCA, a researcher scopes the study by stating the study goal, by specifying a product of interest, by sketching a "product-system diagram" of supply chain steps, and by delineating the study's geographic and temporal focus. After scoping, the researcher collects data. Bill-of-lading data, such as IHS Markit PIERS (https://ihsmarkit.com/products/piers.html), document international trade between companies. Financial analysis tools, such as Bloomberg Terminal (www.bloomberg.com), do this domestically. Table S6 in Supporting Information S1 lists potentially useful, free, and commercial datasets. With *ex situ* data, researchers can start the third step of building linkages between companies, often by finding companies common across datasets that link multiple supply chain steps. *In situ* data can capture more supply chain steps and confirm linkages.

Step four links specific corporate actors to environmental and social change. To avoid simply conveying a company's share of average market impacts, researchers need company-specific data. Fortunately, company location is often revealed alongside identity. Researchers can use this information to develop spatially-explicit LCAs linking companies to hotspots of environmental impacts. Remote sensing data and tools from land change science can aid here. For the social dimensions, *ex situ* data can identify companies for social-LCA analysis without requiring industry collaboration (which might limit the release of unfavorable findings). Scorecards of labor conditions at individual factories, such as the "Better Work" project (www.betterwork.org), can also inform social-LCA. Lastly, as we expand on below, analysis using political-industrial ecology explores issues of justice, equity, and power along the supply chain.

4.2 | Data challenges

Although some companies make their supply chains transparent (see Table S6 in Supporting Information S1, for example, initiatives), others consider it a proprietary source of competitive advantage (Doorey, 2011; Kashmanian, 2017; O'Rourke, 2014). So, public data are limited for most supply chains. Available data may contain numerous complications. For instance, the following might afflict customs data alone: company names anonymized, only one company in a transaction listed, data recorded in a foreign language, or no data on mass traded between companies. Some gaps can be easily overcome (e.g., language translation), while others cannot (e.g., company anonymization). Company-level data are usually produced when governments collect tariffs on imported goods or monitor exports. Because tariffs are not paid on domestic shipments, transaction-level data on trade within countries are scarce. *In situ* methods can fill these gaps. Researchers may also need to visit sites along the supply chain to capture undocumented or improperly documented flows of goods into the supply chain ("leakage") and to confirm whether goods from different sources are blended together at certain nodes in the supply chain (Newell, 2008).

4.3 | Societal impact of research

Peer-reviewed publications that use robust scientific methods and avoid misrepresentations of transparency data (Gardner et al., 2019) would be of significant interest to media, NGOs, and corporate actors, especially given the high level of trust enjoyed by academics. Media coverage and NGO campaigns can produce improvements in corporate supply chains or alert regulatory agencies with remit to punish environmental crimes (Gibson & Warren, 2016). Both NGOs and academics have collaborated with industry to audit and improve certification schemes (Dauvergne, 2017; Gibbs et al., 2016). Academics can create websites, such as TRASE (www.trase.earth), that enable the public to visualize the impacts from corporate supply chains. NGOs have utilized such publicly available data to support their work. For example, Mighty Earth (2016) used the Stockholm Environment Institute's TRASE database to support their Burger King campaign. Under the right circumstances, direct collaboration between NGOs and academics could be mutually beneficial.

4.4 | A political-industrial ecology of corporate supply chains

Political-industrial ecology uses mixed methods to understand how environmental, socioeconomic, and political processes shape the stocks and flows of material and energy across space and time (Newell, Cousins, & Baka, 2017). It combines the quantitative tools of industrial ecology with theories and methods from the social sciences, with particular focus given to political ecology. By addressing the sociopolitical dimensions often given short shrift in industrial ecology, political-industrial ecology provides a more nuanced understanding of sustainability across

production–consumption nexus. Political-industrial ecology is committed to using this knowledge to re-shape nature–society relations around principles of equity and justice (Newell & Cousins, 2014).

With respect to developing a political-industrial ecology of supply chains and brands, we can identify three developments. First, this work would publish rigorous methodological studies on the supply chains of individual companies, using TRACAST and related approaches. This could nudge corporations to build more sustainable and fairer supply chains. Second, this work would identify hotspots of impact in supply chains and the processes that lead to their creation. In this vein, work by political ecologists and scholars of GCC, GVC, and GPN have much to contribute. Political ecology "chains of explanation," for example, reveal causal (often distant) political-economic mechanisms behind local impacts in specific places (Robbins, 2012). Work on GPNs similarly links global pressures to local changes, and provides the concept of "embeddedness" to explain why some supply chains become fixed in space and social networks (while others are more fluid) via social, economic and political structures (Hess, 2004). Third, studying corporate supply chains grapples with the unequal distribution of benefits and costs, as part of a commitment to justice and equity. Work in urban political-ecology on "urban metabolism" explains *why* supply chains (re)produce hotspots of impacts and create environmental, social, and economic "winners and losers." (Heynen, Kaika, & Swyngedouw, 2006) Likewise, GCC and GVC analyses explore power asymmetries in supply chains and unequal value capture (Gereffi, Humphrey, Kaplinsky, & Sturgeon, 1994).

Like industrial ecologists, GCC, GVC, and GPN scholars study supply chains. They focus on the socioeconomic and spatial dimensions of industrial organization, while industrial ecologists prioritize environmental aspects. A political-industrial ecology framework would simultaneously address environmental, social, *and* spatial aspects of production and consumption, rather than a focus primarily on just one (Newell et al., 2017). This interdisciplinary work would strengthen industrial ecology while reciprocally addressing gaps in GCC, GVC, and GPN work: only limited attention to environmental impacts (Bolwig, Ponte, du Toit, Riisgaard, & Halberg, 2010) and a focus on extractive sites and factories (Bloomfield, 2017). Given that consumers seek brands aligned with their personal values (Rindell, Strandvik, & Wilén, 2014), this work could be of interest outside the academy. Working alongside NGOs or building public-facing web-tools can amplify this message and nudge corporations or sectors toward sustainability. In a time of escalating environmental degradation (Steffen et al., 2018) and labor exploitation (International Labour Organization, 2017a, 2017b), academics need to explore all avenues in working toward this elusive goal. Ultimately, linking individual corporations to environmental and social impacts is an important way for academics to use their trusted voices to catalyze an urgently needed shift towards an economy that respects people and planet.

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CONFLICT OF INTEREST

The authors have no conflict to declare.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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