Truth or Consequences: Stakeholder Influences on the Relationships Between ESG Reporting and Profitability in the Global Automotive Industry Supply Chain

Abstract

We examine the influences of customers, suppliers, employees, industry associations, and investors on the environmental, social, and governance (ESG) reporting and profitability of over 600 firms in the global automotive industry. Linking 11 of the largest automotive manufacturers with their tier 1 and tier 2 suppliers, we empirically examine the relationships between ESG reporting and profitability along each global supply chain, and explore how other stakeholders impact these outcomes. We find there are statistically significant impacts from OEM's ESG scores on the ESG of their suppliers. We also find that ESG scores of firms are generally not significantly related to their accounting profits, but are more significantly related to their Tobin's Q, reflecting a stronger influence of ESG reporting on share values of firms than on internal accounting measures.

Keywords: ESG, Supply Chain, Stakeholders, Automotive Industry

1 Introduction

Investors are increasingly interested in sustainable investing opportunities. In a 2019 Morningstar study based on a nationally representative sample of 948 respondents, over 72% of the respondents chose equities that had some sustainability focus versus focusing only on financial returns (Sin & Lamas, 2019). This interest has grown even more over the past two years (Lane, 2021). The Global Sustainable Investment Alliance reports over \$35 trillion of sustainable assets under management in 2020, an increase of 15% over 2018, and a total of 36% of total assets under management (*Global Sustainable Investment Review 2020*, 2021). There is also increasing attention to climate change and environmental concerns as evidenced in the August 9, 2021 United Nations report on climate change (Masson-Delmotte et al., 2021), and President Biden's August 5, 2021 executive order that by 2030, 50% of car sales in the US must

be electric vehicles (*Executive Order on Strengthening American Leadership in Clean Cars and Trucks*, 2021).

However, there exists significant concerns about the credibility of corporate environmental, social, and governance (ESG) reports to reflect actual practices and impacts. This skepticism is so great that the term "greenwashing" has been coined to describe the practice of firms "presenting itself as environmentally friendly in an attempt to obscure its past or current practices that are harmful to the environment" (Merriam-Webster Online Dictionary, 2021; Polman, 2021). Addressing these credibility concerns will be a key to focusing corporate efforts to actually undertaking the sustainability challenges rather than simply producing glossy sustainability reports to satisfy investors.

One of the primary challenges in credible ESG reporting is the complexity and lack of transparency in global supply chains. It can be particularly difficult for multinationals to monitor and report on the environmental and social policies and practices of their lower tier suppliers that compete primarily on factors such as quality, cost and delivery, lack sophistication in ESG reporting, and operate in countries that do not have a similar tradition of environmental and labor regulations (Villena & Gioia, 2018).

While the European Financial Reporting Advisory Group (EFRAG) (*Sustainability Reporting Standards Interim Draft*, 2021) is leading the world in developing meaningful ESG reporting standards to address the European Green Deal aimed at revitalizing economic growth, pressure by institutional investors and the public have spurred recent initiatives by the International Financial Reporting Standards Foundation and others to harmonize meaningful ESG standards to provide improved credibility to reporting policies to meet these important societal concerns. Developing credible, verifiable ESG reporting mechanisms and encouraging firms to implement them throughout their supply chain will be critical to obtaining the investment capital, skilled workforce, and regulatory approvals needed within the cost and profitability constraints of global competition.

We examine ESG reporting by understanding its relationship with stakeholders in the global supply chain and with financial performance. Our approach involves a broad examination of the relationships between various manufacturers, stakeholders, and participants in the global value chain in the automotive industry. Our research aims to provide insight into ESG and sustainability reporting by identifying meaningful linkages between ESG actions and ESG reporting, and in turn, linkages to the financial performance of these manufacturers. The research questions we seek to answer are:

- **Question 1:** Do original equipment manufacturers (OEMs) influence the ESG practices, reporting, and outcomes of their tier 1 and tier 2 suppliers?
- **Question 2:** How do stakeholders of OEMs and their suppliers influence ESG practices and outcomes along the supply chain?

Because financial performance and profitability is essential to firm survival, our final research question is:

- **Question 3:** How do firm ESG practices, reporting, and outcomes influence firm financial performance along the supply chain?

By integrating the influences of crucial stakeholders along the supply chain in the global automotive and auto parts industry, our research addresses the complexity of sustainable business and reporting in one of the planet's largest and most important manufacturing sectors in terms of environmental, human capital, and societal impact. The automotive industry supply chain is the ideal focus for this research not only because of its impact on global GDP and employment, but also because of the life cycle environmental impact of the end product in addition to the manufacturing process. Transportation is the largest contributor to greenhouse gas emissions (*Sources of Greenhouse Gas Emissions*, 2021) and the increasing attention to climate change as well as to urban traffic congestion and noise is foreshadowing a global transition from internal combustion engines to electric cars, ride sharing, and other innovations that are profoundly changing the industry. Focusing on the global automotive industry will allow us to focus on the challenges of meeting sustainability and profitability goals simultaneously in an evolving competitive landscape.

This research also contributes to the theoretical understanding of the sustainable reporting eco-system. By incorporating the influence of a broad set of stakeholders–employees, labor unions, regulators, NGOs, etc. – in addition to investors in our models, our research will contribute to a better understanding of how stakeholders in different countries and regions impact firm sustainability practice and outcomes. The global focus on climate change and social justice has elevated attention to ESG reporting in the past few years. Our study seeks to provide more clarity about whether and how large firms influence the ESG activities and profits of firms with which they have economic relationships.

2 Theoretical Framework

Research on sustainable practice adoption in global supply chains is rather limited (Kano, Tsang, & Yeung, 2020). Over the past 40 years, global value chains have evolved from vertically integrated organizational structures to distinct forms of asymmetrical networks with orchestrating firms, often OEMs, providing a key role in selecting network participants, coordinating the inclusion of non-business intermediaries, leading joint strategizing, particularly in the development of new products for the market, providing financial and relational capital, monitoring multilateral feedback mechanisms, and influencing rules for equitable value distribution in terms of technological sharing as well as financial rewards (Kano, 2018). With increased focus on the environmental and societal impacts of global firms, understanding and coordinating ESG activities and outcomes along the global value chain is increasingly important (*Sustainability: The "must have" strategic initiative*, 2021).

Research on the impact of stakeholders on ESG initiatives is also lacking, particularly research on how multiple stakeholders, including regulators, NGOs and community groups may work jointly and interact with management to impact policies, actions, and outcomes relating to ESG (Doh, Tashman, &

Benischke, 2019). Marano, Tashman, and Kostova (2017) examined how emerging country MNEs use CSR to overcome the perceived institutional voids in their countries to enhance their image in international markets. Only a few studies have linked NGO participation to ESG reporting and outcomes (Li & Wu, 2020), while others have linked supply networks to share price returns and risk (Wang, Li, Wu, & Anupindi, 2021). However, these studies have not examined the complex roles in a multi-stakeholder environment and along the global value chain. Our study integrates quantitative and qualitative analysis from a variety of sources to provide deeper understanding of this increasingly important topic. Figure 2 describes our comprehensive theoretical model of how stakeholders drive various elements of ESG reporting, and how these stakeholders and ESG activities impact firm profitability of the various members of the global supply chain.
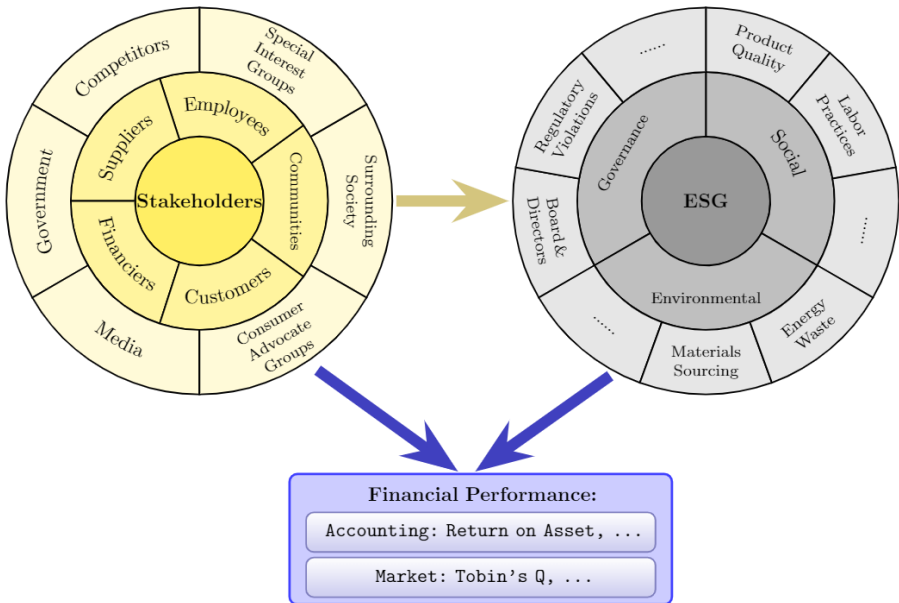

Fig. 1: Illustration of our proposed theoretical models: stakeholders affect ESG, and ESG along with stakeholders affect financial performance.

Our study draws from three theories in the strategy literature. (Porter, 2008) describes the impact of supplier and customer power on industry competition. His classic theory refers to many stakeholders that also influence industry competition. For example, regulators may be key to maintaining barriers to entry from new entrants. Firms with high capital requirements will need to consider creditors and investors as stakeholders in their strategic formulation. Porter's model also includes competitors, both current and potential as influences in the firm's strategy.

We also draw on stakeholder theory (Freeman & Dmytriyev, 2017) by formally articulating and integrating a variety of stakeholders, including employees, customers, suppliers, financiers, communities, the institutional environment, NGOs, industry organizations, and employee unions in our analysis.

More recently, researchers have developed the concept of open strategy to describe new ways that firms are involving stakeholders in strategy. Open strategy details how modern firms are using both traditional analog as well as digital methods to gather input from a variety of internal and external stakeholders (Hautz, Seidl, & Whittington, 2017; Stadler, Hautz, & von den Eichen, 2020). Detailing 35 examples drawn from the literature and other sources, (Hautz, Hutter, Sutter, & Füller, 2019) classified examples of open strategy methods used to generate new ideas, develop and select from new strategy ideas, and integrate strategies into the organization. Their research also detailed how and from whom open strategy input was gathered in these 35 cases. Our integration of supply chain and other stakeholder effects on ESG and profitability outcomes in our empirical models provides an innovative lens into how open strategies may impact firms in the real world.

2.1 Global Value chains

As our theoretical model in Fig. 1 indicates, the first issue we examine is the role of stakeholders, particularly the interrelationship of customer and supplier firms in the global value chain. Kano et al. (2020) provides a multidisciplinary literature review of global value chains (GVC), drawing works from the last 20 years. They created a framework to organize their examination of GVCs classifying articles into macro-level influences, including cultural institutional, geographical and economic characteristics of the home/host locations; micro-level influences including behavioural assumptions of decision makers in lead firms and peripheral units; and GVC level characteristics including structural and strategic governance issues. They found that while a great deal of research has been published there is not yet a dominant theory of GVC. They identified knowledge gaps and called for further empirical research regarding the measurement of geographic dispersion of GVCs, including firm level GVC mapping and linking locations with detailed data on flows of services and skills, employment, revenue and value creation as well as identification of where the most value is generated in the network. They also call for more research on the affect of the lead firm on structural and strategic governance, and the impact of family firm-led GVCs. Our approach of specifically identifying tier 1 and tier 2 suppliers of major OEMs in Asia, the EU and US, and linking them in terms of revenue flows addresses these gaps in the literature.

(Villena & Gioia, 2018) made an exploratory attempt at examining linkages in the supply chain by conducting a qualitative analysis of three multinationals in different industries and 9 tier 1 and 22 tier 2 suppliers in their GVC. They developed a conceptual model for managing supply chain sustainability and conducted in-depth interviews supplemented by archival reports to validate their model. They found that lower tier suppliers pose the most risk for MNCs, as these lower tier suppliers often have little expertise and few systems in place for

monitoring sustainability. However, increasing pressure by regulators and other stakeholders, and the reputation risk created by suppliers makes it imperative for MNCs to better monitor ESG throughout their GVC. Our study of these supply chain linkages in the automotive industry is much more comprehensive, examining the OEMs that represent over 80 percent of world market share and linkages with over 600 of their Tier 1 and Tier 2 suppliers. In one of the few large empirical studies linking GVCs, (Wang et al., 2021) identified supplier networks of 2258 focal firms in a variety of industries using the FactSet Revere database to determine whether the financial risks (volatility) of tier 1 and 2 supplier firms resulted in greater risk for their focal firm customers. They also examined whether external shocks (power outages and natural disasters) affecting supplier firms impacted focal firm risk or stock returns. While their findings are significant, the focus of the studies are primarily of benefit to investors and do not provide management or other GVC participants with insights to make foresighted decisions.

2.2 The role of stakeholders

Our study also examines the role of other stakeholders in the global value chain. We further operationalize the conceptual models described in stakeholder theory (Freeman & Dmytriyev, 2017; Freudenreich, Lüdeke-Freund, & Schaltegger, 2020) and open strategy (Hautz et al., 2017) to the automotive industry by identifying and incorporating influences and data about multiple stakeholders including employees, NGOs (e.g. UNDP), industry associations (e.g. AIAG), investors (green funds), and various ESG reporting initiatives (e.g. GRI, SASB). We draw on a variety of sources to provide insight into how these stakeholders influence ESG activities along the supply chain in various locations.

One prior study that examines the influence of NGOs on sustainability outcomes is (Li & Wu, 2020) who examined whether firm participation in UNGC had an impact on the incidence of actual negative ESG events that they gathered using the RepRisk database. Comparing a matched sample of non-participating UNGC firms they found that private firms' real ESG performance did improve after participation in UNGC, while public firms' real ESG outcomes did not. Our study includes data regarding the impact of stakeholders on ESG outcome metrics and financial performance.

Numerous ESG reporting standards and database firms have developed (Siew, 2015). For example, the Sustainability Accounting Standards Board (SASB) has led efforts in the US to develop industry specific reporting standards, which are now the second most commonly used reporting regime (KPMG IMPACT, 2020). Fortunately the SASB and GRI and others have recently announced an initiative to work together to better enable firms to efficiently report ESG data that is both industry specific and useful across diverse domains (GRI and SASB, 2021). Unfortunately, while China now has the largest proportion of world manufacturing GDP, Chinese participation in ESG reporting is sorely lagging behind the west. While the efforts of NGOs such as Clean Air Asia (*Clean Air Asia*, 2021) are trying to address these issues, the lack of comparable environmental and workforce regulatory regimes, along with opaque

governance practices throughout much of Asia has left US manufacturers at a competitive disadvantage in global markets (KPMG, 2020). As stakeholder pressure grows for US and EU firms to verify the ESG policies and practices throughout their supply chains, it is imperative that mechanisms be developed to level the playing field and allow firms, employees, customers, investors and policymakers to verify ESG performance along with cost, quality and financial outcomes across the globe.

2.3 ESG and Profitability

Interest in why firms conduct ESG activity, and whether ESG improves the firm's financial performance is longstanding and increasing. The results are mixed, and more importantly, our understanding of the mechanisms and factors affecting this relationship remains fragmented. A meta-analysis of 198 studies from the business and accounting literature examining the relationship between sustainability performance and financial performance was conducted in Lu and Taylor (2016). The research findings are sometimes contradictory, however, the meta-analysis suggests that sustainability performance likely increases a firm's financial performance, especially in the long run. In comparison to social factors, environmental sustainability was found to contribute more to the positive ESG to financial performance relationship. In addition, they found that ESG appears to be more highly correlated with accounting-based measures of performance than with share price performance indicators. Multi-industry, pre-2000 studies, and non-U.S. sample firms seem to show a stronger impact on the positive relationship between ESG and financial performance, perhaps because of the longer experience of reporting ESG factors in the integrated reporting system in Europe.

A comprehensive review of studies between 1980 and 2019 examining the relationship between ESG with corporate financial performance is conducted in Huang (2021). It is noted that much of the research focuses on observable end outcomes of ESG and financial performance, with comparatively little work that conceives ESG as part of overall firm activity. The studies show the strongest relationship between ESG measures and operational performance measures, with declining correlation coefficients to accounting measures and to stock market performance measures. This comprehensive review (Huang, 2021) concluded that scholars need a more holistic and multi-disciplinary approach to ESG research, with less focus on outcomes without sufficiently understanding the motivators and causality of the relationship as well as ESG's place in overall firm strategy (Grewatsch & Kleindienst, 2017; Ullmann, 1985). There is also a need to better understand company processes by which ESG actions lead to particular outcomes (Aguinis & Glavas, 2012; Gautier & Pache, 2015; Hang, Geyer-Klingeberg, & Rathgeber, 2019; Wood, 2010), and in turn to better understand the levers by which motivators are transformed into outcomes for the firm.

With regard to the impact of ESG on profit, common wisdom may suggest that sustainability increases cost. However, the interactive effects are more complicated. Customers may be willing to buy more sustainable products at

higher prices, thereby offsetting the higher costs and even creating higher profit margins. Traditional investment theory would suggest that if ESG investment leads to lower risk, we would expect market returns for such firms to also be lower. However this does not seem to be the case. Indeed, meta-analysis (Huang, 2021; Lu & Taylor, 2016) of existing studies on the relationship between ESG performance and financial performance (Aguinis & Glavas, 2012; Bénabou & Tirole, 2010; Gautier & Pache, 2015; Grewatsch & Kleindienst, 2017; Hang et al., 2019; Ullmann, 1985; Wood, 2010) calls for more comprehensive analysis and more decisive conclusions.

To the best of our knowledge, there is no prior empirical work on ESG business decision-making problems that take into account the elements of stakeholder influence and supply chain linkages on both sustainability and profitability. Our research focuses on examining how firms balance their long-term financial performance while improving ESG measures. As such, our study of why and how firms may conduct ESG activity sits at the intersection of two central pillars for economic activity – the self-interested action of economic agents focused on productive efficiency, and societal and government interventions to address issues of safety, pollution, climate change and social justice, that may result from inadequate cost measurement issues and market failures (Bénabou & Tirole, 2010).

3 Methods

3.1 Global Value Chains

To test our research questions and operationalize our theoretical model, we first identify significant firms in the global value chains of the largest OEM firms in the automotive industry. The eleven OEMs in our study are Ford, GM, BMW, Daimler, Volkswagen, Renault, Stellantis, Honda, Nissan, Toyota and Hyundai. These firms account for 80 percent of the world market share and span three continents, with sales, subsidiaries, and supplier operations in virtually every country. Using the Bloomberg Supply Chain function, we identify the top 12 to 15 tier one suppliers for each OEM, and in turn the top 15 tier two suppliers for each of the tier one suppliers. This process results in an initial linked data set of 751 firms, consisting of the 11 OEMs, 83 tier one suppliers and 657 tier two suppliers. We note that many suppliers are shared by more than one OEM, or more than one tier one supplier, especially in the US and EU.

node size: proportional to sales
node shape: circles are OEMs, squares are tier 1 suppliers
node color: blue for European, red for North American, yellow for Asian
node color intensity: darker for higher ESG scores, lighter for lower ESG scores
distance between OEM and tier 1: shorter for high percentage of revenue from OEM
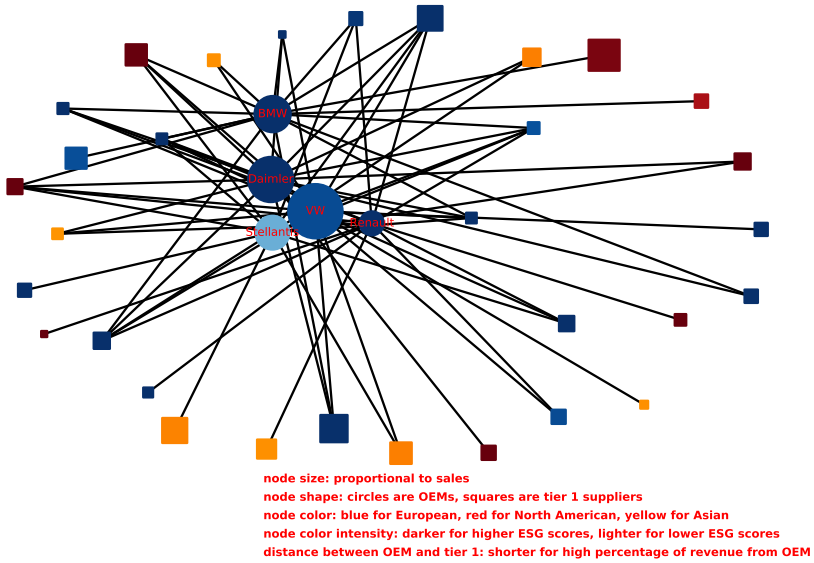
Fig. 2: Visualization of the supply chain networks of European OEMs.

node size: proportional to sales
node shape: circles are OEMs, squares are tier 1 suppliers
node color: blue for European, red for North American, yellow for Asian
node color intensity: darker for higher ESG scores, lighter for lower ESG scores
distance between OEM and tier 1: shorter for high percentage of revenue from OEM
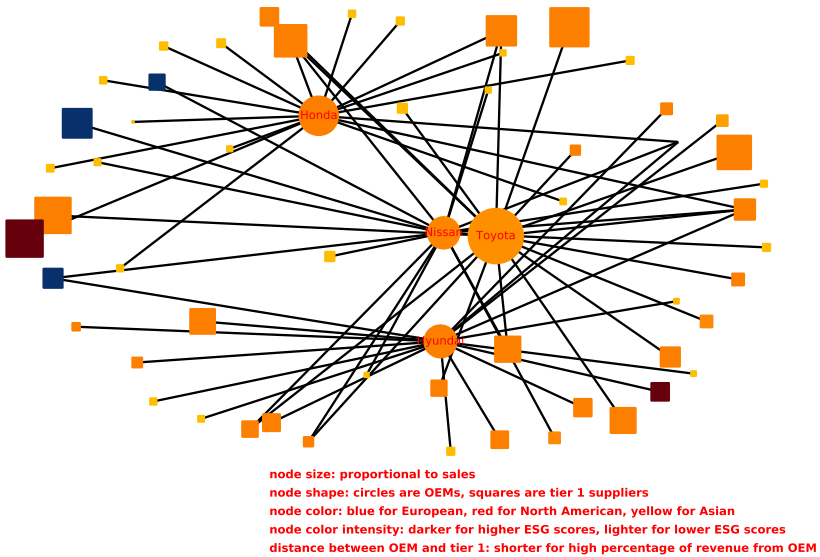
Fig. 3: Visualization of the supply chain networks of Asian OEMs.

node size: proportional to sales
node shape: circles are OEMs, squares are tier 1 suppliers
node color: blue for European, red for North American, yellow for Asian
node color intensity: darker for higher ESG scores, lighter for lower ESG scores
distance between OEM and tier 1: shorter for high percentage of revenue from OEM
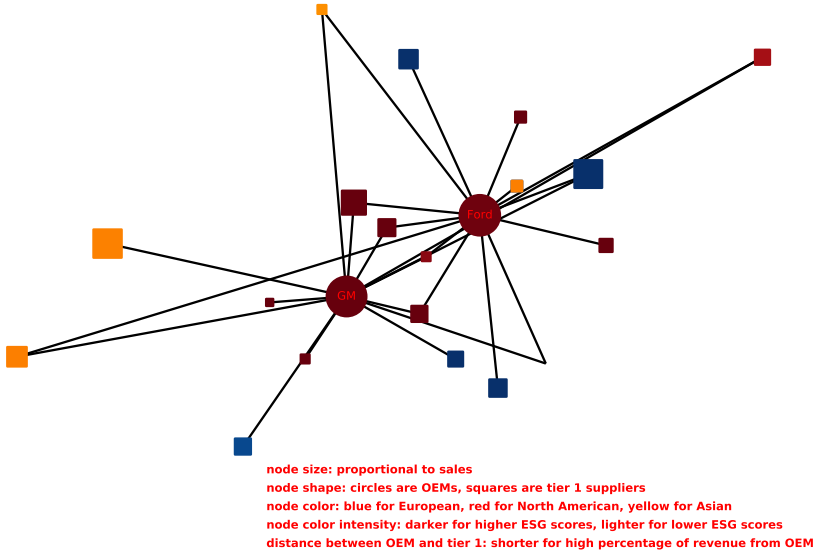
Fig. 4: Visualization of the supply chain networks of American OEMs.

Figures 2, 3, and 4 graphically illustrate the eleven industry global value chains for each continent. In the figures, circles represent OEMs and squares represent tier 1 suppliers. (Due to the large number of tier 2 suppliers, they are not included in these figures but are included in our other analysis models.) Node size is proportional to the firm size measured by revenues. The length of the connecting lines reflect the percentage of the supplier's revenue that comes from the OEM customer, with shorter lines representing that a higher percentage of the tier 1 supplier revenue comes from that OEM customer. We use blue for European firms, red for North American firms, and yellow for Asian firms. Color intensity indicates higher ESG disclosure scores. In Asia, there is a much greater level of exclusivity in the tier one suppliers compared to the US and EU, where suppliers often participate in more than one value chain as indicated by multiple lines to the Tier 1 supplier. That said, there are a few firms that serve virtually all OEMs. These firms include large suppliers such as Continental, Denso, Magna, ZF Friedrichshafen, Aisin and others that are known to be among the largest 50 automotive suppliers in the world.

3.2 ESG and Stakeholders

Next we gathered financial data and ESG data for 2010-2020 for the firms in these global value chains. ESG data is gathered from two sources – the Bloomberg ESG data set and Refinitive database. In addition to scores, the Refinitive database includes information about a variety of ESG policies, actions and outcomes regarding engagement with customers, suppliers, employees, regulators, etc., as well as ESG outcome measures. Financial data from DataStream

is available for all OEMs, 81 of 83 tier 1 suppliers and 565 of 657 tier 2 suppliers. Logically this is because some of the suppliers included in the Bloomberg supply chain data are not publicly held. Table 1 provides descriptive statistics for the OEMs in each continent and their related Tier 1 and Tier 2 suppliers. We can see that US OEMs are about 10 times the size of their tier 1 suppliers and 23 times their tier 2 suppliers based on median sales values. In the EU, OEM are about 7.6 times larger than tier 1 suppliers and 14.5 times tier 2 suppliers. In Asia, the size differences are even smaller on average with OEMs being 6.4 times larger than their tier 1 suppliers and 11 times larger than their tier 2 suppliers. Interestingly, despite the size differences, the profitability of OEMs and their suppliers do not vary so dramatically, with median EBIT to sales percentages hovering in the 6 to 9 percent range for all continents and levels in the value chain.

Conceptually, sustainable business is achieved through a comprehensive examination of the design of products produced, often with customer dialogue and input, and a rigorous process improvement system to look for opportunities to minimize the use of energy, water and other waste materials. Workforce diversity, union representation, and engagement are also elements of the social contract of workers and their employers and require efforts to recruit women and minorities, monitor the culture in the workplace, and measure progress toward defined goals. Workplace safety is a critical factor in attracting a high quality workforce, requiring commitment from top management as well as training, safety systems and monitoring. A variety of external stakeholders outside the supplier-customer value chain may influence the firm's ESG initiatives. For example, firms are required to comply with various regulations of state and federal governments (EPA, OSHA, SEC). Firms will also be influenced by various industry groups, such as the Auto Industry Action Group (AIAG), the National Association of Manufacturers (NAM), who may provide training resources, may advocate on behalf of the industry with various stakeholder groups, etc. NGOs such as the United Nations, Transport and Environment, and Clean Air Asia may also influence ESG initiatives of firms in various locations. ESG reporting standards organizations such as EFRAG, SASB, and GRI provide guidelines that are primarily voluntary but may have significant influence on investors.

To identify key stakeholders we draw on information from the firms' annual sustainability reports and financial filings and selected variables from industry websites, as well as the Refinitive dataset. For example, to assess firm interactions with competitors as stakeholders, we measured whether the firm was involved with the Auto Industry Action Group (AIAG). To measure the involvement of investors as stakeholders, we identified whether the firm is listed in a green investment fund. We also measured whether the firms use GRI reporting requirements and whether the information is audited by an external auditor. To measure community stakeholder involvement we used financial donations as a proxy. To measure the involvement of employees as stakeholders we used employee unionization, gender diversity, and safety statistics.

Table 1: Descriptive statistics by continent

Panel A. Europe (N is the number of firm-year data samples from 2010 to 2020)

	OEM ($N = 55$)		Tier 1 ($N = 279$)		Tier 2 ($N = 1,666$)	
	Mean	Median	Mean	Median	Mean	Median
Net Income (in millions)	6,207	6,021	1,175	642	1,055	351
Sale (in millions)	136,385	119,253	23,570	16,635	17,875	8,682
Total Assets (in millions)	222,640	184,831	24,507	14,558	24,015	10,354
EBIT to Sale	0.07	0.07	0.08	0.07	0.12	0.08
Leverage	0.75	0.75	0.57	0.57	0.55	0.55
Book-to-market	1.17	1.07	0.60	0.50	0.62	0.51
ROA	0.03	0.03	0.05	0.05	0.04	0.04
Q	1.00	0.99	1.49	1.33	1.65	1.35
ESG_DISC_SCORE	0.90	0.93	0.79	0.84	0.76	0.84
ENV_DISC_SCORE	0.94	0.94	0.84	0.93	0.77	0.90
SOC_DISC_SCORE	0.90	0.92	0.79	0.87	0.74	0.84
GOV_DISC_SCORE	0.66	0.73	0.52	0.55	0.58	0.68

Panel B. Asia (N is the number of firm-year data samples from 2010 to 2020)

	OEM ($N = 44$)		Tier 1 ($N = 315$)		Tier 2 ($N = 1,485$)	
	Mean	Median	Mean	Median	Mean	Median
Net Income (in millions)	6,685	4,753	1,129	568	1,120	361
Sale (in millions)	137,562	106,525	27,812	16,635	19,366	9,796
Total Assets (in millions)	212,870	160,331	28,441	16,717	27,067	11,959
EBIT to Sale	0.06	0.06	0.07	0.06	0.10	0.07
Leverage	0.63	0.61	0.54	0.55	0.53	0.52
Book-to-market	1.15	0.98	0.91	0.83	0.71	0.66
ROA	0.03	0.03	0.04	0.04	0.04	0.04
Q	0.99	1.01	1.24	1.08	1.50	1.21
ESG_DISC_SCORE	0.76	0.79	0.65	0.72	0.74	0.81
ENV_DISC_SCORE	0.93	0.94	0.82	0.93	0.81	0.91
SOC_DISC_SCORE	0.84	0.85	0.71	0.81	0.76	0.86
GOV_DISC_SCORE	0.22	0.17	0.21	0.11	0.43	0.30

Panel C. U.S. (N is the number of firm-year data samples from 2010 to 2020)

	OEM ($N = 22$)		Tier 1 ($N = 179$)		Tier 2 ($N = 953$)	
	Mean	Median	Mean	Median	Mean	Median
Net Income (in millions)	6,003	6,381	805	564	875	302
Sale (in millions)	146,025	148,304	16,522	14,078	13,618	6,470
Total Assets (in millions)	190,382	189,612	14,506	11,221	19,622	8,882
EBIT to Sale	0.06	0.07	0.09	0.07	0.14	0.09
Leverage	0.82	0.83	0.56	0.56	0.56	0.54
Book-to-market	0.64	0.64	0.53	0.48	0.60	0.50
ROA	0.03	0.03	0.06	0.07	0.04	0.04
Q	1.11	1.10	1.54	1.37	1.63	1.37
ESG_DISC_SCORE	0.86	0.91	0.75	0.81	0.74	0.81
ENV_DISC_SCORE	0.92	0.93	0.80	0.92	0.75	0.90
SOC_DISC_SCORE	0.74	0.79	0.70	0.80	0.72	0.82
GOV_DISC_SCORE	0.82	0.83	0.55	0.63	0.58	0.68

3.3 Profitability and financial performance

Financial data for all firms was obtained from DataStream for 2010-2020. Table 1 contains the descriptive statistics for the firms in each continent's OEM's

global value chain we that use for our analysis to examine our three major research questions.

To provide insight on our three major research questions we perform a variety of graphical, correlational and regression analyses to explore how ESG initiatives and outcomes occur along each supply chain. We also examine the impact of stakeholders on ESG and profitability outcomes. Finally we analyze how profits are shared along each OEM global supply chain and the linkages between ESG, stakeholder involvement and profits. There are a variety of financial metrics we use to indicate the firm's performance, profitability and efficiency. Profitability measures include Return on Assets (ROA), EBIT to sales, and Tobin's Q.

4 Results

4.1 Global value chains and ESG

The first research question asks how OEM's influence the ESG practices, reporting and outcomes of their tier 1 and tier 2 suppliers. Figures 5, 6, and 7 provide the 10 year trends for the 11 OEMs and their tier 1 and tier 2 suppliers' sales, EBIT/sales, ESG scores and Environmental scores. Rather than 11 separate sets of graphs for each OEM supply chain, we group the OEM global value chains by continent, with OEMs represented by circles, tier 1 by squares and tier 2 by triangles. Different OEMs and their value chains are represented by different colors and line patterns. This analysis allows us to visually examine whether OEM annual profits and ESG scores trend similarly to the annual mean sales, profits and ESG scores of their tier 1 and tier 2 suppliers.

Figure 5a shows the ten year sales trends for the European OEMs and the mean sales for their tier 1 and tier 2 suppliers. Volkswagen is by far the largest European OEM followed by Daimler. Stellantis was created in 2021 by the merger of Peugeot and Fiat-Chrysler and the combined sales volume puts them in third place, just ahead of BMW. Renault is the smallest European OEM. Because the supplier lines are the means of many firms, the sales trends lines show less variability over the 10 year period. Profitability in the European supply chain, measured by EBIT/sales is shown in figure 5b. Regardless of the size disparity, the EBIT profit margins converge and in fact we see that the OEM profits often tend to be lower than those of suppliers. We see that BMW's tier 2 suppliers are among the most profitable, and we note a sharp decline in profitability for Renault in 2020 when they experienced a loss. In Figure 5c, we see the 10 year trend in ESG scores for the European firms. Most scores are between .5 and 1.0. The OEM ESG scores are generally higher than the mean ESG scores of their suppliers, with the exception of Volkswagen, which shows a great deal of volatility and a sharp drop in 2019 and 2020. Tier 1 supplier mean ESG scores are generally in the middle, with the tier 2 supplier mean ESG scores mostly lower. However, Renault and Volkswagen tier 1 supplier ESG means were lowest between 2013 and 2018 but have since improved. Figure 5d shows the Environmental scores for the European supply chain. The OEM's environmental scores are higher than their suppliers, although the gap between
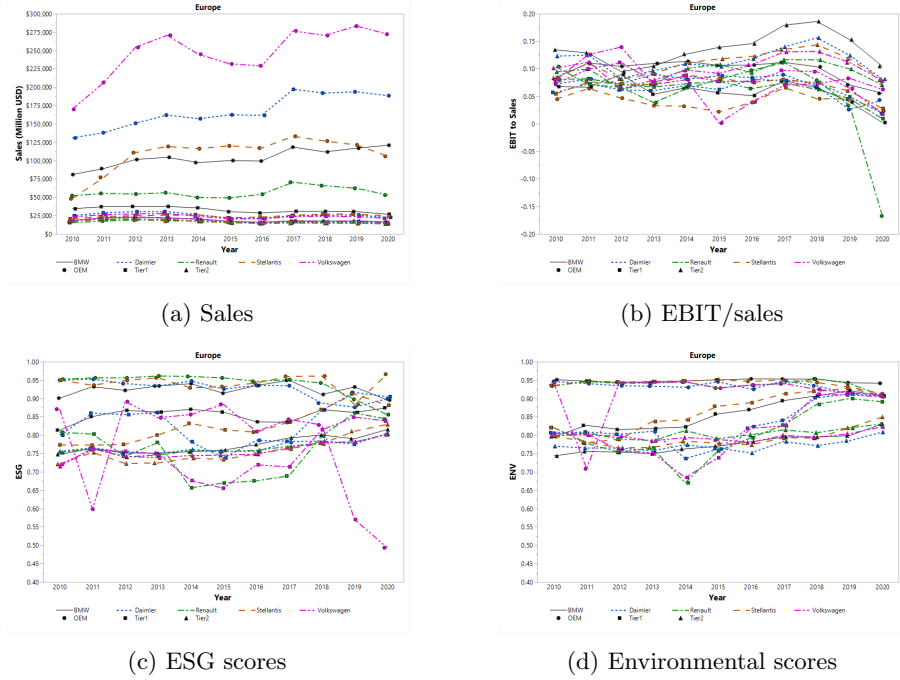
(a) Sales

(b) EBIT/sales

(c) ESG scores

(d) Environmental scores

Fig. 5: Trends of key variables of European OEMs and their tier 1 and tier 2 suppliers.

environmental scores of OEM and supplier groups seems to be narrowing over time.

Figure 6 addresses the 10 year trends in the Asian automotive industry. Figure 6a shows that Toyota has over twice the sales volumes of other Asian OEMs. Honda is the second largest and by 2020, Nissan and Hyundai sales volumes are similar in size. Honda's tier 1 supplier mean sales volume are the next largest, with other supplier group means appearing relatively stable. Figure 6b shows the profitability within the Asian value chain. Tier 1 and tier 2 suppliers for Honda and Hyundai seem to be among the most profitable. Most firms' profits dropped in 2020, and Nissan suffered a loss in 2020. Asian firm ESG scores are shown in Figure 6c. Toyota tier 1 supplier ESG scores are significantly lower than all other firms until 2018 and are now comparable to other firms. However, Toyota ESG scores dropped sharply in 2019 and 2020. Nissan's scores also dropped in 2019 recovering somewhat in 2020. Similarly Hyundai's ESG scores dropped significantly from 2017 to 2019 recovering somewhat in 2020. While there seems to be an improving trend and convergence in supplier ESG scores by 2020, it is hard to perceive much correlation within OEM supply chain trends based on the graphs. Figure 6d shows environmental scores, and we see most OEM firms in the Asian value chain performing consistently well. Hyundai's tier 1 suppliers started the decade significantly lower but improved
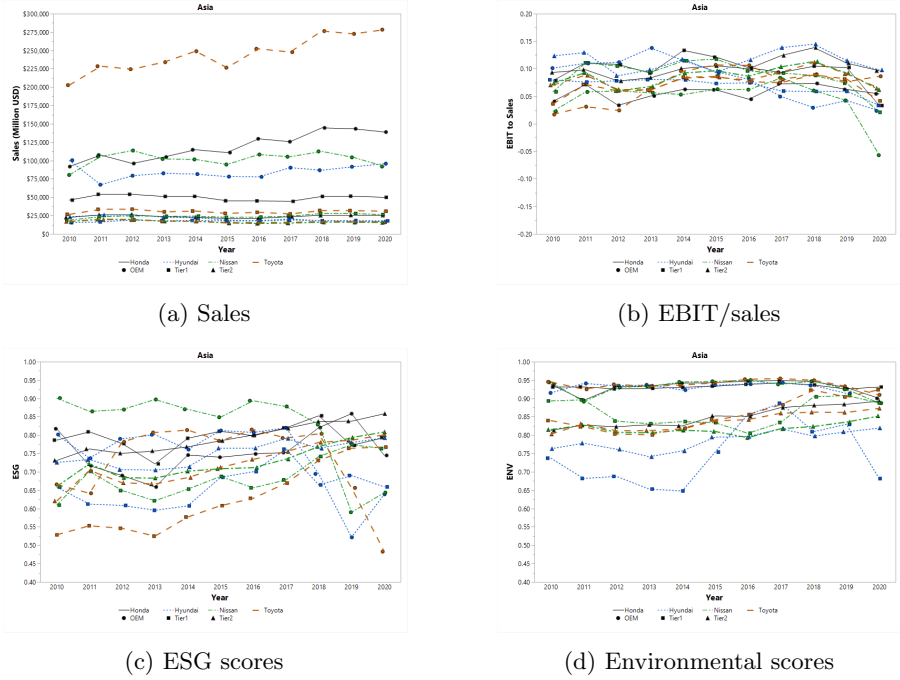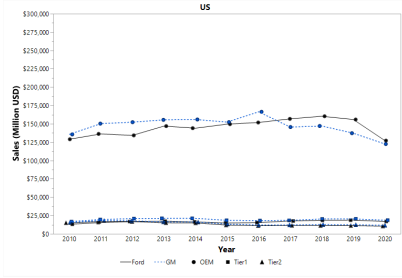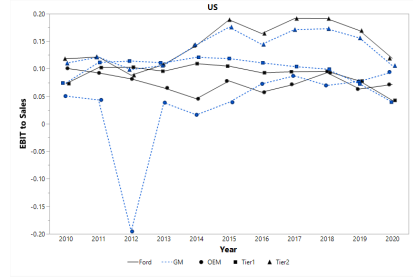
(a) Sales

(b) EBIT/sales

(c) ESG scores

(d) Environmental scores

Fig. 6: Trends of key variables of Asian OEMs and their tier 1 and tier 2 suppliers.

significantly until 2020 when they dropped below other supplier groups. With that exception, we see convergence in environmental scores by 2020.

Figure 7a shows the 10 year sales trends for the US OEM's value chains. Ford's sales exceeded GM's for the first time in 2017. All supplier means are of similar size with little difference between tier 1 and tier 2 suppliers for either supply chain. Figure 7b shows profitability for the US supply chain. GM suffered a sharp drop in profits in 2012 but recovered in 2013. On average, the tier 2 suppliers are the most profitable especially after 2014. By 2020 we see some convergence in EBIT to sales for firms in the value chains with suppliers profits declining while OEM profits improved. As shown in Figure 7c, Ford's ESG scores were high until 2018 when they declined. Ford's tier 1 ESG scores have improved steadily since 2015. GM's ESG scores finished highest after much volatility over the period. GM's tier 1 suppliers have generally improved over the period with much convergence overall by 2020. The US supply chain's Environmental scores are shown in Figure 7d. By 2020, both Ford and GM and their tier 1 supplier scores are relatively high with scores of .9. The tier 2 supplier scores are steady in the .75 range.
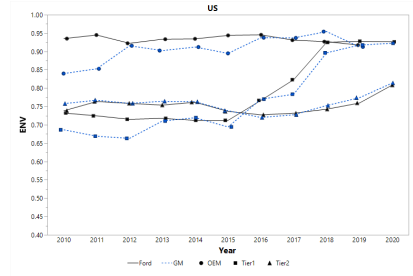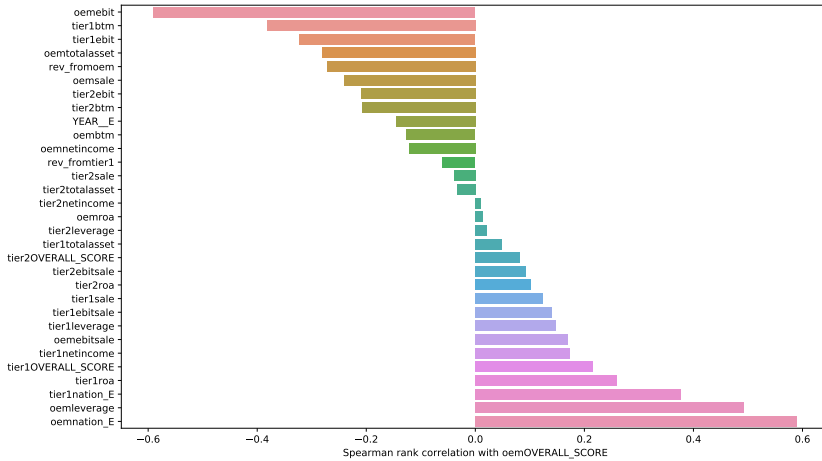
(a) Sales

(b) EBIT/sales
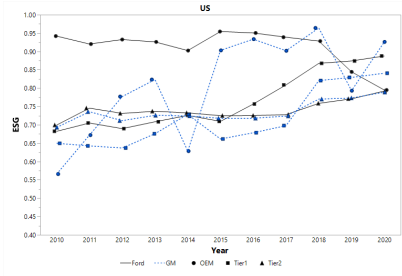
(c) ESG scores

(d) Environmental scores

Fig. 7: Trends of key variables of U.S. OEMs and their tier 1 and tier 2 suppliers.

Fig. 8: Visualization of Spearman rank correlations between OEMs' ESG scores and quantitative and encoded categorical variables.

To measure whether OEM ESG scores are significantly correlated with other variables and the outcomes along the value chain we computed the Spearman correlation coefficients between OEM ESG overall scores with all variables and illustrate them in Figure 8. Most correlations are relatively weak – less than positive 0.20 or negative 0.20. The most significant negative correlations reflect a negative relationship between ESG and firm size. The highest positive correlations are between OEM ESG and OEM nation. The highest OEM ESG scores are in the US and Europe, while the lowest OEM ESG scores for OEMs and suppliers are in Asia. There is a positive but relatively weak relationship between OEM ESG scores and tier 1 ESG scores.

Table 2: Regression results for ESG scores along the supply chain.

Dependent variable	tier 1 ESG scores	tier 2 ESG scores
Data Summary		
Number of observations	538	2,301
Mean of dependent variable	0.705	0.730
Fit Statistics		
R^2	0.248	0.291
Adjusted R^2	0.243	0.289
Root MSE	0.203	0.202
Denominator DF	55	262
Estimated Regression Coefficients		
Intercept	-2.132 (0.000)	-1.700 (0.000)
OEM ESG score	0.511 (0.000)	0.142 (0.130)
tier 1 ESG score	not used	0.261 (0.000)
tier x^1 size	0.100 (0.000)	0.092 (0.000)
tier x leverage	0.151 (0.442)	-0.028 (0.646)
tier x btm	0.002 (0.946)	-0.004 (0.845)
Year fixed effect	Yes	Yes
Nation fixed effect	Yes	Yes

p values are reported in parentheses.

[1]$x = 1$ when the dependent variable is tier 1's ESG scores, $x = 2$ when the dependent variable is tier 2's ESG scores.

We next use regression analysis to further explore research question 1 about the influence of OEM firms on the ESG of their suppliers. Tables 2, 3 and 4 contain a series of regression models in which the tier 1 and tier 2 supplier ESG scores serve as dependent variables. Table 2 column 1 shows that OEM ESG scores are significantly related to the ESG scores of their tier 1 suppliers. In column 2 we examine the impact of both OEM ESG and tier 1 firm ESG on the tier 2 firm ESG scores. We see that while OEM firm ESG has no significant influence on tier 2 ESG scores, the more direct link from the tier 1 supplier customer is very significant. These results are consistent with Villena and Gioia (2018) who found that MNEs have little control over downstream suppliers.

Table 3 provides more insight into the specific OEM firm impact on their tier 1 suppliers by including OEM firms as independent dummy variables (column 1 and 3) and the OEM ESG scores (column 2 and 4) as independent variables. Columns 1 and 2 use tier 1 ESG scores as the dependent variable and Columns

Table 3: Regression results for tier 1 ESG and environmental scores.

Dependent variable OEM variable	ESG scores dummy	ESG scores ESG scores	ENV scores dummy	ENV scores ESG scores
Data Summary				
Number of observations	538	538	522	515
Mean of dependent variable	0.705	0.705	0.828	0.830
Fit Statistics				
R^2	0.439	0.410	0.284	0.268
Adjusted R^2	0.424	0.394	0.264	0.247
Root MSE	0.177	0.182	0.176	0.176
Denominator DF	55	55	55	55
Estimated Regression Coefficients				
Intercept	-1.905	-1.963	-1.283	-1.214
	(0.000)	(0.000)	(0.017)	(0.039)
tier 1 size	0.115	0.114	0.092	0.087
	(0.000)	(0.000)	(0.000)	(0.001)
tier 1 leverage	-0.056	0.092	-0.003	0.077
	(0.613)	(0.641)	(0.980)	(0.658)
tier 1 btm	0.018	0.026	0.024	0.035
	(0.474)	(0.484)	(0.386)	(0.343)
Ford	0.135	0.167	0.040	0.029
	(0.003)	(0.141)	(0.431)	(0.830)
GM	-0.099	-0.060	-0.097	-0.168
	(0.024)	(0.621)	(0.035)	(0.127)
BMW	0.012	0.024	-0.022	-0.004
	(0.820)	(0.855)	(0.646)	(0.967)
Daimler	0.060	0.095	0.003	-0.200
	(0.252)	(0.620)	(0.957)	(0.093)
Renault	-0.0093	0.036	0.002	-0.014
	(0.855)	(0.738)	(0.965)	(0.832)
Stellantis	0.169	0.229	0.105	0.139
	(0.002)	(0.180)	(0.048)	(0.342)
Volkswagen	-0.112	-0.068	-0.091	-0.050
	(0.065)	(0.657)	(0.084)	(0.591)
Nissan	-0.075	-0.244	0.018	0.038
	(0.236)	(0.063)	(0.744)	(0.727)
Honda	-0.001	-0.386	-0.029	-0.258
	(0.993)	(0.104)	(0.651)	(0.059)
Hyundai	-0.136	-0.233	-0.119	-0.162
	(0.004)	(0.043)	(0.030)	(0.060)
Toyota	-0.169	-0.258	-0.052	-0.049
	(0.002)	(0.049)	(0.303)	(0.465)

p values are reported in parentheses.

3 and 4 use the tier 1 Environmental scores as the dependent variable. We also include supplier size, leverage and book to market value as control variables. In all the models we see that supplier firm size is significant and positively related to ESG scores. We see in column 1 that tier 1 supplier ESG scores are positively related to being in Ford' and Stellantis' value chains, while Tier 1 suppliers in GM, Hyundai, and Toyota, and to a less significant degree, Volkswagen have lower ESG scores as indicated by the statistically significant negative coefficient. In column 2 we test whether the OEM ESG scores are related to their tier 1 supplier ESG scores. The significance levels are lower, with only Toyota and Hyundai being negatively related at the .05 level and Nissan at the .10 level. In Columns 3 and 4 the dependent variable is the Tier 1 supplier Environmental score. Using OEM dummy variables we find that a negative

affect for tier 1 supplier Environmental scores for Hyundai followed by GM and then Volkswagen. Only Stellantis suppliers seem to have higher Environmental scores. Using the OEM Environmental scores as the independent variable, we find negative effects for Honda, then Hyundai and Daimler.

Table 4: Regression results for tier 2 ESG and environmental scores.

Dependent variable OEM variable	ESG scores dummy	ESG scores ESG scores	ENV scores dummy	ENV scores ESG scores
Data Summary				
Number of observations	2,301	2,301	2,231	2,215
Mean of dependent variable	0.730	0.730	0.774	0.775
Fit Statistics				
R^2	0.296	0.301	0.352	0.340
Adjusted R^2	0.291	0.296	0.348	0.336
Root MSE	0.201	0.201	0.200	0.202
Denominator DF	262	262	262	262
Estimated Regression Coefficients				
Intercept	-1.381	-1.293	-1.496	-1.466
	(0.000)	(0.000)	(0.000)	(0.000)
tier 2 size	0.090	0.094	0.095	0.098
	(0.000)	(0.000)	(0.000)	(0.000)
tier 2 leverage	-0.043	-0.065	0.014	0.003
	(0.467)	(0.281)	(0.824)	(0.959)
tier 2 btm	-0.005	-0.009	0.028	0.025
	(0.789)	(0.667)	(0.008)	(0.026)
Ford	0.033	-0.124	0.004	-0.112
	(0.237)	(0.218)	(0.903)	(0.317)
GM	-0.002	-0.070	-0.042	-0.202
	(0.922)	(0.394)	(0.183)	(0.021)
BMW	0.064	-0.050	0.074	-0.043
	(0.005)	(0.474)	(0.074)	(0.548)
Daimler	0.020	-0.087	-0.035	-0.165
	(0.493)	(0.450)	(0.266)	(0.068)
Renault	0.034	-0.083	0.060	-0.020
	(0.120)	(0.245)	(0.044)	(0.809)
Stellantis	0.035	0.106	0.027	0.114
	(0.218)	(0.335)	(0.448)	(0.458)
Volkswagen	-0.013	-0.188	-0.003	-0.025
	(0.640)	(0.089)	(0.912)	(0.744)
Nissan	-0.060	-0.489	0.001	0.027
	(0.092)	(0.003)	(0.986)	(0.835)
Honda	0.035	-0.071	0.019	0.027
	(0.260)	(0.602)	(0.563)	(0.793)
Hyundai	-0.006	-0.251	-0.024	-0.119
	(0.808)	(0.002)	(0.317)	(0.028)
Toyota	0.006	-0.204	0.099	0.042
	(0.816)	(0.014)	(0.000)	(0.414)

p values are reported in parentheses.

We also computed the economic significance of the results. OEM ESG scores range from an average of .76 in Asia to .89 in the EU and have a standard deviation of .11. The average tier 1 ESG firm score is .705. We computed that if the OEM ESG score increased by one standard deviation, the average magnitude change in the tier 1 ESG score would be .056 which is about 8 percent of the average. It is difficult to determine, but we do not believe that

most users of ESG data would consider these impacts significant. The lack of significant positive affects leads us to conclude that most OEMs have a very limited meaningful impact on the ESG and environmental outcomes of their tier 1 suppliers. While the overall models were significant, it is hard to concluded that OEMs are able to positively influence the ESG practices of their tier 1 suppliers.

Table 4 explores whether OEMs influence the ESG and Environmental practices of their tier 2 suppliers. For the tier 2 firms, book to market becomes a significant control variable along with size. Column 1 shows that ESG scores of BMW tier 2 suppliers are statistically higher while Nissan's tier 2 suppliers are lower, though with weaker statistical significance. Column 2 shows that tier 2 supplier ESG scores for Hyundai, Nissan and Toyota, and to a lesser extent Volkswagen, are negatively related to the OEM ESG score. There are no positive relationships, indicating that an improvement in OEM firm ESG scores does not seem to trickle down positively through the supply chain. Column 3 and 4 address the tier 2 Environmental scores. In column 3, we see that tier 2 environmental scores for Toyota are significantly higher than the mean, and to a lesser extent Renault and BMW. Using OEM Environmental scores in column 4, we find only negative relationships for GM, Hyundai and Daimler. We also computed models combining the tier 1 and tier 2 suppliers into one data set and found similar findings (not shown). While the supplier ESG scores may differ between the OEM value chains, the supplier ESG scores are not positively correlated with the ESG scores of the OEMs. Therefore we cannot conclude that OEMs ESG practices are significantly influencing the ESG practices of their suppliers. For the most part we conclude that OEM firm ESG scores have little meaningful relationship to their tier 1 and tier 2 suppliers ESG scores.

Table 5: Summary statistics of variables related to stakeholders.

Variable	Mean	Std Dev	25th	Median	75th
OVERALL_SCORE	0.79	0.18	0.74	0.84	0.92
ENV_SCORE	0.86	0.14	0.86	0.92	0.94
SOC_SCORE	0.81	0.18	0.76	0.87	0.93
GOV_SCORE	0.49	0.34	0.15	0.45	0.85
Emerging	0.18	0.39	0	0	0
lnCO2emission	14.03	2.07	12.82	13.95	15.27
renewableenergyuse	0.72	0.45	0	1	1
productrecall	0.10	0.30	0	0	0
policycustomerhealth	0.55	0.50	0	1	1
avoidchildlabor	0.51	0.50	0	1	1
corporaterespaward	0.65	0.48	0	1	1
endhumanrightsupplier	0.32	0.47	0	0	1
flexibleworkingscheme	0.54	0.50	0	1	1
partnerwithNGO	0.70	0.46	0	1	1
strike	Strikes	0.28	0	0	0
Greenfund	0.15	0.36	0	0	0
AIAG	0.20	0.40	0	0	0
size	23.50	1.31	22.56	23.43	24.40
leverage	0.56	0.16	0.44	0.55	0.68
btm	0.77	0.52	0.40	0.67	1.00

All variables have 1,991 samples.

4.2 Stakeholder impacts on ESG

The second research question explores how stakeholders influence ESG. Table 5 contains the descriptive statistics for our entire sample from the automotive global supply chain consisting of 1991 firm years. Refinitive ESG scores are shown for each category – overall, environmental, social, and governance. Other variables include physical environmental measures which are often of most interest to regulators and environmentally oriented stakeholders (CO_2, renewable energy). Stakeholder variables of interest to general community stakeholders are product recalls, human rights policies and breaches, corporate responsibility awards, and environmental partnerships. Employee stakeholders are represented by flexible working schemes and strikes. Investors are represented by inclusion in a green fund, while industry stakeholders are represented by membership in the Auto Industry Action Group (AIAG). We also separate the firms into those from emerging markets versus developed markets using a dummy variable.

Table 6: Regression results for impacts of stakeholders on ESG scores.

Dependent variable	Overall	Environmental	Social	Governance
Data Summary				
Number of observations	1991	1991	1991	1991
Mean of dependent variable	0.791	0.865	0.806	0.492
Fit Statistics				
R^2	0.359	0.304	0.356	0.427
Adjusted R^2	0.354	0.299	0.351	0.422
Root MSE	0.145	0.120	0.149	0.258
Denominator DF	251	251	251	251
Estimated Regression Coefficients				
Intercept	0.204 (0.208)	0.409 (0.003)	0.140 (0.387)	0.338 (0.351)
Emerging	-0.053 (0.006)	-0.010 (0.599)	0.007 (0.723)	-0.213 (0.000)
lnCO2emission	0.003 (0.560)	-0.001 (0.877)	0.001 (0.737)	-0.003 (0.826)
renewableenergyuse	0.067 (0.000)	0.075 (0.000)	0.070 (0.000)	0.013 (0.655)
productrecall	-0.042 (0.014)	-0.008 (0.561)	-0.060 (0.001)	-0.054 (0.262)
policycustomerhealth	0.023 (0.124)	0.038 (0.001)	0.061 (0.000)	-0.081 (0.009)
avoidchildlabor	0.068 (0.000)	0.017 (0.080)	0.063 (0.000)	0.073 (0.002)
corporaterespaward	0.052 (0.000)	0.050 (0.000)	0.051 (0.000)	0.044 (0.082)
endhumanrightsupplier	0.056 (0.000)	0.005 (0.583)	0.036 (0.000)	0.175 (0.000)
flexibleworkingscheme	0.008 (0.566)	0.039 (0.000)	0.058 (0.000)	-0.132 (0.000)
partnerwithNGO	0.052 (0.002)	0.034 (0.006)	0.060 (0.001)	0.074 (0.009)
strike	0.003 (0.804)	-0.035 (0.007)	-0.049 (0.000)	0.117 (0.001)
Greenfund	0.053 (0.001)	-0.007 (0.678)	-0.003 (0.856)	0.245 (0.000)
AIAG	-0.006 (0.664)	0.022 (0.059)	-0.010 (0.486)	-0.045 (0.198)
size	0.018 (0.038)	0.013 (0.069)	0.019 (0.028)	0.004 (0.819)
leverage	-0.037 (0.418)	-0.015 (0.690)	-0.026 (0.572)	0.177 (0.058)
btm	-0.044 (0.001)	0.009 (0.416)	-0.006 (0.618)	-0.100 (0.001)

p values are reported in parentheses.

Table 6 contains regression models examining the influence of each stakeholder variable on the ESG overall and component scores of the firms. With regard to the overall ESG score we see the emerging market firms have significantly lower ESG scores. The most significant positive stakeholder factors are use of renewable energy, avoiding child labor, corporate responsibility awards,

favorable human rights policies, and partnering with NGOs. Investor influence through greenfund membership is also a significant factor in ESG scores, while customer influence from product recalls negative impacts ESG scores. We found little influence from employee related variables on the overall ESG scores.

Examining the models for the component E, S, and G measures, we see that the employee related variables of flexible work schemes and strikes become significant for Environmental and Social components, and surprisingly is that the positive or negative signs for these variables changes but remains significant for the governance component scores. Being in an emerging market (negative) and being in a green fund (positive) are very significant for the governance scores but not for the environmental or social scores. Conversely, renewable energy is a significant factor in environmental and social scores but not governance. Product recalls impact social scores but not environment or governance. AIAG membership is positive and significant only for the environment scores. Human rights and avoiding child labor seem to be significant for all score components.

Table 7 details the impact of the stakeholder variables on ROA, EBIT margin, and Tobin's Q. Few strong significant variables are shown between the stakeholder variables and accounting profit measures of ROA and EBIT. AIAG membership is negatively related to EBIT while being in a green fund is positive. The significance of the stakeholder variables with Tobin's Q is more significant,m as measured by the R2 of this model, indicating their greater relationship to stock prices versus accounting profits. Interestingly, product recalls, CO2 emissions, AIAG membership, and being in an emerging market are strongly negatively related to Tobin's Q. Being in a green fund is strongly positive for Tobin's Q.

4.3 GVCs, stakeholders, ESG and profitability

The last research question addresses how Stakeholders, including the supplier-customer relationship ESG, affects firm profitability.

Table 8 contains regression models for tier 1 supplier firm profitability. We use three measures of profitability– ROA, EBIT margin, and Tobin's Q. Independent variables for each model include control variables for size, leverage and book to market (or ROA for Tobin's Q). Independent variables of interest are the tier 1 firm's own ESG score and the ESG scores of their OEM customers. The table shows that firms with more leverage and higher book to market, have lower ROA and EBIT margin. The firm's own ESG score is not significantly related to any profit measures. OEM ESG scores are weakly significant to ROA but significantly and positively related to Tobin's Q.

Table 9 contains regression models for tier 2 supplier firm profitability. Independent variables include the tier 2 firm's ESG score, their tier 1 customer's ESG score and the OEM lead firm ESG score. The ROA of tier 2 suppliers is significantly related to their own ESG score and to the OEM ESG score. The tier 2 firm EBIT margin is also significantly related to the OEM firm ESG score, but not the tier 1 customer. However, for tier 2 firm Tobin's Q, the tier 1 customer ESG and OEM firm ESG are both significantly positively related. We computed the economic significance of these results and found that a one

Table 7: Regression results for impacts of stakeholders on profitability.

Dependent variable	ROA	EBIT/Sale	Tobin's Q
Data Summary			
Number of observations	1991	1991	1991
Mean of dependent variable	0.043	0.095	1.428
Fit Statistics			
R^2	0.251	0.195	0.344
Adjusted R^2	0.245	0.188	0.339
Root MSE	0.055	0.122	0.696
Denominator DF	251	251	251
Estimated Regression Coefficients			
Intercept	0.025 (0.610)	-0.269 (0.127)	2.778 (0.000)
Emerging	0.011 (0.033)	0.014 (0.469)	-0.162 (0.025)
lnCO2emission	-0.001 (0.223)	-0.012 (0.264)	-0.109 (0.000)
renewableenergyuse	-0.004 (0.283)	0.005 (0.692)	0.090 (0.128)
productrecall	0.010 (0.116)	-0.029 (0.097)	-0.166 (0.015)
policycustomerhealth	0.007 (0.100)	-0.026 (0.076)	0.025 (0.687)
avoidchildlabor	0.003 (0.455)	-0.009 (0.349)	0.077 (0.147)
corporaterespaward	0.003 (0.456)	-0.011 (0.367)	0.053 (0.267)
endhumanrightsupplier	0.002 (0.646)	-0.005 (0.615)	0.062 (0.423)
flexibleworkingscheme	-0.006 (0.145)	0.012 (0.403)	-0.047 (0.456)
partnerwithNGO	-0.008 (0.082)	0.008 (0.671)	0.000 (0.994)
strike	-0.003 (0.513)	0.006 (0.670)	-0.017 (0.796)
Greenfund	0.014 (0.052)	0.032 (0.051)	0.656 (0.000)
AIAG	-0.002 (0.652)	-0.024 (0.006)	-0.121 (0.090)
size	0.006 (0.011)	0.030 (0.009)	-0.014 (0.665)
leverage	-0.141 (0.000)	-0.196 (0.000)	0.245 (0.163)
btm	-0.043 (0.000)	-0.072 (0.000)	not used
ROA	not used	not used	4.409 (0.000)

p values are reported in parentheses.

Table 8: Regression results for tier 1 profitability.

Dependent variable	Tier 1 ROA	Tier 1 EBIT/Sale	Tier 1 Tobin's Q
Data Summary			
Number of observations	538	538	538
Mean of dependent variable	0.046	0.066	1.339
Fit Statistics			
R^2	0.264	0.422	0.165
Adjusted R^2	0.257	0.416	0.159
Root MSE	0.040	0.049	0.460
Denominator DF	55	55	55
Estimated Regression Coefficients			
Intercept	0.180 (0.101)	-0.155 (0.327)	0.896 (0.382)
tier 1 ESG score	0.010 (0.432)	-0.050 (0.165)	-0.325 (0.220)
OEM ESG score	0.044 (0.068)	0.022 (0.395)	0.955 (0.000)
tier 1 size	-0.004 (0.408)	0.017 (0.043)	-0.026 (0.577)
tier 1 leverage	-0.095 (0.000)	-0.209 (0.001)	0.440 (0.292)
tier 1 btm	-0.032 (0.006)	-0.060 (0.000)	not used
tier 1 ROA	not used	not used	5.693 (0.000)
Year fixed effect	Yes	Yes	Yes
Nation fixed effect	Yes	Yes	Yes

p values are reported in parentheses.

standard deviation increase in tier 1 supplier ESG would result in a 9 percent increase in Tobin's Q for the tier 2 supplier. While these results are difficult to interpret, it may be that these smaller tier firm stock prices benefit from being associated with a more reputable customer base and supply chain. We also know that on average, OEMs in the EU and US have higher ESG scores than Asian firms, so tier 2 suppliers in those chains might have higher market values and accounting profits which may explain these results.

Table 9: Regression results for tier 2 profitability.

Dependent variable	Tier 2 ROA	Tier 2 EBIT/Sale	Tier 2 Tobin's Q
Data Summary			
Number of observations	2,301	2,301	2,301
Mean of dependent variable	0.041	0.109	1.548
Fit Statistics			
R^2	0.133	0.091	0.183
Adjusted R^2	0.131	0.088	0.181
Root MSE	0.064	0.166	0.917
Denominator DF	262	262	262
Estimated Regression Coefficients			
Intercept	0.055 (0.253)	-0.111 (0.407)	3.231 (0.000)
tier 2 ESG score	0.029 (0.008)	-0.019 (0.505)	0.206 (0.276)
tier 1 ESG score	0.009 (0.402)	0.047 (0.200)	0.759 (0.000)
OEM ESG score	0.037 (0.054)	0.161 (0.004)	0.698 (0.008)
tier 2 size	0.001 (0.826)	0.010 (0.093)	-0.139 (0.000)
tier 2 leverage	-0.135 (0.000)	-0.269 (0.000)	0.062 (0.779)
tier 2 btm	-0.016 (0.126)	-0.043 (0.006)	not used
tier 2 ROA	not used	not used	4.824 (0.000)
Year fixed effect	Yes	Yes	Yes
Nation fixed effect	Yes	Yes	Yes

p values are reported in parentheses.

5 Discussion

Our results show that there are significant relationships between OEM firm ESG practices and their suppliers OEM practices and profits. However the economic magnitude of these relationships is not great. Contrary to some conventional wisdom while OEM firms are larger than their suppliers, they are not necessarily more profitable. In fact in some supply chains the tier 2 suppliers are the most profitable. To meet today's challenges to achieve greater ESG as well as profitability, firms may need to modify their business models by engaging differently with customers, suppliers, and other stakeholders, developing new sustainable products and services, training and realigning their workforce, accelerating their digital capabilities, investing in sustainable technology and processes, and optimizing their asset base. The business challenge is to better understand and enhance sustainable and responsible manufacturing while supporting the ability of firms to remain globally competitive on the dimensions of cost, quality and delivery that have been cornerstones of manufacturing for many years. Achieving this goal will provide firms with the necessary capital

to innovate through research and development and upgrade and transition their physical resources to compete in the evolving automotive industry. It will also provide insight on regulatory policy and workforce needs. Developing new capabilities in ESG reporting will enable established companies and entrepreneurs to operate profitably while reducing the impact of manufacturing on the environment and addressing global challenges such as climate change, improving the health and quality of life of the workforce, and meeting societal expectations of social justice.

Given their societal focus on the stakeholder model of corporate governance, the EU has the longest experience in ESG reporting and many large European firms use Integrated Reporting and Global Reporting Initiative (GRI) standards across firms and industries. In fact, the GRI is the most commonly used ESG reporting regime for public firms (KPMG IMPACT, 2020), and we found that most of the firms in our dataset use GRI reporting. More recently the EU EFRAG has launched an initiative to strengthen regulations and standardize reporting to support the European Green Deal. While these regulations are not yet in effect, we expect these and other efforts to improve and standardize ESG reporting may greatly increase the usefulness of this information. The formidable size and influence of US capital markets led by institutional investors is driving the growth of ESG reporting in the US. The Sustainable Accounting Standards Board (SASB) has developed industry specific standards to complement the more generic GRI standards. In addition the SASB is working to develop an XBRL like taxonomy for their reporting system to allow it to be integrated into SEC reporting mechanisms. While the SEC has been reluctant to prescribe reporting standards for factors they deem not materials to the financial statements, the large capital flows into green funds and ETFs is putting more pressure on the SEC to provide guidance to protect investors to whom these funds are marketed. Activist investors are frequently demanding more explicit environmental policies and ESG reporting by their portfolio firms, and trillions in sustainable investment funds are available to incentivize firms to upgrade their ESG performance and reporting (*Sustainable Investment Funds Near \$2 Trillion in Assets*, 2021).

Decision making and operations management in a competitive manufacturing environment is complex. Firms strive to maximize their profits and revenues, but many factors may contribute to business success. While poor operating performance may result from new channels of competition within an industry or from commodity and supply price shocks, such threats may be overcome by appealing to a market that is sensitive to factors other than cost. Regulatory and societal expectations relating to environmental responsibility and equitable treatment of a diverse workforce are increasingly becoming critical to competitive advantage. As ESG reporting becomes more ubiquitous and social media has a pervasive impact on firms' reputation risk, manufacturers will need a more comprehensive understanding of their markets' ESG expectations and processes to efficiently and transparently meet those expectations. Better ESG reporting processes will also improve the firm's risk management and

help avoid unexpected liabilities arising from litigation or environmental events, leading to lower cost of capital. Intelligent enterprise risk management (ERM) planning can identify many potential business risks allowing foresighted business decisions to avoid or mitigate many risks that could threaten the entity's competitive position.

Rather than lamenting the challenge of environmental regulations, manufacturers are beginning to embrace the opportunity to build their expertise and abilities in ESG to use as a competitive advantage in the marketplace. Similar to the quality movement in the 1980s, firms that embrace a continuous improvement approach to sustainability stand to achieve synergies with cost reduction, differentiation in the market place supporting higher price points, and the ability to attract and retain a higher quality workforce. And as in the management of quality, effective management of sustainability will require careful measurement and monitoring of processes and the involvement of a well trained and engaged workforce. Technological innovations will also become increasingly important as cleaner energy production and recycling and treatment of waste will be imperative. Firms with a record of success in ESG will also have access to the capital they need for research and development and physical expansion. This superior access to capital combined with a well-trained workforce will always be a competitive advantage for manufacturing firms.

Our study contributes to the literature as it differs from existing works in three aspects. Our research analyzes the interrelationships among players along the global supply chain, examining the specific firm relationships rather than generic industry connections. As such it is designed to provide greater insights into how firms are impacted by these economic relationships. Our study also examines how relevant stakeholders may impact firms' ESG reporting and profitability. By addressing stakeholder influences on ESG and profitabilty, we begin to learn more about the potential challenges and tradeoffs that firms face. Finally by focusing on a key global industry that involves aspects of traditional manufacturing and high technology, supply chains in a variety of countries with different cultures and stages of development, we embrace the incredible complexity that international business scholars and practitioners face.

6 Limitations and Directions for further research

Our research has several limitations with regard to data availability. Although we covered a large segment of the automotive industry, the number of firms we included in our supply chains are only a fraction of the industry. Also, we were unable to obtain data on Chinese OEM joint ventures, which are among the largest unit manufacturers. although most of the product is sold within China. Similarly we did not include Indian OEMs or new electric vehicle OEMs. These firms are currently a small fraction of the market but will become more important in the future. The ESG data for this was largely drawn from Refinitive, and many firms are not included in their database. The alternative ESG data from Bloomberg was even more limited. Furthermore the ESG scores for these firms do not seem highly correlated, indicating the possibility for measurement error that could affect our results. In the future we plan to

gather more qualitative data and information through interviews with OEM and tier 1 firm representatives and discussions with consultants with public accounting and other external verification experts to gain greater insights about the relationships between the firms, their stakeholders, and the challenges of ESG reporting.

Appendix A   Definition of Variables

Table A1: Variables, measures, and sources of data.

Variable	Measure	Source
OVERALL_SCORE	ESG overall scores reported by Refinitiv	Refinitiv
ENV_SCORE	Environmental scores reported by Refinitiv	Refinitiv
SOC_SCORE	Social scores reported by Refinitiv	Refinitiv
GOV_SCORE	Corporate governance score reported by Refinitiv	Refinitiv
ROA	Return on assets calculated by net income (item 7220) divided by total assets (item 7230)	Datastream/Worldscope
EBITsale	Earnings before income taxes to sales ratio calculated by earnings before income taxes (item 18191) divided by sales (item 1001)	Datastream/Worldscope
Q	Tobin's q calculated by total assets (item7230) plus market capitalization (item 7210) minus book value of equity (item 7220) divided by total assets (item 7230)	Datastream/Worldscope
Emerging	1 if firms' origins are the emerging economies; 0 otherwise.	United Nations Conference on Trade and Development (UNCTAD)
lnCO2emission	Natural logarithm of CO_2 equivalents emissions (En_En_ER_DP023)	Refinitiv
renewableenergyuse	Does the company make use of renewable energy? (EN_EN_RR_DP046)	Refinitiv
productrecall	Has the company announced a mass recall of products or has completely withdrawn a product due to defects or safety reasons? (So_Cu_PR_DP060)	Refinitiv
policycustomerhealth	Does the company have a policy to protect customer health & safety? (So_Cu_PR_DP012_1)	Refinitiv
avoidchildlabor	Does the company have a policy to avoid the use of child labor? (So_So_HR_DP010_2)	Refinitiv
corporaterespaward	Has the company received an award for its social, ethical, community, or environmental activities or performance? (So_So_Co_DP074)	Refinitiv
endhumanrightsupplier	Does the company report or show to be ready to end a partnership with a sourcing partner if human rights criteria are not met? (So_So_HR_DP029)	Refinitiv
flexibleworkingscheme	Does the company provide flexible working schemes? (SO_WO_DO_DP026)	Refinitiv
partnerwithNGO	Does the company report on partnerships or initiatives with specialized NGOs, industry organizations, governmental or supra-governmental organizations, which are focused on improving environmental issues? (En_En_ER_DP070)	Refinitiv
strike	Has there has been a strike or an industrial dispute that led to lost working days? (So_Wo_EQ_DP037)	Refinitiv
Greenfund	1 if firms are included in one of the top 10 ESG funds; 0 otherwise.	Forbes Advisor
AIAG	1 if firms are the members of Automotive Industry Action Group (AIAG); 0 otherwise.	Automotive Industry Action Group
size	Natural logarithm of total assets (item 7230)	Datastream/Worldscope
leverage	Leverage calculated by total liabilities (item 3351) divided by total assets (item 2999)	Datastream/Worldscope
btm	Book-to-market ratio calculated by book equity (item7220) divided by market capitalization (item 7210)	Datastream/Worldscope

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