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Goldman Sachs

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GS SUSTAIN

A new framework for assessing business resilience, applied to Autos

The role of supply chains in business continuity is a key emerging theme seeing increasing scrutiny and focus by investors, regulators and consumers. Only a portion of a company's climate or geographical exposure is housed in its core operations; the remainder extends across multiple layers of the value chain. The importance of these risks has been thrown into sharp relief by recent business disruptions that impaired companies' ability to get product to market. To plug gaps in a patchy data landscape for measuring supply chain risks, we introduce a new framework for generalists and ESG investors, the **GS SUSTAIN Supply Chain Mosaic**, to assess business resilience. In collaboration with our Macro analysts, our framework blends data on supply chain location and concentration with our GS SUSTAIN proprietary scoring of suppliers' ESG engagement and sovereign ESG risk. Given the sector's complex supply chains and exposure to significant production disruptions over the past two years, we apply our Mosaic first to the Automotive sector, with three case studies (Toyota, Volkswagen and BYD).

Sharmini Chetwode, Ph.D.
+852-2978-1123
sharmini.p.chetwode@gs.com
Goldman Sachs (Asia) L.L.C.

Keebum Kim
+852-2978-6686
keebum.kim@gs.com
Goldman Sachs (Asia) L.L.C.

Emma Jones
+61(2)9320-1041
emma.jones@gs.com
Goldman Sachs Australia Pty Ltd

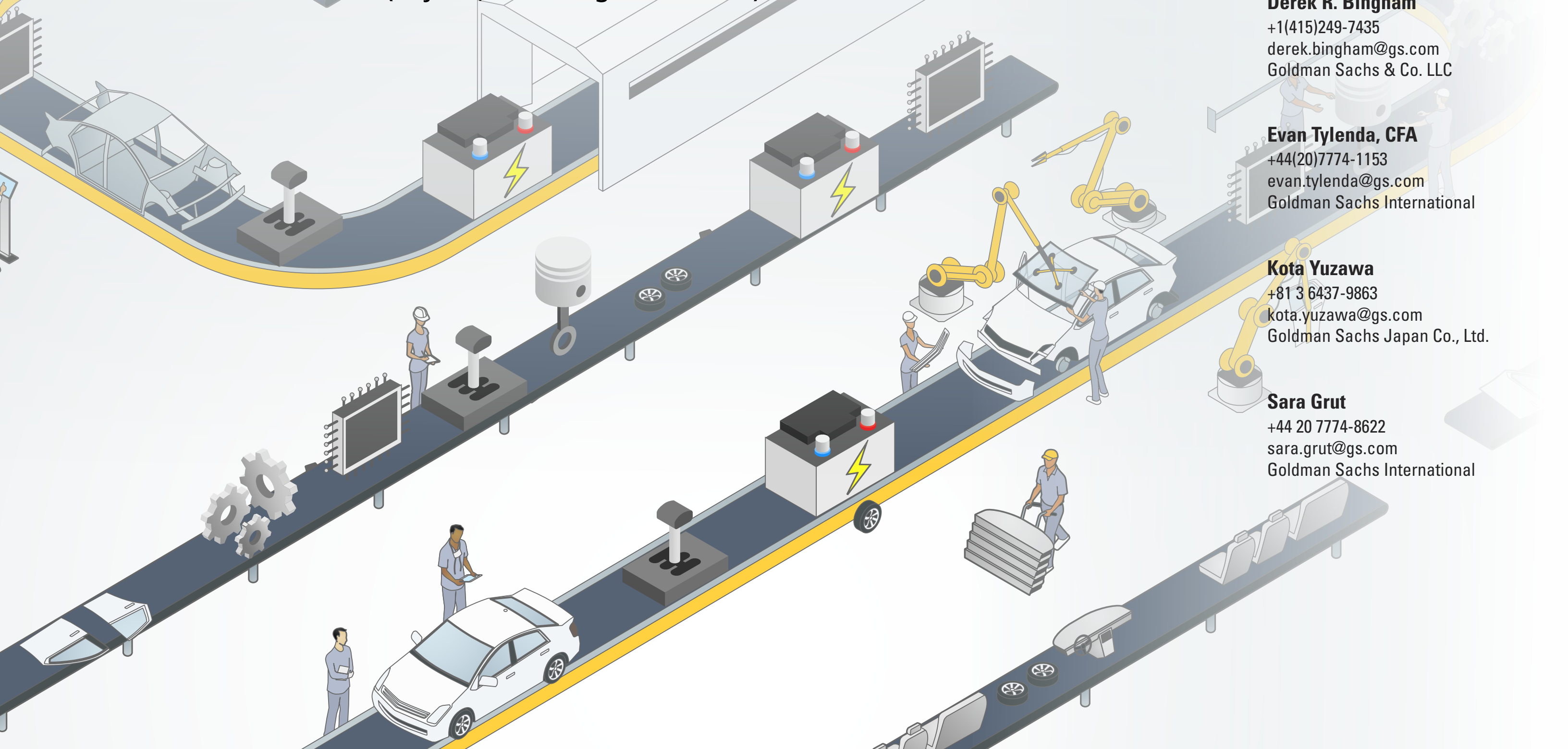
Brian Singer, CFA
+1(212)902-8259
brian.singer@gs.com
Goldman Sachs & Co. LLC

Derek R. Bingham
+1(415)249-7435
derek.bingham@gs.com
Goldman Sachs & Co. LLC

Evan Tylenda, CFA
+44(20)7774-1153
evan.tylenda@gs.com
Goldman Sachs International

Kota Yuzawa
+81 3 6437-9863
kota.yuzawa@gs.com
Goldman Sachs Japan Co., Ltd.

Sara Grut
+44 20 7774-8622
sara.grut@gs.com
Goldman Sachs International



The Goldman Sachs Group, Inc.

Contributing Authors

Sharmini Chetwode, Ph.D.
+852-2978-1123
sharmini.p.chetwode@gs.com
Goldman Sachs (Asia) L.L.C.

Keebum Kim
+852-2978-6686
keebum.kim@gs.com
Goldman Sachs (Asia) L.L.C.

Emma Jones
+61(2)9320-1041
emma.jones@gs.com
Goldman Sachs Australia Pty Ltd

Brian Singer, CFA
+1(212)902-8259
brian.singer@gs.com
Goldman Sachs & Co. LLC

Derek R. Bingham
+1(415)249-7435
derek.bingham@gs.com
Goldman Sachs & Co. LLC

Evan Tylenda, CFA
+44(20)7774-1153
evan.tylenda@gs.com
Goldman Sachs International

Sara Grut
+44(20)7774-8622
sara.grut@gs.com
Goldman Sachs International

Teresa Alves
+44(20)7051-7566
teresa.alves@gs.com
Goldman Sachs International

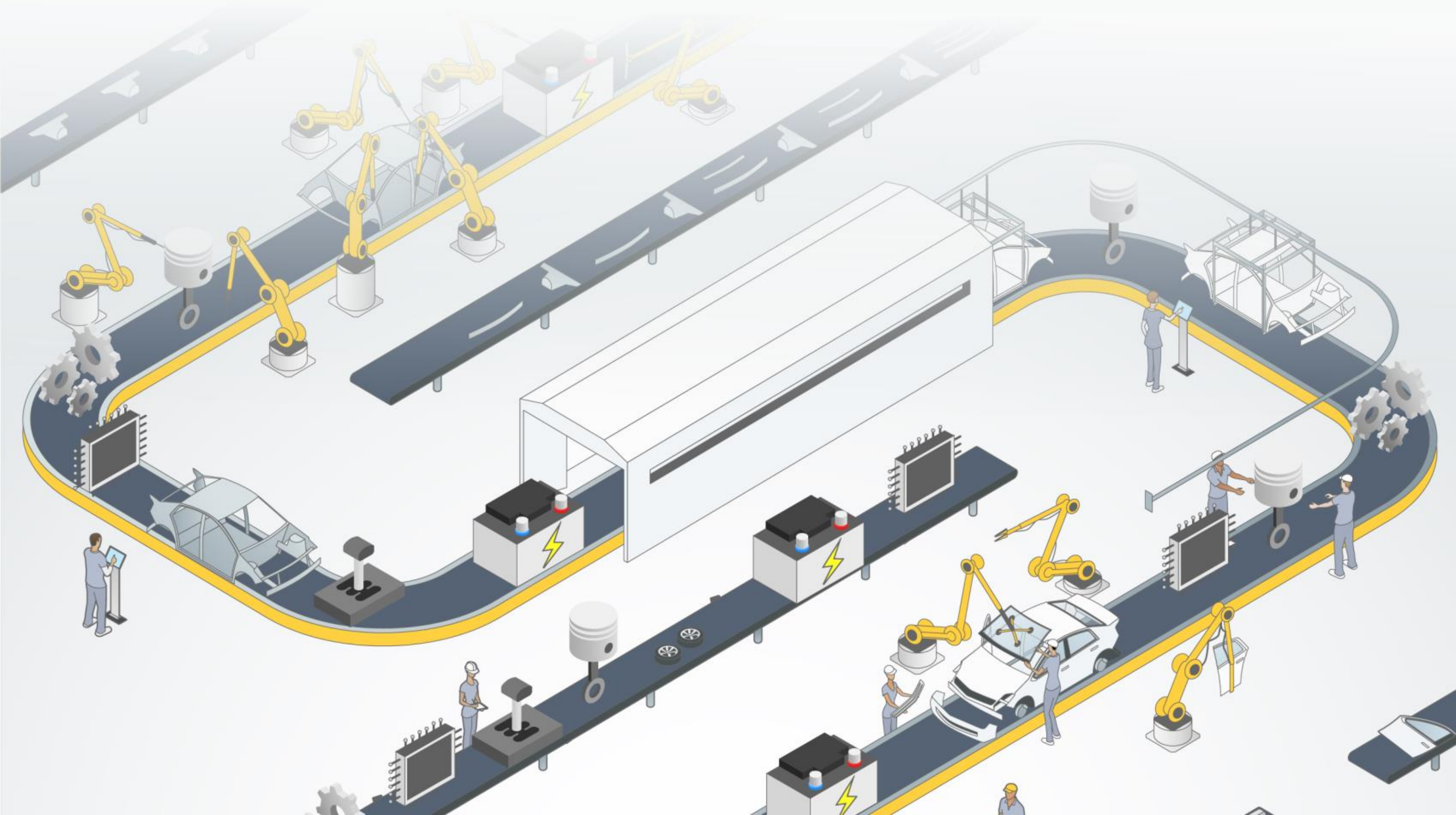
Kamakshya Trivedi
+44(20)7051-4005
kamakshya.trivedi@gs.com
Goldman Sachs International

Kota Yuzawa
+81(3)6437-9863
kota.yuzawa@gs.com
Goldman Sachs Japan Co., Ltd.

Fei Fang
+852-2978-1383
fei.fang@gs.com
Goldman Sachs (Asia) L.L.C.

George Galliers
+44(20)7552-5784
george.galliers@gs.com
Goldman Sachs International

Mark Delaney, CFA
+1(212)357-0535
mark.delaney@gs.com
Goldman Sachs & Co. LLC



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Executive Summary

The importance of supply chains has been thrown into sharp relief for investors given recent business disruptions and their implications for companies' ability to get product to market. At the same time, ESG investors are increasingly focused on supply chains to understand companies' ability to manage climate change, optimise environmental and social outcomes and avoid unpredictable surfacing of abuses. As a result, understanding supply chains in more depth is going to be a prerequisite to assess ongoing business resilience. We introduce the GS SUSTAIN Supply Chain Mosaic to better understand supply chain engagement, geographical exposure and concentration. In this report we examine the Auto sector, blending insights from our Mosaic with the fundamental views of our single stock analysts.

GS SUSTAIN Supply Chain Mosaic: A business resilience overlay for Generalists and ESG specialists

For **Generalist investors**, supply chains are core to business resilience and sustainability driven changes in consumer behavior are creating business opportunity. For **ESG specialists** understanding sustainability of the whole value chain is becoming increasingly important as ESG risks exist throughout it. In this report, we take what we believe investors are looking to understand about the supply chain, and plug gaps in what is a patchy data landscape. We introduce the GS SUSTAIN Supply Chain Mosaic, which uses data on supplier engagement, combined with supply chain location and concentration, expanding on supply chain elements partly covered in our GS SUSTAIN framework. Given its complex supply chains and exposure to significant production disruptions recently, we apply our Mosaic first to the Automotive sector. Our Mosaic aims to provide insight, which, though not definitive, together with fundamental analysis, can provide a sense of risk supply chains pose to a business and represents a foundation for further discussion with company management and engagement with supply chain regulations.

We combine a range of data sources to produce a Mosaic that helps investors address three critical areas of inquiry in collaboration with our Macro analysts and our single stock teams. We analysed ~1,600 Tier 1 suppliers to 63 Automotive Manufacturers, identifying country of domicile and disclosure of 15 supply chain engagement metrics to help investors assess business resilience. The GS SUSTAIN Supply Chain Mosaic dataset for Automobile Manufacturers is available upon request.

1. **How are companies engaging with their suppliers and how are their suppliers managing ESG?** We use a range of supplier related corporate disclosures, and the GS SUSTAIN operational framework within the supply chain, to gain insight into human rights, environmental issues, health and safety and accountability. ESG risks exist throughout the value chain, raising the importance of understanding supplier engagement practices. Our analysis suggests that companies that have higher supply chain ESG disclosures tend to score higher on our Operational E&S framework (which is correlated with higher corporate returns and stock

performance) and have better ESG fund ownership.

2. **Where are the suppliers?** Locations of suppliers can influence resilience to business impacts and geographical ESG exposures (given differences in the rule of law, corruption, prevalence of forced labor). We use **our EM Strategy team's sovereign ESG scores** which combine assessments of Environmental, Social, and Governance risk, to allow us to compare companies on the geographical exposure in their supply chains.
3. **Supply chain concentration.** We measure the number of suppliers and reliance on unique providers to assess business resilience and risk management. We explore the various trade-offs of different supply chain structures and assess performance of three Automotive companies against today's environment of tight component access and physical disruption.

How to use our data: A framework for corporate engagement, regulatory navigation, fundamental overlay

Our Mosaic can be used to supplement information gaps that can exist even with direct corporate engagement. We believe that the assessment of supply chain resilience has yet to be put into a structured framework by corporates or investors due to the complexity of multi-layered supply chains spread across diverse geographies. Our GS SUSTAIN Supply Chain Mosaic provides an **inroad** for investors to analyze **ESG engagement practices, geographical dispersion** and the level of **concentration** in corporate supply chains based on supplier data gathered on a bottom-up basis. Below, we highlight three use cases.

1. **A tool for corporate engagement:** Identify companies showing the most consistent engagement with their supply chains and areas where further verification and engagement are required, and to understand where geographical exposure lies.
2. **Navigate growing regulatory requirements** to understand the supply chain.
3. **A fundamental overlay.** Our information can help pinpoint where there may be backup supply chains for material components and provide a deeper perspective of supply chain complexity and concentration.

Applying our Mosaic to the Automobile sector: Key takeaways

1. Auto companies' engagement with their own suppliers is greater than the level of engagement of their suppliers with Tier 2 providers, however, Automotive companies are still not disclosing 56% of the supply chain metrics that we believe are material.
2. Automobile supply chains are highly concentrated in a few regions reflecting various factors (demand, production incentives and cost), adding different blended geographical risks.
3. OEMs tend to commonly share Auto Parts providers, but have significant diversification in the sourcing of other key components such as Materials, Hardware/Semis, Software and Cap Goods.

Based on this, we and our Auto equity research team believe that partnering our supply chain framework with fundamental analysis of production strategies adds additional context in several areas: Geographical exposure, ESG engagement and flexibility of the supply chain for different components.

Automotive company standouts

In this report, we profile three Auto companies through case studies with our GS analysts. While not all three companies screen well across all pillars of our Supply Chain Mosaic, we blend insights from the Mosaic with the fundamental views of our analysts to identify areas of peer relative risk and opportunity for generalists, and potential areas of further corporate inquiry for ESG investors. **Volkswagen** and **Toyota** stood out on **supplier engagement** and **geographical exposure** on our Mosaic. Below, we summarize additional insights into how Automotive companies are managing supply chain challenges.

- **Toyota: Near-term supply chain uncertainties remain, but one of few automakers capable of creating a vertically integrated model for electric vehicles (EVs).** Toyota stands out in terms of supplier diversification on our Mosaic, with access to one the largest pool of suppliers compared to peers, likely a function of its scale and wide range of product offerings. Our analysts view Toyota as one of the few automakers capable of building a vertically integrated model for EVs (including batteries), and expect it to be a major beneficiary of growth in EV adoption. In the near term, semiconductor shortages, COVID lockdowns may impact production volumes.
- **Volkswagen: Underappreciated transition beneficiary, but expect near-term headwinds in sourcing of raw materials and commodities.** Our analysts expect Volkswagen to benefit from climate transition as it continues to invest more than its global peers in electrification and software, areas which will further differentiate its products. In the near term, supply chain shortages will continue to be a risk factor, but the company has recently increased engagement with Tier 2 and Tier 3 suppliers to explore ways to address the challenges.
- **BYD: Well positioned domestically to mitigate supply chain disruptions through a diversified production base and integrated model.** Our analysts expect near-term supply chain uncertainties to remain for BYD due to local lockdowns. However, they believe BYD stands out domestically as an integrated OEM with the ability to internally manufacture automotive semiconductors, and has seen limited impact in its manufacturing facilities which are spread across multiple regions in China.

We introduce the GS SUSTAIN Supply Chain Mosaic, which measures Supply Chain Engagement, Geographical Exposure and Supply Chain Concentration

Example of the GS SUSTAIN Supply Chain Mosaic

Supply Chain Engagement Pillar assesses the level of ESG engagement that companies have with their supply chain based on disclosures of 15 different supply chain metrics.

Tier 1 Supplier Engagement assesses the companies' own disclosures.

Tier 2 Supplier Engagement looks a layer deeper into disclosure practices of the companies' Tier 1 Suppliers.

Number of Suppliers Mapped	417 listed suppliers
1. Supply Chain Engagement	
Tier 1 Supplier ESG Engagement	93%
Tier 2 Supplier ESG Engagement	42%
2. Supply Chain Geographical Exposure	
Geographical Exposure	63%
3. Supply Chain Concentration	
Total Number of Tier 1 Suppliers	98%
Exposure to Unique Suppliers	56%
Number of Suppliers by GICS 2	
Auto Parts	100%
Capital Goods	97%
Materials	100%
Tech Hardware	99%
Semiconductors	48%
Software	85%
Others	95%

The ***GS SUSTAIN Supply Chain Mosaic*** *maps companies' Tier 1 suppliers as a starting point.*

Supply Chain Geographical Exposure Pillar estimates geographical ESG exposures that companies have through their suppliers. We embed Sovereign ESG scores sourced from our GS EM Strategy team, using 27 macro indicators to score E, S and G exposures by country.

Supply Chain Concentration Pillar provides a lens on how large and unique companies' supply chains are relative to peers.

Note: All figures are percentile ranked against industry peers in the MSCI ACWI. For Supply Chain Engagement, higher percentiles mean better disclosure on supply engagement. For Geographical Exposure, higher percentiles mean better supplier Sovereign ESG scores. For Supply Chain Concentration, higher percentiles mean # of suppliers or proportion of unique suppliers is higher.

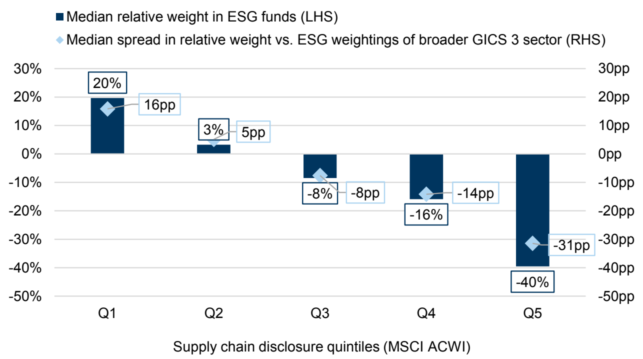
Source: FactSet, Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

The research views in this report are those of the analysts who cover the relevant areas:

- *ESG views are expressed by GS SUSTAIN analysts: Sharmini Chetwode, Keebum Kim, Emma Jones, Brian Singer, Derek Bingham and Evan Tylenda.*
- *Sovereign ESG score related views are those of Global EM Macro and Sovereign Credit analysts: Sara Grut, Teresa Alves and Kamakshya Trivedi.*
- *Equity research views are expressed by Equity Research analysts: Kota Yuzawa, Fei Fang, George Galliers and Mark Delaney.*

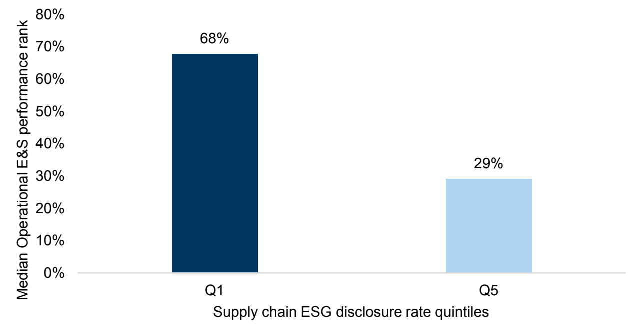
Thesis in charts

Exhibit 1: In the absence of supply chain performance data, investors appear to be rewarding more transparent companies...
Supply chain disclosure quintiles vs. relative weights in ESG funds



Source: Morningstar, Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

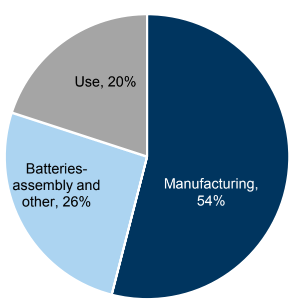
Exhibit 2: ...which in turn tend to deliver better Environmental and Social performance
Supply chain ESG disclosure rates vs. operational E&S scores on the SUSTAIN framework (MSCI ACWI)



Note: Supply chain engagement metrics include 15 different metrics across multiple supply chain ESG topics

Source: Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Exhibit 3: Supply chains are intrinsic to business continuity, and hold the key to decarbonization downstream...
Breakdown of lifecycle emissions of Battery Electric Vehicles (BEVs)



Life-cycle emissions of a BEV is estimated to be **~10 tonnes of GHG (vs. >40 tonnes for ICEs)** assuming 200k km lifetime mileage **charged with low-carbon power sources** (50g CO2/kWh)

Note: We assume 5kWh power consumption per km

Source: IEA, Goldman Sachs Global Investment Research

Exhibit 4: ...so we have developed a framework that allows investors to compare corporate supply chains....
Overview of GS SUSTAIN Supply Chain Mosaic

	Metric	Details
Supply chain risks and engagement	Tier 1 supplier engagement	Supply chain related disclosures of Automobile Manufacturers
	Tier 2 supplier engagement	Supply chain related disclosures of Automobile Manufacturers' Tier 1 suppliers
	Geographical exposure	Sovereign ESG exposure of suppliers
Auxiliary metrics	Number of Tier 1 suppliers	Size of corporate supply chains
	Common vs. unique suppliers	Breakdown of exposure to suppliers that are commonly shared in the industry vs. suppliers that are relatively unique to the company
	Supplier mix by GICS 2	Sectoral breakdown of suppliers (common and unique)
	ESG score of suppliers	Average E&S and Regional Governance score of Tier 1 suppliers

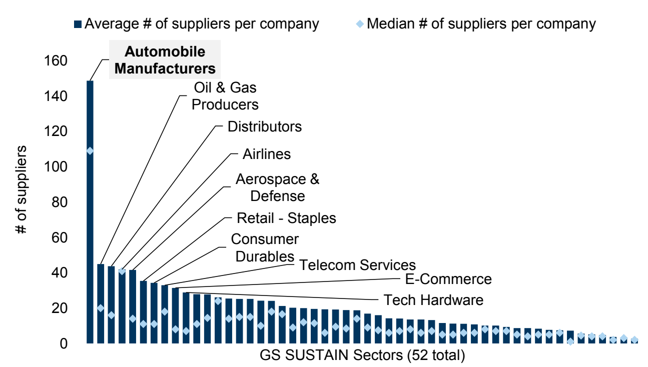
Source: Goldman Sachs Global Investment Research

Exhibit 5: ...for example to compare supply chain concentration and diversification by input category
of Tier 1 suppliers for Automakers, by GICS2

	Lower bound:10th %ile	Median	Upper bound: 90th %ile
# of Auto Parts Suppliers	8	60	169
# of Capital Goods Suppliers	3	19	63
# of Material Suppliers	1	9	31
# of Tech Hardware Suppliers	0	4	16
# of Semiconductor Suppliers	0	1	6
# of Software Suppliers	0	4	29

Source: FactSet, Goldman Sachs Global Investment Research

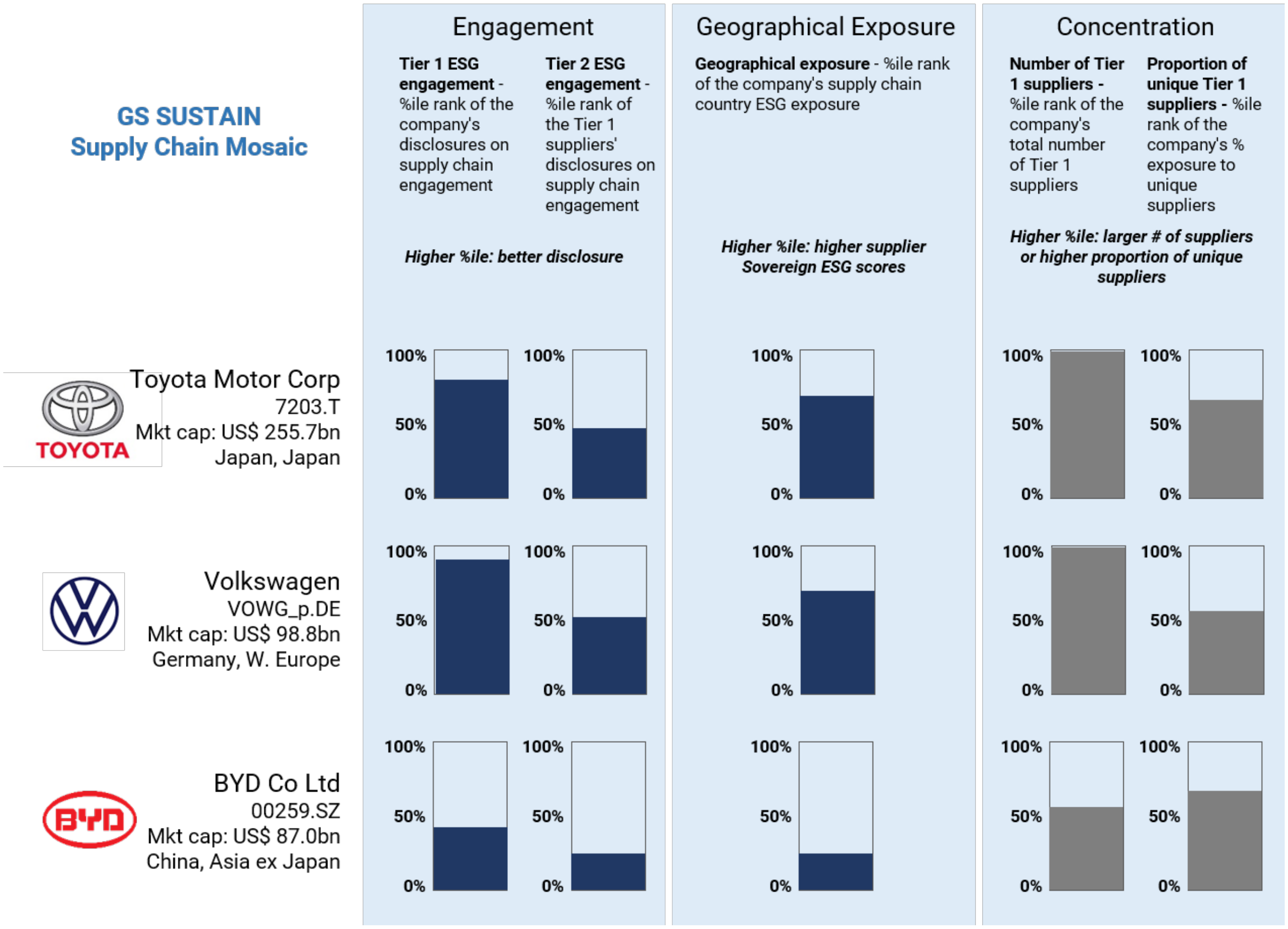
Exhibit 6: The Auto sector has the most complex supply chains and so we applied our Mosaic to it first
Size of corporate supply chains based on Tier 1 supplier mapping data



Note: Universe is MSCI ACWI

Source: FactSet, Goldman Sachs Global Investment Research

Exhibit 7: Volkswagen and Toyota rank Q2 or above on Tier 1 supplier engagement and geographical exposure
Overview of our GS SUSTAIN Supply Chain Mosaic



Supply Chain Concentration is only an Auxiliary metric in our Mosaic, as different supply chain structures need to be considered against the size of the product offering and come with various trade-offs that we discuss further in this report. All %ile metrics are ranked against MSCI ACWI industry peers.

Source: FactSet, Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Supply chains under the microscope

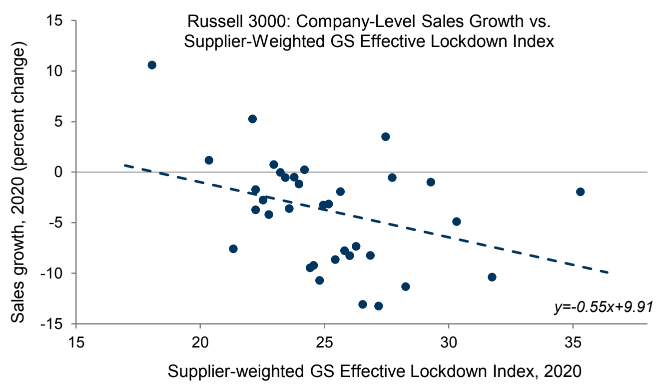
In recent months, it has become increasingly clear that understanding climate and business continuity risk is impossible without knowledge of supply chains. In this report, we piece together disparate sources of information, creating a mosaic that allows us to compare companies on their supplier engagement with ESG, supply chain geographical exposure, and supply chain concentration.

Generalists

Supply chains are core to business resilience. Supply chain location, engagement and concentration information are an increasingly relevant overlay to stock selection for generalists. Understanding supply chain resilience and the way companies are managing suppliers relative to their peers helps size risks of business disruption.

Sustainability driven changes in consumer behavior are creating business opportunity. Shifts in consumer attitudes towards responsible consumption are rising in many countries. We believe that over time, companies that can demonstrate greater ESG transparency and traceability will be better positioned to benefit from secular shifts in consumer behavior.

Exhibit 8: Investors are confronting production disruptions driven by supply chain weaknesses
Sales growth vs. supplier weighted GS Effective Lockdown Index



Source: FactSet, Goldman Sachs Global Economics Research

ESG specialists

Understanding sustainability of the whole value chain. Growing stakeholder pressure from consumers, asset owners, and regulators for investors to integrate ESG into investment processes will require a deeper understanding of supply chains, as ESG risks can exist throughout the whole value chain for portfolio companies.

Decarbonization requires companies to understand their supply chains. The majority of corporates' emissions occur in the value chain rather than within their core operations. More companies are committing to net zero targets that encompass Scope 3 emissions, impacting suppliers' energy strategy. As implied by Apple's net zero pledge, climate targets will require significant shifts in the energy mix of much of the supply chain. Failure to meet standards over time could potentially lead to supplier termination, based on Apple's supplier accountability policy (see 2022 Annual Progress Report). Companies in other industries such as GM and IKEA have also announced requirements for suppliers to transition in an effort to manage value chain emissions. As such, we believe that over time, supplier emissions will be increasingly factored into companies' supplier selection process, making supply chain location important for investors to understand. Lack of ESG disclosures from suppliers may create challenges for both corporates and investors attempting to size corporate Scope 3 footprints and track progress towards supply chain decarbonization; only 23% of the ~1,600 suppliers to the Automobile Manufacturers publicly disclose Scope 1-2 emissions (ie. the upstream Scope 3 emissions of Auto OEMs), and only 18% have set CO2 targets.

Below, we present our **data solutions for three critical areas of supply chain inquiry:** supplier engagement, geographical exposure and supply chain concentration/diversification. We caveat that our data approach doesn't provide full insight into business resilience in companies that are highly vertically integrated and does not cover directly owned manufacturing facilities.

1. Supply chain engagement

Why it's relevant

Only a portion of ESG risks are housed in the core operations of a company; the remainder extend across multiple layers of the value chain. Increasingly, ESG investors are looking to better understand the E, S and G risks of suppliers, which in part is leading companies to disclose more about the diligence they are performing on their supply chain. Our data estimates the level of ESG engagement in the Tier 1 and Tier 2 supply chain, giving an indication of where companies' suppliers perform relative to those of their peers. We assess corporate engagement with Tier 1 suppliers by measuring disclosures of companies on their supply chains. We then go a layer further by analysing the disclosures of the Tier 1 suppliers to assess engagement with their suppliers (Tier 2). We also consider how suppliers in our 7,000 company GS SUSTAIN database are performing on our operational Environmental & Social and Governance frameworks.

In the absence of measurable metrics, we rely largely on companies' policy disclosures to assess corporate supply chain engagement levels. This can mean that companies with relatively more controversial track records on supply chain management may, paradoxically, have better disclosures than peers – likely because controversial incidents can force companies to establish and disclose remediation initiatives to prevent future issues.

While policy metrics do have some drawbacks, our analysis suggests that companies that have **higher supply chain ESG disclosures** tend to score **higher on our Operational E&S framework**, which in turn is correlated with higher corporate returns and stock performance. Such companies also have better ESG fund ownership (Exhibit 1, Exhibit 2).

How we measure

How are companies **engaging** with their suppliers and how are the suppliers managing ESG? We use a range of supplier related corporate disclosures, and the GS SUSTAIN operational framework within the supply chain, to gain insight into human rights, environmental issues, health and safety and accountability. Given the lack of reported measurable metrics, the majority of our data are policy-based.

Tier 1 and Tier 2 suppliers: We measured how companies are engaging with their supply chains through two lenses. We first analyzed corporate disclosures to assess how the corporates are engaging with **Tier 1** suppliers. We measured a set of **15 supply chain metrics** relating to (1) human rights, (2) environment, (3) health, safety and training and (4) accountability and broader ethics. We added **analyst views** on whether they saw their covered companies as leading, improving, have room to improve or are not materially differentiated on supply chain management (raw materials, environmental issues, human rights) and worker conditions/relations in their operations. Lastly, we looked at how corporates' Tier 1 suppliers are engaging with their own suppliers on the same set of metrics to assess risks in the **Tier 2 supply chain**.

Metric selection: We explored over 80 environmental and social metrics (both numeric and binary) that are broadly associated with safety, human rights, environmental protection and broader business ethics. We selected those that are more closely tied with supply chains, resulting in 15 ESG metrics across multiple topics that we believe reflect the breadth of material ESG issues related to supply chain management.

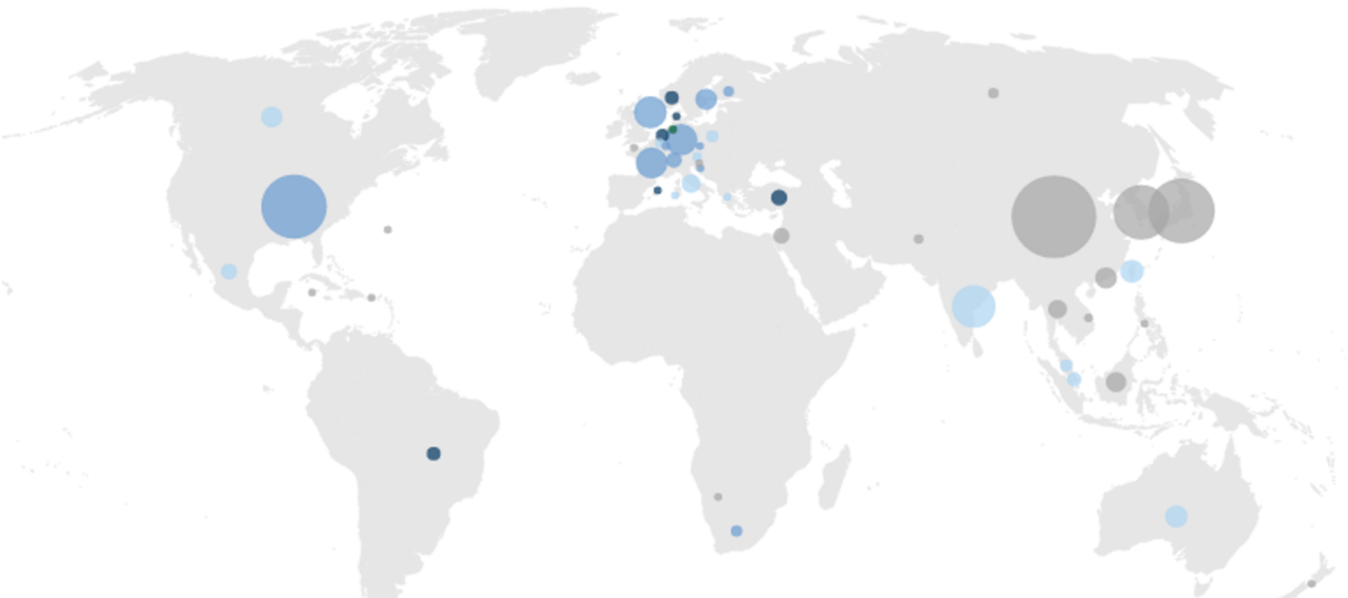
Exhibit 9: The GS SUSTAIN Supply Chain Mosaic includes 15 ESG metrics under multiple topics, as well as GS analyst inputs for selected covered companies
Metrics covered in the Mosaic

Human rights	Health, safety and training
Child labor policy - Policy	**Supply chain health & safety policy** - Policy
Forced labor policy - Policy	**Supply chain health & safety training** - Policy
Support ILO or UN declaration of human rights - Policy	**Supply chain ESG training** - Policy
Use of human rights as criteria for contractor selection - Policy	**Systems to measure supply chain health & safety improvements** - Policy
Contractor termination for human rights breaches - Policy	
Environmental	**Accountability and broader ethics**
Use of environmental criteria for supplier selection - Policy	**Audits suppliers** - Numeric
Supply chain monitoring - Policy	**ESG linked compensation** - Policy
Supplier termination for environmental breaches - Policy	**UNGC supporter** - Policy
GS analyst inputs	
Analyst views on whether relevant GS covered companies are leading, have room to improve or are not materially differentiated on **supply chain management** (e.g. responsible sourcing, human and indigenous rights, health and safety, etc) - Analyst inputs	

Source: Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Geographical distribution of the Automotive supply chain, contextualised against supplier engagement

Bubbles sized by Number of suppliers in the country, colored by Supply Chain Disclosure Rate percentile range



Country	#Suppliers	Supply Chain Disclosure Rate %ile	Country	#Suppliers	Supply Chain Disclosure Rate %ile
Mainland China	373	8%	Poland	8	24%
Japan	229	18%	South Africa	7	59%
United States of America	224	46%	Russia	6	13%
Korea; Republic (S. Korea)	163	17%	Finland	6	41%
India	99	21%	Austria	5	27%
United Kingdom	57	44%	Belgium	5	30%
Germany	55	50%	Pakistan	5	8%
France	53	58%	Ireland; Republic of	4	98%
Taiwan	29	25%	Vietnam	4	0%
Australia	27	32%	Luxembourg	4	59%
Hong Kong	25	9%	Spain	3	66%
Sweden	25	58%	Denmark	3	62%
Canada	24	35%	Greece	3	33%
Indonesia	22	11%	Portugal	3	30%
Italy	19	34%	Cayman Islands	2	0%
Thailand	19	10%	Philippines	2	19%
Turkey	14	69%	Czech Republic	2	48%
Mexico	14	26%	Croatia	1	60%
Israel	14	13%	Namibia	1	0%
Switzerland	13	56%	Bermuda	1	0%
Singapore	11	26%	New Zealand	1	0%
Brazil	10	64%	Guernsey	1	0%
Norway	10	70%	Slovenia	1	0%
Netherlands	9	70%	Puerto Rico	1	0%
Malaysia	8	21%			

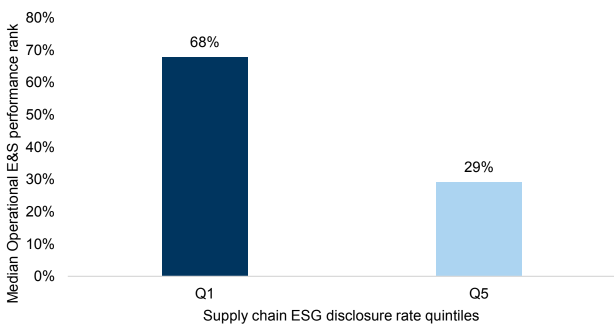
Field coordinates are approximations. Suppliers are mapped based on country of headquarters. Supply chain disclosure ranks are colored based on suppliers' disclosures of 15 engagement metrics that we discuss further in this report.

Conclusions for Autos: Room for better ESG engagement in Tier 1, and even more in Tier 2

In terms of engagement, we found that MSCI ACWI Automobile Manufacturers disclosed 44% of the 15 Supply Chain metrics we included (please see Exhibit 9 for the full set of metrics), but supply chain engagement significantly declined (18% disclosure rate) once we looked a layer deeper into the Tier 1 suppliers' engagement practices in the Tier 2 supply chain. For context, Q1 disclosers in the Automobile Manufacturers industry within the MSCI ACWI tend to have >60% disclosure rates while Q5 disclose less than 20% of the metrics.

Exhibit 10: Companies that have higher supply chain ESG disclosure rates tend to score higher on our Operational E&S framework

Supply chain ESG disclosure rates vs. operational E&S scores on the SUSTAIN framework (MSCI ACWI)



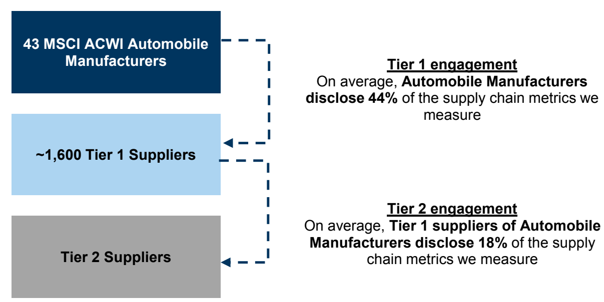
Note: Supply chain engagement metrics include 15 different metrics across multiple supply chain ESG topics

As of May 2022 based on latest data available.

Source: Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Exhibit 11: Automobile manufacturers are engaging with their Tier 1 suppliers, but engagement declines as we go upstream

Supplier engagement levels in the Automobile value chain



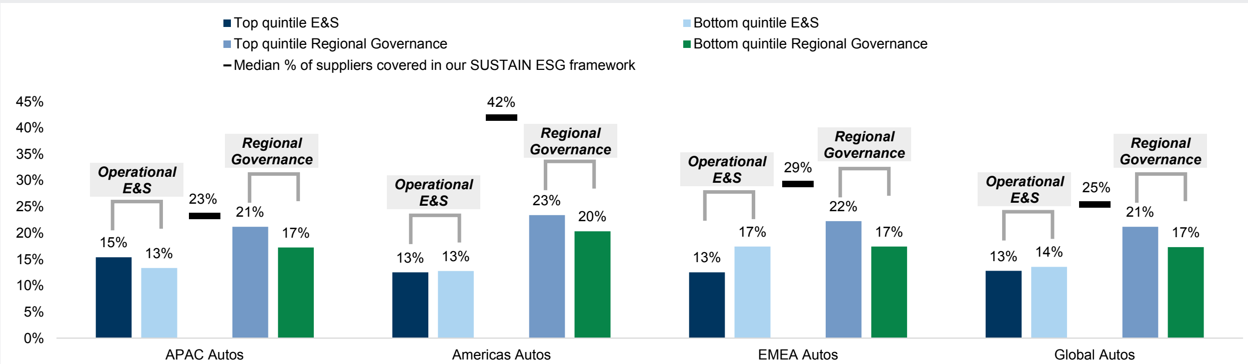
As of May 2022 based on latest data available.

Source: FactSet, Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

ESG performance of Automobile Manufacturers' suppliers: Insights from the GS SUSTAIN framework

We mapped the suppliers of all Automobile Manufacturers in the MSCI ACWI to our GS SUSTAIN operational E&S and G framework, and found that our framework (applied across >7,000 global publicly-traded companies) covers only 26% of Automobile Manufacturers' suppliers. Based on this limited coverage we assessed the % of suppliers that fall in the top and bottom quintile on ESG performance for Automobile Manufacturers, as shown in the Exhibit below. We note that companies covered in our GS SUSTAIN framework are constituents of most major global indices, and correspondingly those that are not covered tend to be smaller companies. The data can be used as an indicator to assess companies' exposure to suppliers that are performing well on Environmental, Social and Governance, and the converse.

Exhibit 12: Percentage of suppliers in the bottom and top quintile on ESG performance for Automobile Manufacturers based on suppliers that are part of our GS SUSTAIN universe



Note: Figures above are only limited to suppliers to MSCI ACWI Automobile Manufacturers that are covered in the GS SUSTAIN universe.

Source: FactSet, Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

2: Supply chain geographical exposure

Why it's relevant

We believe investors are looking to understand risk of potential disruptions from geopolitics or physical disruptions, and differences in sovereign ESG risks, based on variations in the rule of law, corruption and prevalence of forced labor. Many materials critical for the climate transition, such as Lithium, Graphite, Cobalt and Rare Earths are highly concentrated in a few regions where sovereign ESG scores may be lower, see Exhibit 14. Secondly, as corporates push suppliers to decarbonize, understanding where suppliers are located will be important. In some regions renewable energy access and affordability will be lower, potentially encouraging parts of global supply chains to move to countries with better access to renewable energy, rather than cost considerations being the sole decision factor. See Exhibit 16 below using our Strategists' EM sovereign ESG data.

How we measure

We mapped ~1,600 Tier 1 suppliers to 63 global Automobile Manufacturers that we cover in the GS SUSTAIN ESG framework (including 43 in the MSCI ACWI). The median number of suppliers mapped for the MSCI ACWI Automobile Manufacturers was 110. While the HQ location of a supplier may not be reflective of all its operations, the HQ houses key personnel, and key facilities may be local to HQ. As such, the sovereign ESG risk in the HQ location is, in our view, a leverageable proxy for geographical exposure in the absence of asset level data. We then mapped the locations of Tier 1 suppliers of Automobile Manufacturers [1], and produced an equal weighted blended geographical risk assessment for each company's Tier 1 supply chain using our EM Strategy team's sovereign ESG framework. While our supplier geographical exposure scores are not COGS weighted, given the lack of corporate disclosures on this front, we believe this equal weighted data can help us reflect potential tail risks in corporate supply chains as disruptions can impact companies irrespective of the size of the supplier.

Sovereign ESG scores

Our Strategists' Sovereign ESG framework incorporates 27 different macro indicators to assess ESG risk exposure:

Environmental variables cover current levels of resource use, pollution and energy consumption, as well as environmental risks related mainly to climate change. **Social** relates to inequality in terms of income and access to basic resources, as well as the health and nutrition levels of the population. **Governance** mostly refers to policy and effectiveness of policy, such as the country's infrastructure, rule of law, control of corruption and female participation both in the workforce and in government (see Exhibit 13 below).

[1] We leverage FactSet, which collects supply chain relationship information exclusively through primary public sources such as SEC 10-K annual filings, investor presentations, and press releases, which are fully reviewed on an annual basis.

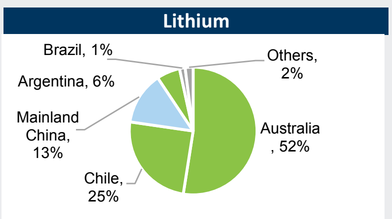
These supplier scores were then used to calculate an overall sovereign ESG score for each Automobile Manufacturer.

Exhibit 13: Our EM Strategy team assesses Sovereign ESG scores based on 27 different macro variables...
List of variables used to asssess Sovereign ESG scores

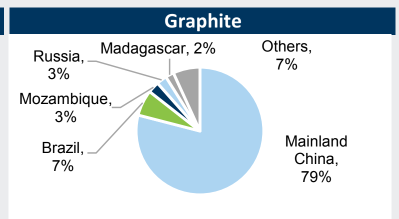
Environmental	Social	Governance
Natural resources depletion (% of GNI)	Population using at least basic sanitation services	Individuals using the internet
Fossil CO2 emissions per $1,000 of GDP	Access to electricity	Regulatory quality
PM2.5 air pollution	Unemployment rate	Government effecetiveness
Energy intensity level of primary energy	Life expectancy at birth	Control of corruption
Renewable energy consumption %	Adolescent birth rate	Political stability and absence of violence/terrorism
Renewable electricity output %	Mortality rate	Rule of Law
Change in forest area	Prevalence of undernourishment	Ratio of female to male labor force participation rate
Gain Index	Inclusiveness	Proportion of seats held by women in national parliaments
		Voice and accountability
		Fragility Index
		Electoral Process Score - Freedom in the World

Source: World Bank, SDG Database, University of Notre Dame, Our World in Data, European Commission, Haver Analytics, The Social Progress Imperative, Fund for Peace, Freedom House, IPU, Goldman Sachs Global Investment Research

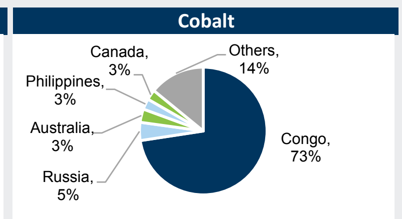
Exhibit 14: ...providing a starting point to assess geographical exposure for some critical materials and components
Regional breakdown of production volume of critical inputs to EVs (2021)



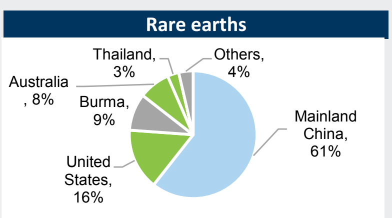
At least **13% of Lithium is sourced** from countries with <40th percentile Sovereign ESG scores or in fragile and conflict-affected regions as defined by the World Bank.



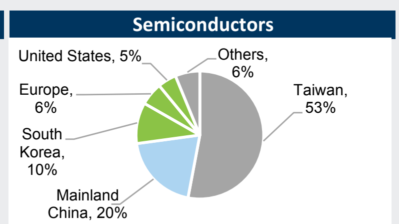
At least **82% of Graphite is sourced** from countries with <40th percentile Sovereign ESG scores or in fragile and conflict-affected regions as defined by the World Bank.



At least **79% of Cobalt is sourced** from countries with <40th percentile Sovereign ESG scores or in fragile and conflict-affected regions as defined by the World Bank.



At least **61% of rare earths are sourced** from countries with <40th percentile Sovereign ESG scores or in fragile and conflict-affected regions as defined by the World Bank.



At least **20% of semiconductor foundry capacity** is based in countries with <40th percentile Sovereign ESG scores or in fragile and conflict-affected regions as defined by the World Bank.

- Regions that score above **40th percentile on Sovereign ESG** scores
- Regions that score **below 20th percentile on Sovereign ESG** scores or those that are in **fragile and conflict-affected regions** as defined by the World Bank
- Regions that score **between 20th-40th percentile on Sovereign ESG** scores
- Regions where production data is limited or those that are not covered in our Sovereign ESG universe

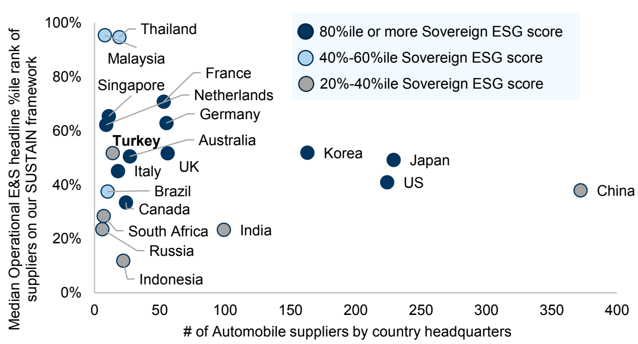
Source: USGS, Gartner, Goldman Sachs Global Investment Research

Conclusions for Autos: Concentration in a few countries, partly reflecting production and demand

Using the approach discussed above, we found that automobile supply chains tend to be **largely concentrated in China, Japan, the US and Korea, where automobile demand is high.** Around 60% of the ~1,600 suppliers providing inputs to OEMs (both by revenue and # of suppliers) are based in these regions, where vehicle demand tends to be concentrated (these regions collectively account for nearly half of global Auto demand). The geographical concentration of Automobile supply chains is also driven by government incentives such as tax benefits and subsidies for locally made vehicles, especially for EVs where more governments are increasingly looking to localize production as focus on climate transition accelerates. Lastly, some regions (predominantly EMs) provide significant cost benefits for manufacturers as wages can be multiple times lower than in their DM counterparts. However, as discussed earlier, many OEMs (not just in Autos) have recently increased focus on how they can achieve supply chain decarbonization as upstream processes can account for the majority of their products' lifecycle emissions (see Exhibit 32). As the importance of reaching net zero continues to rise, we believe supply chain emissions will play an increasing role in corporates' supplier selection process where suppliers in some regions will be advantaged with greater access to low-carbon power sources through greener national grid systems as shown in Exhibit 16.

Exhibit 15: The best performing suppliers on ESG account for a minority of the supply chain

Overview of # of Automobile Suppliers headquartered by region (top 20 regions only), median E&S rank of suppliers and Sovereign ESG scores

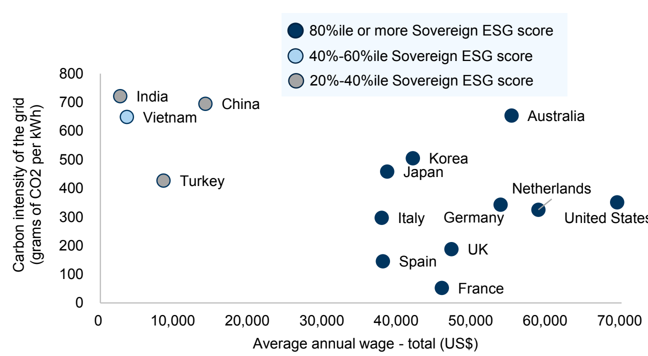


Note: The chart does not include Hong Kong and Taiwan due lack of Sovereign ESG coverage.

Source: FactSet, Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Exhibit 16: Geographical exposure and carbon intensity will be a consideration for location of supply chains in future

Breakdown of carbon intensity of power, average annual wage and sovereign ESG scores by country



Note: Carbon intensity data is as of 2021 or the latest available. Average wage is as of 2020 or latest available.

Source: IEA, World Bank, OECD, Goldman Sachs Global Investment Research

3: Supply chain concentration

Why it's relevant

The structure of a supply chain (size, uniqueness, diversification of access to critical components) can help investors contextualise a company's potential exposure to **business disruption**, including from **ESG events** relative to close peers. The size of a supply chain will clearly depend on product range and complexity. This, as well as the level of vertical integration will influence ability to access inputs, and the effort needed by corporates and investors to engage with supply chains. While our Mosaic does not directly measure the degree of vertical integration, there are environments when a highly concentrated supply chain (if vertically integrated) may pay at least temporary dividends via greater flexibility to access inputs – for example in the current environment of supply tightness. However, more diversification may be preferable in other periods – for example when certain geographies see disruptions to operations (physical, geopolitical, COVID related).

How we measure

Number of suppliers: We measured the number of Tier 1 suppliers of global Automobile Manufacturers and percentile-ranked that data relative to industry peers in the MSCI ACWI. We see the number of suppliers as an auxiliary datapoint. This is because supply chain **size** is an area where there are subtleties in interpretation – a **larger supplier base** with greater **geographical diversity**, especially for critical components, may provide business resilience in times of supply disruption. These characteristics could also bring greater burden of **risk management**, particularly in countries, usually emerging markets, where environmental and social protections tend to be weaker. We use data from external vendors to map supplier lists to companies.

Unique vs shared suppliers: We defined **shared suppliers as Tier 1 suppliers that are supplying to companies that together contribute to at least 50% of the industry revenue** within the MSCI ACWI. We then broke the supplier list down further by GICS 2 classification to understand how many suppliers there were by component. Among the 24 GICS 2 categories, we selected six verticals including Auto Components, Capital Goods, Materials, Hardware, Semiconductors and Software as potential inputs critical to the automotive supply chain. Companies with a strong reliance on suppliers that are commonly shared within the industry should generally have greater supply chain transparency (common suppliers tend to have greater ESG disclosures based on our work). On one hand, this increases the company's exposure to **systematic risks** and could limit the bargaining power of the buyer in an environment where supply-demand is tight for a given component. On the other, exposure to unique suppliers could provide differentiated and tailored products, but also increase idiosyncratic risks. Selecting stocks that have a balanced mix of both risks could provide a way to mitigate general risk exposure, and we assess this balance in our Mosaic.

Exhibit 17: Our Mosaic provides a range of supply chain metrics, where supply chain concentration is an auxiliary metric...

Overview of GS SUSTAIN Supply Chain Mosaic

	Metric	Details
Supply chain risks and engagement	Tier 1 supplier engagement	Supply chain related disclosures of Automobile Manufacturers
	Tier 2 supplier engagement	Supply chain related disclosures of Automobile Manufacturers' Tier 1 suppliers
	Geographical exposure	Sovereign ESG exposure of suppliers
Auxiliary metrics	Number of Tier 1 suppliers	Size of corporate supply chains
	Common vs. unique suppliers	Breakdown of exposure to suppliers that are commonly shared in the industry vs. suppliers that are relatively unique to the company
	Supplier mix by GICS 2	Sectoral breakdown of suppliers (common and unique)
	ESG score of suppliers	Average E&S and Regional Governance score of Tier 1 suppliers

Source: Goldman Sachs Global Investment Research

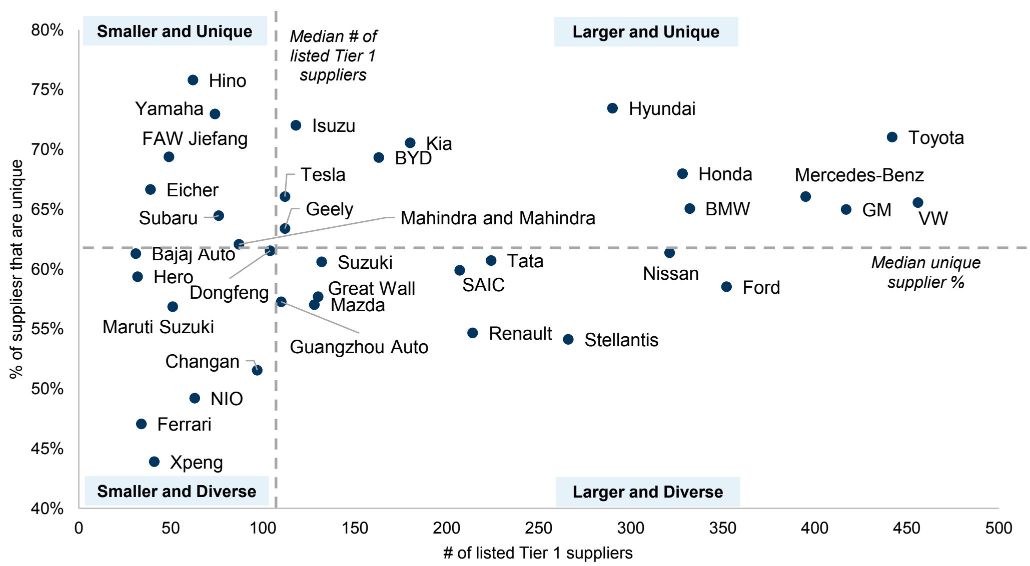
Exhibit 18: ... as different supply chain structures have benefits and trade-offs

Trade-offs in supply chain structures in terms of size and exposure to unique suppliers

Source: Goldman Sachs Global Investment Research

Exhibit 19: An overview of a company's supply chain structure is a starting point to assess business resilience

Supply chain size and uniqueness of Automobile Manufacturers in the MSCI ACWI



Note: Unique suppliers are those that supply to Automakers that contribute to less than 50% of the industry revenue within the MSCI ACWI. The chart excludes stocks that rank <15%ile on total # of suppliers due to limited supply chain related data.

Source: FactSet, Data compiled by Goldman Sachs Global Investment Research

Trade-offs in supply chain structures

As shown in the exhibit above, corporate supply chains tend to differ in both size and uniqueness; each structure can bring significant benefits as well as drawbacks. Currently, raw materials and components are in short supply due to physical disruptions (e.g. lockdowns), underinvestment and geopolitical tension. We find that companies that have a **more widely diversified supply chain** (e.g. back-up suppliers across multiple geographies) **have seemingly weathered these disruptive challenges better** than those with highly concentrated and smaller supply chains based on our discussions with our GS analysts across Tech Hardware and Industrials. However, our analysts also point out that companies with **smaller and more integrated supply chains** have historically (under more normalised circumstances) **enjoyed significant benefits** relative to those with diversified supply chains. These include greater bargaining power with suppliers (i.e. lower input cost) and better product customization, potential drivers of competitive advantage. Turning to the Auto industry specifically, it has been constrained by a series of supply chain challenges (e.g. shipping/logistics, component constraints, labor availability, COVID, etc) throughout 2021 and into 2022. Most notable has been the impact of semiconductor shortages (sparked by several factors in combination, including several natural disasters impacting semiconductor fabs, and allocation of semiconductors away from the auto industry during the start of COVID). Our US Auto analyst, Mark Delaney highlights the benefits of vertical integration, noting that vertically integrated companies have been able to shield themselves from semi shortages significantly better than peers. He attributes this to several factors, including the ability to re-engineer semiconductor chips at times to limit the impact of a shortage of a particular chip. Vertically integrated companies may be able to move more quickly to alternative sources, helping them ensure adequate supply (e.g. in batteries).

Vertical integration aside, below we provide broader trade-offs that come with differences in supply chain size and uniqueness.

Size of supply chain:

Having a larger supply chain can offer companies potential back-up supply in disruptive environments. However, having larger supply chains can also make it more difficult for companies to control input quality and customize components compared to companies with smaller supply chain structures. Our analysis of the Automobile industry suggests that companies with larger supply chains tend to have more diversified product portfolios (e.g. Toyota and Volkswagen), while those with smaller supply chains had more niche specialty product offerings (e.g. NIO and Ferrari).

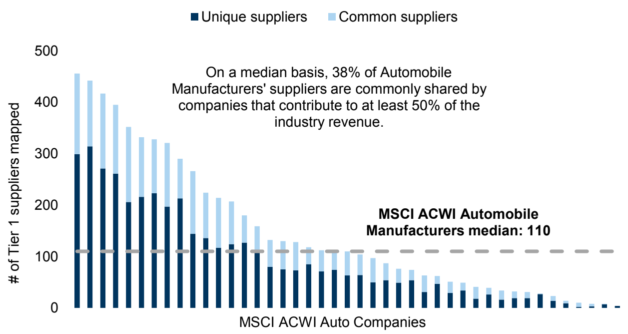
Exposure to unique suppliers: Having greater exposure to unique suppliers can provide better bargaining power for OEMs and lead to stronger relationships with suppliers over time. However, this also can increase a company's vulnerability to idiosyncratic risks in the event that significant suppliers experience disruptions or ESG events. In industries such as Tech Hardware, this can be particularly disruptive, as establishing new supplier relationships, designing components and sourcing the product can collectively take more than 12 months.

Conclusions for Autos: Companies have built unique supply chains for certain components

By component within the Automotive sector, Auto Parts has the highest level of shared suppliers, while Hardware and Software, Materials and Semis had much lower levels.

Exhibit 20: Our Mosaic provides an indication of systematic versus idiosyncratic risk from unique vs shared suppliers

Breakdown of unique and shared listed suppliers to Automakers

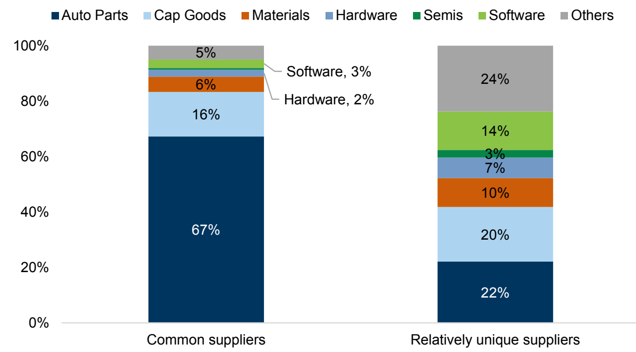


Note: "Common suppliers" refer to companies that supply to Automakers that contribute to at least 50% of the industry revenue within the MSCI ACWI.

Source: FactSet, Goldman Sachs Global Investment Research

Exhibit 21: We found that Automobile Manufacturers commonly share Auto Parts providers, but diversify their purchases in other verticals

GICS 2 breakdown of Automobile Manufacturers' suppliers in the MSCI ACWI



Source: FactSet, Goldman Sachs Global Investment Research

Use cases: Corporate engagement, regulations and fundamental overlay

Below, we highlight three key applications of our Supply Chain Mosaic.

Corporate engagement: Our GS SUSTAIN Supply Chain Mosaic provides a lens on geographical distribution of supply chains and how corporates are managing ESG risks in their Tier 1 and Tier 2 supply chains. Our Mosaic can be used by investors to make peer relative assessments on standout supply chain risks and opportunities, which can potentially provide more targeted topics for engagement.

Regulations: As we discuss later in this report (*'Looking forward: Change agents for data improvement'* section), global regulators are increasingly requiring companies (and in some cases investors) to increase transparency on how they are managing ESG risks, including, for example, whether corporates are upholding minimum social safeguards (per the EU Taxonomy). We believe our Mosaic offers a starting point to help investors navigate evolving regulatory requirements and the challenging data landscape.

Fundamental overlay to stock selection: Lastly, we believe our Mosaic can complement fundamental analysis as an overlay to the stock selection process. Investors can leverage our Supply Chain Engagement pillar to identify companies with the highest level of supply chain engagement, region-relative. We recommend using our Supply Chain Engagement pillar on a region-relative basis to mitigate regional biases in ESG disclosures.

Exhibit 22: Our Mosaic can be used to assess corporate supply chain engagement performance, region relative

Selected Automobile Manufacturers covered by GS, sorted by companies with highest average disclosure rates of supply chain engagement metrics in the Tier 1-2 supply chain within each region

Company	Ticker	Market cap (US$ bn)	Country	Tier 1 SPLC disclosure rate	Tier 2 SPLC disclosure rate	Average Tier 1-2 SP disclosure rate	Relative weight in ESG funds
Asia ex. China							
Honda	7267.T	52	Japan	69%	14%	41%	-20%
Mazda	7261.T	5	Japan	63%	16%	39%	22%
Toyota	7203.T	256	Japan	63%	16%	39%	-19%
Yamaha	7272.T	8	Japan	63%	8%	35%	183%
Kia	000270.KS	25	South Korea	50%	17%	33%	-56%
Mitsubishi Motors	7211.T	4	Japan	50%	17%	33%	-74%
Nissan	7201.T	18	Japan	50%	16%	33%	-67%
Maruti Suzuki	MRTI.NS	33	India	50%	16%	33%	-11%
Hyundai	005380.KS	19	South Korea	50%	14%	32%	-50%
Isuzu	7202.T	10	Japan	44%	16%	30%	8%
Suzuki	7269.T	19	Japan	38%	15%	26%	19%
Hero	HROM.NS	7	India	38%	13%	25%	121%
Hino	7205.T	5	Japan	38%	12%	25%	43%
Bajaj Auto	BAJA.NS	14	India	38%	10%	24%	-52%
Subaru	7270.T	13	Japan	25%	19%	22%	-50%
China							
SAIC	600104.SS	33	China	44%	9%	27%	81%
BYD	002594.SZ	87	China	38%	8%	23%	74%
Dongfeng	0489.HK	7	China	38%	8%	23%	-29%
BAIC Motor	1958.HK	3	China	31%	12%	22%	-82%
Guangzhou Auto	601238.SS	10	China	31%	10%	21%	5%
Changan	000625.SZ	16	China	19%	10%	14%	-1%
NIO	NIO.N	29	China	0%	22%	11%	14%
Li Auto	2015.HK	24	China	0%	21%	10%	-21%
Great Wall	601633.SS	19	China	6%	12%	9%	-34%
Americas							
Ford	F.N	71	United States	81%	21%	51%	-61%
GM	GM.N	69	United States	81%	15%	48%	-46%
Tesla	TSLA.OQ	837	United States	66%	22%	44%	-26%
EMEA							
BMW	BMWG.DE	53	Germany	88%	20%	54%	31%
Stellantis	STLA.MI	56	Netherlands	81%	24%	53%	47%
Mercedes-Benz	MBGn.DE	82	Germany	88%	17%	52%	-20%
VW	VOWG_p.DE	99	Germany	81%	18%	49%	-38%
Aston Martin	AML.L	2	United Kingdom	56%	41%	49%	-90%
Renault	RENA.PA	9	France	69%	23%	46%	94%
Volvo	VOLCARb.ST	20	Sweden	19%	47%	33%	353%
Ferrari	RACE.MI	39	Italy	25%	35%	30%	-54%

The disclosure rate figures include 15 metrics that we present in the 'Supply chain engagement and ESG performance' section of the report. We exclude stocks with <15 suppliers mapped.

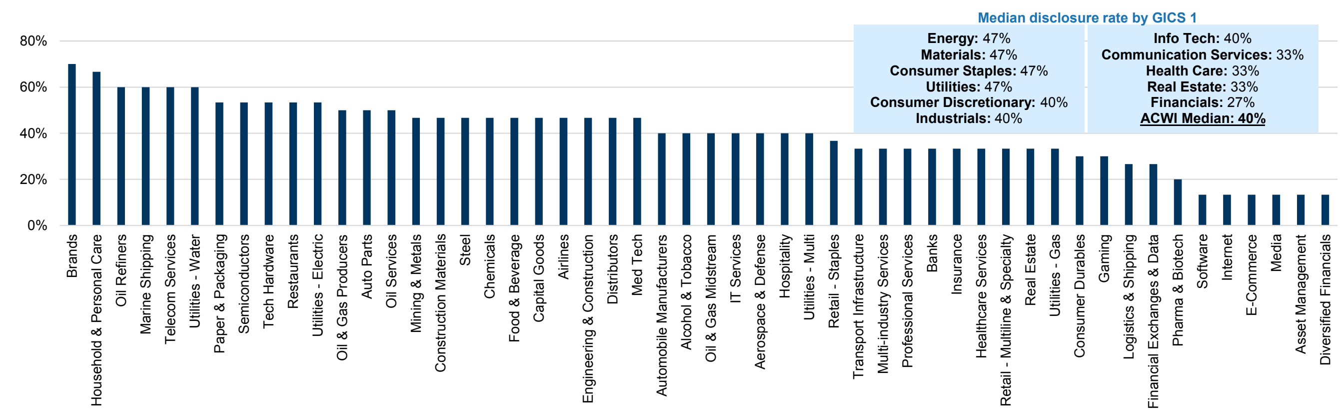
Source: FactSet, Bloomberg, Refinitiv Eikon

Supply chain data constraints drive the need for our Mosaic

As we looked to understand supply chains for this report, we found a number of gaps in supply chain information, including geographical exposure (e.g. origin of COGS by country), density and diversification of supply chains. Reporting requirements under GAAP and on a more limited basis, the IFRS, do require some customer exposure information from suppliers, but reconciling this for downstream manufacturers is onerous. Although a low percentage of companies report the number of suppliers audited or terminated for E&S breaches (Exhibit 25, Exhibit 26), companies do offer public statements of commitments to manage certain risks and, in some cases, the processes for doing this. There is a growing level of supply chain ESG disclosure, from a low base, across the MSCI ACWI; some detail provided below.

Exhibit 23: Supply chain ESG disclosures are strongest in sectors commonly targeted by ESG investors (e.g. Energy, Utilities), as well as sectors that have more direct exposure to end consumers (e.g. Staples, Discretionary)

Median supply chain disclosure rate by SUSTAIN sector

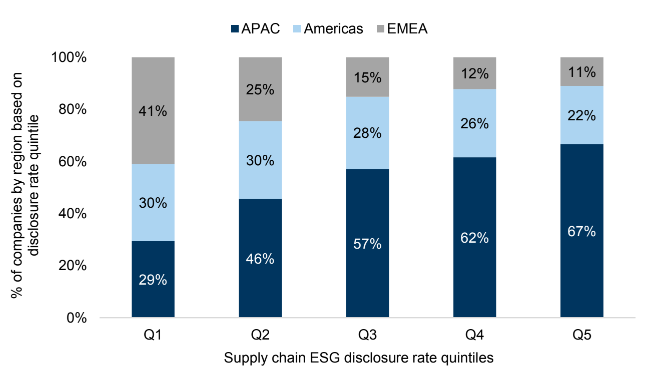


The analysis includes disclosure rates across 15 different Supply Chain metrics that we detailed earlier in the report.

Source: Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Exhibit 24: Despite being home to much of the world's supply chain, Asian companies' supply chain disclosures tend to be weak

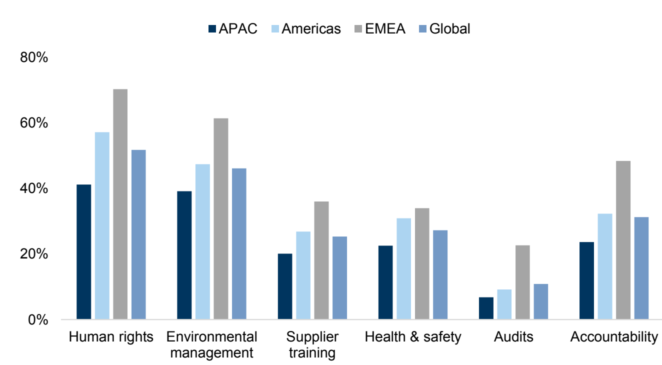
Breakdown of companies based on supply chain disclosure rates (MSCI ACWI)



Source: Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Exhibit 25: By topic, human rights related disclosures are highest across all regions although supply chain audits are still uncommon

Average disclosure rates by Supply Chain topic (MSCI ACWI)



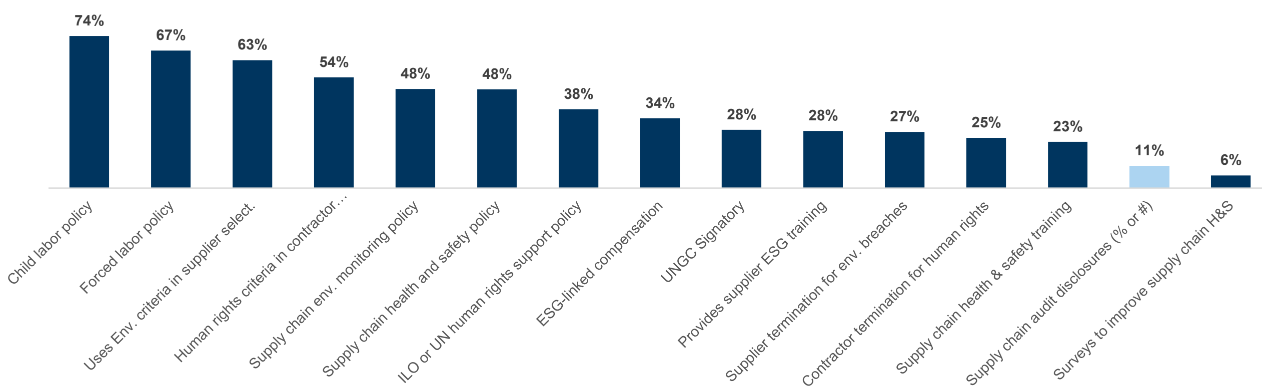
All metrics other than Audit metrics are policy-based. Audits represent disclosure of % or # of suppliers audited.

Source: Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

There are several factors that could potentially reverse the current disincentives for corporates to report supply chain data:

- **Challenges of cost and complexity may recede with technology,** as per the grey box below.
- **Penalties for non-disclosure.** Other than potential impact on reputational risk, that may or may not manifest, existing policies have lacked proportionate penalties for non-disclosure or non-compliance with reporting requirements. However, in some jurisdictions, such as the UK, revisions are being made to Modern Slavery-type regulation to include financial penalties for inadequate disclosure and engagement.
- **Greater confidence in ESG data.** Conflicting conclusions between different ESG rating systems, combined with reporting fatigue, may be deterring some corporates from providing comprehensive ESG disclosures that include the supply chain. This could change with standardization initiatives such as the global ESG and climate reporting standards being developed by the International Sustainability Standards Board (ISSB).

Exhibit 26: Only 11% of companies in the MSCI ACWI disclose the number or % of suppliers audited
Disclosure rates of supply chain metrics across the MSCI ACWI Index, latest available



Source: Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Supply chain audits: Technology should increase prevalence and reduce cost

As supply chain disclosures become more important for investors, auditors will play a bigger role in improving corporate data quality and transparency. We spoke with external supply chain auditors that provide assurance and auditing services for corporates; below is a summary of the highlights.

Supply chain audits are costly

A supply chain audit involves a review of a company's extended supply chain to assess risks across several dimensions. Supply chain audit costs can vary significantly by company and industry, but supply chain assurance and more intricate audits come with significant costs, as (1) many companies have highly diversified supply chains across multiple geographies and (2) traceability of raw ingredients is a significant challenge in multi-layered supply chains.

Because of these obstacles, most external supply chain audits are normally conducted on a limited scale to address certain "high risk" supplier entities or facilities suspected to have greater risk exposure. Auditors also note that while some companies do have internal supply chain engagement programs to monitor suppliers (e.g. collecting self-assessment ESG surveys), they are not always verified internally due to limitations in both financial and human capital to conduct internal audits.

Advancements in technology could provide solutions

Supply chain audits often entail on-site inspections and worker interviews to ensure safety and human rights standards are met. With the widespread adoption of digital solutions (e.g. tele-meetings), coupled with travel restrictions driven by COVID, auditors are increasingly finding ways to digitalize the auditing process. While this can create challenges in validating certain aspects of the supply chain audit, it also helps create cost efficiencies that could ultimately help auditors scale their services. Some organizations have also explored ways to leverage new technologies such as blockchain to create transparent networks that record worker-related data such as history of salary disbursements and immigration documentation which can help mitigate social issues such as abuse of migrant workers.

Limitations and caveats

Supplier data: Supply chain data is not exhaustive due to lack of corporate disclosures. For selected companies in our Mosaic, we have expanded the supplier universe we gathered through FactSet by adding more suppliers into the list based on our analysts' feedback. In addition, our Mosaic only includes listed suppliers due to lack of disclosures available from private entities.

Materiality: The current lack of granular supply chain disclosures such as COGS allocation by region or by component limit our ability to define materiality of each supplier in terms of volume (e.g. suppliers that account for the majority of costs) or input criticality (e.g. suppliers that provide inputs that cannot be substituted within the value chain).

Location: We acknowledge that Tier 1 suppliers do not provide a comprehensive picture, the location of their headquarters may ignore other countries of operation within their businesses and a full analysis of the chain would need to go deeper.

Policy data: While our framework is heavily policy-based, we acknowledge that supply chain policy disclosures may not represent corporate engagement at the same level as measurable metrics.

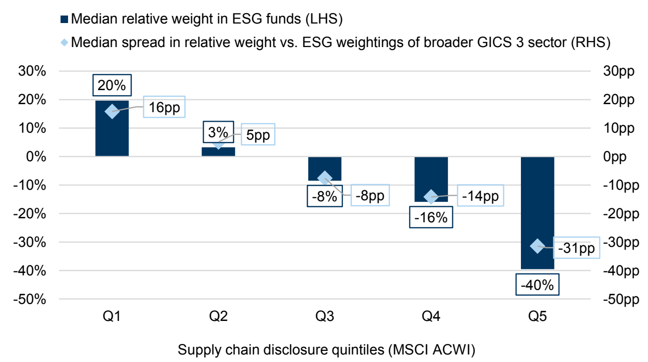
Vertical integration: Supply chain datasets only provide a limited lens on companies that are vertically integrated, as inputs can also be sourced through joint ventures (JVs) or subsidiaries which are not always captured by third party vendors. Our Supply Chain Mosaic does not cover the internal manufacturing operations of a company.

Despite these limitations, we believe disclosure is the first step toward engagement and that when we look across tens of hundreds of suppliers, a picture of their level of policy disclosure is a valuable input to understanding a company's upstream ESG risk.

When combined, we believe that the core and auxiliary metrics in our Mosaic can provide a good risk signal. The reality is that today's low availability of supply chain information (reasons for this and path forward discussed later) mean that these initial steps toward understanding supply chain resilience will be open to critique. We aim to expand our approach in future iterations as further data becomes available.

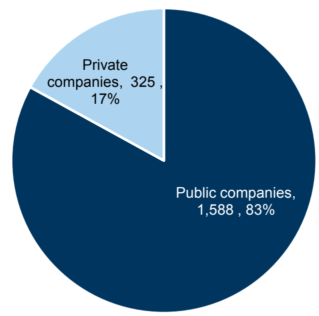
Lastly, we did not use our Controversy dataset in our Mosaic. Although we were able to screen for supply chain controversies within the dataset, the output was skewed by English language reporting.

Exhibit 27: In the absence of data, ESG investors appear to be rewarding companies that are more transparent on supply chain practices
Supply chain disclosure quintiles vs. relative weights in ESG funds



Source: Morningstar, Refinitiv Eikon, FactSet, Goldman Sachs Global Investment Research

Exhibit 28: Our Mosaic only includes publicly traded suppliers due to disclosure limitations for private entities
Breakdown of public and private companies supplying companies in our Automobile universe



Source: FactSet, Refinitiv Eikon, Goldman Sachs Global Investment Research

Looking forward: Change agents for data improvement

There is a range of stakeholders whose efforts are already impacting corporate engagement with supply chain data reporting. Over time, we see greater emphasis on disclosures, driven by the need to understand business risk, including disruptions, climate goals and equitable labor practices, tightening links between supply chain performance and competitive advantage. Earlier in the report, we discussed corporates and consumers as key drivers for supply chain transparency; here, we discuss two other important stakeholders – regulators and shareholders.

Regulators and shareholders

In recent years, a range of regulations have emerged globally to hold companies more accountable for ESG risks throughout their supply chains. Some policies are direct – such as the Australian and the UK Modern Day Slavery Acts, the US Uyghur Forced Labor Prevention Act, and Germany's Supply Chain Due Diligence Act. Others are indirect – for example the Minimum Social Safeguards provisions embedded within the EU Taxonomy. Despite the regulatory focus, reports from the Australian Council of Superannuation Investors have found that the overall quality of supply chain disclosures and engagement is still lacking, even in Australia after the much anticipated introduction of the Modern Day Slavery Act in 2018. In this section, we explore the evolving policy landscape and outline some of the challenges for corporates such as cost and traceability, which limit disclosures.

Financial reporting requirements deliver some insight. Companies reporting under US GAAP must **disclose the identity of key customers** that account for at least 10% of their revenues (required under SFAS No. 14). This means that even though companies are not required to disclose the identity of their suppliers, investors can still partially assess supplier relationships by looking at disclosures of certain customers that have 10% or more revenue tied to a given company. On the other hand, while the IFRS also requires companies to provide disclosures on whether a single customer accounts for at least 10% of revenue (IFRS 8), disclosures on the identity of the specific customer are not mandatory. This puts limits on the ability of investors to inversely map supplier relationships through customer related disclosures for global companies reporting under the IFRS.

Supply chain due diligence and transparency regulations have accelerated over the past 12 months. In order to satisfy these requirements, companies will want to understand further aspects of their supply chains. More recent developments include:

- New York State's proposed Fashion Sustainability and Social Accountability Act that would impose significant reporting requirements on fashion retailers and manufacturers doing business in New York State.
- Europe's proposed Corporate Sustainability Due Diligence (CSDD) laws that would require large companies operating in the EU to align their businesses with limiting global warming to 1.5C and hold firms civilly liable for offenses relating to human

rights or the environmental incidents committed by suppliers.

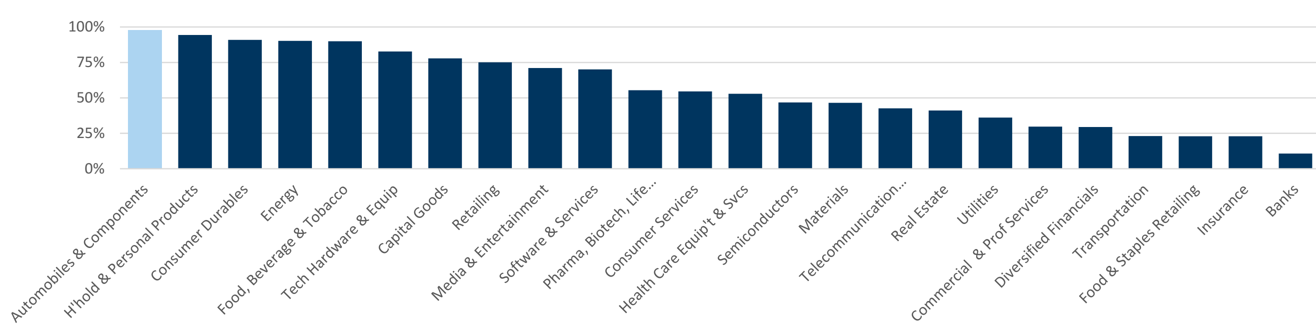
- Norway's Transparency Act that will come into effect from July 1st 2022 and require large companies domiciled or selling products into Norway to comply with mandatory human rights due diligence obligations and report on findings and remedies. There will be a **citizen's right-to-know** provision, where information can be requested from members of the public relating to due diligence processes in the supply chain.
- Germany's Ministry of Economy announced in April 2022 that it had launched a consortium of 11 partners (auto and battery makers) with the goal to develop a common taxonomy on a European "battery passport". The goal is to enhance the traceability of battery components and the carbon footprint of batteries sold in Europe, which will later be embedded into vehicle CO2 emissions regulations in the future.

Green Taxonomies continue to emerge with social supply chain considerations embedded. One notable feature of Europe's Taxonomy is the incorporation of a Minimum Social Safeguards requirement which puts the onus on companies to ensure that human rights are being protected before revenue from an activity can be considered green, including entities within the value chain.

Scope 3 includes emissions upstream in the supply chain.

Increased adoption of climate reporting will hold corporates more accountable for Scope 3 (includes suppliers and end users) emissions. Regulator support for the Task Force for Climate-related Financial Disclosures (TCFD) reporting framework continues to accelerate, with the US most recently proposing TCFD-aligned mandatory reporting for corporates, which includes disclosure of Scope 3 emissions where material or where companies have set targets incorporating Scope 3. The Science Based Targets initiative also requires Scope 3 be included where it is material (generally where it represents >40% of the total footprint). Corporate targets that cover a product's full lifecycle, such as Apple's net zero 2030 target, will have significant sustainability and cost implications for the full supply chain of some industries.

Exhibit 32: For many industries, Scope 3 contributes over 40% of total Scope 1-3 footprint. For Autos, this is as high as 98%.
Scope 3 as a % of total Scope 1-3 footprint, median values by GICS 2 sector, MSCI ACWI universe



Data is dependant on company disclosures and standard of reporting. We note there are significant challenges with company reported Scope 3 data.

Source: Refinitiv Eikon, Goldman Sachs Global Investment Research

Import bans for products originating from regions with known forced labor risks. For example, the US Uyghur Forced Labor Prevention Act prevents imports from certain regions in mainland China on the rebuttable presumption that any (even partial) goods from the region have been subject to forced labour. Similar regulation is being considered in Australia, the EU, and the UK. Non-compliant companies can have supply chain vulnerabilities, emphasising the business case for robust supplier traceability and engagement practices.

Sustainable sourcing and circular economy policies may also encourage greater supplier engagement. Disclosure requirements for the sourcing of specific controversial ingredients (such as conflict minerals) have been mandated in Europe (Conflict Minerals Regulation) and the US (Dodd-Frank Act). Elsewhere, China and the OECD adopted voluntary guidelines to encourage similar due diligence and disclosure of supply chain risks for companies sourcing minerals from conflict-affected and high-risk areas. The introduction of more stringent circular economy regulations for corporates in the EU could also-increase stakeholder demand for evidence of supply chain management. For example, in 2020, the European Commission published its new Circular Economy Action Plan which aims to introduce frameworks to address various circular economy topics across multiple industries both upstream (e.g. responsible sourcing disclosures for batteries) and downstream (e.g. collection and recycling of waste).

For more information on ESG regulations related to supply chains and corporate/ investor disclosure requirements see GS SUSTAIN: APAC ESG Regulation: A new era for ESG in Asia Pacific.

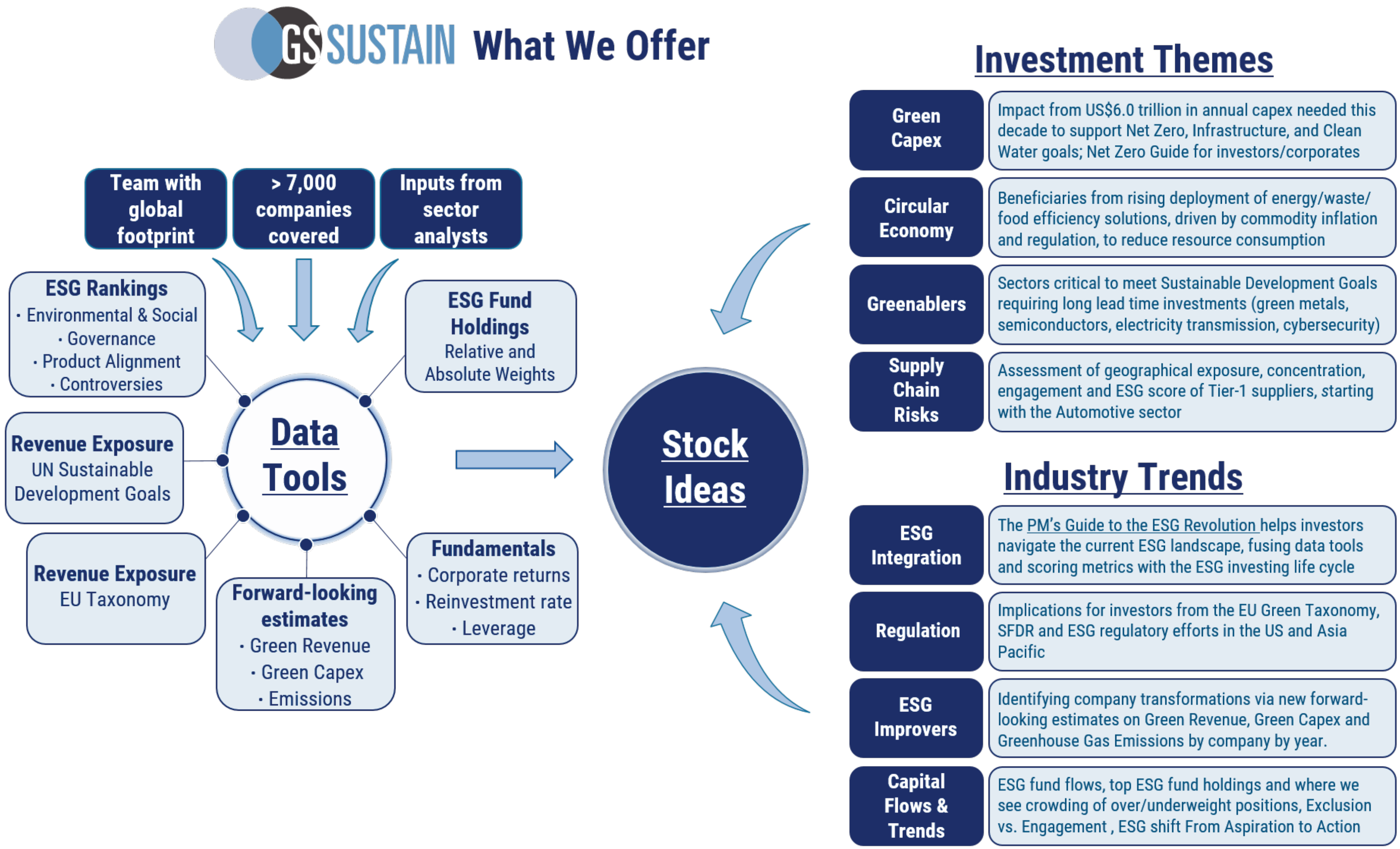
GS SUSTAIN data and research offerings

GS SUSTAIN can provide access to proprietary tools and resources to quantify impact and identify ESG Improvers, enabling greater recognition of underappreciated opportunities across sectors. Our expanded offering of SUSTAIN tools can help investors to answer a myriad of ESG questions at the portfolio and security levels, enabling more systematized and quantitative reporting while providing detailed and transparent data sets for idea generation, security selection and corporate engagement.

- **Our multi-pronged SUSTAIN scoring framework** can help provide greater granularity and objectivity for asset managers in both security selection and reporting. The framework across >7,000 companies includes our recently introduced Product Alignment framework, based on the SDGs, EU Taxonomy and GS analyst views, and can help investors cast a wider net in the search for impact ideas aligned to less obvious sustainability themes. Existing pillars detail performance around sector-specific environmental and social operational metrics, governance, and controversies.
- **Forward-looking estimates.** Looking ahead, we believe investment performance will be more driven by future change and have taken our first steps toward incorporating forward-looking estimates in our proprietary industry analyst inputs, which now include sustainable product revenue and capex in select industries. Of the more than 3,000 companies under GS coverage globally, 53% saw a change in net E&S scores as a result of our analyst survey inputs. Furthermore, we have taken first steps to offering quantitative forecasts of sustainable product revenue/capex for ~650 companies in 19 industries. We now add Scope 1 and 2 greenhouse gas emissions for a smaller segment of companies in 7 sectors.
- **EU Taxonomy revenue alignment.** We see the EU Taxonomy as one of the most seminal regulatory developments driving standardization in reporting for both corporates and asset managers. Our EU Taxonomy alignment tool maps companies' revenues to Taxonomy-defined activities to determine potential Taxonomy-eligible and aligned revenue based on technical screening checks where data exist, and "Do No Significant Harm" (DNSH) and "Minimum Social Safeguards" (MSS) criteria.
- **SDG revenue alignment.** The UN Sustainable Development Goals (SDGs) have emerged as one of the most commonly used frameworks for taxonomizing impact across a broad set of sustainability challenges. Our SDG alignment tool employs granular revenue data, GS analyst inputs and other company metadata to map alignment, exposure and misalignment to ten of the SDGs we deem to be most investable.
  - **Company mapping for SDG 12: Responsible Consumption & Production:** Our SDG 12 screen targets companies advancing the circular economy or reducing the environmental impact of commonly used materials, logistics and shipping businesses, and companies that offer waste management, pollution control, maintenance, recycling, rental or reuse services or the equipment or

machinery used in these services. Recycling facilities, companies that produce RFID devices, recycling equipment and machinery, pollution control equipment, recyclable materials and companies that offer hazardous waste collection & treatment and environmental engineering & consulting services are considered aligned. Otherwise, to be aligned a company must have >10% clean energy revenue based on BNEF data, eco-design products or take-back initiatives. If the company is in paper & packaging, it must have labeled wood products. If the company is in the auto parts, brands, consumer durables, household & personal care or chemicals sectors, the company must have eco-design products and sustainable packaging or take-back initiatives.

- **ESG fund ownership.** Aggregating fund holdings across a universe of ~3,000 ESG funds, we analyze this pool of ESG assets to better understand trends in ESG ownership at both the sector and company level. The full dataset provides absolute and momentum ESG ownership detail for well over 10,000 securities.
- **ESG fund flows, valuations and performance**. Our ESG Tracker series analyzes the aforementioned ESG fund universe to gauge ESG fund flow momentum and sizing relative to the broader market, breaking out differences by strategy, fund type and fund style. The tracker also examines valuation and performance across categories.



Source: Goldman Sachs Global Investment Research

GS SUSTAIN ESG Pillars

Product Alignment

Key issues addressed
How do the company's products & services impact consumers, communities, & the environment in the use-phase and at end-of-life?

Outputs
1. **Headline Product Impact (NEW)**
   - Product Portfolio
   - Product Strategy
2. **Forward-looking forecasts (NEW)**

Inputs and sources
- Business activity taxonomy
- Specialized raw data
- Industry analyst qualitative and quantitative input

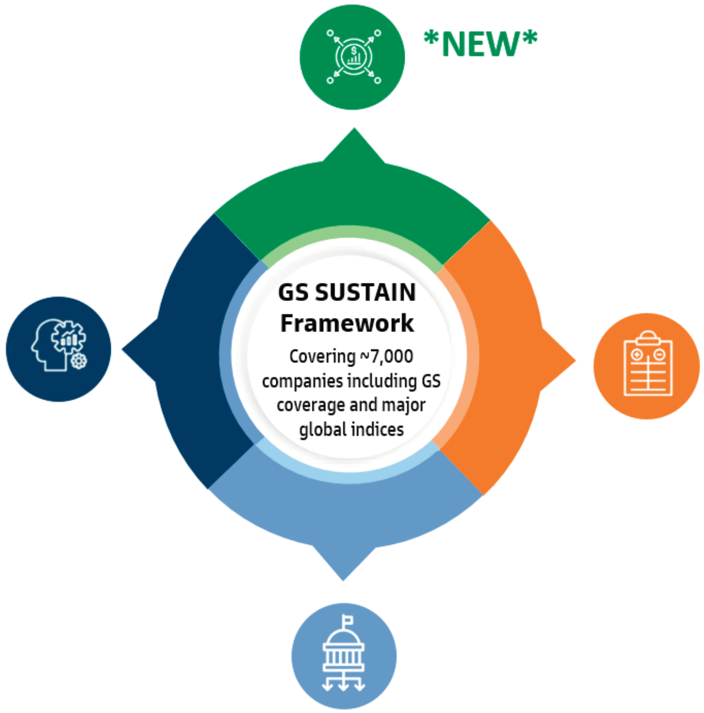
EU Taxonomy & SDG alignment
- Net revenue alignment to the SDGs and the EU Green Taxonomy

Operational E&S

Key issues addressed
What are the industry-relevant measurables offering insight into exposure and performance on key environmental & social issues?

Outputs
1. **Headline E&S Rank**
2. **E&S Momentum**
3. ***E&S Disclosure %***

Inputs and sources
- Corporate disclosure
- Specialized alt-data
- Industry analyst inputs



Controversies

Key issues addressed
Does the company have real-time or a history of ESG exposures not yet reflected in company disclosures or captured or quantified by available data?

Outputs
1. **Headline Controversy Rank**
   - Long-term track record
   - Long-term momentum
   - Short-term 1m sentiment
   - Short-term 3m sentiment

Inputs and sources
- Media controversy coverage
- News sentiment analysis

Governance

Key issues addressed
Has the company put in place foundational structures of accountability, checks & balances, and shareholder alignment?

Outputs
1. **Global-relative Governance Rank**
2. **Region-relative Governance Rank**

Inputs and sources
- Corporate disclosure
- Specialized raw data

ESG Fund Holdings

'Nifty Fifty Series'

- How widely owned, over/underweight (v. benchmark), companies are in ~3,000 ESG funds (active & passive) representing US$2tn in AUM
- Covers the market's view of ESG, **offering ESG discovery value**

Source: Goldman Sachs Global Investment Research

Disclosure Appendix

Reg AC

We, Sharmini Chetwode, Ph.D., Keebum Kim, Emma Jones, Brian Singer, CFA, Derek R. Bingham, Evan Tylenda, CFA, Kota Yuzawa, Fei Fang, George Galliers and Mark Delaney, CFA, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

We, Teresa Alves and Kamakshya Trivedi, hereby certify that all of the views expressed in this report accurately reflect our personal views, which have not been influenced by considerations of the firm's business or client relationships.

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Growth is based on a stock's forward-looking sales growth, EBITDA growth and EPS growth (for financial stocks, only EPS and sales growth), with a higher percentile indicating a higher growth company. **Financial Returns** is based on a stock's forward-looking ROE, ROCE and CROCI (for financial stocks, only ROE), with a higher percentile indicating a company with higher financial returns. **Multiple** is based on a stock's forward-looking P/E, P/B, price/dividend (P/D), EV/EBITDA, EV/FCF and EV/Debt Adjusted Cash Flow (DACF) (for financial stocks, only P/E, P/B and P/D), with a higher percentile indicating a stock trading at a higher multiple. The **Integrated** percentile is calculated as the average of the Growth percentile, Financial Returns percentile and (100% - Multiple percentile).

Financial Returns and Multiple use the Goldman Sachs analyst forecasts at the fiscal year-end at least three quarters in the future. Growth uses inputs for the fiscal year at least seven quarters in the future compared with the year at least three quarters in the future (on a per-share basis for all metrics).

For a more detailed description of how we calculate the GS Factor Profile, please contact your GS representative.

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	Rating Distribution			Investment Banking Relationships		
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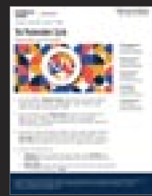
MINDCRAFT: OUR THEMATIC DEEP DIVES

China de-carbonization

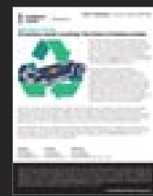
Circular Economy

The Future of Battery

The poster modern cycle



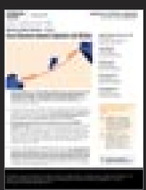
EV battery metal recycling



ESG of the Future

APAC ESG Regulation

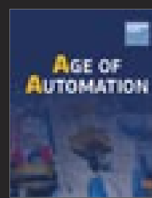
Balanced Bear Despair



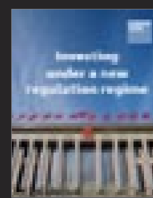
The Post-Pandemic Cycle

The PM's Guide to ESG

Age of Automation



China Regulations

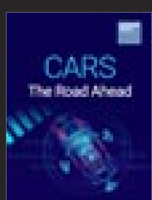


Automotive Software

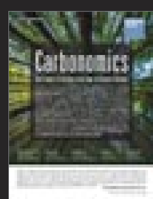
India Mobility

EUV 2.0

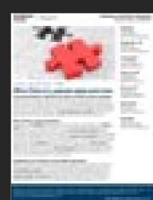
Electric Vehicles



Carbonomics



EM ex-China asset class

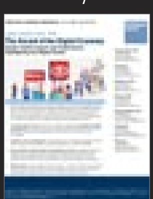


Top of Mind

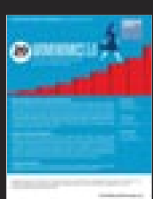
Top Projects

China A Shares

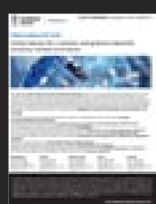
Asia Digital Economy



Womenomics



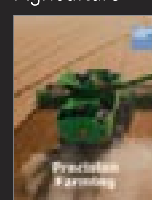
China Industrial Tech



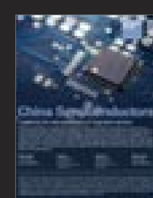
Europe Digital Economy

India Internet

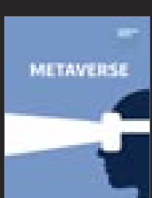
Precision Agriculture



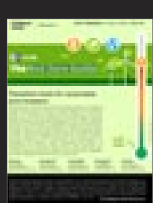
China Semiconductors



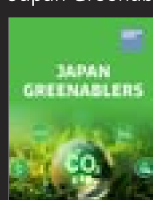
Metaverse



Net Zero Guide

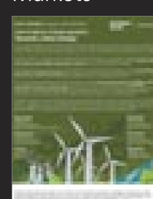


Japan Greenablers



China net zero

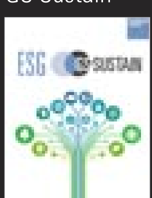
Future of Power Markets



India Digital Economy

China's Post-95s

GS Sustain



EM Macro Navigator

C-Suite Conversations

Blockchain

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