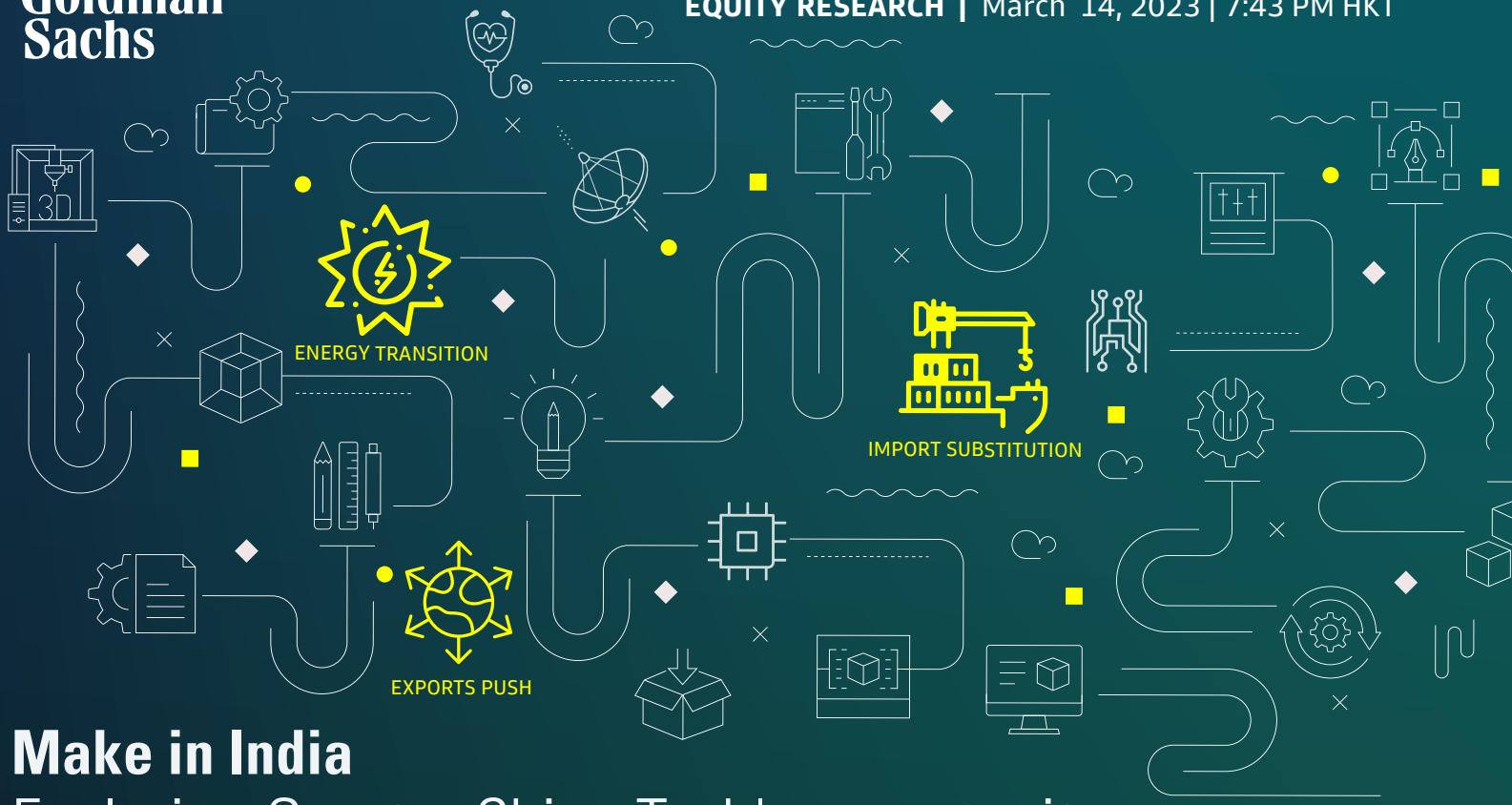
Goldman Sachs



Make in India

Exploring Greater China Tech's opportunity

Our prior Make in India report revealed Tech as a key beneficiary of India's Production-Linked-Incentive (PLI) schemes. In this context, we explore:

- The substantial opportunity for Greater China tech firms, with tech representing more than half the PLI opportunity. GC capex commitments total US$2bn so far, or 85% of total commitments, with the most advanced investments in assembly. Semis remains a more distant prospect in our view. If India follows China's mobile phone manufacturing path, exports could grow 6x times through 2025 as a starting point for a 5-year investment cycle.
- Existing manufacturing leaders, including Hon Hai and Luxshare (both Buy-rated), which we expect to benefit given their balance sheet capacity to expand and longer experience in managing a scaled labor force, complex supply chains and logistics. We forecast margins and returns to be lower initially, but to scale to profitability within 4 years as capacity ramps, supply chains are established and with the benefit of government subsidies of up to 6% of revenues.
- Challenges early on, including a limited supply chain ecosystem, intermittent instability in power supply and a lower likelihood of growth in the more complex and valued added opportunities in Semis, as well as local competition that is likely to scale. We also believe global end customers will keep an eye on ESG challenges, both environmental and social.

Allen Chang
+852 2978-2930
allen.k.chang@gs.com
Goldman Sachs (Asia) L.L.C.

Verena Jeng
+852-2978-1681
verena.jeng@gs.com
Goldman Sachs (Asia) L.L.C.

Pulkit Patni
+91(22)6616-9044
pulkit.patni@gs.com
Goldman Sachs India SPL

The Goldman Sachs Group, Inc.

For the full list of authors, see inside.

Contributing Authors

Allen Chang
+852-2978-2930
allen.k.chang@gs.com
Goldman Sachs (Asia) L.L.C.

Verena Jeng
+852-2978-1681
verena.jeng@gs.com
Goldman Sachs (Asia) L.L.C.

Pulkit Patni
+91(22)6616-9044
pulkit.patni@gs.com
Goldman Sachs India SPL

Rahul Jain
+91(22)6616-9161
rahul.m.jain@gs.com
Goldman Sachs India SPL

Bruce Lu
+852-2978-6368
bruce.lu@gs.com
Goldman Sachs (Asia) L.L.C., Taipei Branch

James Wang
+886(2)2730-4191
james.p.wang@gs.com
Goldman Sachs (Asia) L.L.C., Taipei Branch

Ting Song
+852-2978-6466
ting.song@gs.com
Goldman Sachs (Asia) L.L.C.

Xuan Zhang
+852-2978-1478
xuan.zhang@gs.com
Goldman Sachs (Asia) L.L.C.

Yuhe Wu
+852-2978-1072
yuhe.wu@gs.com
Goldman Sachs (Asia) L.L.C.

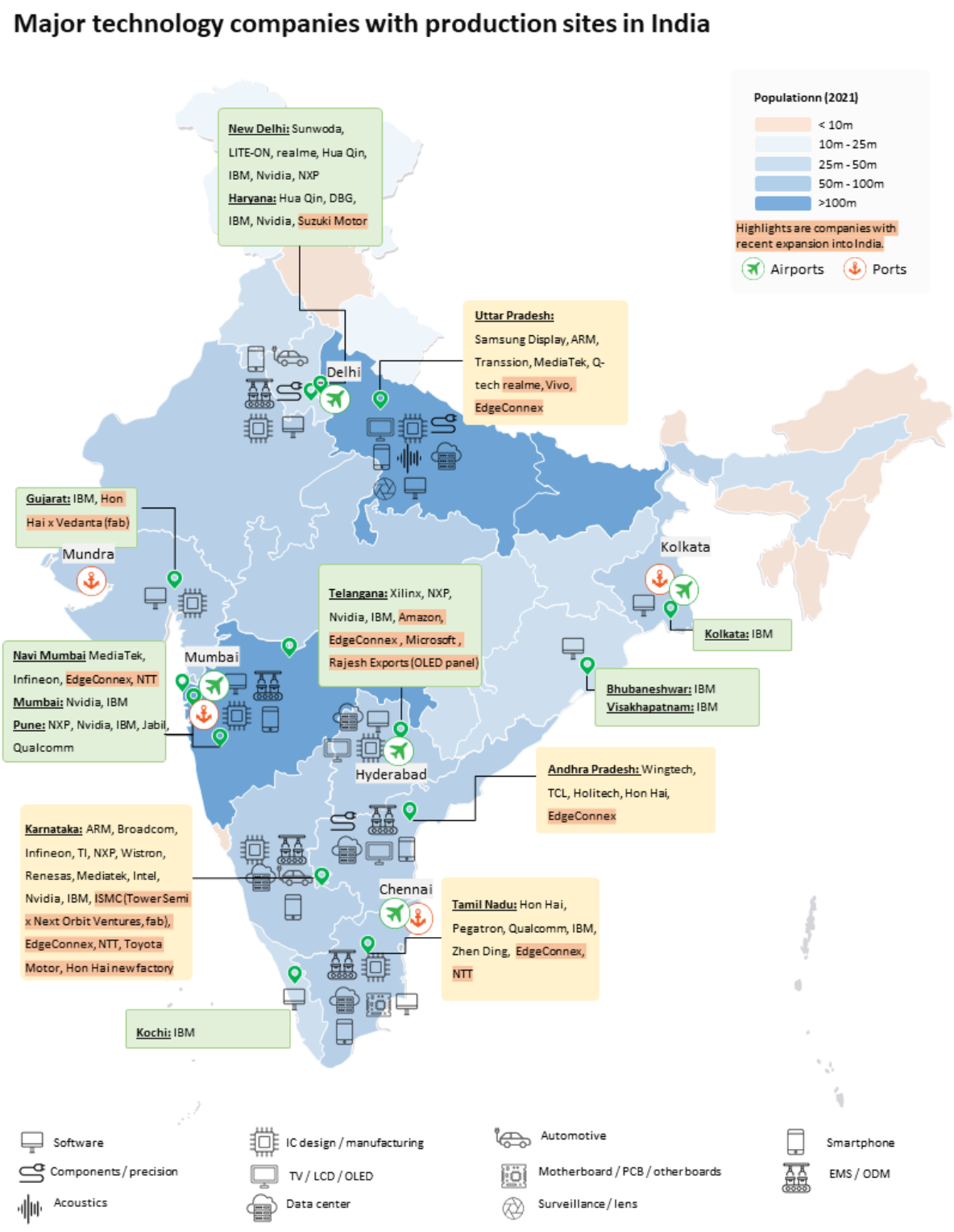
Emma Jones
+61(2)9320-1041
emma.jones@gs.com
Goldman Sachs Australia Pty Ltd

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

Table of Contents

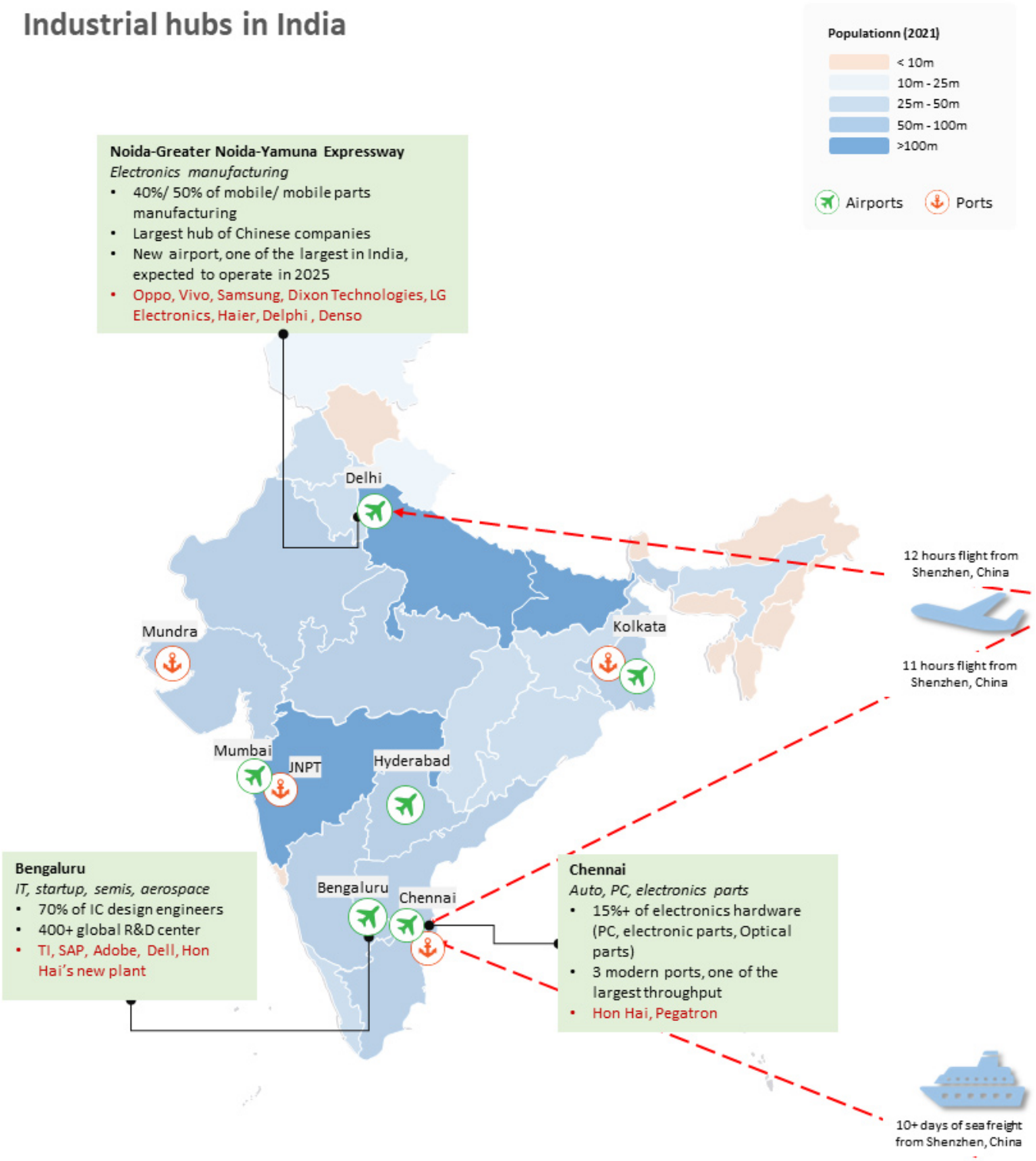
India: Major Tech companies and their production sites	3
Greater China Tech in India in numbers	5
PLI schemes: Technology plays a vital role	7
The flow of expansion: From China to Southeast Asia to India	8
Benefits: policies, lower labour costs, large domestic market	10
Challenges: Lower ROIC, no mega sites, and geographical distance from supply chain	13
Smartphones: China brands and supply chain remain large	16
Components: More focused in SEA as close to supply chain	21
India and Southeast Asia expansion pipeline	21
Semiconductors: Less motivation for Foundry, but higher possibility for IC design/back-end services to expand in India	22
Investment implications for Greater China Technology	23
Downside risks to GC Tech's India opportunity	26
Longer-term ESG considerations	27
Appendix: Greater China Technology Comparison Table	31
Disclosure Appendix	32

India: Major Tech companies and their production sites



Highlight indicate companies with recent expansion into India.

Source: Company data, Data compiled by Goldman Sachs Global Investment Research



Source: Company data, Data compiled by Goldman Sachs Global Investment Research

Greater China Tech in India

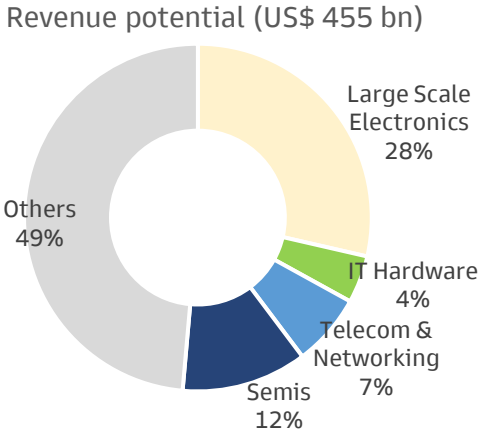
in numbers

Tech sector to drive 51% of the US$455bn incremental revenue from PLIs

Revenue

51%

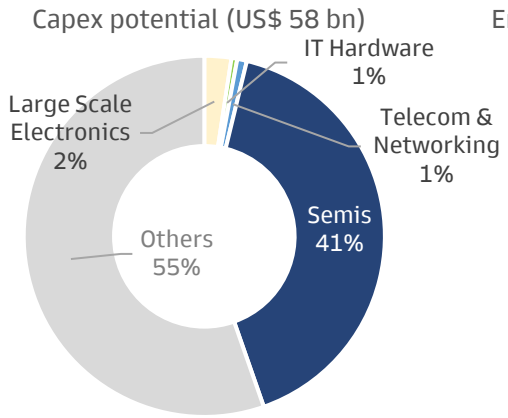
The four Tech sector PLIs* represent 51% of total revenue potential among 14 PLIs, or US$234bn



Capex

41%

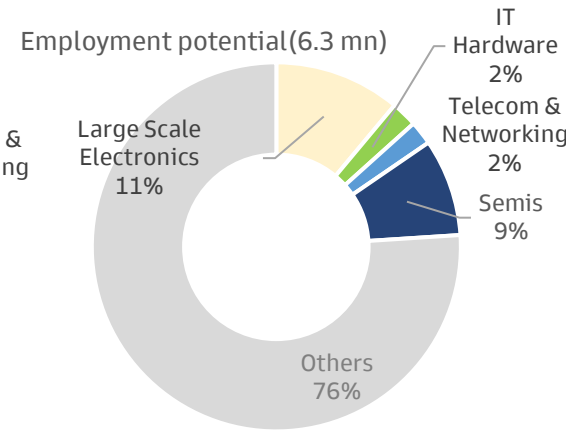
The four Tech sector PLIs represent 45% of total capex potential among 14 PLIs, or US$26bn



Employment

24%

The four Tech sector PLIs represent 24% of total employment potential among 14 PLIs, or 1.5mn jobs

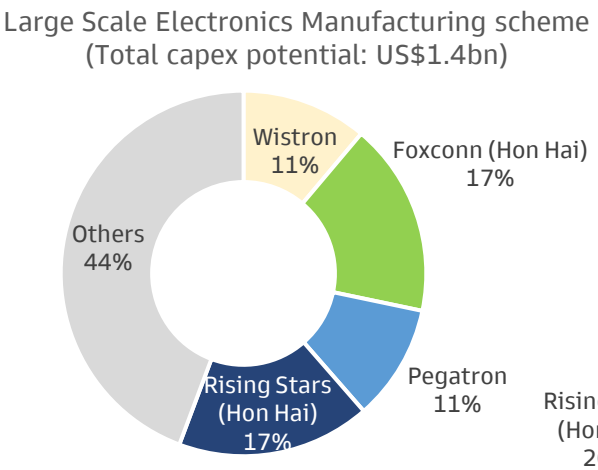


Greater China Tech company's capex contribution in Tech sector PLIs

Electronics

56%

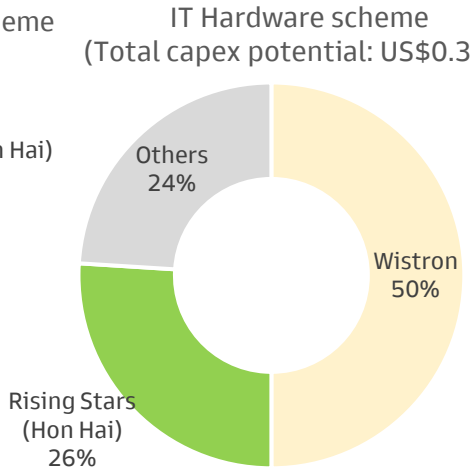
GC tech companies represent 56% of potential capex under Large Scale Electronics Manufacturing scheme



PC, tablet

76%

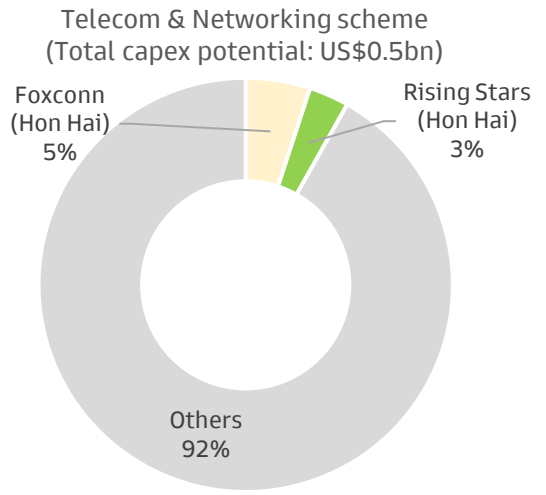
GC tech companies represent 76% of potential capex under IT hardware (PC, tablets) scheme



Telecom equipment

8%

GC tech companies represent 8% of potential capex under telecom and networking scheme



*The Production Linked Incentive (PLI) schemes are Indian government's massive subsidies plan for 14 sub-sectors. Among the 14 PLIs, there are four related to the Tech sector (Large Scale Electronics, IT hardware, Telecom & Networking and Semis)

Source: Government of India, Goldman Sachs Global Investment Research. As of Jan 2023.

Greater China Tech in India

in numbers

PARALLELS TO CHINA

3-4 year

upward cycle for India foreign fixed asset investment

Foreign fixed asset investment growth in China grew in an upward trend in 2001-05. Should India follow China's path, it could see a 3-4 year upward capex cycle.

+54% CAGR

for India mobile phone exports in 2022-25

China enjoyed positive export volume growth for 15+ years from 2000 to 2015. India's 2022 exports appear similar to China's 2001 exports trend. If India follows China's path, it could see mobile phone exports grow at +54% CAGR in 2022-25.

Parallels to China: How China mobile phone exports ramped in 2000-19

OPM AND ROIC

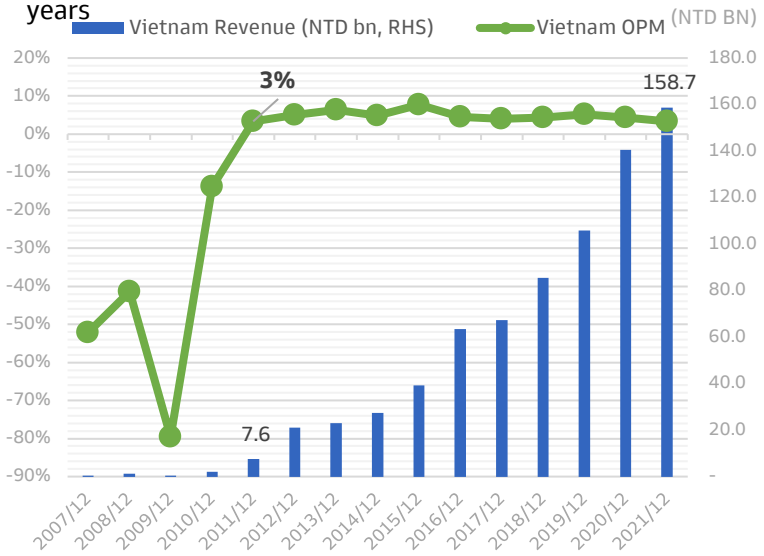
3% and 2% lower

Leading EMS's ROIC is down 3% on avg. in 2015 vs. 2021, a period before vs. after capacity expansion triggered by trade tension in 2019. **OPM is down 2% on avg. over the same period.** We note, capacity expansion in India could lead to lower ROIC and OPM in initial stage, due to factors such as cultural differences, distance from from supply chain and lower production efficiency.

4 years

OPM and ROIC could catch up once scale ramps. **It took Hon Hai 4 years to turn its Vietnam business to a positive OPM.**

Hon Hai's investment in Vietnam: OPM turned positive after 4 years



CAPACITY ALLOCATION

25%

Media suggests Apple is likely to move 25% of global iPhone production to India in 2 years; Hon Hai could invest in a new factory in India in 2023 with ~100k new jobs.

WILL CHINA TECH COMPANIES BENEFIT? - EXISTING LEADERS LIKELY

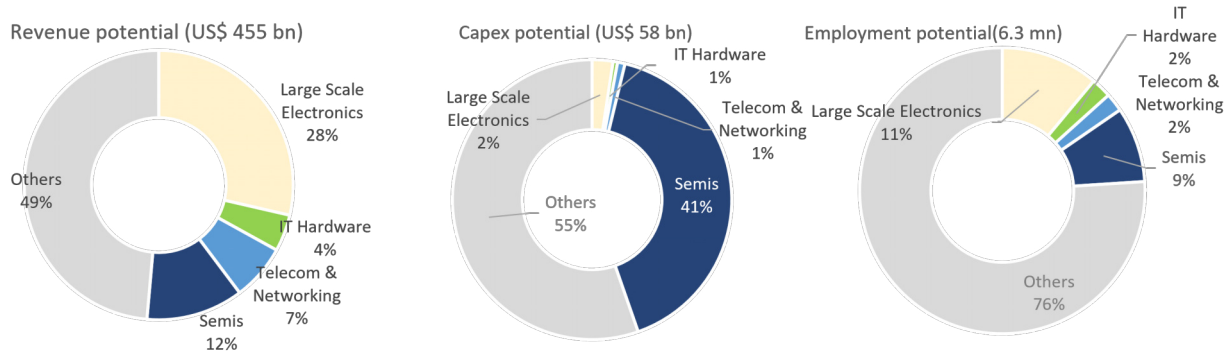
- **Competition from local peers**
- **Incremental investment**
- **Management and supply chain complexity**
- **Geopolitical tension**

Source: China customs, Company data, Goldman Sachs Global Investment Research

PLI schemes: Technology plays a vital role

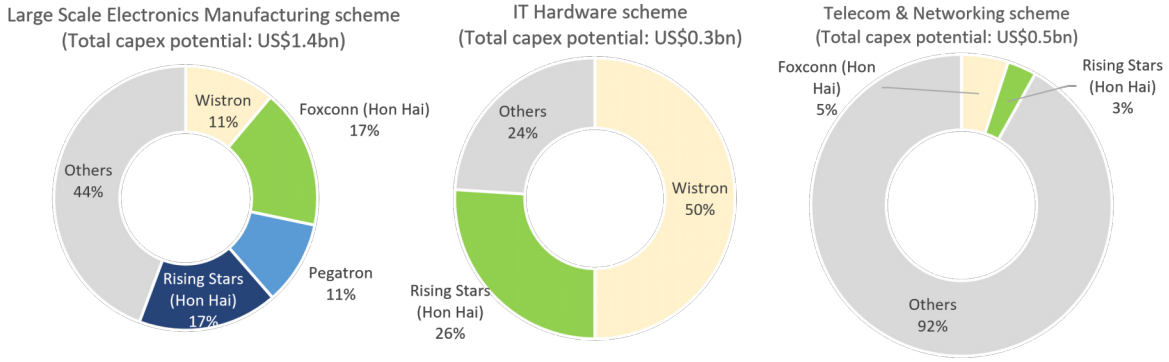
The Production Linked Incentive (PLI) schemes are the Indian government's substantial subsidies plan for 14 sub-sectors, potentially to create US$455bn incremental revenues, US$58bn capex and 6.3mn jobs for the country (read more about the PLI potential: report link). We see GC tech companies actively participating in 1) Large-scale electronics & components, 2) IT hardware, 3) Telecom & Networking Products, and 4) Semis PLI scheme, and the four areas account for 51%, 45% and 24% of the total revenue, capex and employment potential of the 14 PLI schemes. GC tech companies' commitments in capex during the incentive period (4-5 years, varies in each scheme) also play an important role, accounting for 56%, 76% and 8% of the PLI of large-scale electronics, IT hardware and telecom & networking products, respectively.

Exhibit 1: Tech-related PLI schemes account for 51%, 45% and 24% of the total revenue, capex and employment potential of 14 PLI schemes
Potential benefits of Electronics, IT hardware, Telecom & Networking and Semis PLI as a percentage of total 14 PLI schemes



Source: Company data, India government, Goldman Sachs Global Investment Research

Exhibit 2: GC tech companies' announced capex accounts for 56%, 76% and 8% of capex in Electronics, IT Hardware and Telecom & Networking PLI schemes
GC tech companies' capex contribution to different PLI schemes

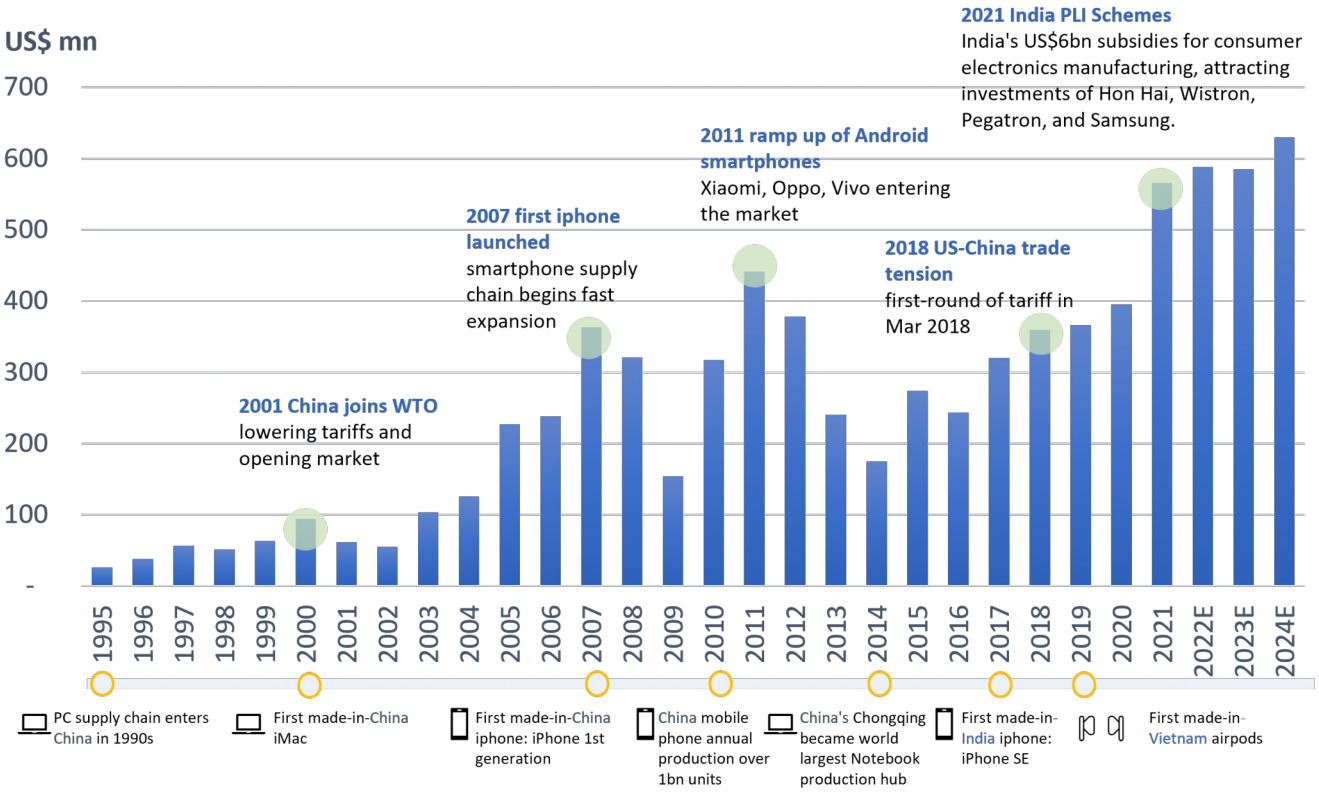


Source: Company data, India government, Goldman Sachs Global Investment Research

The flow of expansion: From China to Southeast Asia to India

We have reviewed Greater China Technology manufacturers' capex trend since 1990s, to show the expansion path from China to SEA and India through the past 25-30 years. In the 1990s, the PC supply chain expanded in China, and the first made-in-China iMac was produced in 2001, also the year when China joined the WTO, attracting more foreign direct investments in the country. In 2007, the first iPhone was made in China, and in 2014, the inner city, Chongqing, became a production hub of PC; while in 2017-19, the expansion gradually moved to Vietnam and India triggered by trade tension and growing labour costs and labour turnover rate in China. In 2017, iPhones started to expand production in India, and in 2019, Airpods started to be made in Vietnam. In 2021, India provided US$6bn subsidies to attract more FDI.

Exhibit 3: Expansion trend: from China to SEA and India
Average capex of mainland China/Taiwan consumer electronics companies from 1995-2024E



Includes Hon Hai, Pegatron, Accton, TCL, Holitech, Sunwoda, Lite-On, DBG, Transsion, Wistron, Inventec, Cheng Uei, Delta Electronics, TSMT, Zhen Ding.

Source: Company data, Goldman Sachs Global Investment Research, Bloomberg

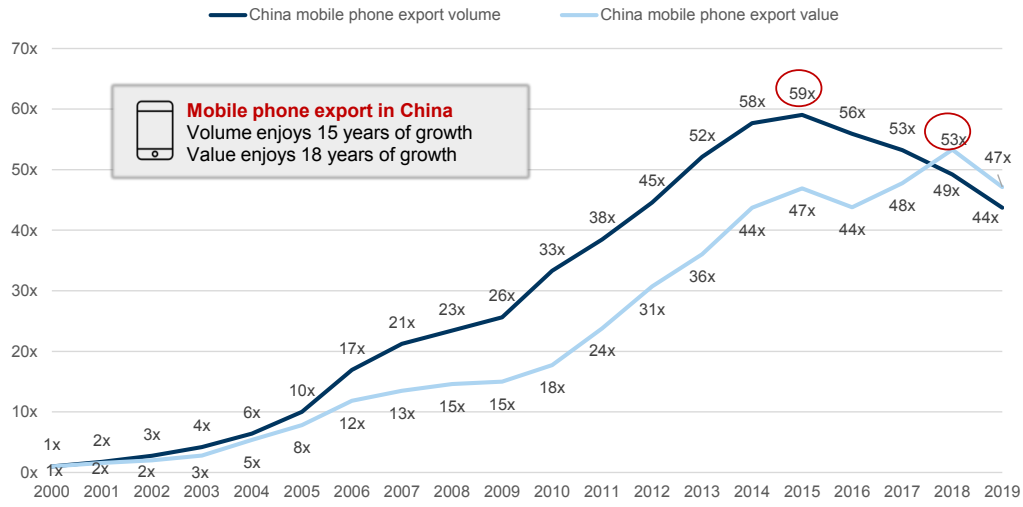
China's mobile phone exports grew rapidly after it joined the WTO in 2001: we use 2000 as the base year to review the growth pattern of China and find:

- In 2000-2015, China's mobile phone export **volume** grew 59x, then saw a gradual decline as other regions such as India, SEA started to pick up.
- In 2000-2018, China's mobile phone export **value (in US$)** grew 53x, then saw a gradual decline. The export value declined later than export volume, as the China supply chain kept improving its technology and exported more high-end models to

the world.

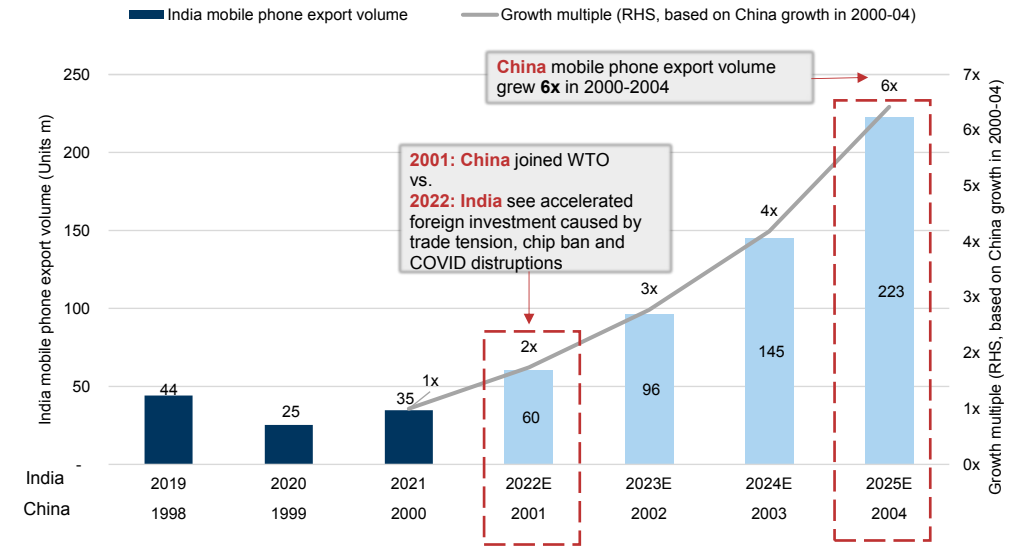
If it grows at the same rate as China did, India will export 223mn units of mobile phones in 2025E, vs. 35mn units in 2021. If we assume the 2022 of India is the 2001 of China and that India follows a similar growth trajectory, we calculate India mobile phone export volume will grow 6x in 2021-2025E. We believe India's 2022 is similar to China's 2001 - after trade tensions, the US chip export restrictions and Covid disruptions, the global supply chain again saw a trend of decentralized and localized production to increase supply chain security. As a leading end market with a large labour force, India became one of the key beneficiaries of the trend in 2022.

Exhibit 4: The growth of China production: how China mobile phone exports ramped from 2000 to 2019



Source: China Customs, Wind

Exhibit 5: If it grows at the same rate as China did, India will export 223mn units of mobile phones in 2025E



Source: India Customs, Goldman Sachs Global Investment Research

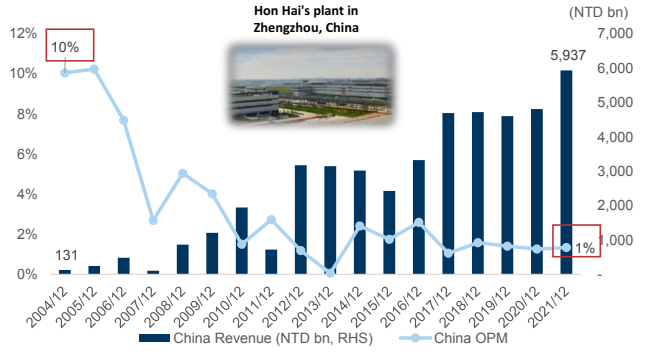
Capex trend: Take Hon Hai as example, which is the largest EMS provider globally. Hon

Hai's investment into China climbed in 2001-2017 or over 15 years, and has slowed down since 2018, given the US-China trade tension. China's smartphone demand peaked in 2016, and the increased investment in 2016-17 was supported by export demand.

Exhibit 6: Hon Hai's investment in China: flattened since 2018, after US-China trade tension

Source: Company accounts

Exhibit 7: Hon Hai's investment in China: OPM now stable at 1%-2%

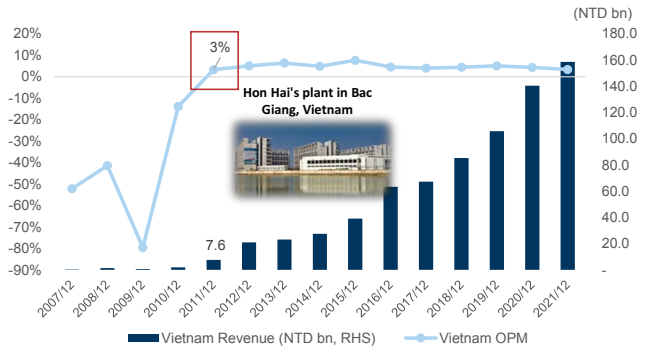


Data include all consolidated subsidiaries in China. Factory photos provided by Hon Hai.

Source: Company data,

Profit trend: It took Hon Hai 4 years to turn its Vietnam business to positive OPM. Hon Hai's India OPM was at -1% in 2021, which is still below the company's blended OPM of 2.5%, which we believe reflects that the new factory has lower efficiency, higher depreciation, and is far away from its supply chain, despite lower labour costs (50% lower vs. China). We expect the OPM to gradually improve through time on the back of scale ramp-up, and improving manufacturing efficiency.

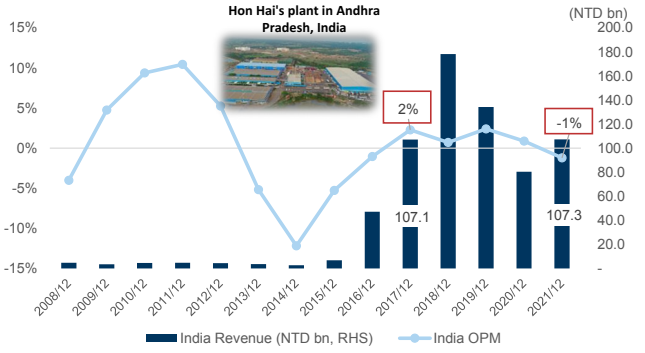
Exhibit 8: Hon Hai's investment in Vietnam: OPM turned positive after 4 years



Data include all consolidated subsidiaries in Vietnam. Factory photos provided by Hon Hai.

Source: Company data

Exhibit 9: Hon Hai's investment in India: OPM still unstable



Data include all consolidated subsidiaries in India. Factory photos provided by Hon Hai.

Source: Company data

Benefits: policies, lower labour costs, large domestic market

Government subsidies drive domestic investments. From 2020-22, India's government has implemented 6 subsidy plans with a total budget of over US$17bn in the technology sector. The subsidies are provided for smartphone, PC/ tablets, server,

electronic components, semis, and telecom equipment, and incentives are directly linked to incremental revenue, incremental net profits or capex that the company earned or invested, providing a strong attraction for companies. For example, the Production Linked Incentive (PLI) for Large-scale electronics manufacturing provides a 3%-6% incentive to incremental sales, which enterprises find attractive as the GM for leading EMS was only 4%-6% (Hon Hai 6%, Pegatron 4%, Wistron 6%) in 2021. For greater China tech companies, Taiwan players are major participants in these subsidies schemes. However, some smartphone brands from mainland China are also actively seeking partnership with India EMS that qualify for the PLI schemes. We note that Transsion has said it is looking for JV partnership with India's domestic EMS to share the benefits of PLI subsidies.

Exhibit 10: India's recent subsidies for the technology sector

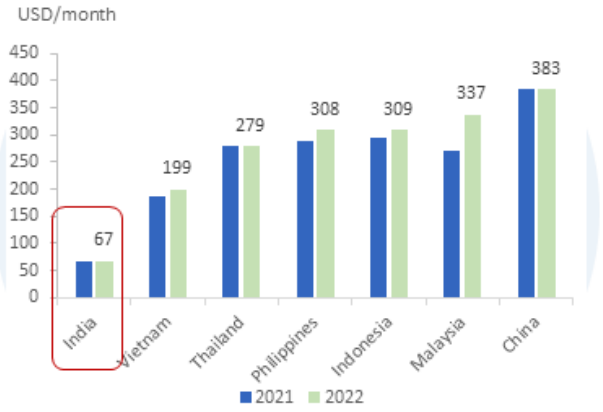
India policies for technology sector	Announcement date	Total budget (INR bn)	Total budget (US$bn)	Incentive Details	Greater China Participants
PLI for Large Scale Electronics Manufacturing: ***Electronic Components***	Round 1: 2020 Round 2: 2021	409.51	4.9	Round 1: 4%-6% on incremental sales Round 2: 3%-5% on incremental sales	Hon Hai, Wistron, Pegatron
PLI for IT Hardware: ***PC, Tablets, Servers***	2021	73.25	0.9	2% to 4% on incremental sales	Hon Hai, Wistron
Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS): ***Electronic components, semis, capital goods***	2020	32.85	0.4	25% on capex	-
Modified Electronics Manufacturing Clusters Scheme (EMC 2.0): ***Electronics Manufacturing***	2020	37.62	0.5	up to 50% of infrastructure project cost	-
PLI for Promoting Telecom & Networking Products Manufacturing: ***Telecom equipment***	2021	121.95	1.5	4% to 7% on incremental sales	Hon Hai
Modified Programme for Semiconductors and Display Fab Ecosystem: ***fabs and semi design***	2022	760	9.1	Fab: 50% of capex project cost Semi design: 50% R&D costs and 6% - 4% on net sales	Hon Hai (announced JV with Vedanta)

Source: India Ministry of Electronics & Information Technology, Company data

Besides government incentives, per our checks with the Greater China technology supply chain, major drivers for expanding production in India include: **(1) Large domestic market.** India's population had reached 1,408m by 2021, similar to that of China (1,412m), supporting large domestic demand. **(2) Lower labour costs**, only 50% of those in China given lower wages and lower employment turnover. **(3) Trade tension and geopolitical uncertainties**, which are driving companies to build a diversified production network and build backup facilities outside of China. **(4) Market share**; we see brand customers are keen to diversify production sites given macro uncertainties (e.g. geopolitical tension, COVID and inflation), and those that can expand capacity globally have a better chance of keeping or expanding market share. As an example, three Taiwan-headquartered companies were added to Apple's top supplier list in FY 2021 (Link), while none of them produce products for Apple in Taiwan – two of them produce the products in mainland China and one in both mainland China and India.

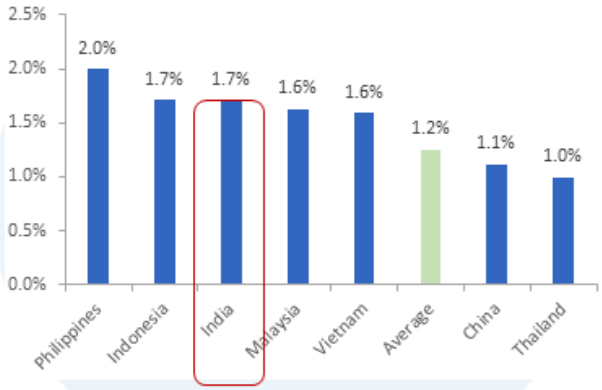
Exhibit 11: India is advantageous in terms of wage level and demographic structure, while still catching up with education
Comparing wage level, demographic structure, education and power prices in India, China and South-east Asia

India has the lowest minimum wage



Source: Trading Eco

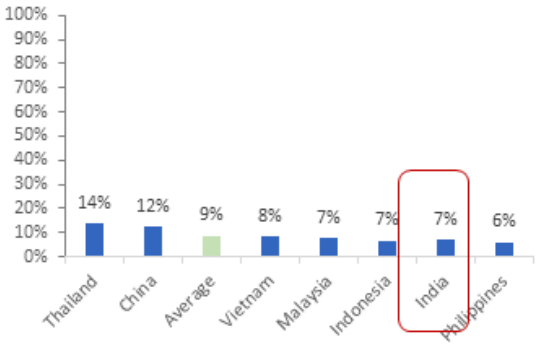
India has a higher birth rate



Source: World Bank, as of 2020

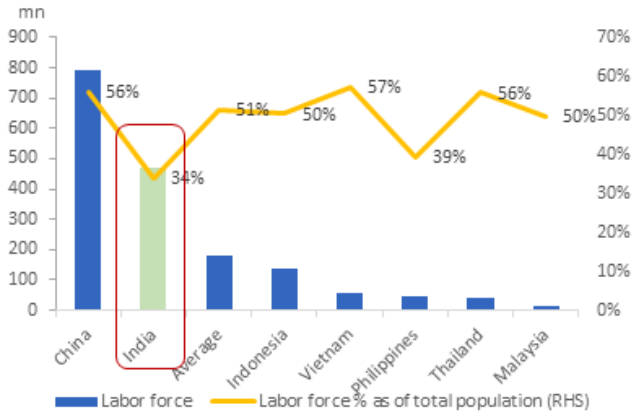
India has a better age structure than China, with a lower % of elderly people

Percentage of population aged 65 and above



Source: World Bank, as of 2021

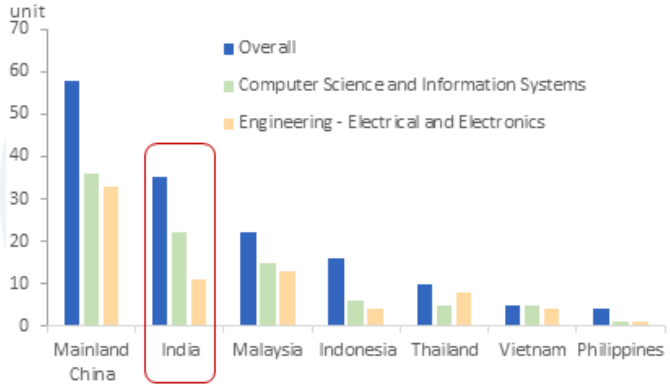
Labor force in China and India far larger than in SEA



Source: World Bank, as of 2021

Mainland China has the most universities ranking 1-1,000

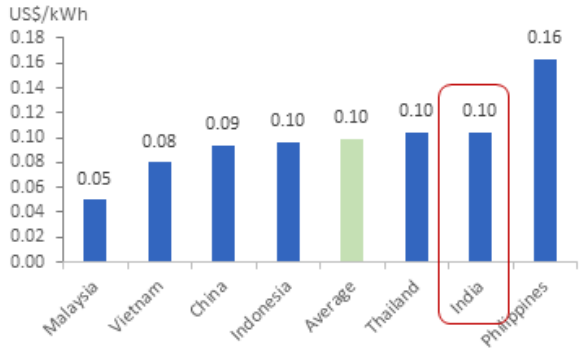
Number of universities ranked in the top 1,000 (2022)



Source: QS World Ranking

India has a similar industrial electricity price to China

Electricity prices in China, India and Southeast Asia (2021)



Source: Global Petrol Prices

Exhibit 12: Tax rate in India is similar to China (2021)

Country	VAT	CIT	VAT Special tax rate	CIT Special tax rate
China	13%	25%	• 6% for R&D and technology services, and value-added telecom services. • 9% for transportation, infrastructure, and real estate leasing business.	• 10% for selected IC design and key software enterprises • 15% for government-supported high technology enterprises • 20% for qualified small and medium enterprises
India	12.5%	25%/30%	• 1% for gold, silver, and precious stones. • 4% for cooking oil, tea, and medicines. • 20% for motor spirit (petrol, diesel and aviation turbine fuel), and liquor.	• 25% only for companies that turnover did not exceed INR 4 billion in FY 2020/21 • Additional 4% for health and education services • Additional 1.2% for companies with net income up to INR 10 million • Additional 3.38% for companies with net income up to INR 10-100 million • Additional 4.94% for companies with net income > INR 100 million **• 40% for foreign companies** • Additional 1.6% for foreign companies with net income up to INR 1-10 million • Additional 2.43% for foreign companies with net income up to INR 10-100 million • Additional 3.68% for foreign companies with net income > INR 100 million

Source: State Taxation Administration of China, Vietnam FIA, The Revenue Department of Thailand, Philippines Bureau of Internal Revenue, Ministry of Finance Malaysia, pwc

Challenges: Lower ROIC, no mega sites, and geographical distance from supply chain

Key challenges to ramping up production in India include lower investment return (ROIC), different languages and **work-life preferences**, geographical distance from the supply chain, and dispersed production sites. While talent supply is a market concern, companies are relatively positive, stating that local talent is sufficient for manufacturing, especially when more companies move in and train local workers.

Tariffs play a key role in driving local production in India. Take smartphones for example. The Indian government charges a 20% tariff for imported smartphones, which means that local production in India carries higher profitability than phones produced outside of India. Per our supply chain channel checks, labor costs in India are 50% below China, though we note that India is further away from the supply chain, leading to higher transportation fees. In addition, India's power supply has not been stable (link), suggesting potential to cap development of higher value-added products, such as panels, semiconductors, or precision components. The newly established factories in India also carry higher depreciation costs and lower efficiency as they need to train laborers. Different working habits, such as laborers preference to work in their hometowns rather than stay in dormitories, also leads to smaller scale per production site, leading to lower manufacturing efficiency. We estimate the GM in India is lower than in China, if excluding the 20% tariff.

Exhibit 13: With a 20% tariff, local production in India enjoys better profitability
Illustrative margin on smartphone production: Made in China vs. Made in India

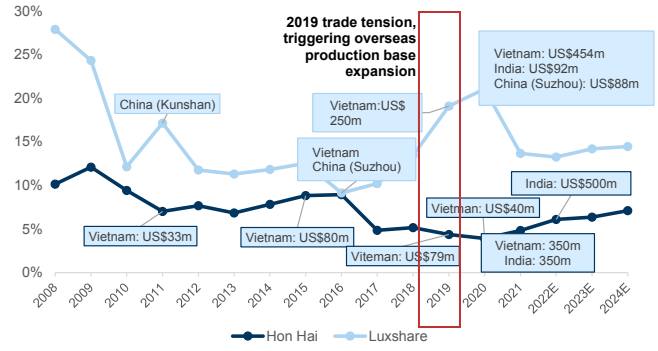
Smartphones	Made in China, sell in India	%	Made in India, sell in India	%	Diff.	Remarks
Revenue	**100.00**		**100.00**		**0%**	
Cost of good sold						
1. Raw materials	76.00	*64%*	81.32	*82%*	7%	Main components are shipped from China to India, creating higher costs
1.1 Key components	76.00		76.00		0%	
1.2 Tariff	0.00		3.80		n.a.	Assume blended tariff is 5% (10%-15% import tariff of camera module, display and vibrator motor)
1.3 Transportation	0.00		1.52		n.a.	Assume transportation cost at 2% of good values
2. Labour	7.00	*6%*	3.50	*4%*	-50%	Lower labor cost in India due to larger working aged population and lower turnover rate
3. Manufacturing	4.48	*4%*	4.70	*5%*	5%	Assume 5% lower production efficiency in India than in China for long-term, due to smaller production site
4. Depreciation	4.48	*4%*	4.70	*5%*	5%	Higher depreciation cost due to newer production lines
5. Utility	4.48	*4%*	4.70	*5%*	5%	Industrial electricity price in China and India are similar; however, power supply is less stable vs. China
6. Tariff	20.00	*17%*	0.00	*0%*	n.a.	20% import tariff of smartphone from China to India
7. Transportation	2.00	*2%*	0.00	*0%*	n.a.	Assume transportation cost at 2% of good values
Cost of good sold	**118.44**	*100%*	**98.93**	*100%*	**-16%**	
Gross profits	**-18.44**		**1.07**			
Gross margin	-18.44%		1.07%			With 20% tariff, local production in India enjoys better profitability

Source: Company data, India Central Board of Excise & Customs, Goldman Sachs Global Investment Research

Production is less scalable in India than in China due to different work-life preferences. Generally speaking, India's workers tend to work close to home, and Chinese workers are used to staying away from their hometowns in dormitories / factories. For example, Hon Hai operates in three smaller manufacturing campuses in India across Sri City in Andhra Pradesh state and Sriperumbudur in Tamil Nadu state, while it has a centralized production base in Zhengzhou, China. The three India sites host 30-40k workers and 50+ assembly lines in total, while the Zhengzhou base has 200-300k workers (in peak season) and 90+ assembly lines. Pegatron's production sites in India are a similar size, with 20-30k workers per site. Hon Hai is planning to invest in a new factory in India, which could potentially recruit up to 100k workers.

ROIC and OPM could be lower initially. The dispersion of factories across India could bring lower production efficiency compared to the mega sites that operate in China. Hon Hai and Luxshare are two key names in Greater China Tech that have expanded capacity to diversify production sites for clients. However, both companies' ROIC declined over the past decade in step with their capacity expansion, potentially reflecting lower efficiency under a regional production hub model compared to a centralized production base.

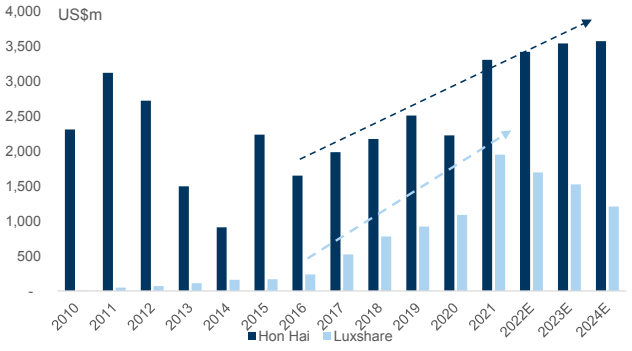
Exhibit 14: Both Hon Hai and Luxshare's ROIC declined with capex in expansion



2022-24E are GSe.

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 15: Both Hon Hai and Luxshare have increased capex for production base diversification

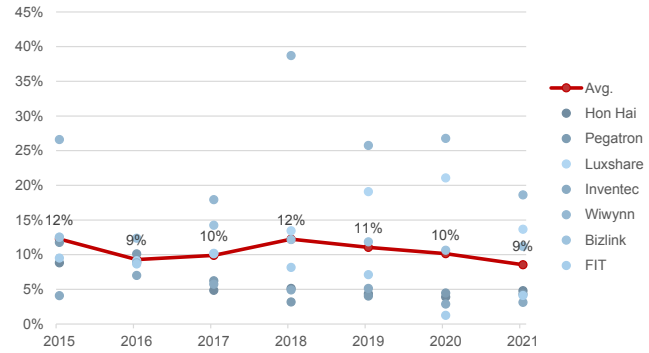


2022-24E are GSe.

Source: Company data, Goldman Sachs Global Investment Research

- **Leading EMSs ROIC down by 3% on avg. in 2015-2021**: We compared the ROIC of companies that expanded capacity into India/SEA in 2015 vs. 2021, periods before and after the capacity expansion triggered by trade tensions in 2019. We note that most companies' ROIC declined during the period (down from 12% in 2015 to 9% in 2021, on average). The decline in ROIC was mainly due to increased capex, lower production efficiency in new sites, a longer supply chain, and reduced scale effects given decentralized production.
- **Lower ROIC compared to local peers:** Compared to local peers, Greater China companies that expanded into SEA and India also have lower ROIC. In 2015, Greater China companies' average ROIC was 12% vs. local peers (SKP in Malaysia, Hana in Thailand, and Dixon in India) at an average 17%. By 2021, Greater China companies' average ROIC had fallen to 9% vs. the local peer average sustained at 12%. We believe this reflects the diversifying production base business model carrying a lower ROIC.
- **Lower OPM:** Greater China Tech companies' OPM was higher when in 2015 (on average 6%, centralized production sites) vs. in 2021 (4%, diversified production), as production sites became more diversified and competition intensified in consumer electronics. Greater China Tech companies that diversified production had an avg. OPM of 4% vs. localized peers at 6%, which could potentially reflect a higher efficiency of centralized production compared to regional production hubs.

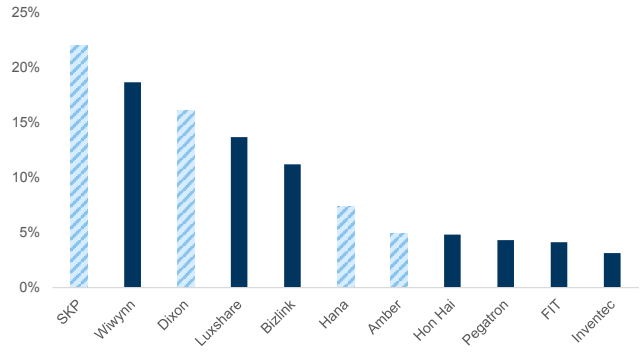
Exhibit 16: Global leading EMS ROIC was on average 12% in 2015 (centralized production sites) vs. 9% in 2021 (diversified production)



Source: Company data

Exhibit 17: Local EMS has higher ROIC compared to Greater China vendors expanding to India and SEA

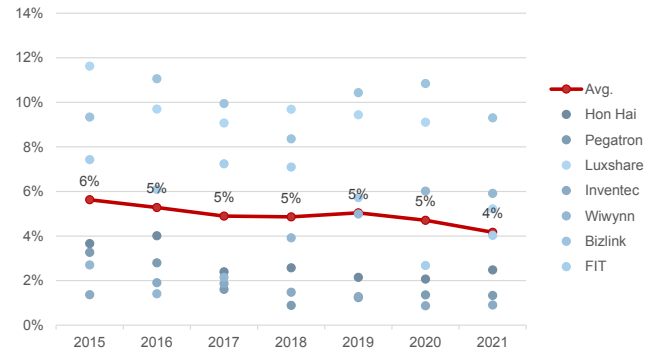
ROIC in 2021: local EMS vs. Greater China vendors expanding to India



SKP in Malaysia, Hana in Thailand, and Amber and Dixon in India

Source: Company data

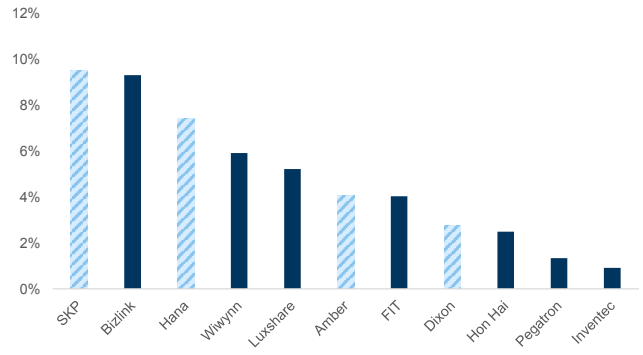
Exhibit 18: Global leading EMS OPM was on average 6% in 2015 (centralized production sites) vs. 4% in 2021 (diversified production)



Source: Company data

Exhibit 19: Local EMS has higher OPM compared to Greater China vendors expanding into India and SEA

ROIC in 2021: local EMS vs. Greater China vendors expanding to India



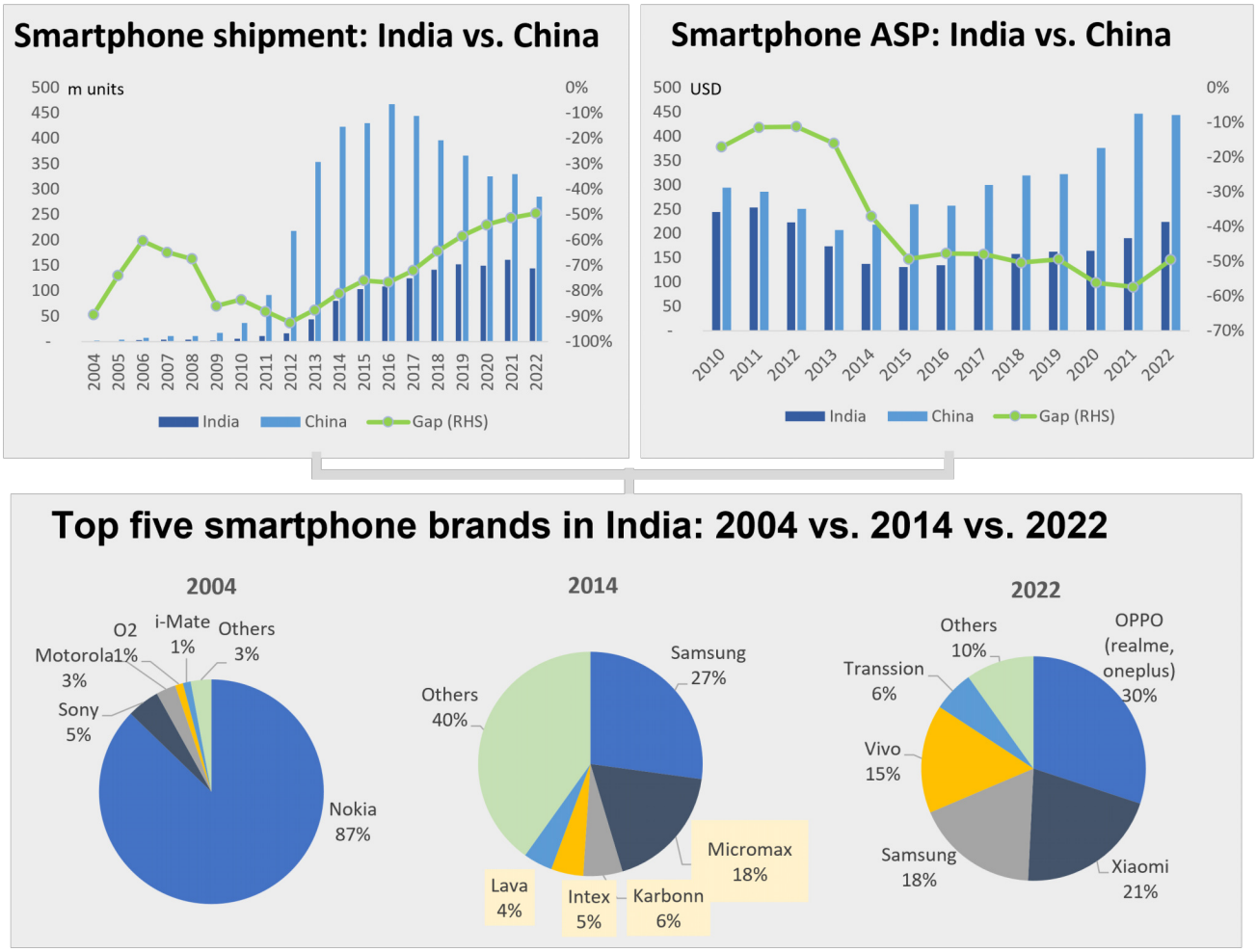
SKP in Malaysia, Hana in Thailand, and Amber and Dixon in India

Source: Company data

Smartphones: China brands and supply chain remain large

India smartphone market is at 144m units in 2022, or 12% of global market share, which is 50% below China despite similar population; ASP is at US$224 in 2022, also 50% below China. The smartphone penetration rate is at 72% in India, much lower than China's 98%, showing upside, per IDC. India smartphone market is dominated by China smartphones, with OPPO (including realme and oneplus), Xiaomi, Vivo, and Transsion accounted for 73% of market in 2022, followed by Samsung at 18%, and Apple at 5%, per IDC.

Exhibit 20: Top five smartphone brands in India: 2004 vs. 2014 vs. 2022



Source: IDC

Products: latest specification from Chinese brands: We compare the high/ mid/ low end models of Indian local brands and Chinese brands, and found: (1) Chinese brand address a more high-end market, with stronger SoC, larger storage, better display (OLED vs. LCD, higher resolutions), better camera (high pixels and more cameras per phone) and fast charging (up to 120W for Chinese vs. 18W for local) and (2) With budget (US$100 or below), the smartphones specification between Chinese brands models and Indian ones are quite similar.

Exhibit 21: High-end, Mid-end, Low-end models of each brand in India

High end	*Chinese brand*			*Indian local brand*	
Brand	**Xiaomi**	**Oppo**	**Vivo**	**Micromax**	**Lava**
Model	**Xiaomi 13 Pro**	**Reno 8 Pro 5G**	**X80 Pro**	**in note 1**	**Blaze 5G 6GB**
Release date	Dec 2022	Jul 2022	Apr 2022	Nov 2020	Oct 2024
Price starting (US$)	1,099	647	1,062	122	200
Chipset, storage					
Network	5G	5G	5G	4G	5G
RAM (max)	12GB	12GB	12GB	4GB	6GB
ROM (max)	256GB	256GB	512GB	128GB	128GB
SoC	Qualcomm Snapdragon 8 Gen 2 (4 nm)	Mediatek Dimensity 8100-Max (5 nm)	Qualcomm Snapdragon 8 Gen 1 (4 nm)	Mediatek Helio G85 (12nm)	Mediatek Dimensity 700 (7 nm)
Panels					
Display type	OLED	OLED	OLED	LCD	LCD
Refresh rate	120Hz	120Hz	120Hz	-	90Hz
Panel size	6.73	6.7	6.78	6.67	6.52
Panel resolution	1440 x 3200 (522 ppi)	1080 x 2412 (394 ppi)	1440 x 3200 (517 ppi)	1080 x 2400 (395 ppi)	720 x 1600 (269 ppi)
Cameras					
Front camera (MPx)	32	32	32	16	8
Rear camera (MPx)	50.3+50+50	50+8+2	50+48+12+8	48+5+2+2	50+2+VGA
Fast charging and battery					
Battery	4820 mAh	4500 mAh	4700 mAh	5000 mAh	5000 mAh
Charging	120W	80W	80W	18W	10W

Mid end	*Chinese brand*			*Indian local brand*	
Brand	**Xiaomi**	**Oppo**	**Vivo**	**Micromax**	**Lava**
Model	**K50i 5G**	**F21 Pro 5G**	**V27 Pro**	**in 1b**	**Yuva 2 Pro**
Release date	Jul 2022	Apr 2022	Mar 2023	Nov 2020	Feb 2023
Price starting (US$)	391	391	562	98	122
Chipset, storage					
Network	5G	5G	5G	4G	4G
RAM (max)	8GB	8GB	12GB	4GB	4GB
ROM (max)	256GB	128GB	256GB	64GB	64GB
SoC	Mediatek Dimensity 8100 (5 nm)	Qualcomm Snapdragon 695 5G (6 nm)	Mediatek Dimensity 8200 (4 nm)	Mediatek Helio G35 (12 nm)	Mediatek Helio G37 (12 nm)
Panels					
Display type	LCD	OLED	OLED	LCD	LCD
Refresh rate	144Hz	-	120Hz	-	-
Panel size	6.6	6.43	6.78	6.52	6.52
Panel resolution	1080 x 2460 (407 ppi)	1080 x 2400 (409 ppi)	1080 x 2400 (388 ppi)	720 x 1600 (269 ppi)	720 x 1600 (269 ppi)
Cameras					
Front camera (MPx)	16	16	50	8	5
Rear camera (MPx)	64+8+2	64+2+2	50+8+2	13+2	13+VGA+VGA
Fast charging and battery					
Battery	5080 mAh	4500 mAh	4600 mAh	5000 mAh	5000 mAh
Charging	67W	33W	66W	10W	10W

Low end	*Chinese brand*			*Indian local brand*	
Brand	**Xiaomi**	**Oppo**	**Vivo**	**Micromax**	**Lava**
Model	**Redmi A1**	**A17k**	**Y02**	**in 2C**	**X3**
Release date	Sep 2022	Oct 2022	Nov 2022	May 2022	Dec 2022
Price starting (US$)	110	159	159	73	98
Chipset, storage					
Network	4G	4G	4G	4G	4G
RAM (max)	3GB	3GB	3GB	3GB	3GB
ROM (max)	32GB	64GB	32GB	32GB	32GB
SoC	Mediatek Helio A22 (12 nm)	Mediatek Helio G35 (12 nm)	-	Unisoc T610 (12 nm)	Mediatek Helio A22 (12 nm)
Panels					
Display type	LCD	LCD	LCD	LCD	LCD
Refresh rate	-	-	-	-	-
Panel size	6.52	6.56	6.51	6.52	6.52
Panel resolution	720 x 1600 (269 ppi)	720 x 1612 (269 ppi)	720 x 1600 (270 ppi)	720 x 1600 (269 ppi)	720 x 1600 (269 ppi)
Cameras					
Front camera (MPx)	5	5	5	5	5
Rear camera (MPx)	8+0.08	8	8	8+VGA	8+VGA
Fast charging and battery					
Battery	5000 mAh	5000 mAh	5000 mAh	5000 mAh	4000 mAh
Charging	10W	-	10W	10W	10W

Source: Company data

Brands: China smartphones as dominators: India smartphone market is dominated by China smartphones, sharing the similar supply chain. The larger local brands are

Micromax, Lava and Reliance (Jio), with 8-13 years history; yet small annual shipment at 0.4-0.7m or <1% market share each.

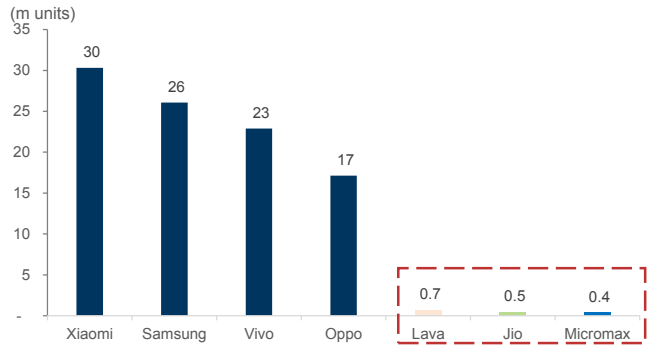
- **Shipment and ASP:** India local brands' shipment is small (market share <1%). ASP also lower, avg. at US$87, vs. Chinese players' avg. ASP at US$180.
- **Brand image varies:** (1) Indian brand: Lava emphasis 'Made in India' and 'trust worthy', Micromax are closer to young people, while Jio has a more Tech specifications included by partnering with Google to bring an 'Indian customized OS' to consumers; (2) Chinese Brand: Xiaomi focuses on 'Made in India' and price-performance ratio; Oppo and Vivo are more expensive with 'Good quality'.
- **Marketing strategy:** Indian brands' marketing are much simpler: Lava spends less in brand ambassador, Micromax are less advertised and Jio highlights partnership with Google. Chinese players are more aggressive, with higher spending in brand ambassadors, TV/ airport/ outdoor advertisements and sponsorship to sports teams/ sports games.
- **Channel strategy:** Lava and Micromax rely on online brand stores and retailer partnerships, and Jio utilize its telecom channel as largest telco operator in India; It is not common for these local brands to have their own brick-and-motor brand stores. Chinese players' channels in India has been quite sophisticated.

Exhibit 22: Smartphone brand comparisons in India: Chinese brands vs. Indian brand

Smartphone brands in India	*China brands*			*India brand*		
Brand	Xiaomi	Oppo	Vivo	Lava	Micromax	Jio
2022 shipment in India (m units)	30	17	23	0.68	0.37	0.47
2022 ASP in India (US$)	152	184	204	82	106	73
Market share	21%	12%	16%	0.5%	0.3%	0.3%
Brand image	Made in India, high price–performance ratio	Good quality	Good quality	Made in India, most trusted brand	Young	Tech
Marketing strategy	✓ Brand ambassador (Indian actor)	✓ Advertisement (posters, TV, airport) ✓ Sponsorship to Indian national cricket team	✓ Advertisement (posters, TV, airport) ✓ Sponsorship to India's professional cricket league	✓ Brand ambassador (Indian actor)	-	✓ Partnership with Google (Customized AndroidOS)
Channel strategy	✓ Brand online store ✓ Brand offline store ✓ Retailers (12k+) ✓ Telecom channel	✓ Brand online store ✓ Brand offline store ✓ Retailers (60k+)	✓ Brand online store ✓ Brand offline store ✓ Retailers (70k+)	✓ Brand online store ✓ Retailers	✓ Brand online store ✓ Retailers	✓ Telecom channel (Jio is the largest Telecom operator in India)

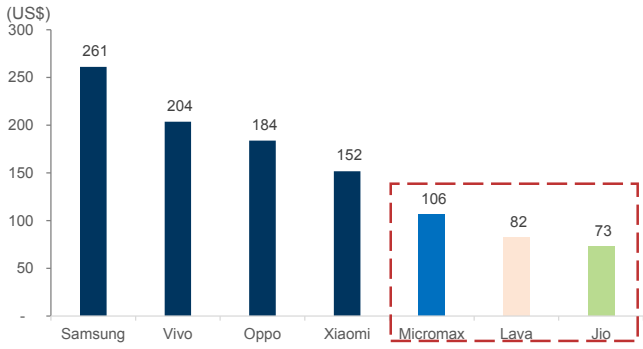
Source: Company data, IDC

Exhibit 23: India's local smartphone brands' shipment were <1m in 2022
India smartphone shipment by brand



Source: IDC

Exhibit 24: India local smartphone brands' ASP was US$87 on avg. in 2022, vs. market blended at US$256
India smartphone ASP by brand



Source: IDC

Supply chain: some components can be produced locally; while ICs rely on import:

- **Display,** Samsung, TCL, Tianma Holitech, Lianchuang, and TXD Tech have back-end display modules factories in India. India mining Group Vedanta aims to build TFT LCD panel and module plant in India (in partnership with Innolux), which would be India's first flat panel display factory including both TFT, color filter, and cell frontplane processes and module assembly (link).
- **Camera module/ finger print module**, Sunny Optical, Q-tech, Holitech have local capacity. Indian firm Murugappa group recently acquired a camera module factory in India in 2022 (link) and could potentially become a local supplier. **PCB,** Zhen Ding has built local capacity. **Casing/ Mechanical parts**, Lingyi iTech has built local capacity. **Cable & Chargers,** with both international and local suppliers (Creatons).
- **Assembly**, mostly self-own factories (Micromax, Intex), some out-sourced to Hon Hai (Reliance Jio), based on our industry check. There are also multiple local EMS (Dixon, Creaton) in India.
- **SoC**, UniSoC and MediaTek are used, however these SoC cannot be produced locally. **Other ICs**, some Chinese IC designers have R&D centers in India (Espressif, Faraday), while manufacturing still rely on import.

Exhibit 25: Smartphone supply chain in India (2022)

Smartphone supply chain in India		International suppliers	Local suppliers
Components			
Display module		Samsung, TCL, Tianma	Vedanta (technology from Innolux)
Camera Module		Sunny Optical, Q-tech, Holitech	Murugappa group
PCB		Zhen Ding	-
Chipset		Espressif (Design), Faraday (Design)	-
Casing/ structural parts		Lingyi iTech, Everwin Precision, Wingtech	TATA Group
Cable & Chargers		Cheng Uei Precision, Yingtong	Creatons
Battery		Sunwoda	Creatons
Assembly		Hon Hai, Pegatron, Flex, DBG Technology, Jabil, Wistron, BYDE, Wingtech, Oppo, Vivo, Transsion	Bhagvati Products, Intex, Dixon, Creatons
Package		YUTO Packaging	
Brands		Samsung, Xiaomi, Oppo, Vivo, realme, Transsion	Lava, Micromax, Karbonn, Jio

Source: Company data

Components: More focused in SEA as close to supply chain

Despite EMS' rising focus on India given the more sufficient labor supply, hardware component supply chain vendors (PCB/CCL/Power supply/Connector) appear more focused on Southeast Asia as they are working on production site diversification from China given the relatively more mature supply chain cluster (e.g. back-end semiconductors in Malaysia). For example, leading smartphone CCL supplier, Elite Material, and leading server PCB supplier, Gold Circuit, both plan to build new production sites either in Vietnam or Thailand, marking their first non-Greater China factory. Global EV/telecom/cloud power supply leader Delta Electronics has quite a strong production footprint in Thailand, due to its close ties with Delta Thailand. Leading smartphone FPCB supplier, Zhen Ding, appears to be an exception as the company has spent over US$100mn building its factory in India; while the production line is for back-end SMT which may provide last-mile component delivery support to its parent company Hon Hai.

India and Southeast Asia expansion pipeline

While H/W component supply chain vendors are focused on expansion opportunities in Southeast Asia, it is worth noting that current and/or planned into India at US$15.6bn is equal to c.90% of the total investment in SEA. Within the US$15.6bn investment, we see GC tech commitments so far at US$2bn in India, with 85% out of the US$2bn goes

to assembly.

Exhibit 26: Expansion roadmap in Southeast Asia (SEA) and India

Country	Sector	2021 and before	2022	2023	2024	2025	Long-term/ not specified	Investment (US$ mn)	Total investment (US$ mn)
India	Consumer electronics		**Hon Hai** (Taiwan): smartphone assembly capacity expansion					500	
			Vivo (China): smartphone assembly					429	
		Hon Hai (Taiwan): smartphone assembly capacity expansion						350	
				Sunny Optical (Hong Kong): camera modules				300	
		Pegatron (Taiwan): smartphone assembly						135	
		Zhen Ding (Taiwan): PCB SMT						113	
		Luxshare (China): smartphone assembly						92	
			Realme (China): TWS manufacturing*					33	
		DBG Technology (China): smartphone assembly						6	
		Q-tech (Hong Kong): camera modules						4	
	Data Center		**Amazon** (US): data centre					4,400	
		NTT (Japan): data centre						2,000	
			Microsoft (US): data centre					1,837	
	Semis		**Tower Semis** (US) **x Next Orbit Ventures** (India): Analog IC fab (65nm)					3,000	
			Hon Hai (Taiwan): Chip-related production line					119	
	Automotive		**Suzuki** (Japan): EV manufacturing, EV battery					1,370	15,557
			Toyota (Japan): EV parts					624	(GC Tech
			Kia (Korea): EV manufacturing					245	companies: 2,081)
Vietnam	Consumer electronics		**Samsung** (Korea): smartphone components (mainboards, PCB, camera modules, linear motors)*					920	
			Samsung (Korea): TV and home appliances*					841	
			Ju Teng (Taiwan): NB/ car monitor casing					43	
		BYDE (China): tablet assembly						27	
	Semis	**Samsung** (Korea): FC-BGA package substrate						852	2,736 (GC Tech
	Automotive	**Gotion** (China): EV LFP batteries						53	companies: 123)
Malaysia	Data Center		**GDS** (China): data centre					306	
			Wiwynn (Taiwan): server PCBA assembly					68	
		Wiwynn (Taiwan): server rack assembly						15	
	Semis	**Intel** (US): advanced packaging and testing						7,000	
			Infineon (Germany): SiC / GaN fab					2,087	
			ams OSRAM (Austria): LED, micro LED					873	
			Tongfu (China): OSAT for processors					455	
			ASE (Taiwan): OSAT for copper clip and image sensor					300	
	Automotive		**Samsung** (Korea): EV Cylindrical batteries					1,300	12,952 (GC Tech
		SK Group (Korea): copper foil for EV battery						548	companies: 1,144)
Indonesia	Semis		**Infineon (Germany):** packaging and testing for car power ICs					34	194 (GC Tech
	Automotive	**Hyundai Motor** (Korea): car manufacturing						160	companies: -)
Thailand	Semis		**WUS Printed Circuit** (China): PCB					280	
			Quanta Storage (Taiwan): SSD, robots					10	
	Automotive		**Hon Hai** (Taiwan): EV manufacturing					400-800	1,589 (GC Tech
			Great Wall Motor (China): EV manufacturing					699	companies: 1,589)

As of Mar 2023.

Source: Company data, data compiled by Goldman Sachs Global Investment Research

Semiconductors: Less motivation for Foundry, but higher possibility for IC design/back-end services to expand in India

For Foundries, we do not expect second tier or leading Taiwan Foundries like TSMC or UMC to build capacity in India in the foreseeable future. This is because they likely have less motivation to move to India given the lack of existing ecosystem, infrastructure and semiconductor cluster. Moreover, both companies currently have sufficient non-Taiwan capacity to address potential S/D headwinds and have supply chain resilience among the supply chain. Other Taiwan Foundry names are also unlikely given their lack of scale to expand.

On the other hand, we see a higher chance for IC design and back-end OSAT companies to expand in India. IC design houses' main investment is R&D has been due to an R&D shortage in Taiwan. We see a higher possibility for IC design companies to expand in

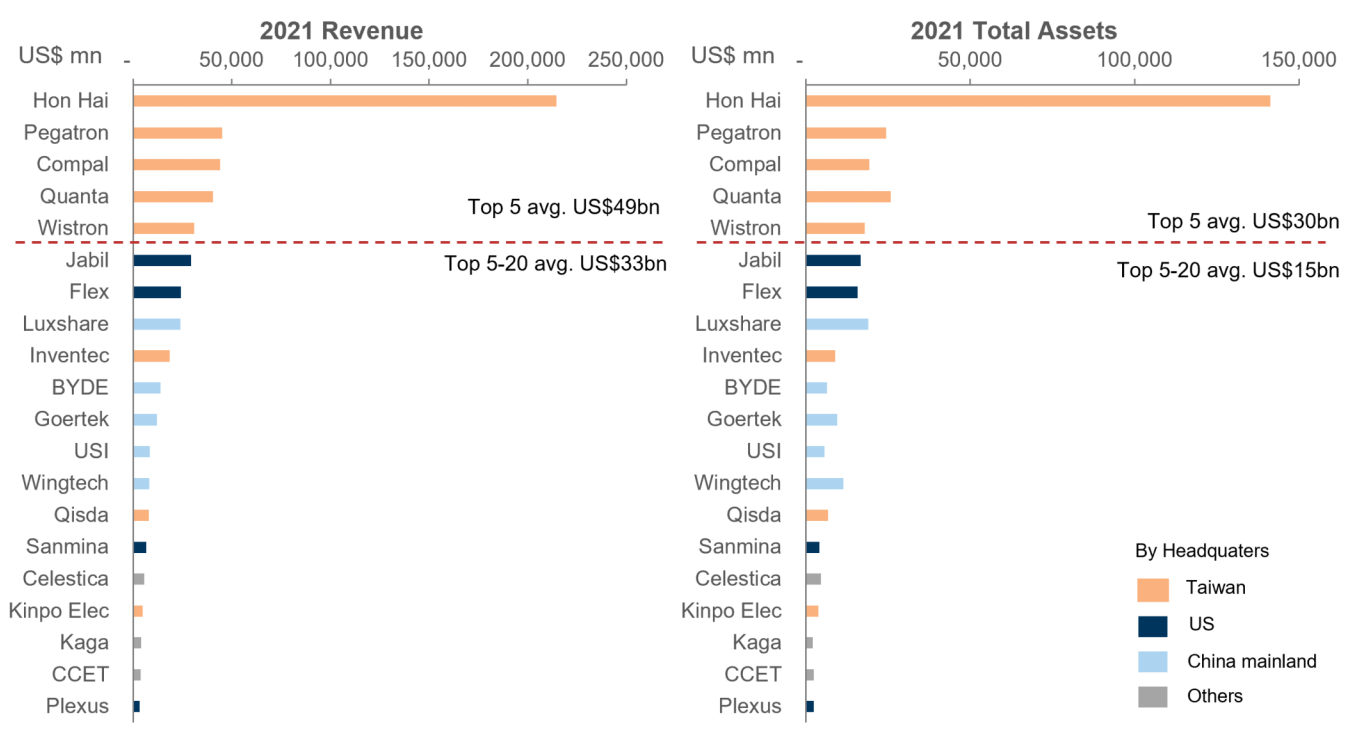
India to seek more R&D talents. For instance, Taiwan IC design houses like MediaTek, have already expanding their R&D center to India. Furthermore, we also see back-end OSAT (outsourced semiconductor assembly and test) services companies as more likely to expand in India as they generally need to be closer to their end-markets and customers. That said, more aggressive subsidy programs from the government may be needed to attract more Investment in India.

Investment implications for Greater China Technology

Will China tech companies benefit from diversification into India? While still too early to gauge given many moving parts, e.g. COVID, geopolitical tensions, macro pressures in various regions, and supply chain disruptions, we expect GC Tech leaders to be benefit, given the rising entry barriers, and leaders having (1) stronger balance sheets to support global capacity expansion, (2) longer experience to manage labour, supply chain, inventory, logistics, and government relations globally, and (3) stronger fundamentals to compete with local peers (e.g. global tier brand customers still rely on 1-2 global leading suppliers but can allocate some orders to local suppliers to secure supply chain safety).

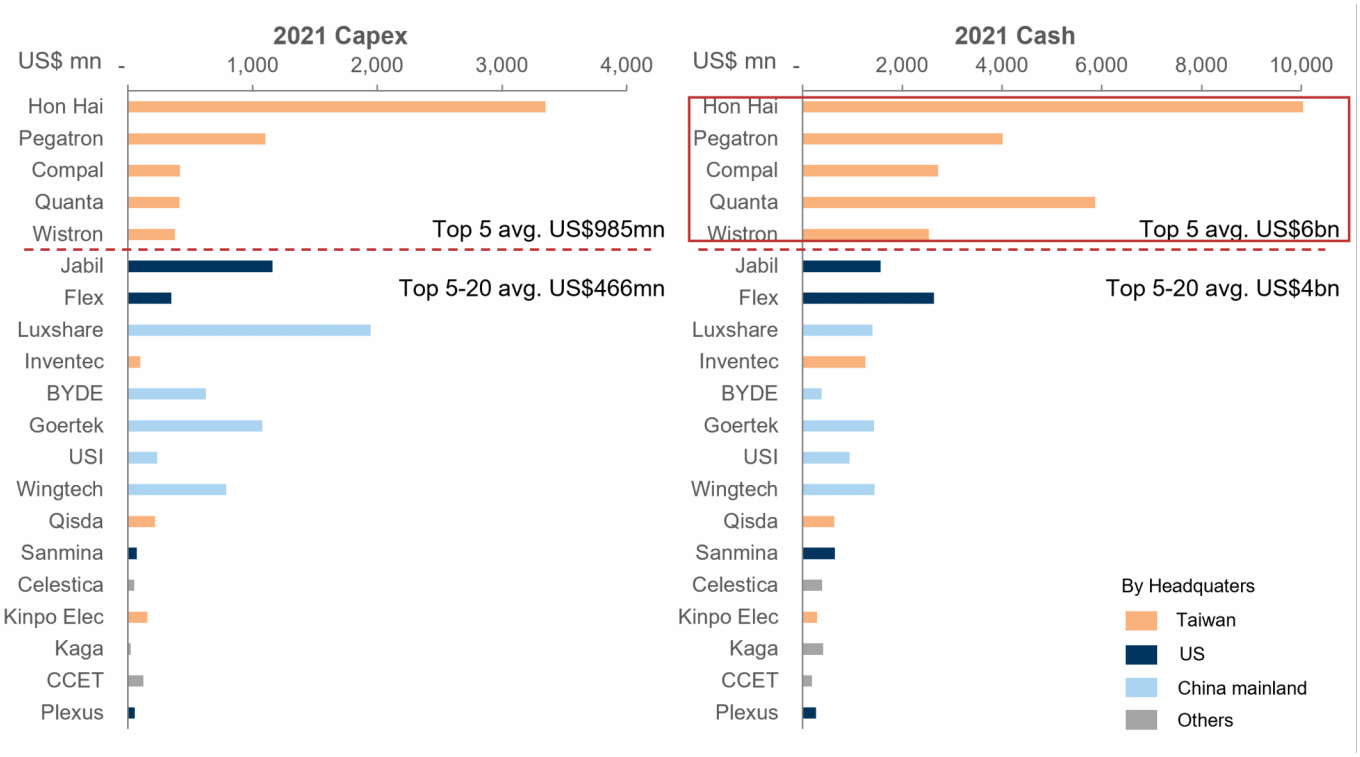
Street thinks EMS is a low value-added business with fierce competition; however, entry barriers are rising as brand makers are asking for diversified production sites to help reduce macro uncertainty. Healthy balance sheets and global experience in managing labour, supply chain, logistics, government relations has become more and more critical to garnering new orders. **Consensus views are that India may be too far away from supply chains challenging value for manufacturers to invest; however, we believe brand customers and government policies could drive India to creating its ecosystem, as was witnessed in China.** Furthermore, we think GC Tech companies who invest early (first mover advantage), will stand out as India's transition to becoming a global manufacturing hub takes hold. **Buy**: Hon Hai, Luxshare.

Exhibit 27: Global EMS / ODM: Top players come with a larger scale



Source: Company data, Bloomberg

Exhibit 28: Mainland China players with larger capex vs. Taiwan players with more cash on hand



Source: Company data, Bloomberg

Potential for more jobs: Both Hon Hai and Pegatron mentioned around 10-20% of their smartphones production for their largest customer will be made in India in the coming 2

years; production in India is currently in single digits. A potential new factory for Hon Hai in Karnataka could potentially bring 100k new jobs (link); meanwhile, Hon Hai's / Pegatron's other factories in India currently have 10-20k labours per site (vs. 200-300k at Hon Hai's Zhengzhou factory).

Opportunities for local supply chain: Local companies also have the potential to have a role in India's transition, considering brand customers' needs. Take China for example, when brand customers established production sites in China, this cultivated local supply chain too: e.g. Luxshare in acoustics, cable/connectors, antenna, wireless charging, haptics, and assembly; Sunny Optical in cameras; AAC; Lens Tech and Biel Crystal in casings; BOE in panels.

Implication to Hon Hai; India contribution could remain low by 2025 considering its large scale: Hon Hai's capacity is 70% in China, and among the 30% outside of China, the largest capacity is in Vietnam; India is in the low single digits. The company's India capacity is set to expand in the coming 2 years with Apple's latest production plan (link). In 2021, Hon Hai's India revenues contribution was around 2%. For context, based on the latest Apple news about shifting more iPhone production to India, if we assume a 4x larger likely revenue contribution in 2025, this would imply contribution of around 6%, which would low in our view given Hon Hai's large scale. We expect a stable capex through 2025 despite growing investments in India, given its factories in other places are mainly requiring maintenance or raising automated levels. Our sensitivity analysis shows that for every 5% decline in smartphone revenue, this would imply a 1% decline on Hon Hai's gross profits, all else equal.

Exhibit 29: Hon Hai: Every 5% smartphone business revenue decline, could translate to a 1% decline in GP

2025E	+0%	-5%	CHG	Remark
Total revenues (NT$m)	**7,266,258**	**7,144,957**	**-2%**	
Smartphones for the largest customer	2,426,014	2,304,713	-5%	Sensitivity analysis: every 5% of revenues decline…
Others	4,840,244	4,840,244	0%	
Mix	**100%**	**100%**	**0%**	
Smartphones for the largest customer	33%	32%	-1%	
Others	67%	68%	1%	
GM	**7.1%**	**7.2%**	**0%**	
Smartphones for the largest customer	5.3%	5.3%	0%	
Others	8.0%	8.0%	0%	
GP (NT$m)	**517,486**	**511,057**	**-1%**	Sensitivity analysis: ...will bring 1% GP decline
Smartphones for the largest customer	128,579	122,150	-5%	
Others	388,907	388,907	0%	

Source: Company data, Goldman Sachs Global Investment Research

We see EV remaining the key catalyst to Hon Hai considering India may remain a small operating segment to Hon Hai given its large scale. 2023 could be a milestone year as its passenger EV should start mass production. With others also announcing production e.g. Fisker in 2024, production is moving toward Hon Hai's 5% market share target in 2025. EV carries stronger market growth and higher margins, which could support a higher valuation e.g. Magna trades at a 13x 2023E P/E vs. 8x for Hon Hai currently. **Recent market concerns on Hon Hai:** (1) Lordstown paused production given quality and performance issues (report link), we note that Lordstown's revenue contribution is relatively small and that Hon Hai'a US factory is operating at normal capacity. (2) competition from Luxshare; note Hon Hai's investments in both India and China show the company's commitment to its largest brand customer, in our view.

Implication on Luxshare; India factories standby: Luxshare's capacity is 70-80% in China, Vietnam accounts for the remaining 20-30%. The company has 2 factories in India since 2019; however, both are on standby now for its largest brand customer. Management expects disciplined capex in coming years and sees Vietnam as the main production hub outside of China. Luxshare's smartphone assembly business for the largest brand customer is not consolidated but booked as investment income in non-op. Our sensitivity analysis shows that for every 5% decline in the smartphone business revenue, Luxshare could see a 1% decline net income, all else equal.

Exhibit 30: Luxshare: Every 5% smartphone business revenue decline, would bring a 1% decline in net income

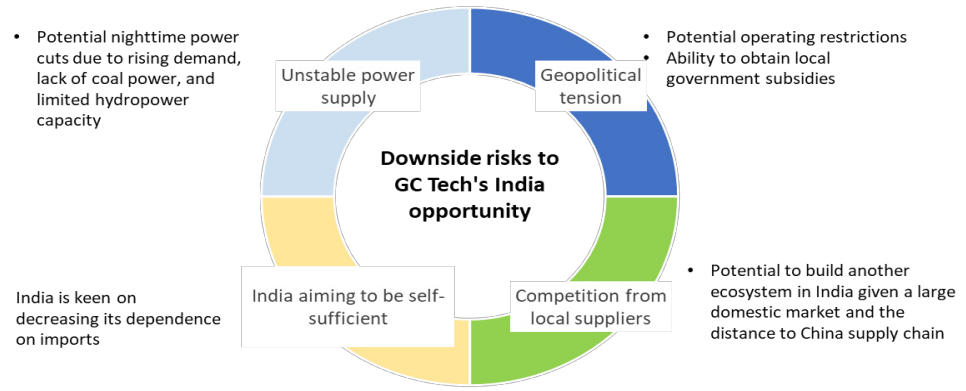
2024E; Rmb m	+0%	-5%	CHG	Remark
Smartphone assembly revenues	**258,252**	**245,340**	**-5%**	
Smartphone assembly net margin	2.0%	2.0%	0.0%	
Smartphone assembly net income	5,165	4,907	-5%	Sensitivity analysis: every 5% of revenues decline…
Booked to investment income	**4,649**	**4,416**	**-5%**	
Operating income	20,403	20,403	0%	
Other non-op income	(635)	(635)	0%	
Pretax income	24,417	24,185	-1%	
Tax	4,395	4,353	-1%	
Minority	-	-	0%	
Net income	**20,022**	**19,831**	**-1%**	Sensitivity analysis: ...will bring 1% NI decline
Tax rate	18%	18%	0%	

Source: Company data, Goldman Sachs Global Investment Research

We see margin recovery and market share gain remaining the key catalysts to Luxshare, considering India is a small operating segment for the company. (1) Margins recovery: top module and metal casing as new business with upside in both scale and yield rate, to drive GM recovery; (2) Market share gain on smartphone assembly. **Recent market concerns on Luxshare** were mainly around potential for geopolitical tensions to cap i market share in global-tier brand makers; concentrated to single customer, leading to more volatile revenue growth.

Downside risks to GC Tech's India opportunity

Exhibit 31: Summary of downside risks to GC Tech's India opportunity



Source: Goldman Sachs Global Investment Research

Geopolitical tension remains a key risk

- As it relates to India production, nowadays, we are seeing more capex investment

from Taiwan companies (e.g. Hon Hai, Pegatron, Wistron) with India government subsidies or partnerships with local companies; meanwhile there has been less investment from mainland China companies. Luxshare, for example, has two factories on standby in India; the company invested in the factories in 2019, but has yet to start production. Luxshare management has mentioned they remain disciplined in capex investment and at present, sees Vietnam as a more vital production site for them outside of China.

- **Operating restrictions could be a risk to Chinese investment in India:** For example, India blocked the use of 118 Chinese apps in 2020 and dozens of Chinese lending apps more recently in Feb 2023, suggesting potential for impact related to government measures. That said, similar bans / restrictions have not been seen in 'hard tech' firms. We note 'hard tech' firms tend to produce fixed assets and provide jobs in India to a greater degree than 'soft tech' ones. They also tend to present fewer concerns in terms of data collection capabilities.

Competition from local suppliers is another key risk. Considering India has a large domestic market, similar to China, and the distance to China supply chain, it is reasonable to think that global-tier brand makers will lean toward investing more in the local market to build another ecosystem. In this vein, we have seen brand makers' investments in mainland China bringing up a comprehensive local supply chain, e.g.: Luxshare in acoustics, cable/connectors, antenna, wireless charging, haptics, and assembly; Sunny Optical in cameras; AAC; Lens Tech and Biel Crystal in casings; BOE in panels.

India aiming to be self-sufficient: India is embracing self-sufficiency especially after Covid-related disruptions in supply chains, similar to the rest of the world. Given its large population, increased demand tends to into manifest in a sizable goods trade deficit for India, a large part of which has been with China. We note that India's PLI in the Semiconductor sector is open-ended and is investment linked (whereas other PLIs are revenue/output linked) likely driven by the government's focus on becoming self-sufficient, encouraging domestic investments and transfers of technology.

Unstable power supply: Power shortage is another key downside risk, which is also a key reason most tech companies in India stay in assembly or modules. Nighttime power cuts could happen this summer and in coming years given rising electricity demand, particularly when solar energy is not available, and given lack of coal-fired energy amid macro challenges (rising coal price, depreciation, inflation) and limited hydropower capacity (link). Technology product manufacturing requires a stable power supply, and with unstable power supply, the industry could be capped at low-end modules or assembly at a smaller scale.

Longer-term ESG considerations

As supply chains continue to diversify into India driven by geopolitical tensions and supportive policy measures to promote India's "Make in India" initiative, we believe

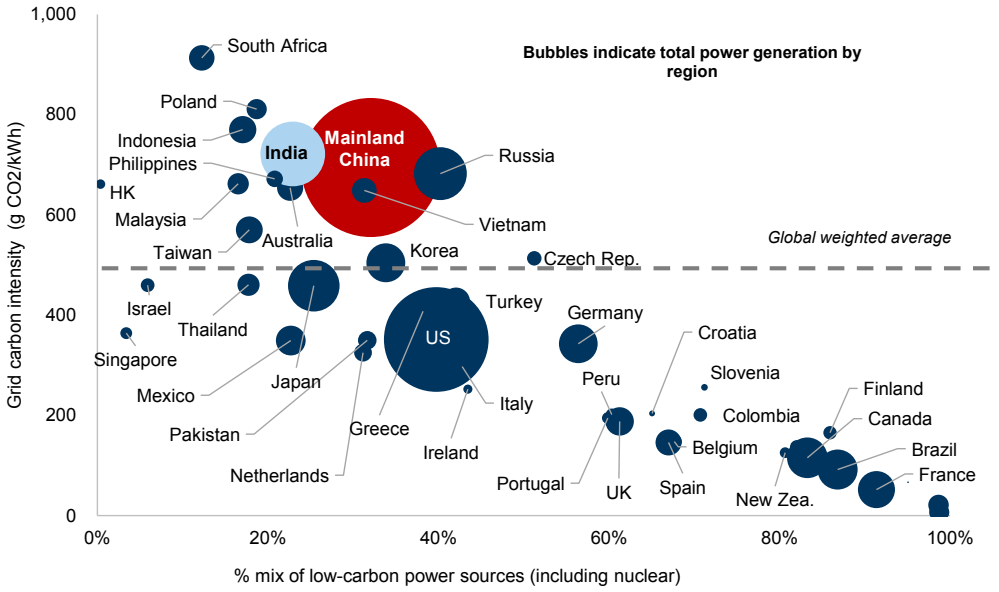
investors, regulators and companies will increasingly focus on the longer-term ESG implications of shifting supply chain capacities into India. In this section, we focus on two key aspects: **(1)** the longer-term **environmental challenges and opportunities** of shifting businesses into India and **(2) social considerations** related to the current wage gaps between India and ex-India EM manufacturing hubs.

Potential environmental implications

Stakeholder demand is growing for greener products. As discussed in our 2020 Apple report and the Net Zero Guide, consumers (both from a B2B and B2C perspective) are increasingly becoming more discerning of environmental attributes of the products they purchase, and investors are increasingly engaging with companies on emissions footprints (currently US$72 trillion in global AUM incorporates Net Zero considerations). In addition, there is growing international focus on implementing carbon border adjustments in regions like the EU (broadly equivalent to carbon tariffs for certain imported goods) which may have longer-term trade implications for exporting countries where environmental regulations are deemed to be relatively less stringent.

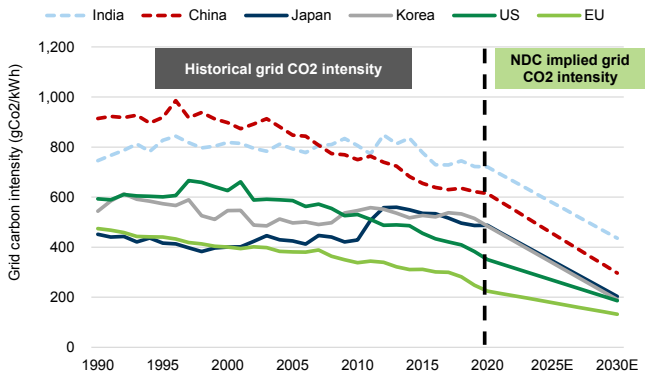
- **Potential challenges:** At the national level, India has a relatively weaker decabonization target both in the near-term (2030) and longer-term (net zero by 2070). India's grid network currently has a moderately higher emissions intensity (CO2 per kWh output) than China's (Exhibit 32), which will indirectly impact local companies' emissions footprints and the embedded carbon emissions of products that they manufacture for buyers. In addition, based on current stated national decarbonization commitments (referred to as Nationally Determined Contributions, or NDCs), India is expected to achieve a lower rate of decarbonization than China (Exhibit 33) driven by lower emissions per GDP reduction targets (e.g. India targets to reduce emissions per GDP by 45% by 2030 vs. 2005, while China is aiming for a 65% reduction during the same period). Longer-term, this may ultimately mean that companies in India will have to pursue decarbonization initiatives that exceed the current national ambitions in order to be globally environmentally competitive.
- **Potential opportunities:** Despite the relatively weaker emissions intensity reduction targets, India is among the most cost-competitive places to deploy renewable energy at scale (Exhibit 34), in part due to lower wage costs and abundance of solar resources (i.e. higher utilization rates). As the cost for renewables and other low-carbon solutions declines over time through innovation, we believe companies in India will be well-positioned to procure affordable renewable energy directly by deploying renewables on-site or indirectly through market based instruments such as power purchase agreements. According to India's Ministry of New and Renewable Energy (MNRE), the cost of solar energy is already competitive enough to achieve grid parity (i.e. the cost of solar energy is equal to or less than the unit cost of the overall grid).

Exhibit 32: India and China's national grid networks both currently have significantly greater carbon intensity than DM peers, with India being moderately more carbon intensive than China
Breakdown of local grid carbon intensity, mix of low carbon power sources and total power generation by region



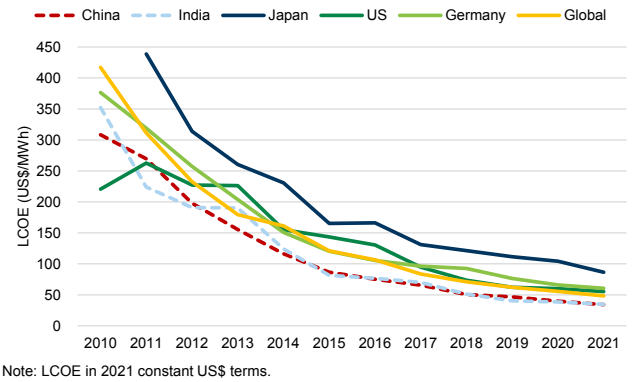
Source: IEA, Goldman Sachs Global Investment Research

Exhibit 33: Assuming national grids decarbonize at a similar rate as stated NDC pathways, India's grid network is expected to decarbonize at a slower rate than China's by 2030
National grid carbon intensities by region



Source: IEA, UNFCCC, Goldman Sachs Global Investment Research

Exhibit 34: India, along with China has among the lowest LCOEs for solar power
Weighted average LCOE of utility scale PV solar



Note: LCOE in 2021 constant US$ terms.

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

Social considerations

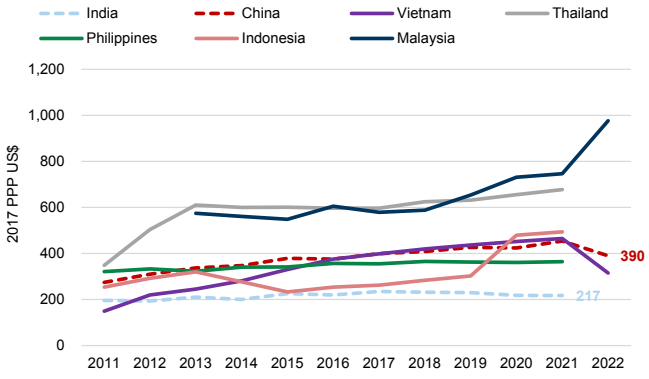
On top of growing environmental considerations, there is increasing focus on social externalities for consumers purchasing goods and services, as well as for investors. As discussed in our SUSTAIN colleagues' APAC ESG regulation report and EU Taxonomy series, investors are increasingly incorporating "minimum social safeguards" as a key criteria for stock selection, which is driving greater focus on how companies and their supply chain partners manage social issues across the value chain.

While relatively lower wages in India may help support the economics of supply chain

expansion into India as discussed earlier in the report, data from the International Labour Organization suggests that workers in India are generally more susceptible to social risks and poverty. When adjusted for differences in purchasing power, the minimum wage (in PPP US$ terms) in India is significantly lower than in most other Asian EMs (Exhibit 35). In addition, the working population in India has a higher likelihood of living below the global poverty line threshold (Exhibit 36). Meanwhile companies in our GC Technology coverage are broadly aiming to maintain competitive wage levels in their India operations, we believe **investors will increasingly look for greater clarity on corporate strategies to mitigate social risks within their supply chains.** Where companies are responsible operators and are proactive in managing and mitigating these heightened social risks, we see job creation and training and development opportunities for local talent as a potential benefit of companies' expansion into the Indian market.

Exhibit 35: Adjusted for differences in purchasing power, the minimum wage in India is significantly lower than other major Asian EM manufacturing hubs

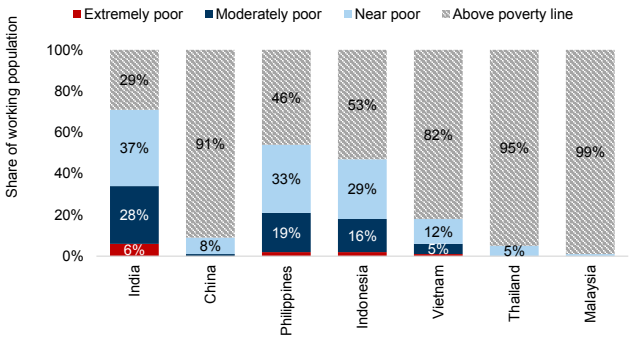
Minimum monthly wages in US$ PPP terms



Source: International Labour Organization, Data compiled by Goldman Sachs Global Investment Research

Exhibit 36: Relative to China and many other Asia EMs, India has a higher prevalence of employed population that live below the international poverty line

Share of working population by economic class



Note: ILO classifies workers living with less than US$1.9 per day as "extremely poor", US$1.9-US$3.2 as "moderately poor" and US$3.2-US$5.5 as "near poor".

Source: International Labour Organization, Data compiled by Goldman Sachs Global Investment Research

Appendix: Greater China Technology Comparison Table

Exhibit 37: Greater China Technology Comp Table

Company name	Ticker	Rating	Analyst	PX (LCY)	TP (LCY)	Market cap (US$m)	3M ADTV (US$m)	EPS CAGR 2021-23E	Trading P/E 2022E	Trading P/E 2023E	Trading P/B 2022E	Trading P/B 2023E	ROE 2022E	ROE 2023E	Div Yield 2022E	Div Yield 2023E
Semiconductors																
SICC	688234.SS	Buy*	Verena Jeng	70.9	146.00	4,374	26	24%	NA	197.7	5.8	5.6	-5%	3%	0.0%	0.0%
StarPower	603290.SS	Buy	Allen Chang	270.1	506.00	6,626	69	67%	56.3	38.9	8.3	7.2	15%	20%	0.5%	0.8%
Wingtech	600745.SS	Buy	Verena Jeng	50.7	89.00	9,053	129	14%	25.8	18.6	1.8	1.6	7%	9%	0.4%	0.5%
3PEAK	688536.SS	Buy	Allen Chang	248.7	398.00	4,293	27	7%	109.6	58.1	8.7	7.7	8%	14%	0.1%	0.2%
Will Semi	603501.SS	Buy*	Lynn Luo	81.9	129.00	13,912	142	-21%	78.7	34.2	5.4	4.8	7%	15%	0.1%	0.2%
Maxscend	300782.SZ	Buy	Verena Jeng	116.0	177.00	8,895	110	3%	57.6	27.5	7.2	5.8	13%	23%	0.2%	0.4%
Novosense	688052.SS	Buy	Lynn Luo	282.6	425.00	4,101	28	41%	122.5	48.2	35.3	20.4	34%	54%	0.0%	0.0%
SG Micro	300661.SZ	Buy	Lynn Luo	151.4	226.00	7,747	63	37%	55.6	40.8	16.4	12.1	34%	34%	0.2%	0.3%
GalaxyCore	688728.SS	Buy	Jin Guo	16.9	24.00	6,069	9	-20%	95.2	49.5	5.3	4.9	6%	10%	0.1%	0.6%
Empyrean	301269.SZ	Buy	Allen Chang	107.0	147.00	8,416	58	28%	297.6	204.7	11.8	11.8	7%	6%	0.0%	0.0%
NavInfo	002405.SZ	Buy	Jin Guo	13.1	17.90	4,468	61	34%	NA	143.7	2.6	2.6	-3%	2%	0.0%	0.0%
Silan	600460.SS	Buy	Lynn Luo	33.7	44.50	6,852	85	-8%	50.3	35.5	6.6	5.6	14%	17%	0.2%	0.3%
Amlogic	688099.SS	Buy	Lynn Luo	78.0	103.00	4,637	44	26%	32.5	25.1	7.0	5.9	23%	26%	0.9%	1.2%
Sanan	600703.SS	Buy	Allen Chang	19.1	25.00	13,700	112	-10%	101.4	80.6	2.8	2.7	3%	3%	0.3%	0.4%
Sinowealth	300327.SZ	Buy	Jin Guo	38.4	50.00	1,884	42	-15%	35.1	48.4	8.8	7.8	26%	17%	0.9%	0.6%
Rockchip	603893.SS	Buy	Lynn Luo	75.6	96.00	4,536	35	0%	84.1	52.3	10.5	9.7	13%	19%	0.7%	1.1%
Hua Hong	1347.HK	Buy	Allen Chang	32.4	40.00	5,390	36	23%	12.0	13.7	1.8	1.6	15%	12%	2.9%	2.2%
CR Micro	688396.SS	Buy	Allen Chang	57.9	70.00	10,975	32	5%	29.2	29.8	3.9	3.5	14%	12%	0.3%	0.3%
C*Core	688262.SS	Buy	Lynn Luo	58.0	70.00	1,999	34	71%	167.6	67.7	4.9	4.6	3%	7%	0.2%	0.4%
Vanchip	688153.SS	Buy	Lynn Luo	46.5	55.50	2,726	9	NA	347.2	141.4	5.0	4.8	2%	3%	0.0%	0.0%
Chipown	688508.SS	Buy	Lynn Luo	74.2	82.00	1,208	20	-3%	93.3	43.9	5.3	4.9	6%	12%	0.4%	0.8%
VeriSilicon	688521.SS	Buy	Allen Chang	67.6	72.00	4,830	36	288%	463.1	149.3	12.1	11.4	3%	8%	0.1%	0.2%
Primarius	688206.SS	Neutral	Allen Chang	29.9	35.00	1,860	10	62%	330.3	163.2	6.0	5.9	2%	4%	0.1%	0.2%
Goodix	603160.SS	Neutral	Lynn Luo	54.2	62.00	3,563	25	-20%	88.6	44.3	2.8	2.6	3%	6%	0.2%	0.3%
GigaDevice	603986.SS	Neutral	Jin Guo	101.0	110.00	9,678	179	-24%	27.6	48.9	4.4	4.2	17%	9%	1.1%	0.6%
SMIC	0981.HK	Neutral	Allen Chang	15.7	16.70	24,005	55	-57%	8.7	50.1	0.8	0.8	10%	2%	0.0%	0.0%
Montage	688008.SS	Neutral	Lynn Luo	55.9	55.50	9,117	90	23%	48.7	50.6	6.9	6.4	15%	13%	0.8%	0.8%
SMIC (A)	688981.SS	Neutral	Allen Chang	43.0	41.90	24,005	87	-57%	27.5	157.8	17.8	17.5	10%	2%	0.0%	0.0%
Etek	688601.SS	Neutral	Lynn Luo	74.6	69.00	968	14	-16%	40.9	51.8	6.2	5.7	16%	11%	0.7%	0.6%
Jingce	300567.SZ	Neutral	Allen Chang	65.3	56.00	2,610	27	12%	66.0	72.8	5.2	5.0	8%	7%	0.4%	0.3%
CFME	688630.SS	Neutral	Allen Chang	83.4	69.00	1,447	22	50%	73.1	42.4	9.7	8.2	14%	21%	0.3%	0.5%
Everbright Photonics	688048.SS	Neutral	Jin Guo	124.0	102.00	2,414	22	-29%	125.4	218.3	5.1	5.0	6%	2%	0.0%	0.0%
Tongfu	002156.SZ	Neutral	Lynn Luo	21.7	17.40	4,712	183	-5%	45.0	33.6	2.6	2.4	6%	8%	0.2%	0.3%
Espressif	688018.SS	Neutral	Lynn Luo	115.1	90.00	1,330	15	5%	67.1	42.3	4.9	4.7	7%	11%	1.0%	1.5%
ASR Micro	688220.SS	Neutral	Lynn Luo	65.6	51.00	3,943	20	-57%	NA	NA	3.7	3.8	-7%	-2%	0.0%	0.0%
Cambricon	688256.SS	Neutral	Verena Jeng	92.0	58.40	5,295	61	3%	NA	NA	7.9	9.8	-24%	-21%	0.0%	0.0%
Awinic	688798.SS	Sell	Lynn Luo	110.7	80.00	2,638	17	-64%	NA	NA	5.0	5.0	-2%	1%	0.0%	0.0%
Huatian	002185.SZ	Sell	Lynn Luo	9.6	6.50	4,423	42	-25%	31.1	34.2	1.9	1.8	6%	6%	0.3%	0.3%
Bestechnic	688608.SS	Sell	Lynn Luo	132.8	86.00	2,289	18	-41%	130.3	112.9	2.7	2.6	2%	2%	0.1%	0.1%
Cellwise	688325.SS	Sell	Jin Guo	46.0	41.00	545	5	-42%	70.1	NA	2.3	2.2	6%	2%	0.0%	0.0%
Anlogic	688107.SS	Sell	Lynn Luo	62.6	39.00	3,599	19	NA	380.0	291.7	16.1	15.5	4%	5%	0.1%	0.1%
JCET	600584.SS	Sell	Lynn Luo	28.2	16.60	7,205	125	-20%	16.2	25.6	2.1	2.0	14%	8%	0.7%	0.5%
Actions Tech	688049.SS	Sell	Lynn Luo	35.0	20.10	613	10	-36%	82.4	100.4	2.4	2.4	3%	2%	0.0%	0.0%
Longsys	301308.SZ	Sell	Lynn Luo	67.6	37.40	4,007	29	-43%	346.6	76.8	6.3	6.0	2%	8%	0.1%	0.5%
Average								45%	40.6	22.4	2.6	1.3	4%	3%	0.4%	48.1%
Median								26%	11.8	8.0	0.2	0.1	1%	0%	0.2%	0.3%
SPE & Semis materials																
ASMPT	0522.HK	Buy	Allen Chang	74.0	91.00	3,886	9	-14%	11.6	13.0	1.9	1.8	17%	14%	5.8%	3.9%
KFMI	300666.SZ	Neutral	Allen Chang	78.6	74.00	3,024	64	66%	69.4	60.8	6.4	5.9	12%	10%	0.3%	0.4%
NSIG	688126.SS	Neutral	Allen Chang	22.0	20.20	8,619	29	73%	184.1	124.0	3.8	3.7	2%	3%	0.0%	0.0%
AccoTest	688200.SS	Neutral	Allen Chang	297.1	240.00	3,885	28	4%	37.3	38.2	6.0	5.3	17%	15%	0.4%	0.4%
ACM Research	ACMR	Neutral	Allen Chang	11.7	8.90	701	10	19%	17.7	12.7	1.1	1.0	6%	9%	0.0%	0.0%
Anji	688019.SS	Neutral	Allen Chang	227.0	170.00	2,435	28	52%	56.1	58.3	11.6	9.9	23%	18%	0.2%	0.2%
AMEC	688012.SS	Neutral	Allen Chang	123.5	80.00	10,930	96	-8%	69.0	77.6	6.1	5.7	8%	8%	0.0%	0.0%
Naura	002371.SZ	Neutral	Allen Chang	261.2	167.00	19,833	290	50%	59.3	54.0	7.2	6.5	13%	13%	0.2%	0.2%
Kingsemi	688037.SS	Neutral	Allen Chang	238.3	141.00	3,170	59	90%	109.8	72.1	10.7	9.6	13%	14%	0.2%	0.3%
Average								37%	68.3	56.7	6.1	5.5	12%	11%	0.8%	0.6%
Median								50%	59.3	58.3	6.1	5.7	13%	13%	0.2%	0.2%
Components & devices																
AAC	2018.HK	Buy	Allen Chang	17.1	28.00	2,606	14	19%	20.7	9.7	0.8	0.8	4%	8%	1.1%	2.4%
Luxshare	002475.SZ	Buy	Verena Jeng	28.8	47.00	29,431	228	46%	21.0	13.5	4.7	3.6	25%	30%	0.5%	0.8%
BYDE	0285.HK	Buy	Verena Jeng	21.6	32.51	6,188	21	27%	24.3	11.3	1.9	1.7	7%	14%	0.4%	0.9%
Bomin	603936.SS	Buy	Jin Guo	13.5	19.20	989	27	2%	NA	NA	1.9	1.8	3%	7%	0.1%	0.4%
LianChuang	002036.SZ	Buy	Verena Jeng	12.4	17.50	1,908	35	148%	NA	NA	3.3	2.8	8%	16%	0.2%	0.5%
O-film	002456.SZ	Buy	Verena Jeng	5.0	7.00	2,330	17	NA	NA	146.9	2.8	2.7	-36%	2%	0.0%	0.0%
Hon Hai	2317.TW	Buy	Allen Chang	102.0	135.00	45,850	122	11%	10.0	8.3	1.0	0.9	10%	11%	3.9%	3.9%
Transsion	688036.SS	Buy	Verena Jeng	82.9	107.00	9,569	33	6%	26.3	15.2	4.2	3.5	17%	25%	1.2%	2.0%
BOE	000725.SZ	Buy	Verena Jeng	4.1	5.22	22,237	180	-41%	20.6	16.5	1.2	1.1	6%	7%	1.0%	1.2%
HTC	2498.TW	Neutral	Allen Chang	62.6	76.00	1,685	61	-13%	NA	NA	59.9	66.0	-13%	-10%	0.0%	0.0%
Sunny Optical	2382.HK	Neutral	Allen Chang	86.7	105.00	12,113	86	-6%	34.6	18.6	3.7	3.2	11%	18%	0.6%	1.1%
Dahua	002236.SZ	Neutral	Verena Jeng	16.1	15.53	7,009	81	-8%	19.2	16.6	1.9	1.8	10%	11%	1.2%	1.4%
Lenovo	0992.HK	Neutral	Verena Jeng	7.3	7.00	11,283	43	-12%	6.5	7.0	2.4	2.0	47%	31%	4.4%	5.2%
FII	601138.SS	Neutral	Verena Jeng	10.9	10.10	30,946	51	-11%	14.5	13.5	1.7	1.6	12%	12%	3.4%	3.7%
Hikvision	002415.SZ	Neutral	Allen Chang	37.8	35.00	50,847	213	-2%	27.8	22.1	5.1	4.5	19%	22%	1.8%	2.3%
Largan	3008.TW	Neutral	Verena Jeng	2,365.0	2,125.00	10,235	45	-2%	14.0	17.5	2.1	1.9	15%	11%	4.3%	2.9%
FIT	6088.HK	Neutral	Verena Jeng	2.1	1.63	1,951	3	-15%	13.3	18.2	0.7	0.7	6%	4%	0.0%	0.0%
Ehang	EH	Neutral	Allen Chang	10.2	4.00	583	23	-32%	NA	NA	0.7	NA	-111%	-343%	0.0%	0.0%
USI	601231.SS	Sell	Lynn Luo	15.6	12.60	4,947	23	-9%	11.3	22.3	2.3	2.2	22%	10%	2.7%	1.4%
Average								6%	18.9	23.8	5.4	5.7	3%	-5%	1.4%	1.6%
Median								-4%	19.9	16.5	2.1	2.0	10%	11%	1.0%	1.2%
Telco & Telco equipments																
YOFC - H	6869.HK	Buy	Jin Guo	15.0	22.40	2,862	4	52%	8.4	6.0	0.9	0.8	11%	15%	3.5%	4.9%
China Unicom	0762.HK	Buy	Jin Guo	5.7	7.50	22,266	47	20%	9.1	7.3	0.4	0.4	5%	6%	8.2%	7.0%
China Telecom	0728.HK	Buy	Jin Guo	4.2	4.60	81,363	54.8	6%	11.8	10.7	0.8	0.7	7%	7%	5.3%	6.1%
Shennan Circuits	002916.SZ	Neutral	Jin Guo	78.2	90.00	5,756	27	-5%	25.7	28.4	3.5	3.2	16%	12%	1.2%	1.1%
China Tower Corp.	0788.HK	Neutral	Jin Guo	0.9	1.05	20,861	23	9%	16.2	16.2	0.7	0.7	5%	4%	4.0%	3.8%
YOFC - A	601869.SS	Neutral	Jin Guo	37.2	39.80	2,862	16	52%	24.1	17.2	2.7	2.4	11%	15%	1.2%	1.8%
China Mobile (HK)	0941.HK	Neutral	Jin Guo	62.0	63.60	173,265	186	5%	9.1	8.7	0.9	0.9	10%	10%	6.7%	7.3%
ZTE - A	000063.SZ	Neutral	Allen Chang	32.3	29.70	20,674	211	6%	18.9	19.6	2.6	2.4	15%	13%	1.6%	0.0%
Ruijie	002396.SZ	Neutral	Jin Guo	23.0	21.00	1,959	32	0%	26.9	24.2	2.6	2.4	10%	10%	0.4%	0.4%
ZTE - H	0763.HK	Neutral	Allen Chang	23.0	20.70	20,674	15	6%	11.7	12.1	1.6	1.5	15%	13%	2.7%	0.0%
Comba	2342.HK	Sell	Jin Guo	1.5	1.36	528	1	NA	20.4	16.5	1.0	1.0	5%	6%	0.0%	0.0%
China United Network	600050.SS	Sell	Jin Guo	5.7	4.90	26,448	394	18%	24.5	19.7	1.6	1.5	7%	8%	7.1%	5.9%
Hengtong	600487.SS	Sell	Jin Guo	14.6	11.00	5,158	139	35%	17.4	13.2	1.5	1.4	9%	11%	0.8%	1.0%
Fiberhome	600498.SS	Sell	Jin Guo	17.0	12.00	2,888	22	26%	45.9	42.2	1.8	1.7	4%	4%	0.7%	0.8%
Average								18%	19.3	17.3	1.6	1.5	9%	10%	3.1%	2.9%
Median								9%	18.1	16.4	1.6	1.5	10%	10%	2.2%	1.4%
Software																
Kingdee	0268.HK	Buy	Allen Chang	14.1	24.86	6,253	39	-2%	NA	NA	5.9	6.1	-5%	-4%	0.0%	0.0%
Chinasoft Intl	0354.HK	Buy	Verena Jeng	5.2	8.50	2,018	17	11%	10.9	9.0	1.0	0.9	10%	11%	0.6%	0.7%
ZWSOFT	688083.SS	Buy	Allen Chang	193.5	305.00	2,409	18	22%	2490.1	58.1	6.0	5.6	0%	10%	0.0%	0.6%
Jingwei Hirain	688326.SS	Buy	Verena Jeng	138.5	216.00	2,387	15	44%	64.6	41.4	3.1	2.9	7%	7%	0.0%	0.0%
Desay SV	002920.SZ	Buy	Verena Jeng	105.0	160.00	8,373	70	37%	63.8	37.3	9.8	8.2	16%	24%	0.5%	0.8%
Thundersoft	300496.SZ	Buy	Allen Chang	100.3	149.88	6,648	83	21%	57.5	45.0	5.1	4.6	11%	11%	0.3%	0.4%
Yonyou	600588.SS	Buy	Allen Chang	25.1	35.00	12,367	101	26%	185.1	72.9	11.9	10.7	7%	16%	0.0%	0.0%
Arcsoft	688088.SS	Buy	Verena Jeng	27.3	36.00	1,594	14	15%	196.9	59.8	4.3	4.2	2%	7%	0.3%	1.0%
iSoftstone	301236.SZ	Buy	Verena Jeng	37.4	47.00	3,410	23	9%	23.3	12.0	2.4	2.1	13%	19%	1.4%	2.8%
Sangfor	300454.SZ	Buy	Allen Chang	144.0	175.00	8,623	60	97%	305.8	56.3	8.0	7.1	3%	13%	0.0%	0.2%
Venustech	002439.SZ	Buy*	Verena Jeng	33.1	37.20	4,526	44	13%	38.0	28.3	4.1	3.6	12%	14%	0.1%	0.1%
Glodon	002410.SZ	Neutral	Allen Chang	61.1	75.00	10,446	52	55%	75.5	43.6	0.8	0.8	16%	25%	0.7%	1.2%
YJK	300935.SZ	Neutral	Allen Chang	31.2	30.00	355	4	-33%	NA	63.7	1.8	1.8	-3%	4%	0.0%	0.0%
iFlytek	002230.SZ	Neutral	Allen Chang	47.6	44.00	16,030	305	-5%	185.7	77.4	6.4	6.0	3%	8%	0.1%	0.2%
Thunisoft	300271.SZ	Neutral	Verena Jeng	9.2	7.78	1,085	36	-11%	NA	32.5	1.3	1.3	-15%	4%	0.0%	0.0%
Kingsoft Office	688111.SS	Sell	Allen Chang	302.9	202.00	20,064	131	25%	124.9	86.3	15.8	13.3	14%	17%	0.0%	0.0%
Average								20%	294.0	48.2	5.5	5.0	6%	12%	0.2%	0.5%
Median								18%	75.5	45.0	4.7	4.4	7%	11%	0.1%	0.2%

* Denotes membership on our regional Conviction List. Target prices are based on a 12-month period. Priced as of Mar 13, 2023.

Source: Bloomberg, Goldman Sachs Global Investment Research

Disclosure Appendix

Reg AC

We, Allen Chang, Verena Jeng, Pulkit Patni, Rahul Jain, Bruce Lu, James Wang, Ting Song, Xuan Zhang, Yuhe Wu, Emma Jones and Keebum Kim, 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.

Unless otherwise stated, the individuals listed on the cover page of this report are analysts in Goldman Sachs' Global Investment Research division.

GS Factor Profile

The Goldman Sachs Factor Profile provides investment context for a stock by comparing key attributes to the market (i.e. our coverage universe) and its sector peers. The four key attributes depicted are: Growth, Financial Returns, Multiple (e.g. valuation) and Integrated (a composite of Growth, Financial Returns and Multiple). Growth, Financial Returns and Multiple are calculated by using normalized ranks for specific metrics for each stock. The normalized ranks for the metrics are then averaged and converted into percentiles for the relevant attribute. The precise calculation of each metric may vary depending on the fiscal year, industry and region, but the standard approach is as follows:

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.

M&A Rank

Across our global coverage, we examine stocks using an M&A framework, considering both qualitative factors and quantitative factors (which may vary across sectors and regions) to incorporate the potential that certain companies could be acquired. We then assign a M&A rank as a means of scoring companies under our rated coverage from 1 to 3, with 1 representing high (30%-50%) probability of the company becoming an acquisition target, 2 representing medium (15%-30%) probability and 3 representing low (0%-15%) probability. For companies ranked 1 or 2, in line with our standard departmental guidelines we incorporate an M&A component into our target price. M&A rank of 3 is considered immaterial and therefore does not factor into our price target, and may or may not be discussed in research.

Quantum

Quantum is Goldman Sachs' proprietary database providing access to detailed financial statement histories, forecasts and ratios. It can be used for in-depth analysis of a single company, or to make comparisons between companies in different sectors and markets.

Disclosures

Other disclosures

Pursuant to Executive Order 13959, as amended, the United States has imposed sanctions restrictions on certain Chinese companies that generally prohibit U.S. persons from investing in securities issued by such companies. This research report is not, and should not be construed as, an inducement to transact in any securities in contravention of U.S. sanctions laws.

The United States Commerce Department's Bureau of Industry and Security (BIS) imposes specific license requirements for the export, re-export and/or transfer (in-country) of specified items to non-U.S. parties that appear on BIS' Entity List. This research report is not, and should not be construed as, an inducement to engage in any unlicensed activities with parties on BIS' Entity List.

Third party brands used in this report are the property of their respective owners, and are used here for informational purposes only. The use of such brands should not be viewed as an endorsement, affiliation or sponsorship by or for Goldman Sachs or any of its products/services.

Distribution of ratings/investment banking relationships

Goldman Sachs Investment Research global Equity coverage universe

	Rating Distribution			Investment Banking Relationships		
	Buy	Hold	Sell	Buy	Hold	Sell
Global	47%	37%	16%	64%	58%	48%

As of January 1, 2023, Goldman Sachs Global Investment Research had investment ratings on 3,201 equity securities. Goldman Sachs assigns stocks as Buys and Sells on various regional Investment Lists; stocks not so assigned are deemed Neutral. Such assignments equate to Buy, Hold and Sell for the purposes of the above disclosure required by the FINRA Rules. See 'Ratings, Coverage universe and related definitions' below. The Investment Banking Relationships chart reflects the percentage of subject companies within each rating category for whom Goldman Sachs has provided investment banking services within the previous twelve months.

Regulatory disclosures

Disclosures required by United States laws and regulations

See company-specific regulatory disclosures above for any of the following disclosures required as to companies referred to in this report: manager or co-manager in a pending transaction; 1% or other ownership; compensation for certain services; types of client relationships; managed/co-managed public offerings in prior periods; directorships; for equity securities, market making and/or specialist role. Goldman Sachs trades or may trade as a principal in debt securities (or in related derivatives) of issuers discussed in this report.

The following are additional required disclosures: **Ownership and material conflicts of interest:** Goldman Sachs policy prohibits its analysts, professionals reporting to analysts and members of their households from owning securities of any company in the analyst's area of coverage. **Analyst compensation:** Analysts are paid in part based on the profitability of Goldman Sachs, which includes investment banking revenues. **Analyst as officer or director:** Goldman Sachs policy generally prohibits its analysts, persons reporting to analysts or members of their households from serving as an officer, director or advisor of any company in the analyst's area of coverage. **Non-U.S. Analysts:** Non-U.S. analysts may not be associated persons of Goldman Sachs & Co. LLC and therefore may not be subject to FINRA Rule 2241 or FINRA Rule 2242 restrictions on communications with subject company, public appearances and trading securities held by the analysts.

Distribution of ratings: See the distribution of ratings disclosure above. **Price chart:** See the price chart, with changes of ratings and price targets in prior periods, above, or, if electronic format or if with respect to multiple companies which are the subject of this report, on the Goldman Sachs website at https://www.gs.com/research/hedge.html.

Additional disclosures required under the laws and regulations of jurisdictions other than the United States

The following disclosures are those required by the jurisdiction indicated, except to the extent already made above pursuant to United States laws and regulations. **Australia:** Goldman Sachs Australia Pty Ltd and its affiliates are not authorised deposit-taking institutions (as that term is defined in the Banking Act 1959 (Cth)) in Australia and do not provide banking services, nor carry on a banking business, in Australia. This research, and any access to it, is intended only for "wholesale clients" within the meaning of the Australian Corporations Act, unless otherwise agreed by Goldman Sachs. In producing research reports, members of Global Investment Research of Goldman Sachs Australia may attend site visits and other meetings hosted by the companies and other entities which are the subject of its research reports. In some instances the costs of such site visits or meetings may be met in part or in whole by the issuers concerned if Goldman Sachs Australia considers it is appropriate and reasonable in the specific circumstances relating to the site visit or meeting. To the extent that the contents of this document contains any financial product advice, it is general advice only and has been prepared by Goldman Sachs without taking into account a client's objectives, financial situation or needs. A client should, before acting on any such advice, consider the appropriateness of the advice having regard to the client's own objectives, financial situation and needs. A copy of certain Goldman Sachs Australia and New Zealand disclosure of interests and a copy of Goldman Sachs' Australian Sell-Side Research Independence Policy Statement are available at: https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html. **Brazil:** Disclosure information in relation to CVM Resolution n. 20 is available at https://www.gs.com/worldwide/brazil/area/gir/index.html. Where applicable, the Brazil-registered analyst primarily responsible for the content of this research report, as defined in Article 20 of CVM Resolution n. 20, is the first author named at the beginning of this report, unless indicated otherwise at the end of the text. **Canada:** This information is being provided to you for information purposes only and is not, and under no circumstances should be construed as, an advertisement, offering or solicitation by Goldman Sachs & Co. LLC for purchasers of securities in Canada to trade in any Canadian security. Goldman Sachs & Co. LLC is not registered as a dealer in any jurisdiction in Canada under applicable Canadian securities laws and generally is not permitted to trade in Canadian securities and may be prohibited from selling certain securities and products in certain jurisdictions in Canada. If you wish to trade in any Canadian securities or other products in Canada please contact Goldman Sachs Canada Inc., an affiliate of The Goldman Sachs Group Inc., or another registered Canadian dealer. **Hong Kong:** Further information on the securities of covered companies referred to in this research may be obtained on request from Goldman Sachs (Asia) L.L.C. **India:** Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (India) Securities Private Limited, Research Analyst - SEBI Registration Number INH000001493, 951-A, Rational House, Appasaheb Marathe Marg, Prabhadevi, Mumbai 400 025, India, Corporate Identity Number U74140MH2006FTC160634, Phone +91 22 6616 9000, Fax +91 22 6616 9001. Goldman Sachs may beneficially own 1% or more of the securities (as such term is defined in clause 2 (h) the Indian Securities Contracts (Regulation) Act, 1956) of the subject company or companies referred to in this research report. **Japan:** See below. **Korea:** This research, and any access to it, is intended only for "professional investors" within the meaning of the Financial Services and Capital Markets Act, unless otherwise agreed by Goldman Sachs. Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (Asia) L.L.C., Seoul Branch. **New Zealand:** Goldman Sachs New Zealand Limited and its affiliates are neither "registered banks" nor "deposit takers" (as defined in the Reserve Bank of New Zealand Act 1989) in New Zealand. This research, and any access to it, is intended for "wholesale clients" (as defined in the Financial Advisers Act 2008) unless otherwise agreed by Goldman Sachs. A copy of certain Goldman Sachs Australia and New Zealand disclosure of interests is available at: https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html. **Russia:** Research reports distributed in the Russian Federation are not advertising as defined in the Russian legislation, but are information and analysis not having product promotion as their main purpose and do not provide appraisal within the meaning of the Russian legislation on appraisal activity. Research reports do not constitute a personalized investment recommendation as defined in Russian laws and regulations, are not addressed to a specific client, and are prepared without analyzing the financial circumstances, investment profiles or risk profiles of clients. Goldman Sachs assumes no responsibility for any investment decisions that may be taken by a client or any other person based on this research report. **Singapore:** Goldman Sachs (Singapore) Pte. (Company Number: 198602165W), which is regulated by the Monetary Authority of Singapore, accepts legal responsibility for this research, and should be contacted with respect to any matters arising from, or in connection with, this research. **Taiwan:** This material is for reference only and must not be reprinted without permission. Investors should carefully consider their own investment risk. Investment results are the responsibility of the individual investor. **United Kingdom:** Persons who would be categorized as retail clients in the United Kingdom, as such term is defined in the rules of the Financial Conduct Authority, should read this research in conjunction with prior Goldman Sachs research on the covered companies referred to herein and should refer to the risk warnings that have been sent to them by Goldman Sachs International. A copy of these risks warnings, and a glossary of certain financial terms used in this report, are available from Goldman Sachs International on request.

European Union and United Kingdom: Disclosure information in relation to Article 6 (2) of the European Commission Delegated Regulation (EU) (2016/958) supplementing Regulation (EU) No 596/2014 of the European Parliament and of the Council (including as that Delegated Regulation is implemented into United Kingdom domestic law and regulation following the United Kingdom's departure from the European Union and the European Economic Area) with regard to regulatory technical standards for the technical arrangements for objective presentation of investment recommendations or other information recommending or suggesting an investment strategy and for disclosure of particular interests or indications of conflicts of interest is available at https://www.gs.com/disclosures/europeanpolicy.html which states the European Policy for Managing Conflicts of Interest in Connection with Investment Research.

Japan: Goldman Sachs Japan Co., Ltd. is a Financial Instrument Dealer registered with the Kanto Financial Bureau under registration number Kinsho 69, and a member of Japan Securities Dealers Association, Financial Futures Association of Japan Type II Financial Instruments Firms Association, The Investment Trusts Association, Japan, and Japan Investment Advisers Association. Sales and purchase of equities are subject to commission pre-determined with clients plus consumption tax. See company-specific disclosures as to any applicable disclosures required by Japanese stock exchanges, the Japanese Securities Dealers Association or the Japanese Securities Finance Company.

Ratings, coverage universe and related definitions

Buy (B), Neutral (N), Sell (S) Analysts recommend stocks as Buys or Sells for inclusion on various regional Investment Lists. Being assigned a Buy or Sell on an Investment List is determined by a stock's total return potential relative to its coverage universe. Any stock not assigned as a Buy or a Sell on an Investment List with an active rating (i.e., a stock that is not Rating Suspended, Not Rated, Coverage Suspended or Not Covered), is deemed Neutral. Each region manages Regional Conviction lists, which are selected from Buy rated stocks on the respective region's Investment lists and represent investment recommendations focused on the size of the total return potential and/or the likelihood of the realization of the return across their respective areas of coverage. The addition or removal of stocks from such Conviction lists are managed by the Investment Review Committee or other designated committee in each respective region and do not represent a change in the analysts' investment rating for such stocks.

Total return potential represents the upside or downside differential between the current share price and the price target, including all paid or anticipated dividends, expected during the time horizon associated with the price target. Price targets are required for all covered stocks. The total return potential, price target and associated time horizon are stated in each report adding or reiterating an Investment List membership.

Coverage Universe: A list of all stocks in each coverage universe is available by primary analyst, stock and coverage universe at https://www.gs.com/research/hedge.html.

Not Rated (NR). The investment rating, target price and earnings estimates (where relevant) have been suspended pursuant to Goldman Sachs policy when Goldman Sachs is acting in an advisory capacity in a merger or in a strategic transaction involving this company, when there are legal, regulatory or policy constraints due to Goldman Sachs' involvement in a transaction, and in certain other circumstances. **Rating Suspended (RS).** Goldman Sachs Research has suspended the investment rating and price target for this stock, because there is not a sufficient fundamental basis for determining an investment rating or target price. The previous investment rating and target price, if any, are no longer in effect for this stock and should not be relied upon. **Coverage Suspended (CS).** Goldman Sachs has suspended coverage of this company. **Not Covered (NC).** Goldman Sachs does not cover this company. **Not Available or Not Applicable (NA).** The information is not available for display or is not applicable. **Not Meaningful (NM).** The information is not meaningful and is therefore excluded.

Global product; distributing entities

Goldman Sachs Global Investment Research produces and distributes research products for clients of Goldman Sachs on a global basis. Analysts based in Goldman Sachs offices around the world produce research on industries and companies, and research on macroeconomics, currencies, commodities and portfolio strategy. This research is disseminated in Australia by Goldman Sachs Australia Pty Ltd (ABN 21 006 797 897); in Brazil by Goldman Sachs do Brasil Corretora de Títulos e Valores Mobiliários S.A.; Public Communication Channel Goldman Sachs Brazil: 0800 727 5764 and / or contatogoldmanbrasil@gs.com. Available Weekdays (except holidays), from 9am to 6pm. Canal de Comunicação com o Público Goldman Sachs Brasil: 0800 727 5764 e/ou contatogoldmanbrasil@gs.com. Horário de funcionamento: segunda-feira à sexta-feira (exceto feriados), das 9h às 18h; in Canada by Goldman Sachs & Co. LLC; in Hong Kong by Goldman Sachs (Asia) L.L.C.; in India by Goldman Sachs (India) Securities Private Ltd.; in Japan by Goldman Sachs Japan Co., Ltd.; in the Republic of Korea by Goldman Sachs (Asia) L.L.C., Seoul Branch; in New Zealand by Goldman Sachs New Zealand Limited; in Russia by OOO Goldman Sachs; in Singapore by Goldman Sachs (Singapore) Pte. (Company Number: 198602165W); and in the United States of America by Goldman Sachs & Co. LLC. Goldman Sachs International has approved this research in connection with its distribution in the United Kingdom.

Goldman Sachs International ("GSI"), authorised by the Prudential Regulation Authority ("PRA") and regulated by the Financial Conduct Authority ("FCA") and the PRA, has approved this research in connection with its distribution in the United Kingdom.

European Economic Area: GSI, authorised by the PRA and regulated by the FCA and the PRA, disseminates research in the following jurisdictions within the European Economic Area: the Grand Duchy of Luxembourg, Italy, the Kingdom of Belgium, the Kingdom of Denmark, the Kingdom of Norway, the Republic of Finland and the Republic of Ireland; GSI - Succursale de Paris (Paris branch) which is authorised by the French Autorité de contrôle prudentiel et de resolution ("ACPR") and regulated by the Autorité de contrôle prudentiel et de resolution and the Autorité des marches financiers ("AMF") disseminates research in France; GSI - Sucursal en España (Madrid branch) authorized in Spain by the Comisión Nacional del Mercado de Valores disseminates research in the Kingdom of Spain; GSI - Sweden Bankfilial (Stockholm branch) is authorized by the SFSA as a "third country branch" in accordance with Chapter 4, Section 4 of the Swedish Securities and Market Act (Sw. lag (2007:528) om värdepappersmarknaden) disseminates research in the Kingdom of Sweden; Goldman Sachs Bank Europe SE ("GSBE") is a credit institution incorporated in Germany and, within the Single Supervisory Mechanism, subject to direct prudential supervision by the European Central Bank and in other respects supervised by German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, BaFin) and Deutsche Bundesbank and disseminates research in the Federal Republic of Germany and those jurisdictions within the European Economic Area where GSI is not authorised to disseminate research and additionally, GSBE, Copenhagen Branch filial af GSBE, Tyskland, supervised by the Danish Financial Authority disseminates research in the Kingdom of Denmark; GSBE - Sucursal en España (Madrid branch) subject (to a limited extent) to local supervision by the Bank of Spain disseminates research in the Kingdom of Spain; GSBE - Succursale Italia (Milan branch) to the relevant applicable extent, subject to local supervision by the Bank of Italy (Banca d'Italia) and the Italian Companies and Exchange Commission (Commissione Nazionale per le Società e la Borsa "Consob") disseminates research in Italy; GSBE - Succursale de Paris (Paris branch), supervised by the AMF and by the ACPR disseminates research in France; and GSBE - Sweden Bankfilial (Stockholm branch), to a limited extent, subject to local supervision by the Swedish Financial Supervisory Authority (Finansinpektionen) disseminates research in the Kingdom of Sweden.

General disclosures

This research is for our clients only. Other than disclosures relating to Goldman Sachs, this research is based on current public information that we consider reliable, but we do not represent it is accurate or complete, and it should not be relied on as such. The information, opinions, estimates and forecasts contained herein are as of the date hereof and are subject to change without prior notification. We seek to update our research as appropriate, but various regulations may prevent us from doing so. Other than certain industry reports published on a periodic basis, the large majority of reports are published at irregular intervals as appropriate in the analyst's judgment.

Goldman Sachs conducts a global full-service, integrated investment banking, investment management, and brokerage business. We have investment banking and other business relationships with a substantial percentage of the companies covered by Global Investment Research. Goldman Sachs & Co. LLC, the United States broker dealer, is a member of SIPC (https://www.sipc.org).

Our salespeople, traders, and other professionals may provide oral or written market commentary or trading strategies to our clients and principal trading desks that reflect opinions that are contrary to the opinions expressed in this research. Our asset management area, principal trading desks and investing businesses may make investment decisions that are inconsistent with the recommendations or views expressed in this research.

The analysts named in this report may have from time to time discussed with our clients, including Goldman Sachs salespersons and traders, or may discuss in this report, trading strategies that reference catalysts or events that may have a near-term impact on the market price of the equity securities discussed in this report, which impact may be directionally counter to the analyst's published price target expectations for such stocks. Any such trading strategies are distinct from and do not affect the analyst's fundamental equity rating for such stocks, which rating reflects a stock's return potential relative to its coverage universe as described herein.

We and our affiliates, officers, directors, and employees will from time to time have long or short positions in, act as principal in, and buy or sell, the securities or derivatives, if any, referred to in this research, unless otherwise prohibited by regulation or Goldman Sachs policy.

The views attributed to third party presenters at Goldman Sachs arranged conferences, including individuals from other parts of Goldman Sachs, do not necessarily reflect those of Global Investment Research and are not an official view of Goldman Sachs.

Any third party referenced herein, including any salespeople, traders and other professionals or members of their household, may have positions in the products mentioned that are inconsistent with the views expressed by analysts named in this report.

This research is not an offer to sell or the solicitation of an offer to buy any security in any jurisdiction where such an offer or solicitation would be illegal. It does not constitute a personal recommendation or take into account the particular investment objectives, financial situations, or needs of

individual clients. Clients should consider whether any advice or recommendation in this research is suitable for their particular circumstances and, if appropriate, seek professional advice, including tax advice. The price and value of investments referred to in this research and the income from them may fluctuate. Past performance is not a guide to future performance, future returns are not guaranteed, and a loss of original capital may occur. Fluctuations in exchange rates could have adverse effects on the value or price of, or income derived from, certain investments.

Certain transactions, including those involving futures, options, and other derivatives, give rise to substantial risk and are not suitable for all investors. Investors should review current options and futures disclosure documents which are available from Goldman Sachs sales representatives or at https://www.theocc.com/about/publications/character-risks.jsp and https://www.fiadocumentation.org/fia/regulatory-disclosures_1/fia-uniform-futures-and-options-on-futures-risk-disclosures-booklet-pdf-version-2018. Transaction costs may be significant in option strategies calling for multiple purchase and sales of options such as spreads. Supporting documentation will be supplied upon request.

Differing Levels of Service provided by Global Investment Research: The level and types of services provided to you by Goldman Sachs Global Investment Research may vary as compared to that provided to internal and other external clients of GS, depending on various factors including your individual preferences as to the frequency and manner of receiving communication, your risk profile and investment focus and perspective (e.g., marketwide, sector specific, long term, short term), the size and scope of your overall client relationship with GS, and legal and regulatory constraints. As an example, certain clients may request to receive notifications when research on specific securities is published, and certain clients may request that specific data underlying analysts' fundamental analysis available on our internal client websites be delivered to them electronically through data feeds or otherwise. No change to an analyst's fundamental research views (e.g., ratings, price targets, or material changes to earnings estimates for equity securities), will be communicated to any client prior to inclusion of such information in a research report broadly disseminated through electronic publication to our internal client websites or through other means, as necessary, to all clients who are entitled to receive such reports.

All research reports are disseminated and available to all clients simultaneously through electronic publication to our internal client websites. Not all research content is redistributed to our clients or available to third-party aggregators, nor is Goldman Sachs responsible for the redistribution of our research by third party aggregators. For research, models or other data related to one or more securities, markets or asset classes (including related services) that may be available to you, please contact your GS representative or go to https://research.gs.com.

Disclosure information is also available at https://www.gs.com/research/hedge.html or from Research Compliance, 200 West Street, New York, NY 10282.

MINDCRAFT: OUR THEMATIC DEEP DIVES

The Future of Batteries

Carbonomics

Europe's Energy Crisis

China Agriculture

Precision Farming

Green Capex

The Circular Economy

Byte-ology

Gene Editing

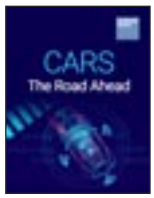
The Metaverse

Cloud Computing

5G

Blockchain

Cars: The Road Ahead



Music in the Air

China Property

China's Credit Conundrum

Age of Automation

China Post-95s

Silicon Carbide

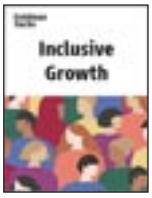
China Decarbonization

The Survivor's Guide to Disruption

Sustainable ESG Investing

Black Womenomics

Inclusive Growth



Market Cycles

Top of Mind

What Matters for IPOs

Top Projects

Tracking the Consumer

EU Taxonomy

Balanced Bear

Clean Hydrogen

Green Metals

The Future of Work

What the Market Pays For

The Great Reset

The Competitive Value of Data