Economics & Strategy

Understanding China

Electronics wave; the old and the new

Group Research

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- The new wave of technological innovation, heralded by the ongoing rapid progress in artificial intelligence and the Internet of Things, is expected to create diverse demand for electronics hardware and bring new opportunities in the global electronics industry.

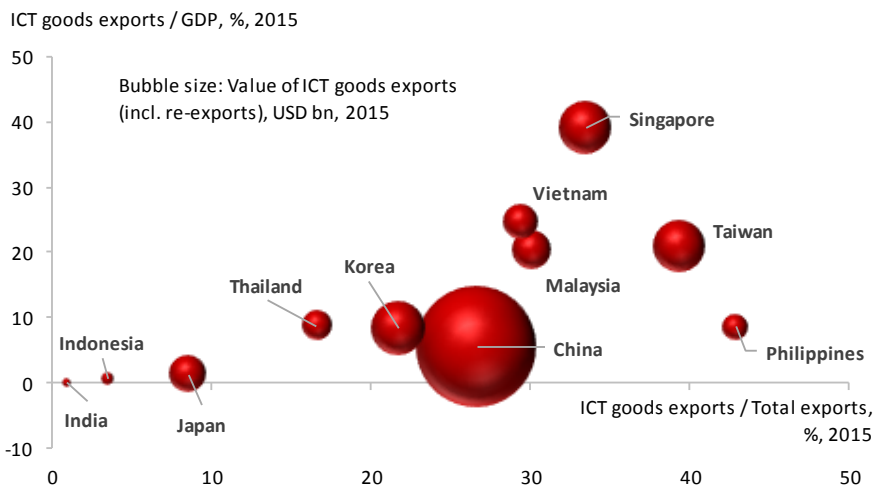
- Asia is well positioned to benefit as it is home to the world's largest electronics manufacturing cluster, with its increasingly intertwined and sophisticated electronics supply chains.

- China should be a major beneficiary. It is the world's and the region's largest electronics production base. Importantly, it has successfully moved up the electronics value chain and will likely continue to do so in the next decade.

- As China climbs up the value ladder and embraces high-end automation, it would challenge existing upstream producers like Singapore, South Korea, and Taiwan. But the relatively strong innovation capabilities in these economies should help them sustain competitiveness in the upper tiers of high value-added electronic segments. Cyber security and intellectual property-related concerns may also put a lid on China's ability to absorb the entire supply chain.

- China's move up in the value chain would create opportunities for lower-income economies in Southeast/South Asia. There is the potential for India, Indonesia, and Thailand to receive some of the manufacturing/assembly works transferred from China and to play a bigger role in the intricate and elaborate Asian electronics supply chain.

Asia: The size and importance of electronics industry



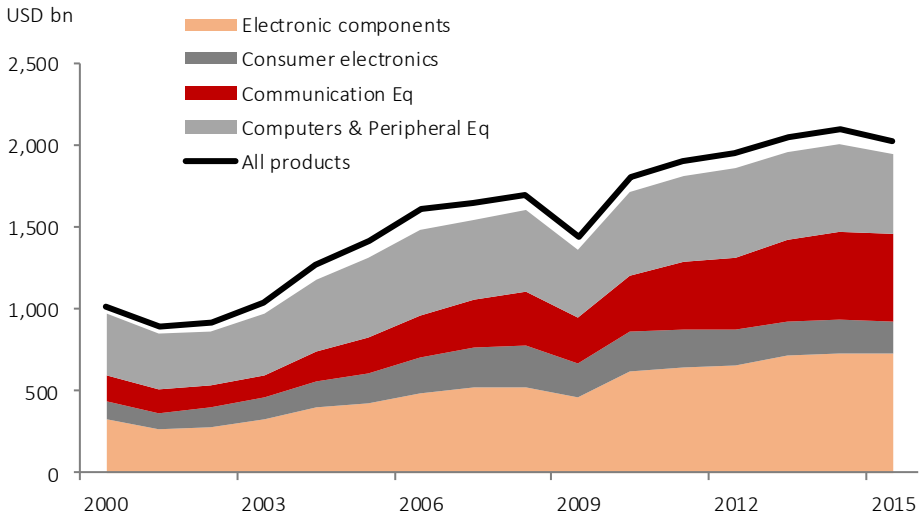
Sources: UNCTAD, CEIC, DBS

Global electronics wave: The old and the new

Personal computers and the Internet in the 1990s; smartphones in the 2000s

The global electronics industry experienced two waves of strong growth in the past two decades. The first was driven by the emergence of personal computers and the Internet in the 1990s, and the second by smartphones in the 2000s. Measured by trade value, global shipments of information and communication technology (ICT) goods have doubled from USD1.0tn in 2000 to USD2.0tn in 2015, registering a compound annual growth rate (CAGR) of 4.7% (Chart 1). This was thanks to robust demand for communication equipment (e.g., smartphones, wireless networks) and electronic components (e.g., chips, semiconductors). Shipments of computers (PCs, tablets) and consumer electronics (TVs, game consoles, audios, etc.) turned flat in recent years, reflecting the saturation in these traditional product categories.

Chart 1: Global trade in ICT goods, by product



Sources: UNCTAD, CEIC, DBS

In addition to technological changes, the strong growth in global electronics exports in the past two decades also got a boost from free trade. Tariff and non-tariff barriers have been removed on many high-tech products across a broad range of markets, thanks to the implementation of the World Trade Organization's or WTO's Information Technology Agreement, and various multilateral/bilateral free trade arrangements.

WTO Information Technology Agreement

The original Information Technology Agreement (ITA) was reached in 1996 at the first WTO Ministerial Conference held in Singapore.

The ITA covers many high technology products, including computers, telecommunication equipment, semiconductors, semiconductor manufacturing and testing equipment, software, scientific instruments, as well as most of the parts and accessories of these products.

The ITA covers 81 WTO members today, which account for 97% of world trade in information technology products.

The ITA requires each participant to eliminate and bind customs duties at zero for all products specified in the Agreement.

Source: World Trade Organization

The third wave of technological innovation: AI, IoT, Big Data, the cloud, 3D printing

Looking ahead, the third wave of technological innovation looks likely to happen in the next 1-2 decades. This is heralded by the ongoing rapid progress in artificial intelligence (AI), the Internet of Things (IoT), Big Data, the cloud, 3D printing, among others. According to PwC, AI will contribute as much as USD15.7tn to the world economy by 2030. Currently, key applications of AI include voice recognition, face recognition, autonomous vehicles, robots, and drones. The areas of application will likely become more pervasive by 2030, ranging from manufacturing and transportation to home service, health care, education, and entertainment. While McKinsey projects that by 2025, IoT could generate USD4-11tn in value globally. The number of IoT-installed devices will increase to 20-30bn by 2020, up from 6-18bn currently, as per various estimates from Gartner, IDC, and IHS.

Diverse demand for electronics hardware

The third wave of technological innovation is expected to create diverse demand for electronics hardware and bring new opportunities for the global electronics industry. For instance, AI will need processors with high computing power to execute the algorithm. IoT devices will require sensors and microcontrollers to allow for data collection, and wireless networks, servers, and memory to allow for connectivity, data transmission, and storage. In addition, to enable IoT/AI, end-use devices will also need to be upgraded. This would involve a wide range of traditional and non-traditional electronic products, such as mobile phones, TVs, refrigerators, washers, speakers, wearables, etc. Consequently, the electronics content in products will rise considerably.

Admittedly, the remarkable growth in global electronics exports/imports seen in the 2000s was also helped by the free trade effect and low base. The world is now confronted with rising trade protectionism and anti-globalisation sentiment. It is uncertain whether advanced economies like the US will pursue tariff/non-tariff measures to restrict the imports of electronic products and to "protect" their domestic industries. Concerns over cyber security, amid rapid technological changes, could be used as an excuse by governments to tighten regulations on electronics imports.

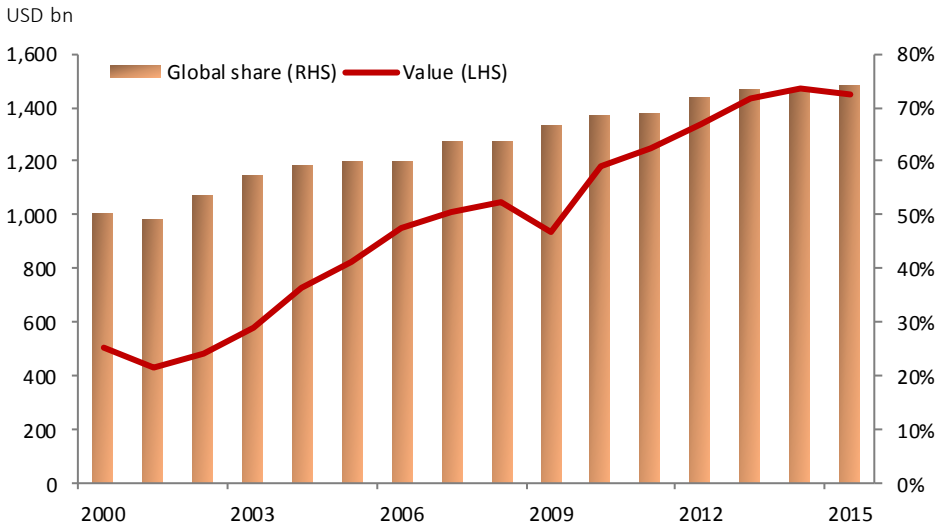
Based on the 2000-15 trend, we reckon that global ICT goods exports could maintain a growth of about 3.6% (CAGR) in 2015-30. Upside risks could come from faster-than-expected progress in technological innovation and broader-than-expected application of new technologies. While downside risks could come from technological bottlenecks, a significant rise in trade protectionism, and over-regulation from governments.

Asia is well positioned to benefit from the new tech wave

Asia has built the world's largest electronics manufacturing cluster

Asia is well positioned to benefit from the new tech wave. Over the decades, Asia has built the world's largest electronics manufacturing cluster, making a broad range of electronic parts/components and finished products. Asia accounted for as much as 74% of global ICT goods exports in 2015, a higher share than the 50% in 2000 (Chart 2). In other words, three quarters of the world's electronic products are made in Asia today.

Chart 2: Asia: ICT goods exports



Sources: UNCTAD, CEIC, DBS

China is the world's largest production base for mobile phones, computers, and consumer electronics

China is Asia's largest electronics production base, accounting for 31% of global ICT goods exports. The actual share would exceed 40%, if considering the indirect shipments from China to the rest of the world via Hong Kong. In terms of specific products, China is the world's largest production base for mobile phones, computers, and consumer electronics, responsible for about 40% of related exports (Table 1).

Advanced Asian economies like Singapore, South Korea, and Taiwan have moved the low value-added electronics production to China and other Asian markets in the past decades. Each of them accounts for only 6% in global ICT exports today. But Singapore, South Korea, and Taiwan remain the world's major producers of electronic parts and components, contributing 13%, 9%, and 12% to the world's related exports, respectively (Singapore's data include re-exports).

South Korea is currently the world's No.1 producer of memory chips and display panels. Taiwan is the largest base for wafer foundry and integrated circuit (IC) packaging & testing globally. Singapore, meanwhile, ranks as the world's biggest manufacturer of hard disk media. The city-state is also home to some of the world's leading semiconductor companies.

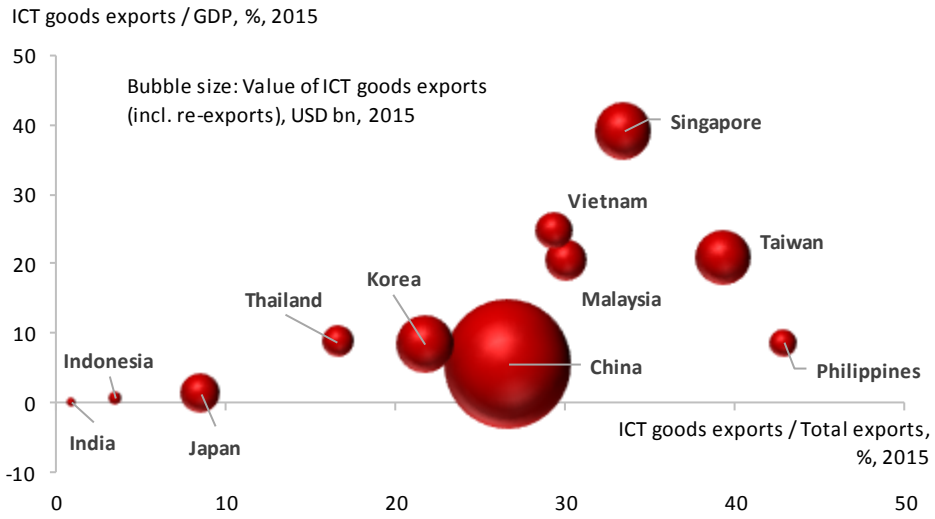
The ASEAN-5 countries also play an important role in the electronics supply chain, contributing a significant 9% to global ICT goods exports. Within this bloc, Thailand is the leading producer of computers (global share: 4%) and consumer electronics (3%). Vietnam has emerged as the largest production base for communication equipment (global share: 6%), thanks to heavy investment from Korea's Samsung to build factories to assemble smartphones. Malaysia is the key supplier of electronic components in this region (global share: 5%).

Table 1: Asia's ICT exports, by product, by country
USD bn (% global share in brackets)

		2000	2010	2015
All products	**China**	44 (4)	460 (27)	608 (31)
	South Korea	59 (6)	100 (6)	114 (6)
	Taiwan	63 (6)	95 (5)	110 (6)
	Singapore	76 (8)	121 (7)	116 (6)
	ASEAN-5	-	132 (8)	173 (9)
Computers & Peripheral equipment	**China**	18 (5)	197 (39)	184 (39)
	South Korea	20 (5)	14 (3)	11 (2)
	Taiwan	29 (8)	11 (2)	9 (2)
	Singapore	31 (8)	22 (4)	16 (3)
	ASEAN-5	-	51 (10)	45 (9)
Communication equipment	**China**	6 (4)	107 (32)	214 (41)
	South Korea	7 (4)	26 (8)	30 (6)
	Taiwan	3 (2)	10 (3)	7 (1)
	Singapore	3 (2)	7 (2)	11 (2)
	ASEAN-5	-	7 (2)	39 (7)
Consumer electronics	**China**	11 (11)	65 (28)	74 (37)
	South Korea	6 (5)	4 (2)	5 (2)
	Taiwan	2 (2)	3 (1)	3 (1)
	Singapore	4 (3)	4 (2)	2 (1)
	ASEAN-5	-	19 (8)	16 (8)
Electronic components	**China**	7 (2)	74 (13)	120 (18)
	South Korea	25 (8)	46 (8)	62 (9)
	Taiwan	26 (8)	66 (12)	83 (12)
	Singapore	35 (11)	87 (15)	85 (13)
	ASEAN-5	-	51 (9)	70 (10)

Notes: ASEAN-5 refers to Malaysia, Thailand, Indonesia, the Philippines, and Vietnam. Singapore's export data include re-exports.
Sources: UNCTAD, CEIC, DBS

Chart 3: Asia: The size and importance of electronics industry



Sources: UNCTAD, CEIC, DBS

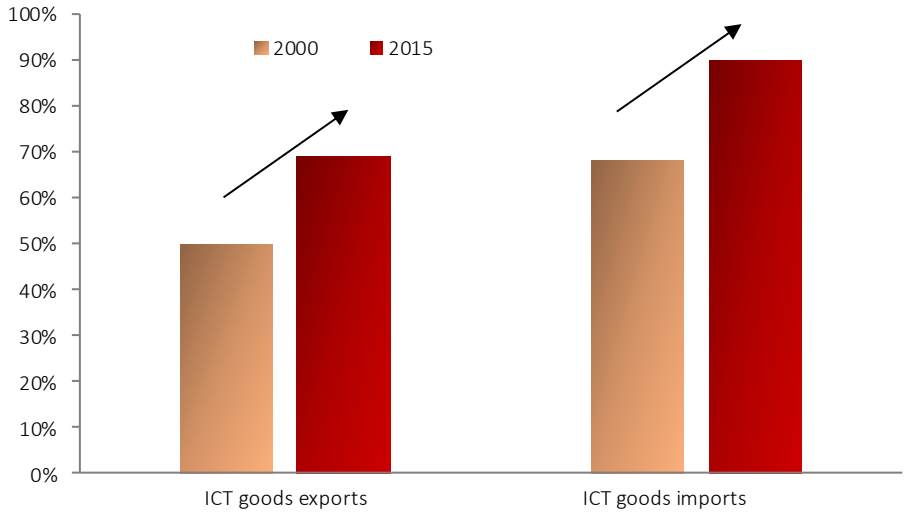
Asia has built an intertwined and sophisticated electronics supply chain

Asia has built an increasingly intertwined and sophisticated electronics supply chain over the decades**.** There is now a well-defined division among the major production bases in the region, including the fabrication of various electronic parts and components, and the assembly, testing, and exports of finished products. The production process of Apple's iPhone is a good example. While the iPhone is designed in the US, its production is largely conducted in Asia. The core processors could be made in Taiwan by TSMC, the displays made in Korea by LG, and the cameras sourced from Sony in Japan. The phone is subsequently assembled in China by Foxconn and exported around the world.

Asia's electronics trade is largely comprised of intra-regional trade nowadays

The establishment of Asia's interdependent electronics supply chain is manifested by the rapid expansion of intra-regional trade**.** Based on the 2015 statistics, 68% of Asia's ICT exports were shipped to countries within the region, a higher share than the 50% in 2000. Then again, as much as 90% of Asia's ICT imports were sourced from countries within the region, also a higher share than the 69% in 2000 (Chart 4). The proportion of intra-regional trade is highest in the electronic components segment, at 89% currently (for both exports and imports).

Chart 4: Asia: **Share of intra-Asia trade in ICT goods trade**



Sources: UNCTAD, CEIC, DBS

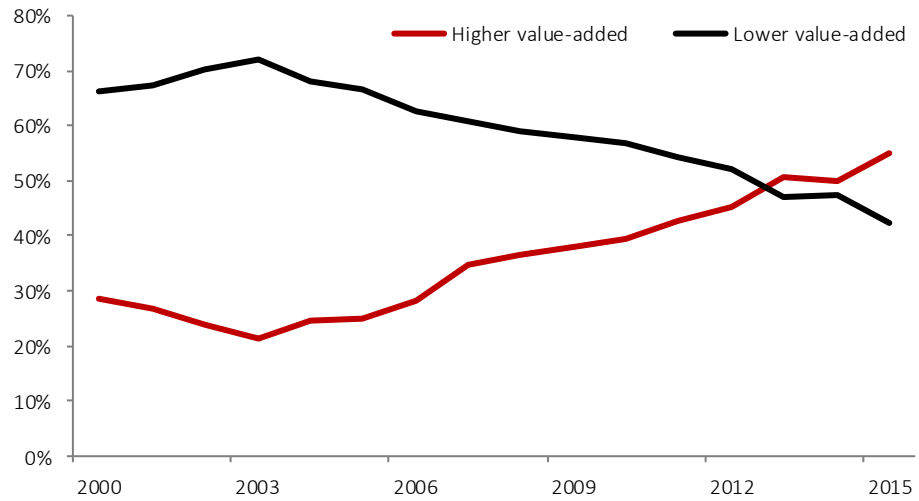
China's rise and rise as an electronics powerhouse

China is likely to benefit considerably from the new tech wave. Through successfully attracting foreign direct investment in the past decades, China has turned itself into the world's and the region's largest electronics manufacturing powerhouse. As mentioned, China is currently the world's biggest manufacturing base of various electronic products – computers, communication equipment, and consumer electronics, responsible for about 40% of related exports.

China has developed its own technological power and moved up the value chain

More importantly, China has demonstrated its ability to develop its own technological power and move up the value chain. In China's total ICT goods exports, the share of higher value-added products (communication equipment and electronic components) has risen to 55% in 2015, up sharply from the 28% in 2000. Conversely, the share of lower value-added products (computers and consumer electronics) has fallen to 42% from 66% (Chart 5).

Chart 5: China: Composition of ICT goods exports



Sources: UNCTAD, CEIC, DBS

Today, it is not only foreign electronics firms that engage in manufacturing works in China; a number of Chinese firms have also emerged as electronics giants. In the smartphone segment, for instance, China is now home to many successful self-branded companies, including Huawei, Oppo, and Xiaomi. Their combined shares in the global market have well exceeded that of Apple's and Samsung's (Table 2).

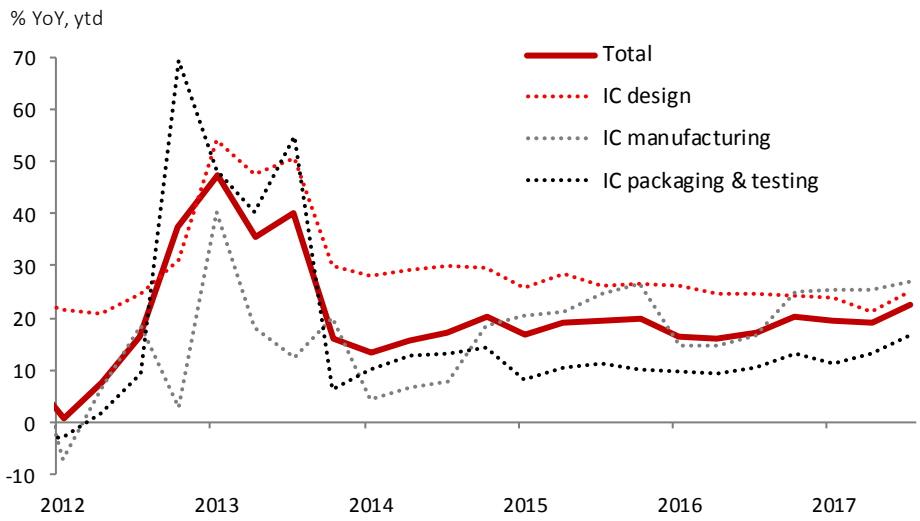
Table 2: Worldwide market share of smartphone companies (%)

	4Q16	2Q17	4Q17
Apple	18.2	11.8	19.7
Samsung	18.0	22.9	18.9
Huawei	10.6	11.1	10.7
Xiaomi	3.3	6.2	7.2
Oppo	7.3	8.0	6.9

Sources: IDC, DBS

China still relies on the foreign supply of some core technologies today. The country remains a net importer of various types of electronic parts and components, such as chips, semiconductors, and precision equipment. Having said that, China has also made significant advances in certain fields in recent years through technological investment and mergers & acquisitions. The country's IC sales began to surge in 2012, registering an average growth of about 20% YoY in the last five years (Chart 6). Growth in IC design was especially strong, at nearly 30% YoY.

Chart 6: China: IC sales



Sources: CEIC, DBS

China's HiSilicon and Unigroup are now among the world's top 10 fabless companies, though still ranking behind many US counterparts (Table 3). Three Chinese names – Jiangsu Changjiang, Tianshui Huatian, and Nantong Fujitsu – have also joined the global top 10 list of IC packaging and testing companies (an area dominated by Taiwan).

Table 3: The world's top 10 fabless companies

2017 Rank	Company	Headquarters
1	Qualcomm	US
2	Broadcom	Singapore
3	Nvidia	US
4	MediaTek	Taiwan
5	Apple	US
6	AMD	US
7	HiSilicon	China
8	Xilinx	US
9	Marvell	US
10	Unigroup	China

Sources: IC Insights, DBS

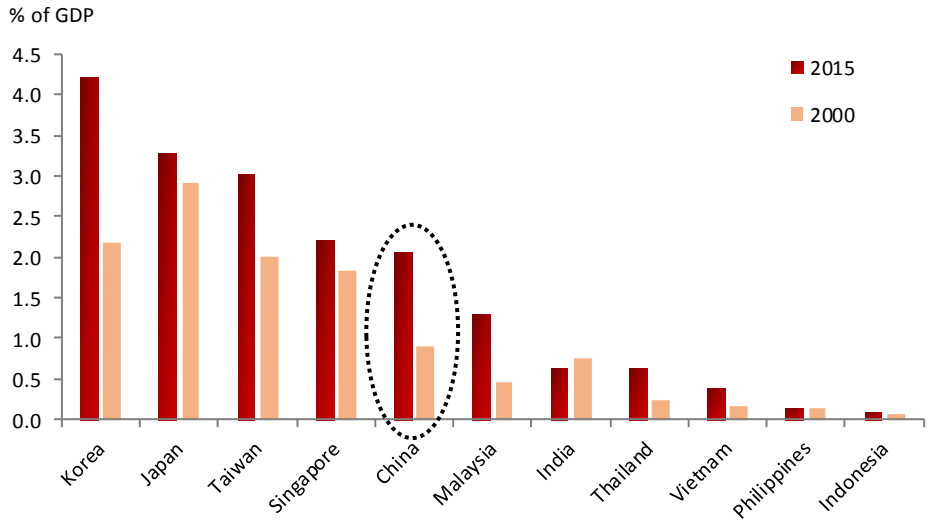
Both public and private sectors make consistent efforts to invest in technology development

There are good reasons to expect China to continue to climb up the value ladder and embrace the new tech wave in the next decade. The Chinese government is actively pushing for industrial upgrade and transformation under the "Made in China 2025" programme. The aim is to strengthen China's capabilities in high-tech industries, ranging from ICs and robots to aviation, marine engineering, new-energy vehicles, among others. The government has allocated more public funds to support technological R&D and is also encouraging large state-owned enterprises to participate in the programme.

In the private sector, there is also impetus for Chinese companies to engage in more R&D and design to increase the value-added elements of their products and/or to employ automated production technology to shift the entire value curve upwards. In the context of an ageing population, a rapid rise in labour costs, and a relatively strong renminbi, technological innovation would be increasingly regarded as the way forward for Chinese manufacturers to boost productivity, sustain profitability, and maintain competitiveness.

China's R&D expenditures have risen significantly in the past decades, from an equivalent of 0.9% of GDP in 2000 to 2.1% in 2015. The pace of increase is the second-fastest in Asia, just after South Korea (Chart 7). Under the 13th Five-Year Plan, the Chinese government aims to lift the R&D expenditure-to-GDP ratio further to 2.5% by 2020. Public and private R&D spending is expected to total RMB11.2tn in 2015-20, nearly double that during the 12th Five-Year Plan.

Chart 7: Asia: R&D expenditure



Sources: The World Bank, DBS

China has a unique advantage in its market scale

In addition, China has a unique advantage in its market scale. China's huge consumer market and rising consumer power provide a favourable environment for the marketisation of new business models and the application of new technologies. Presently, the country has as many as 700mn internet users, the world's largest e-commerce market, and the world's highest mobile payment penetration rate. This could generate a large volume of data, paving the way for the development of machine learning/AI. The application of AI will then boost demand for high-end electronic components and drive the development of China's semiconductor sector. In short, China's domestic demand in the new tech areas could serve as an intrinsic catalyst for its electronics supply chain to continue to evolve.

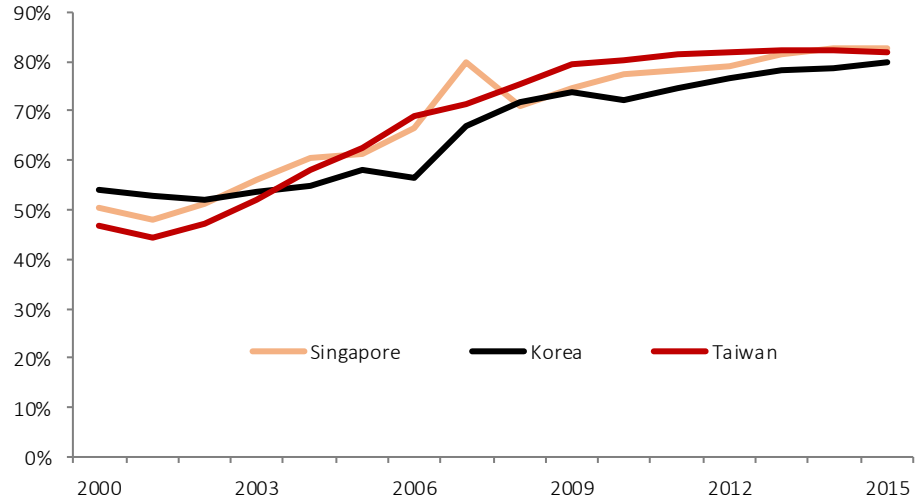
The competitive edge of Singapore, South Korea, and Taiwan

As China moves up the electronics value chain, it will likely erode the market shares of existing upstream producers in Asia's advanced economies, namely Singapore, South Korea, and Taiwan. But this doesn't mean China will readily absorb the upstream

production capacity. The relatively strong innovation capabilities of these economies could help them to sustain competitiveness in the upper tiers of high value-added electronic segments. Meanwhile, given their existing position in the high value-added segments, these three economies should be among the first to benefit from the new tech wave which is expected to boost demand for high-end electronic components. Cyber security and intellectual property-related concerns may also put a lid on China's ability to absorb the entire supply chain.

Singapore, South Korea, and Taiwan have successfully moved up the value chain, upgrading their manufacturing capabilities and transforming their electronics sectors. By moving the production of low value-added electronic products to China, Vietnam, and other Asian countries, they are able to focus on high value-added works today. Electronic components and communication equipment account for as much as 80% of their total ICT goods exports (Chart 8).

Chart 8: Singapore, Korea & Taiwan: Share of higher value-added products in ICT goods exports



Sources: UNCTAD, CEIC, DBS

Singapore, South Korea, and Taiwan have strong R&D capacity, highly-educated human resources, and robust institutional/legal frameworks

Compared to China, these advanced Asian economies have relatively strong R&D capacity, highly-educated human resources, and robust institutional/legal frameworks. Singapore has strong human resources, thanks to the heavy investment in higher education and the government's open immigration policy to import skilled labour. Given its easy business environment, comprehensive free trade networks, and superior geographic location, Singapore could also continue attracting foreign electronics companies to set up headquarters to control their regional operations and supply chains.

South Korea is the leading country in Asia for R&D expenditures, at 4% of GDP. Its chaebol-dominated electronics sector has the willingness and capabilities to take risks, expand R&D budgets, and enter new emerging areas.

Taiwan's advantage is its well-established semiconductor supply chains. Thanks to the vertical division between upstream and downstream (IC design, fabrication, packaging

and testing), Taiwanese semiconductor companies could provide diversified and customised products for global customers in an efficient way.

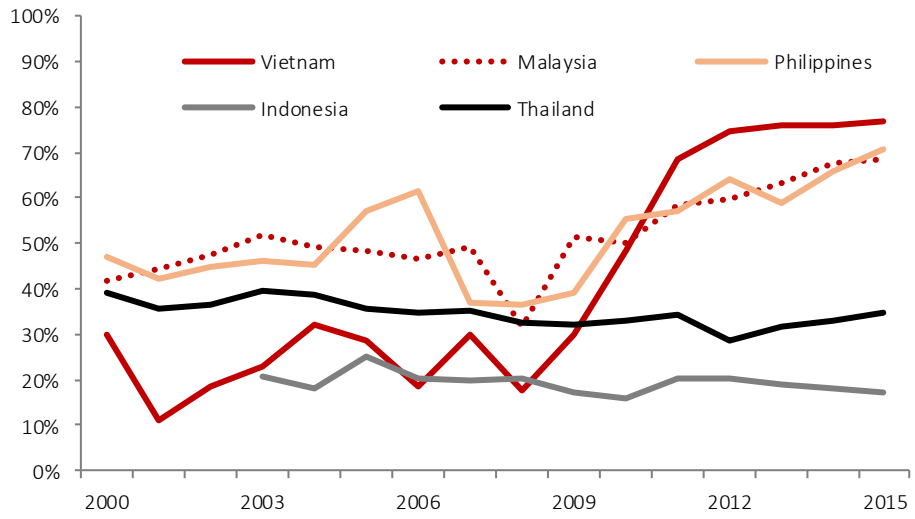
Opportunities for Southeast/South Asia

It will take time for the prices of robots/smart machines to fall to the level of wages in lower-income Asian economies

As China moves further up the electronics value chain, it would also create opportunities for lower-income countries in Southeast/South Asia. Given the rapid rise in wage pressures, Chinese electronics firms and foreign electronics firms based in China will likely consider relocating low-end manufacturing and assembly works to lower-cost Asian countries. It is true that the ongoing technological changes will increase the proportion of automated operations, reduce reliance on labour, and eventually, downplay the importance of labour costs in business investment decisions. But it will still take quite some time for the prices of robots and other smart machines in China to fall to the level of wages in lower-income Asian economies.

Some Southeast Asian countries have made advances in the electronics value chain, while the others remain laggards. Malaysia, the Philippines, and Vietnam have seen a notable rise in the share of high value-added products in total ICT exports in the past decade. But Indonesia and Thailand didn't see much changes (Chart 9). We believe there is room for Indonesia and Thailand to undertake more electronics manufacturing/assembly works and to upgrade their industrial structure.

Chart 9: ASEAN: Share of higher value-added products in ICT goods exports



Sources: UNCTAD, CEIC, DBS

India is not yet embedded in the global electronics supply chain – its share in global ICT goods exports is almost negligible. Given its cheap wages, abundant labour supply, and large consumer market, we also think there is potential for India to receive the lower-end manufacturing/assembly works transferred from China and to play a bigger role in the global electronics supply chain.

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Sources: Data for all charts and tables are from CEIC, Bloomberg and DBS Group Research (forecasts and transformations).