**Semiconductors: Chips on Their Shoulders**

China wants to become a superpower in semiconductors, and plans to spend colossal sums to achieve this

The Chinese government has been trying, on and off, since the 1970s to build an indigenous semiconductor industry. But its ambitions have never been as high, nor its budgets so big, as they are now. In an earlier big push, in the second half of the 1990s, the government spent less than $1 billion, reckons Morgan Stanley, an American bank. This time, under a grand plan announced in 2014, the government will muster $100 billion-$150 billion in public and private funds.

The aim is to catch up technologically with the world’s leading firms by 2030, in the design, fabrication and packaging of chips of all types, so as to cease being dependent on foreign supplies. In 2015 the government added a further target: within ten years it wants to be producing 70% of the chips consumed by Chinese industry.

It has a long way to go. Last year China’s manufacturers, both domestic and foreign-owned, consumed $145 billion-worth of microchips of all kinds. But the output of China’s domestic chip industry was only one-tenth of that value. And in some types of high-value semiconductor – the processor chips that are the brains of computers, and the rugged and durable chips that are embedded in cars – virtually all of China’s consumption is imported.

To help them achieve their dream, the authorities realise that they must buy as much foreign expertise as they can lay their hands on. In recent months, state-owned firms and various arms of government have been rushing to buy, invest in or do deals with overseas microchip firms. On January 17th the south-western province of Guizhou announced a joint venture with Qualcomm, an American chip designer, to invest around $280m in setting up a new maker of specialist chips for servers. The province’s investment fund will own 55% of the business. Two days earlier, shareholders in Powertech Technology, a Taiwanese firm that packages and tests chips, agreed to let Tsinghua Unigroup, a state-controlled firm from the mainland, buy a 25% stake for $600m.

Officials argue that developing a home-grown semiconductor industry is a strategic imperative, given the country’s excessive reliance on foreign technology. They can point to the taxpayers’ money that politicians in America, Europe and other parts of Asia have lavished on their domestic semiconductor industries over the years.

China’s microchip trade gap is, by some estimates, only around half of what the raw figures suggest, since a sizeable proportion of the imported chips that Chinese factories consume go into gadgets, such as Apple’s iPhones and Lenovo’s laptops, that are then exported. Even so, a policy of promoting semiconductors fits with the government’s broader policy of moving from labour-intensive manufacturing to higher-added-value, cleaner industries.

Morgan Stanley notes that profit margins for successful semiconductor firms are typically 40% or more, whereas the computers, gadgets and other hardware that they go into often have margins of less than 20%. So if Chinese firms designed and made more of the world’s chips, and one day controlled some of the underlying technical standards, as Intel does with personal-computer and server chips, China would enjoy a bigger share of the global electronics industry’s profits.

In the government’s earlier efforts to boost domestic manufacturing of solar panels and LED lamps, it spread its largesse among a lot of local firms, resulting in excess capacity and slumping prices. This time it seems to be concentrating its firepower on a more limited group of national champions. For instance, SMIC of Shanghai is set to be China’s champion “foundry” (bulk manufacturer of chips designed by others). And HiSilicon of Shenzhen (part of Huawei, a maker of telecoms equipment) will be one of a select few champions in chip design.

Most intriguing of all, Tsinghua Unigroup, a company spun out of Tsinghua University in Beijing, has emerged in the past year or so as the chosen champion among champions, a Chinese challenger to the mighty Intel. Zhao Weiguo, the firm’s boss, started out herding goats and pigs in Xinjiang, a remote province in north-western China, to where his parents had been exiled in the 1950s, having been labelled as dissidents. After moving to Beijing to study at the university, Mr. Zhao made a fortune in electronics, property and natural resources, before becoming chairman and second-largest shareholder (after the university itself) at Tsinghua Unigroup.

The company’s emergence from obscurity began in 2013 when it spent $2.6 billion buying two Chinese chip-design firms, Spreadtrum and RDA Microelectronics. In 2014 Intel bought a 20% stake in its putative future rival, for $1.5 billion, as part of a plan for the two to work together on chips for mobile devices, an area in which Intel has lagged behind. In May last year Tsinghua spent $2.3 billion to buy a 51% stake in H3C, a Hong Kong subsidiary of Hewlett-Packard that makes data-networking equipment. And in November it announced a $13 billion share placement to finance the building of a giant memory-chip plant.

**Shopping for silicon savvy**

Other Chinese firms have also been splashing out. Jiangsu Changjiang, a firm that packages chips, paid $1.8 billion in 2014 to gain control of STATS ChipPac, a Singaporean outfit in the same line of business. In 2015 state-controlled JianGuang Asset Management paid a similar sum for a division of NXP of the Netherlands, which makes specialist chips for cell-phone base stations. A group led by China Resources Holdings, another state enterprise, has made a $2.5 billion takeover bid for Fairchild Semiconductor International, an American firm. But the undisputed leader of the “national team” buying up foreign chip know-how is Tsinghua.

“Many people suspect I’m a ‘white glove’ for the government,” Mr. Zhao declared recently, “but we’re really just a very market-oriented company.” That somewhat understates the official backing that it clearly enjoys: without this, it is hard to imagine the company affording the 300 billion yuan ($45 billion) that Mr. Zhao says Tsinghua plans to spend on further deals over the next five years.

Chinese approaches to foreign semiconductor firms – unlike its firms’ acquisitions of foreign consumer brands – have not always met with a warm reception. Tsinghua reportedly made a $23 billion bid last year for Micron, a big American maker of DRAM – the type of memory chips used to store data on desktop computers and servers. But the bid faltered because of political opposition. The firm’s overtures to SK Hynix, a South Korean maker of DRAM and flash-memory chips (as used in USB sticks and smartphones), were rebuffed in November. In December Tsinghua bought a 25% stake in Siliconware Precision Industries (SPIL), a Taiwanese chip packager and tester. The resulting political backlash prompted Advanced Semiconductor Engineering (ASE), a bigger Taiwanese chip packager, to launch a takeover bid for SPIL in December. Tsai Ing-wen, the main opposition candidate in Taiwan’s presidential election, declared China’s investments in the island’s chip firms a “very big threat” – and on polling day, January 16th, she emerged the victor.

As to whether China will realise its ambitions, or whether it will continue to be dependent on foreign chip technology, Taiwan’s own experience is instructive. From the 1980s, it was highly successful in developing world-class chip foundries, such as TSMC, and in cultivating sparky designers of processor chips such as MediaTek. But in part that was because of good timing: the chip industry was moving towards a model of separating the design and the fabrication of chips, and Taiwan successfully rode that trend. But its more recent attempt to be big in memory chips was a disaster. Mark Li of Sanford C. Bernstein, a research firm, reckons that despite $50 billion in capital expenditure during the late 1990s and 2000s, mostly financed by the government, Taiwanese firms met with “en masse failure in memory.”

These firms lost further fortunes chasing market share. From 2001 to 2010, the global memory-chip business made $8 billion in aggregate profits – but subtract the two successful South Korean makers, Samsung and SK Hynix, and everyone else lost nearly $13 billion. Despite their vast outlays, reckons Mr. Li, Taiwanese firms spent too little to reach the technology frontier and were expecting profits too early.

Douglas Fuller of Zhejiang University in Hangzhou argues that the maturing of the global semiconductor industry in recent years will make it harder still for China to crack. The incumbents in memory chips have become entrenched, especially after recent consolidation; and the chips themselves, with their associated software, are becoming much more complex, making it harder for Chinese firms to master them. ASE’s chief operating officer, Tien Wu, adds that Taiwanese firms were entering the chip market at a time when it was enjoying heady expansion; it will be more difficult for Chinese firms to succeed at a time of slow growth.

If China’s putative chip champions are to succeed, they must accomplish three hard things. Lee Wai Keong, head of ASM Pacific Technology, a Hong Kong-listed supplier of equipment to the industry, believes that, first, Chinese firms must shift from “a culture of cost to a culture of innovation.” He laughs when asked if firms like Tsinghua can buy in cutting-edge research through acquisitions, insisting there are “no short cuts in semiconductors.” His scepticism is justified: export controls and other policy barriers in Taiwan, South Korea and America inhibit the transfer of the latest technologies to Chinese firms.

The mainland’s chip firms mostly lag far behind global leaders in invention (though HiSilicon is a notable exception). Intel alone spends about four times as much on research and development as does the entire Chinese chip industry, calculates Christopher Thomas of McKinsey, a consulting firm. Besides pumping more into research, Chinese firms also need to attract many more experienced scientists and engineers. This is not impossible, given that Silicon Valley is teeming with brilliant people of Chinese extraction. But if firms like Tsinghua are to attract them, they must learn how to innovate globally, for example by running multiple R&D centres around the world.

That points to the second challenge: the need to shift to a global frame of mind. So far Chinese firms have been mostly catering to booming local consumption. But they must prepare for demanding global markets. Even Chinese firms, especially those serving foreign markets, are unlikely to remain satisfied with subpar chips just because they are made at home.

The final challenge may be the most daunting. Investors in China’s chip firms need to get ready for a long, hard slog. Analysis by McKinsey reveals that across the global semiconductor industry, in memory or processor chips, and in design, fabrication or packaging, the top one or two firms in each area account for all profits – with the rest losing money.

A positive example China could follow, if it wants to avoid wasting its $150 billion, is that of Samsung. It has become a semiconductor colossus by investing heavily in R&D, amassing an array of technical talent and accepting low returns for many years. Boosters argue that Chinese firms could pull this off, given that the government will be the main investor, and is in it as a strategic priority rather than for profit.

However, there is a potential contradiction in the way the government is implementing its latest plan. Burned by the poor outcome of previous efforts to promote microchips, solar panels and LEDs, officials are funnelling a large chunk of their initial investment – around $30 billion – through a handful of state-backed investment funds. The hope is that these intermediaries will make more market-minded investments than bureaucrats did in the past. However, managing these funds so that they achieve this objective, even though outside investors will want a profitable exit before the government’s 2030 target, will be no mean feat.

Even so, Morgan Stanley’s analysts think Chinese firms have a fair chance at becoming world-class in certain parts of the industry. Local chip firms may have a strong hand in product areas such as televisions, mobile phones and computers, in which China dominates both production and consumption. Regulators may be tempted to tilt the playing-field further in their favour by dictating indigenous standards or imposing local-content requirements, though the risk is that China ends up with firms that are strong at home but lack global competitiveness.

In memory chips of either the DRAM or flash variety, Chinese firms’ chances would be bolstered if they could persuade some of the largest foreign firms to form technology-sharing alliances, enlisting those firms to help overcome their home governments’ curbs on technology transfer. In this, having deep pockets will be a great help. In September an offshoot of Tsinghua agreed to pump $3.8 billion into Western Digital, an American maker of hard-disk drives. Its balance-sheet bolstered, Western Digital soon afterwards spent $19 billion buying SanDisk, another American firm, which is among the world leaders in flash memory.

China’s efforts to develop national champions in what it calls “pillar industries” have a decidedly chequered record. In carmaking, its attempts to make foreign firms share their technology through compulsory joint ventures with domestic makers have only entrenched local firms’ dependence on their foreign partners. In commercial aircraft, a state aerospace conglomerate, COMAC, has spent years, and huge sums, developing planes that are still not ready for the market, and will be outdated by the time they arrive.

In the various parts of the microchip business, Chinese firms may eventually catch up technologically, but in the process undermine the industry worldwide, as happened in solar panels, through excessive capacity-building. As Bernstein’s Mr. Li puts it, China “will not stop until it dominates the market, with value and economics being destroyed.” Tsinghua’s boss, Mr. Zhao, is unabashed about his ambitions. “The chip sector is entering the era of giants, with accelerating integration,” he declared recently, making it clear that he intends his firm to be one of the few surviving giants. The coming shakeout will separate the sheep from the goats, which is an area in which Mr. Zhao happens to have some experience.