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LEAPFROGGING OR PIGGYBACKING?

The back of Gopal Raj's book “Reach for the Stars” carries a black-and-white photograph of the nose cone of a sounding rocket, carried on the back of a bicycle. The book chronicles the unlikely beginnings of India's space programme, which launched its first rocket in 1963 from Thumba, a fishing village in the state of Kerala. Thumba was chosen as the launch site in preference to another location whose name translated as “White Elephant Island”.

The programme's founder had little patience for scoffers. “One is often told that such and such a thing is too sophisticated” for a developing nation, he wrote. But “I have a dream, a fantasy maybe, that we can leapfrog our way to development.”

India's path since then has remained idiosyncratic. The skills demanded by its industries are those of a much richer country. This can be shown, roughly, by statistics; more sharply by anecdote. General Electric's technology centre in Bengalooru (formerly Bangalore), to pick one, is working on advanced propulsion systems for jet engines. India's Tata Consultancy Services (TCS) produces the software for Ferrari's Formula One cars. India's drugmakers offer 60,000 finished medicines; only three countries produce a bigger volume.

China's evolution also has its peculiarities. In 1964, recently estranged from its Soviet patron, it devoted a larger share of its GDP (1.7%) to R&D than it ever has since. But after the decade-long Cultural Revolution, this is how one study described the state of its industry on the eve of Deng Xiaoping's economic reforms in 1978: “vans and transformers that failed to keep out rainwater, sewing machines that leaked oil onto the fabric, power tillers rusting outside a factory that churned out fresh batches of unwanted inventory”.

Now, according to Dani Rodrik of Harvard University, China's exports are as sophisticated as those of a country three times richer. The goods it sells to America overlap to a surprising extent with the merchandise America buys from members of the OECD, a club of rich democracies, argues Peter Schott of Yale. By this measure, China's exports are more highly evolved than those of Brazil or Israel.

Particularly stunning is the growth of China's exports of information and communication technology (ICT), a category covering high-tech staples, such as telecoms equipment, computers, electronic components, and audio and video equipment. In 2004, the OECD reports, China passed America to become the world's biggest exporter of such goods (see chart 2).

Xu Zhijun, now head of marketing for Huawei, China's leading vendor of telecoms

equipment, recalls the “distrust and doubt” he faced from 1998 to 2001. The customers he courted would not believe the products were Huawei's own: “We had to make 100 or maybe 1,000 times the efforts of an American or European company.” Kiran Mazumdar-Shaw, boss of Biocon, an Indian biopharmaceutical company, describes a similar progression: “In the early days, we were taken with a big pinch of salt in India. Now we are beginning to upset the big guys. We have nuisance value. That means we are successful.”

A sliver of riches

How big is the technological gap between America and China? Forty-five nanometres, about 1/2,000th of the width of a human hair. That, at least, is the answer you might reach if you visit Semiconductor Manufacturing International Corporation (SMIC), China's leading maker of silicon chips. The company was founded in 2000 by Richard Chang, a Taiwan-born American citizen, who spent 20 years working for Texas Instruments. Having built chip foundries or “fabs” in Taiwan, Italy, Japan and elsewhere, he decided to do the same in China.

Two measurements sum up the stature of a chipmaker: the diameter of the silicon wafers it turns out (bigger is better), and the scale at which it etches them (the smaller the better). Prior to 2000, China could make 6-inch (15cm) wafers, good enough for washing machines perhaps, but more than a decade behind the state of the art. SMIC now boasts two factories that can make 12-inch wafers, as big as any in the industry. Moreover, it can etch circuits at a scale of 90 nanometres; just 45 nanometres behind the industry's leaders.

SMIC's Shanghai fabs defy the stereotype of China's labour-intensive assembly lines. Its wares are not glued, stitched or soldered; they are coated, patterned, etched, doped, annealed, plated and polished. Wages account for no more than 5% of the cost of chipmaking: it is the capital not the labour that steals the show.

Cassettes of wafers move from one expensive piece of kit to the next on overhead tracks, picked and placed by robotic arms. First coated with a thin insulating film and a light-sensitive layer, the silicon is lined up under a “mask”, which leaves some bits exposed to a beam of ultraviolet light, other bits protected. The beam inscribes a pattern, like strap marks on a sunbather, which is then etched into the chip by a jet of plasma. The etch-marks expose the silicon beneath, which is then implanted with phosphorus or boran. These impurities, or “dopants”, transform silicon from its natural state as an insulator—a tidy latticework of atoms with no loose electrons—into its famous modern role as a semiconductor, permitting electrons to stop or go as the chip designer pleases.

Thanks to its prodigious output of electronic gear, China is now the biggest market for integrated circuits in the world. All the laptops and handsets, as well as the refrigerators and air conditioners, rolling off its production lines have chips inside. But China's foundries can satisfy only a tiny fraction of that demand. Their supply amounts to $3.1 billion, whereas China's demand is $62 billion. The supply shortfall could reach $112 billion by 2010.

This gap is one reason why Lee Branstetter of Carnegie Mellon University and Nicholas Lardy of the Peterson Institute for International Economics caution economists like Mr Rodrik not to overestimate China. China's firms have not managed “to leapfrog

ahead and bend or even suspend the law of comparative advantage". China is where electronic goods are made, not where much of the value is added.

As is so often the case, Apple's iPod is the best example. The 30-gigabyte video version was manufactured in China by Inventec, a Taiwanese company. It sold for about $224 wholesale in 2005. But where did that money go? Three economists—Greg Linden of the University of California, Berkeley, together with Jason Dedrick and Kenneth Kraemer of the University of California, Irvine—have peered into the white box to find out. Of the iPod's 424 parts, they reckon 300 cost one cent or less. The display module was worth about $20, but that was made in Japan by Toshiba-Matsushita. China did assemble all these bits and pieces and test them. But that accounted for just $3.70 of the iPod's value. The largest bite was claimed by Apple: about $80 in gross profit.

Perhaps only 15% of the value of China's electronic and IT exports is added in China, Messrs Branstetter and Lardy think. The rest is imported. Look again at China's trade figures for ICT: exports amounted to almost $300 billion in 2006, the highest in the world. But imports were $226 billion. China had a trade surplus in computers, video cameras, TVs and telephones; but it had a deficit of $92 billion in electronic components, including semiconductors, integrated circuits and audio and video parts.

China fetches low prices for its high technologies. The TV sets it sold in 2003 were worth about $73 a unit, according to Mr Rodrik's numbers. Malaysia's were worth twice that. The machinery America buys from other members of the OECD, according to Mr Schott, is four times as expensive as the stuff it buys from China.

China's high-tech firms are cheap; they are also not very Chinese. None of the top ten, by 2005 revenues, was native-born. Foreign firms owned one-fifth of the assets in the ICT sector in 2004, accounted for the lion's share of exports, provided 16% of the employment and claimed 20% of the earnings. The wages they pay stay in China; as do whatever profits they reinvest. But their know-how stems from overseas. Some Chinese firms may soon make their mark in high-tech industries, Messrs Lardy and Branstetter argue. But the transition of the economy "from net importer of technology-intensive goods to net exporter is likely to take many decades."

At your service

As the digital professionals of Bengalooru gather themselves for the punishing commute home from Electronics City, a group of exuberant young men parade noisily in the opposite direction. Streaked from head to shoulder with bright powder paint, they dance and holler ahead of a plastic icon of Ganesh, the elephant-headed god, whose birthday fell some days before. Ganesh appears in some unofficial versions of the Mahabharata, a Hindu epic, as a scribe, whose quill pen breaks in his haste to record the poem as a sage recites it. Not to be beaten, Ganesh snaps off one of his tusks, dips it in ink and does not miss a line.

Those virtues of determination and improvisation explain much of the success of India's celebrated IT firms, such as TCS, Wipro and Infosys. Each firm has its epic tales of deadlines made and obstacles overcome. Their exports of IT services (which do not include other back-office services) grew by 36% in the last fiscal year (which ended March 31st) to reach $18 billion, according to NASSCOM, the industry association. IT services employed

about 560,000 people. Most of them seem to clog Bengalooru's Hosur Road each morning. The big three have landed several deals each worth over $300m (with companies such as Skandia, General Motors, United Biscuits and British Telecom) and margins are still healthy: Infosys, for example, reported an operating margin of 28% for the third quarter.

But some in the industry think India should be doing more with its intellectual resources. It should aspire to be the poet, not the scribe. India's exports of its own software—or licensing of its own intellectual property (IP)—amounted to about $450m in the year ending March 31st, a tiny fraction of its service exports. India, argues Craig Mundie of Microsoft, must go beyond renting out IQ and start creating IP.

Services are labour-intensive; products require a bit of capital. It thus makes sense that India started out by specialising in the former. In the 1970s it had lots of well-trained engineers, bred for an industrial future that somehow failed to materialise. Add a roomful of computers and a company could get to work. Indeed, in the early days, even the computers were sometimes lacking. The so-called “body-shopping” model—despatching Indian engineers to work on the site of an American or British client—first established itself after IBM quit India in 1978. At that time, it was easier to export an Indian programmer to an American computer than it was to import the machine to India.

But it is precisely the labour-intensity of services that must ultimately limit the industry's growth. To double its revenues, a service company has more or less to double its headcount, says Kiran Karnik, head of NASSCOM. That is expensive: wages of IT professionals are growing by 15% a year. TCS, for example, now has over 100,000 employees, having added over 12,000 bodies in the most recent quarter. Will its headcount need to swell to 200,000 before its revenues reach the $9 billion-$10 billion mark?

Eventually, argues Ravi Venkatesan of Microsoft India, the country's firms will need to embody their brain-work in a patentable software product that, like an original poem, can be copied and sold, over and over again. What is stopping them?

One clue is given by a small advert posted in the second-class carriage of a Mumbai commuter train. It proclaims the virtues of Tradeannex, a four-in-one package created by a local software house, which offers small-business owners help with sales, purchases, inventory and taxation. But as well as selling the product, the advert also confesses the company's need for “distributors and channel partners”.

Indian software firms often lack the wherewithal to push a product in the marketplace, and to survive the marketplace's whims. Services yield predictable returns: it is like “an annuities business,” says Mr Karnik. Products, on the other hand, require a heavy outlay up-front, which may never be recouped if the package fails to find enough distributors, “channel partners” and customers. I-flex solutions, India's biggest software-product success, survived its early years by running a services business on the side. Its vice-chairman, R. Ravisankar, thinks other Indian firms lacked the “front-end spit and polish” that a successful brand requires.

To make a successful product, a company needs to be close to its customers. But Indians do not use much software—they bought only $1.6 billion-worth last fiscal year—and when they use it, they do not pay for it. Piracy rates are as high as 72%. One

company, Tally, has succeeded by writing accounting programs for small businesses in India and other emerging markets. It touts "the power of simplicity" and traces its origins to the efforts of its founder and his son to computerise their own company's accounts in the 1980s. You can buy the silver edition of Tally's ninth release for 11,232 rupees ($290). This compares well with foreign packages that are "atrociously expensive" and "require two or three PhDs to run," as Mr Karnik puts it.

Meanwhile, the services firms themselves seem happy renting out IQ. Their aim is not just to add heads but to earn more revenue per head. To do this, they will have to earn money from the right side of their brains as well as the left. K. Ananth Krishnan, the chief technology officer for TCS, uses the analogy of an expensive hairdresser, who might examine you for 15 minutes, then snip two locks of hair. He charges you not for how much he cuts, but for what is left and how he has shaped it. Likewise, India's leading firms hope to move away from charging clients on the basis of inputs—"time and materials"—or even outputs—pieces of code. They want to charge customers on the basis of the gains their IT services can deliver, such as cutting their billing costs.

Mr Karnik thinks it little exaggeration to say that companies are either born as product companies or as service companies, not both. Scribes want to become better scribes. To become a poet, you probably need to be born as one.