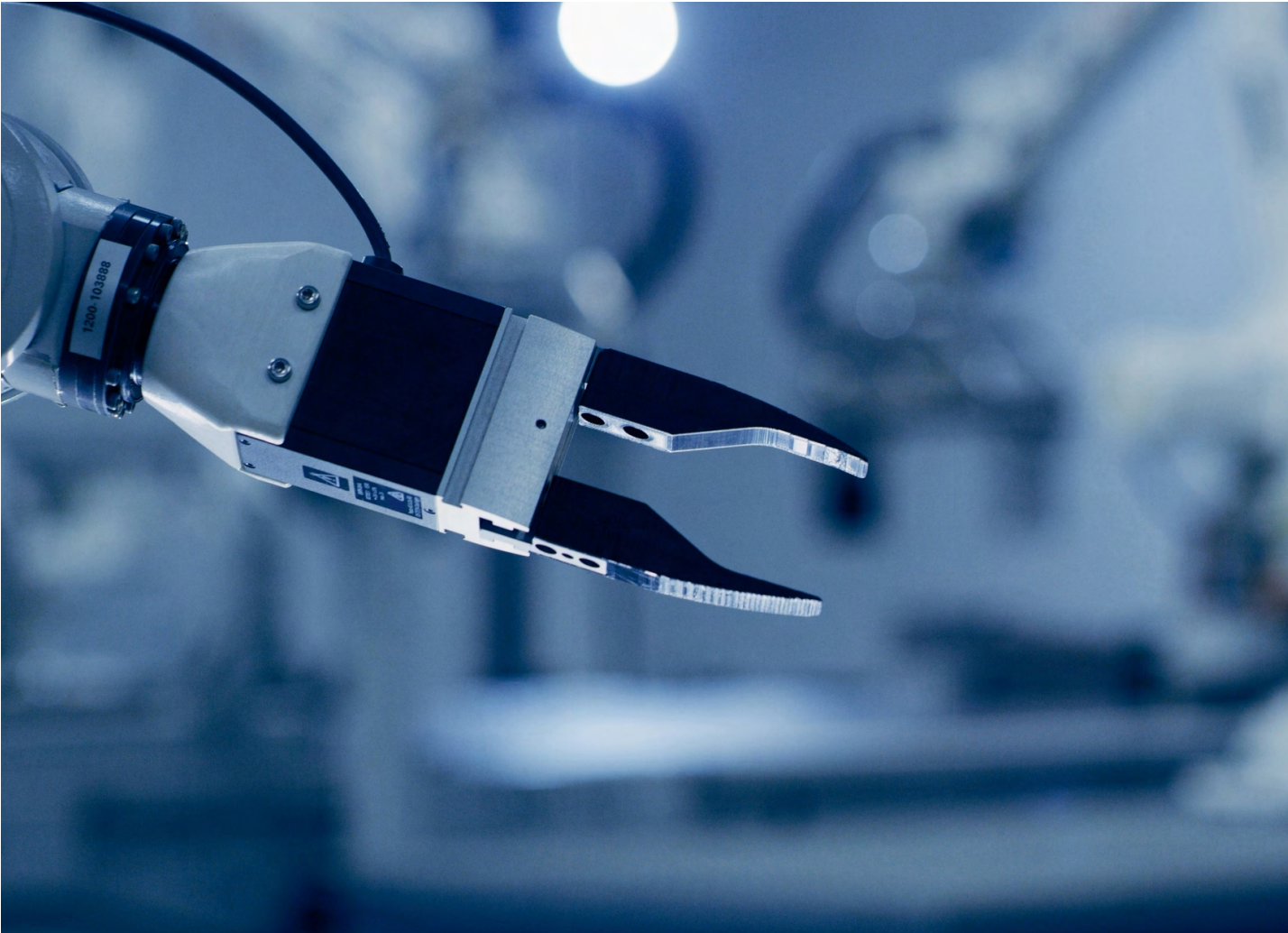


From Bits to Atoms: China's Tech Pivot in Four Acts

AJ Cortese





China's Tech Pivot (Part I): From Behemoth Platforms to Little Giants

The stellar growth of China's consumer internet industry since 2011 is now familiar territory. But all bull runs must end, and it wouldn't be a complete exaggeration to have written the epitaph of the consumer internet's growth in 2021.

At a minimum, that decadal sprint, which created some of the most valuable global companies along the way, is likely to slow to more of a jog.

That the curtains are closing on the golden era of the Chinese consumer internet [isn't simply a result](#) of the big tech smackdown of 2021. Factors such as a saturated market, consumer discontent, and abuses of market power have all contributed to the industry's predicament.

As such, the next paradigm in China tech will be defined by a pivot towards hardware, core innovation, and enterprise solutions. Tech startups, and their funding, will be judged on their ability to enhance the real economy, not simply sell products or services in new digital formats. This is the first in a series that will examine this "pivot" and its associated challenges.

The Peak: Sun Sets on Consumer Internet Growth

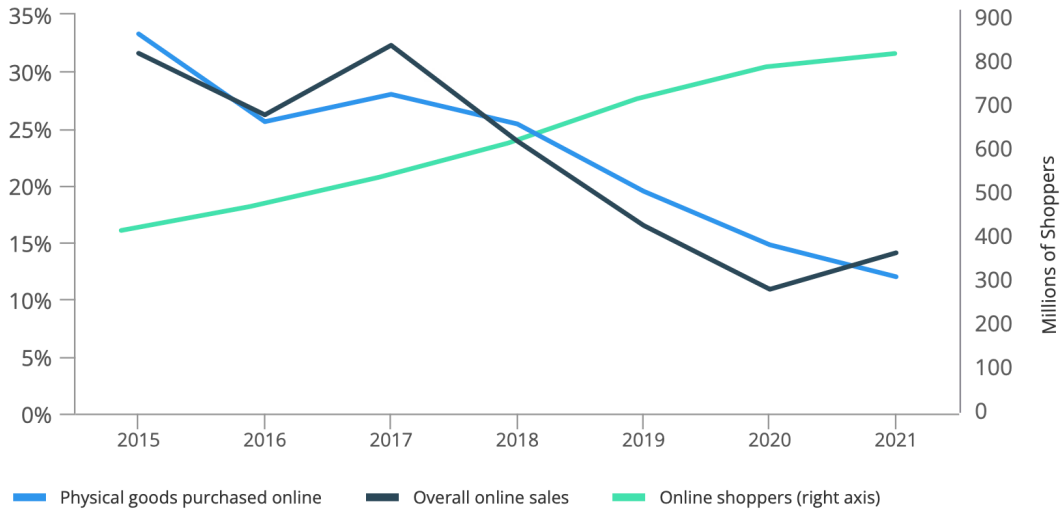
Before getting to the pivot, it's worth examining how the fires of a red-hot sector have been doused.

Capital-rich Chinese internet giants favored a business model centered on "blitzscaling"—burning cash on rapid and aggressive horizontal expansions into numerous sectors where services or products can be digitized (e.g. finance, education etc).

Scale and speed were big advantages in capturing market share in a hyper competitive sector. But what was an effective business model during the "blue ocean (蓝海)" phase (Chinese version of a white space) of the sector became more problematic as the market matured.

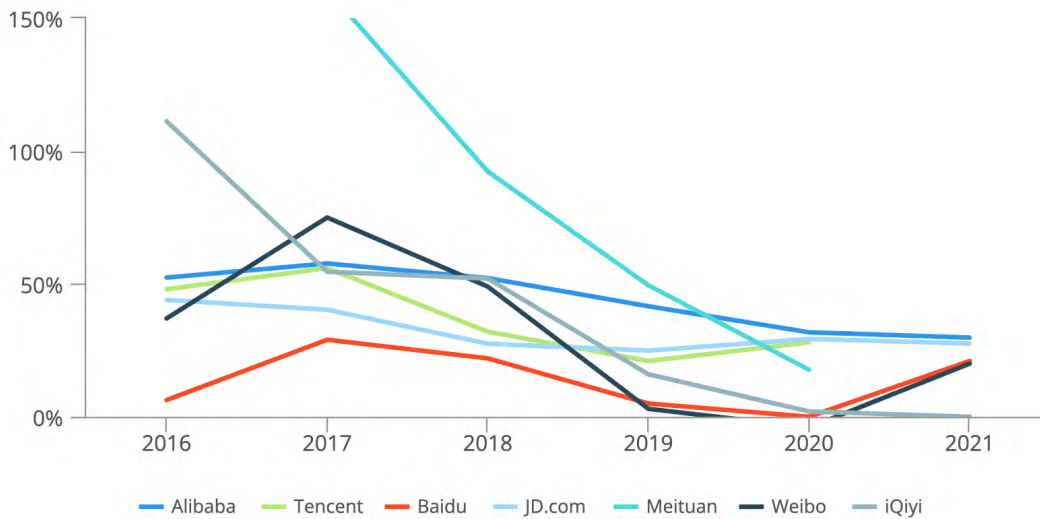
That market saturation has shown up in online sales and slowing revenue growth of the internet giants (see Figures 1a and 1b).

Figure 1a. Online Sales Growth Slows in Maturing Market, 2015-2021



Source: National Bureau of Statistics; China Internet Network Information Center.

Figure 1b. Consumer Internet Giants' Revenue Growth Have Slowed



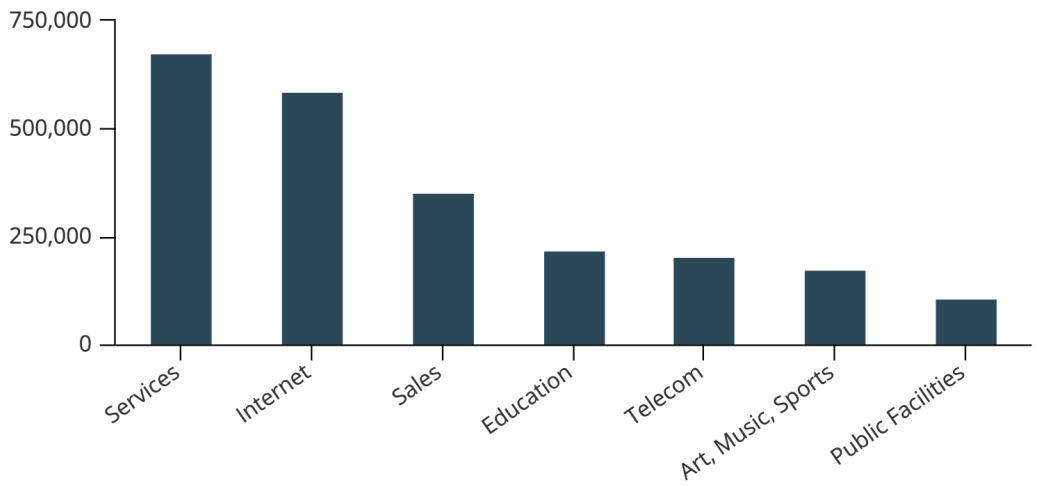
Source: Company financial reports.

Profiting from an increasingly saturated market is difficult. To improve marginal returns typically requires either cutting costs or squeezing customers in some form or both—and squeeze they did.

Small-time merchants felt the brunt of it. Meituan and Alibaba, for instance, were both penalized for using exclusivity agreements that forced merchants to only sell on their platforms or pay a significantly higher commission rate to remain.

What's more, complaints started filing in from both consumers and the legions of gig workers. Since 2015, the consumer internet industry has ranked second only behind the services industry in terms of consumer dissatisfaction (see Figure 2).

Figure 2. Top Sectors for Chinese Consumer Complaints since 2015



Note: Consumer complaints range from false advertising and privacy violations to data mishandling. Source: China Consumers Association.

Gig workers complained about inadequate compensation, dangerous working conditions, and harsh delivery penalties. In a horrific episode, a delivery worker [set himself on fire](#) when a dispute over wages couldn't be resolved.

As a result, public sentiment started to [sour on big tech](#), viewing platform companies as more exploitative and anti-competitive. No surprise that domestic support had been building for government action against these companies long before the crackdown of 2021, even if the ferocity of the campaign surprised observers.

Meanwhile, Beijing also capitalized on the opportunity to [advance its own vision](#) for a technological future focused on core innovation and bolstering basic science and industrial technologies.

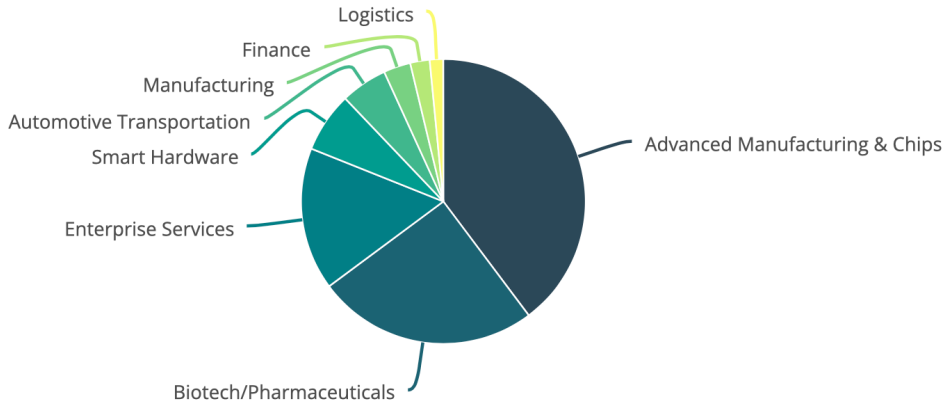
The Pivot: “We wanted 5nm chips, instead we got digital red envelopes”

That paraphrase of the famous Silicon Valley motto perhaps [best captures](#) the Chinese leadership's thinking on technology. To thrive under this new paradigm, China's chastened tech giants will have to align their business models more with national interests and pivot towards enterprise solutions and core innovation.

Some of this has been happening already among the “BAT.” Baidu [has been focusing on](#) cloud computing and transportation. Alibaba, too, is increasingly reliant on its cloud computing business for growth—the segment [made up a record 11%](#) of its 4Q2021 revenue—while it is also starting to make chips for its data centers. Finally, Tencent [unveiled chips](#) optimized for gaming in November 2021.

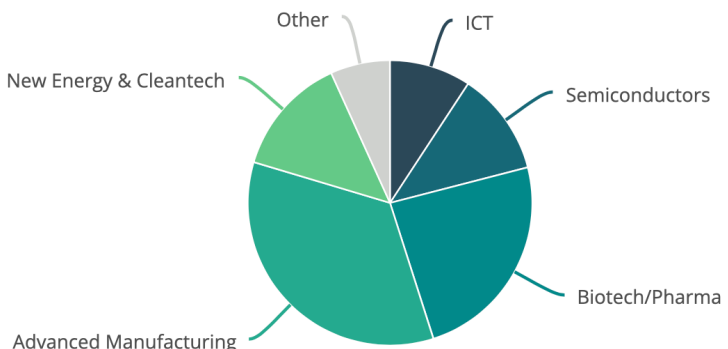
Equally as important, public and private funding are also being redirected toward foundational innovation such as semiconductors, manufacturing and industrial solutions, and biotechnology (see Figures 3a and 3b).

Figure 3a. State-backed Funds' Investments in 2021 Focus on the Real Economy



Note: These funds are typically investment arms of state-owned enterprises, central ministries, and/or local governments.
 Source: ITJuzi.

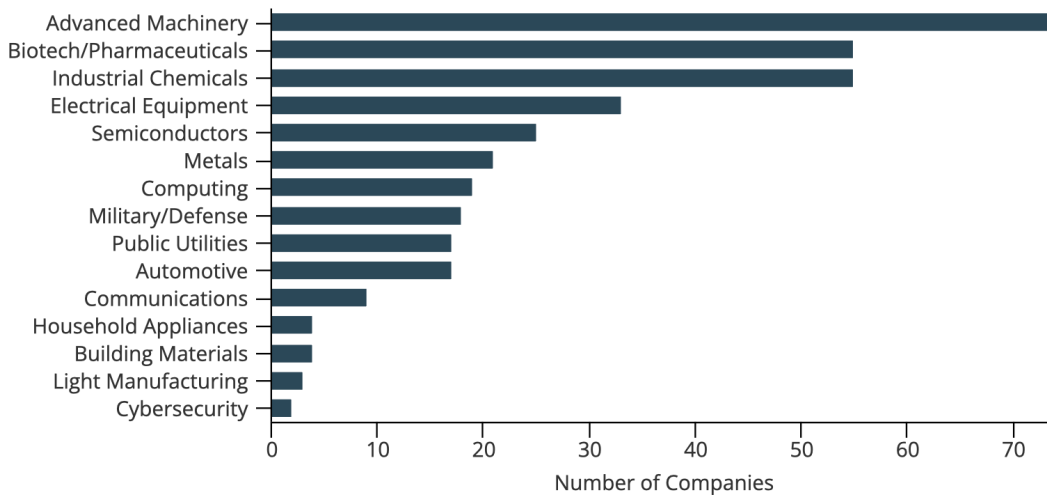
Figure 3b. Vast Majority of STAR IPOs Are in “Atoms” Sectors, Not “Bits”



Source: STAR Market IPO documents.

A prism through which to view this pivot is [a recently launched](#) state-backed incubator program called “Little Giants.” Run by the Ministry of Industry and Information Technology (MIIT), since the program’s debut in 2018, 356 of the 4,762 approved companies on the MIIT list have already “graduated” from the incubator to list on the A-share market (see Figure 4).

Figure 4. Listed Little Giants Align with The Pivot



Source: A-share IPO documents.

MIIT apparently plans [to expand](#) the Little Giants program to include 10,000 companies by 2025, with the hope of cultivating dynamic companies that embody the ethos of *zhuan jing te xin* (专精特新)—broadly meaning niche innovation and specialized technical solutions.

The Little Giants moniker is meant to serve as a signal to investors seeking high-potential firms. It may also help them get preferential access to domestic capital markets, including the [newly founded](#) Beijing Stock Exchange.

But commercializing enterprise technology and core innovation is much more complicated than consumer internet apps. Success of the Little Giants is far from guaranteed, and one of the most important challenges is human capital. That will be the subject of Part II of this series on China’s tech pivot.



China's Tech Pivot (Part II):

**STEM Talent Shortage
Stymies Core Innovation?**

Now that China's tech pivot to enhance the real economy and to master foundational technologies [is under way](#), standing in the way of that pivot is a talent bottleneck.

Yet [despite having](#) the world's most STEM graduates, China surprisingly suffers from talent shortages in areas key to the pivot.

For instance, China is currently [facing a shortage](#) of five million artificial intelligence (AI) talent, according to a white paper from Baidu and Zhejiang University. In addition, more than half of the Chinese chipmakers surveyed [have not fulfilled](#) 60% of their autumn season recruiting objectives in 2021, according to a report from recruitment platform [51job.com](#), China's version of Glassdoor.

Indeed, this next phase of China's technology development will require putting a premium on human capital over financial capital. Not to say money won't matter. But pumping capital into scaling business models won't generate the technological breakthroughs that Beijing wants. China's chip industry is a [case in point](#).

That's because the talent needed for areas like advanced manufacturing, biotech, AI, and chips is qualitatively different from the consumer internet industry that rose over the last decade.

Instead of hordes of app developers and energetic business and marketing associates onboarding vendors to platforms, the pivot requires specialized and highly trained talent to work in the labs and push the frontiers of basic and applied research. These sorts of highly technical innovations require patience more than speed and scale.

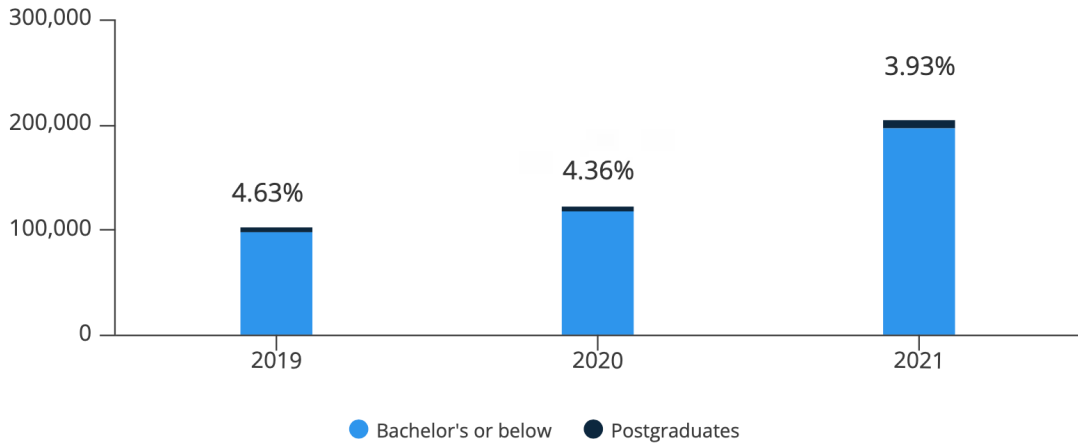
Scarcity of the *right type* of talent combined with the geographic imbalance of talent distribution will exacerbate this supply constraint in the near term. In Part II of this series, we pick up where we left off, using quick studies of the Little Giants and the biopharmaceuticals sector to illustrate how the talent problem could throw sand into the gears of the tech pivot.

Talent Demand and Supply Mismatch: The Case of Little Giants

Beijing may have pinned some of its hope on the Little Giants program to [lead the pivot](#), but many of the enterprises face an even larger deficit in talent than your average tech firm, as their verticals require sophisticated expertise blended with industrial knowledge.

Of the nearly 50,000 STEM doctorates Chinese universities graduated in 2019, [only 349 \(<1%\) were hired](#) by Little Giant enterprises. In fact, although Little Giant enterprises racked up headcount significantly in 2021, the proportion of post-graduate talent actually declined to just under 4%, implying their struggles in attracting top-level talent (see Figure 1).

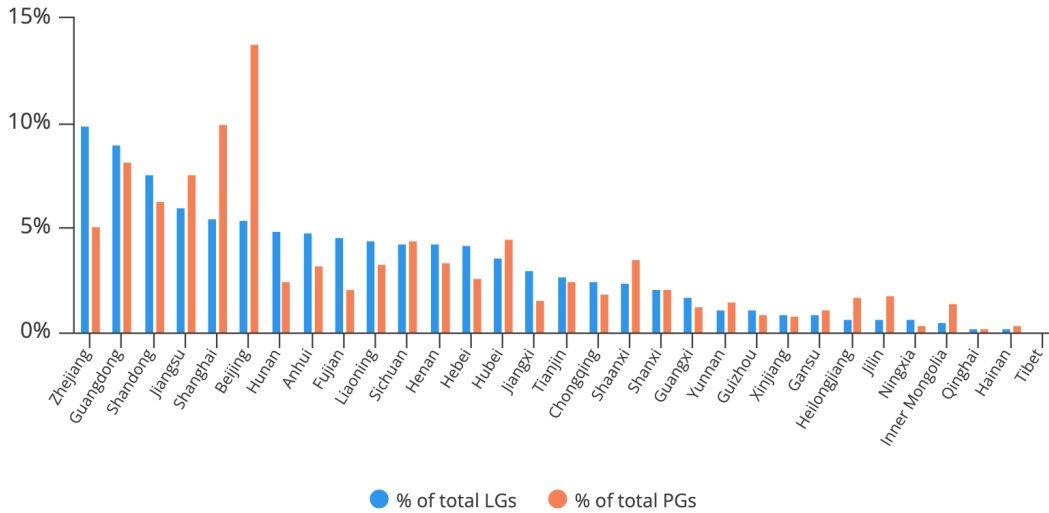
Figure 1. Headcount Expands, but Not of The Right Type



Note: Recruitment data from the 4,672 national-level Little Giant enterprises designated by the Ministry of Industry and Information Technology as of December 2021.
Source: CCID Consulting.

Part of this scarcity of qualified talent can be attributed to the imbalance in human capital distribution. In other words, [there's a mismatch](#) between where postgraduates are concentrated—in superstar cities like Shanghai and Beijing—and the distribution of Little Giant enterprises across China (see Figure 2).

Figure 2. Surplus of Postgraduates in Superstar Cities, Dearth in Other Regions



Note: LGs = Little Giants; PGs = Postgraduates.
 Source: China Statistical Yearbook 2021.

This asymmetry in talent and opportunity distribution is a difficult challenge to overcome. In general, highly educated workers that already live in or near tier-one cities tend to want to stay put rather than move to another province with fewer opportunities.

That’s not great for the 57% of Little Giant firms that are located outside of China’s three major economic clusters—defined as the Yangtze and Pearl River Deltas and the “Jing-Jin-Ji” (the Beijing-Tianjin-Hebei triangle). They will struggle to persuade China’s best and brightest to relocate.

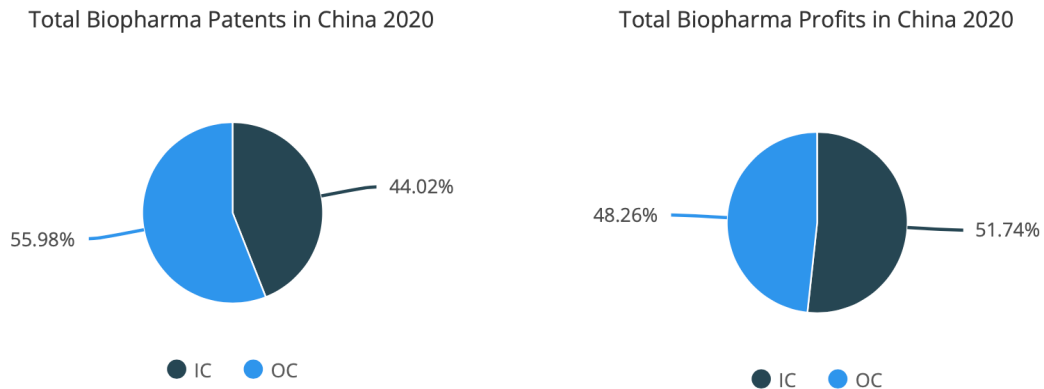
To deal with the talent pipeline issue, some Little Giant enterprises have resorted to sharing engineers and allowing employees to work for multiple startups. That could provide more financial incentives for high-quality talent to live in a city with a lower cost of living. But it’s unclear whether these stop-gap measures will be sustainable or lead to a meaningful redistribution of talent.

Talent Imbalance Shows Up in Firm Performance

The talent gap between economic clusters and the rest of China appears to also manifest in firm performance in terms of the bottom line and innovation. Although far from conclusive, some preliminary evidence in the biopharmaceuticals sector—a vital area of China’s tech pivot—can illustrate this discrepancy.

While only 37.4% of biopharma companies are located inside clusters, this cohort accounted for more than half of the industry’s total profits and 44% of total invention patents in 2020 (see Figure 3). In other words, biopharma firms inside clusters appear to be punching above their weight.

Figure 3. Biopharma Firms Inside Clusters Outperformed Those in Other Regions

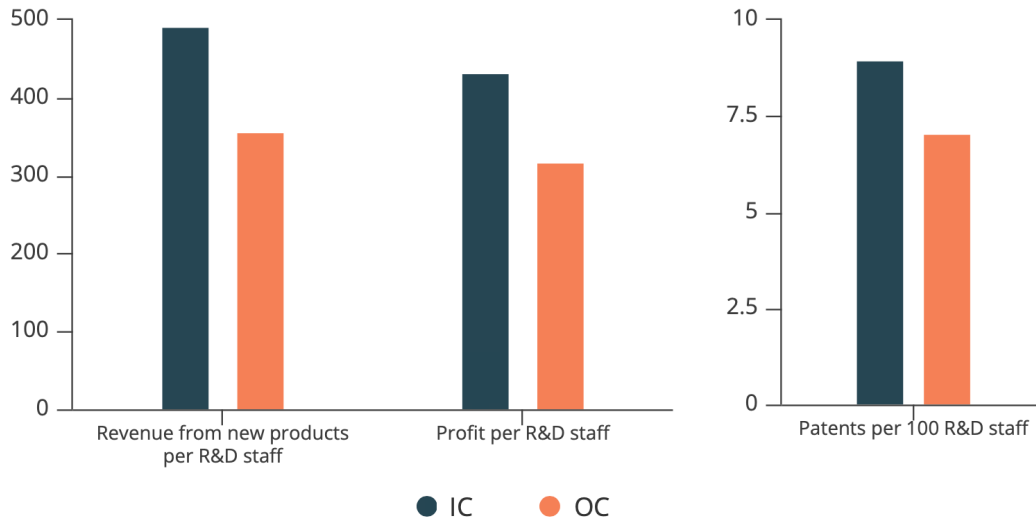


Note: IC = inside clusters; OC = outside clusters.

Source: China High-Tech Industry Statistical Yearbook 2021.

This is further corroborated by the fact that compared to other firms, biopharma companies inside clusters boast stronger profits per researcher, while also generating more innovation patents per 100 researchers (see Figure 4).

Figure 4. Biopharma Firms Inside Clusters Generate More Per Talent



Note: “Inside clusters” includes data from Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, and Guangdong.

Source: China High-Tech Industry Statistical Yearbook 2021.

If this pattern of high-quality talent raising firm performance holds in other tech sectors, then it will likely lead to uneven growth across regions, despite a host of government policies and subsidies. The intensification of competition for scarce technical talent inevitably means that many tech firms and startups will struggle to innovate.

But the human capital constraint isn’t the only thing standing in the way of the pivot. This generation of core innovation startups needs to also create new enterprise-facing commercial strategies and pioneer new business models to succeed. That will be the subject in Part III of this series.



China's Tech Pivot (Part III):

Innovation Without Commercialization?

While China needs to [solve the people problem](#) when it comes to the tech pivot, it faces another daunting challenge: commercialization. Compared to the consumer internet, building and scaling industrial enterprise technologies is much more arduous and takes place mostly behind the scenes.

In the app economy, it simply requires a one-size fits all product to tap a total addressable market of hundreds of millions. Once there is a minimally viable product, an app gets pushed out quickly and scale is reached rapidly. In the industrial enterprise economy, commercializing technologies, whether it's hardware or software as services, requires customization, specific targets, and a customer base across niche industrial verticals.

To illustrate the challenge of commercialization, we analyzed the 93 Little Giant firms listed on the Beijing Stock Exchange, a domestic bourse established in November 2021 specifically to finance high-tech enterprises.

No surprise that this cohort of core innovation startups ascribe to a product-intensive strategy because they are under pressure to develop the next big technical innovation. This can be seen in these companies' resource allocation between research and development (R&D) and sales and marketing (S&M).

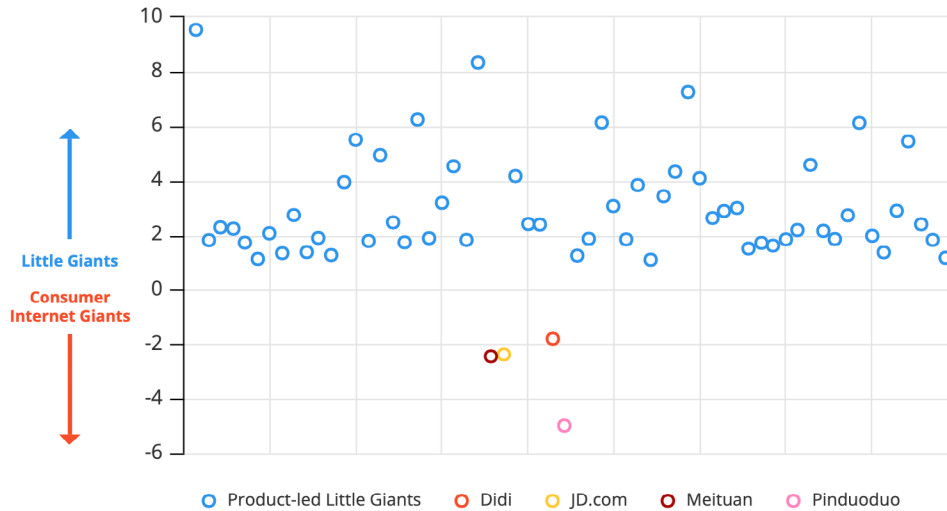
Given an immature and underdeveloped industrial technology market, these firms could be left holding onto their technologies with little idea of how to cross the commercialization "Valley of Death". Indeed, the embryonic industrial enterprise economy means that the state sector will likely have to step in as a market for these core innovation startups.

That is, these firms' technology solutions may target the public sector as customers before scaling across industry verticals. It also means that these firms' relationship with the state will likely be characterized as more symbiotic rather than contentious.

The "If You Build It, Will They Come?" Problem

Since the Little Giants aspire to lead in high-tech verticals, prioritizing R&D over commercialization makes sense from the firm perspective. This helps to attract higher quality talent and create better products over the long term. Of the Little Giant firms listed on the Beijing Stock Exchange, nearly 65% are focused on products, based on their spending (see Figure 1).

Figure 1. Little Giants Spend More on R&D Compared to Consumer Internet Giants



Note: Ratio calculated using 2021 R&D spending and S&M spending. Positive value indicates spending ratio in favor of R&D, negative value indicates spending ratio in favor of S&M.

Source: Corporate 2021 annual reports.

Such a “product first” mentality is similar to the approach taken by many successful Western industrial tech giants. Where they differ is that the US and EU markets were more mature, and had existing enterprise customers already familiar with, and able to pay for, industrial tech solutions.

That customer base, in contrast, is still nascent in China—a phenomenon that has even led to desperation tactics. For instance, an audit of a Little Giant firm Huijiang New Materials revealed that it had [inflated its sales figures](#) by “selling” to customers that were inactive shell companies owned by relatives of management.

This puts the onus on sales and marketing to educate potential customers on technology solutions and to have an after-sales customer success operation to ensure that the technology has uptake within the firm. Core innovation startups’ engagement with potential customers needs to account for the industry’s dynamics as well as specific technical details, as purchase decision-makers and end users of that technology have different considerations.

Back in 2014, all Tencent had to do to [acquire millions](#) of mobile payments users in a single evening was to have WeChat Pay sponsor the Chinese New Year Spring Festival Gala red envelopes. That cheap and fast acquisition of users is a far cry from the customer acquisition strategy that Little Giants need to employ. Targeting and retaining niche, industry-specific customers is much more costly in an enterprise economy [still in its infancy](#).

Moreover, Little Giants will [struggle to communicate](#) their brand and product differentiation because they simply don't have the brand powers of the consumer internet giants. Part of this can be attributed to the low profiles of their founders, a departure from the charismatic, celebrity founders like Jack Ma, Lei Jun, and Richard Liu who dominated the consumer internet era and [created 11 of the top 15](#) most valuable brands in China.

The Public Sector to The Rescue?

In the near term, then, these Little Giants' best bet to make it across the commercialization "Valley of Death" may be the public sector.

China's tech pivot already has the full backing of the central and local governments, which will improve these firms' [access to financing](#) and talent pipelines. But perhaps the most tangible way the state can catalyze these startups is by filling in demand in an underdeveloped market.

Selling to the public sector through government procurement or deals with state-owned enterprises (SOEs) isn't that novel but it may be the only option for some Little Giants that can't yet rely on the private sector. Although far smaller than the private sector, the public sector market could have a galvanizing effect for some of these firms.

Take Little Giant firm Lanxin Mobile, a cloud-based big data startup founded in 2012. It has rapidly ascended to become a key provider of software services to central government ministries and SOEs in less than a decade. Keda Automation Control, too, has carved out a niche by applying Internet of Things services to the state mining industry (see Figure 2).

Figure 2. Cozying Up To Public Sector May Be Good Strategy for Some Little Giants

Lanxin Mobile	
2012	Founded
2013	Secures China Unicom Group as first customer
2018	Became sole provider of management platform software for China's Ministry of Public Security
2020	Became designated work platform for China's SASAC (State-owned Assets Supervision and Administration Commission of the State Council)
2022	Current customer base includes dozens of government ministries, state-owned companies, and private firms like Huawei, Inspur, Kingsoft, Hikvision, and iFlytek.

Keda Automation Control	
2000	Company rebranded to Keda Automation, focusing on industrial internet applications in the mining sector.
2009	Secures Shanxi Coking Coal Xishan Coal Electricity Xiegou Mine as first customer for industrial application service solutions. Expands into state-dominated coal mining sector.
2019	Provided Internet of Things support for China's 70th Anniversary of the PRC's founding celebration.
2021	Included in the first batch of listed companies on the Beijing Stock Exchange.
2022	Current customers include Siemens, ABB, Huawei and other private sector firms.

These dynamics suggest that whether Little Giants want to or not, they may be forced to establish a more symbiotic relationship with the state than the consumer internet giants that came before. On the other hand, the public sector has limits, and companies that want to grow will necessarily have to play outside of the state's orbit.

In the final chapter of this series, we deepen our analysis on the one factor that, above all else, could seriously hamper the success of China's tech pivot: human capital. After all, behind every transformative innovation are the elite researchers and risk-taking entrepreneurs who bring technical breakthroughs to market with the ultimate aim of creating globally competitive companies.



China's Tech Pivot (Part IV): Success Hinges on Tackling the Talent Conundrum

China's tech pivot was [years in the making](#), but the double shock of US-China tech competition and the domestic tech crackdown kicked it into another gear. It heralded the beginning of an arduous and grinding phase, because the main question guiding this process won't be "how fast can we scale this?" Instead, the pivot's success requires overcoming a litany of challenges, chief among them commercialization and talent.

These aren't problems unique to China's tech sector, but they are also uniquely Chinese problems because of the state's role in both. In comparing the two challenges, commercialization will be easier to solve because financing isn't scarce.

Whether it's state financing or raising capital through new markets like the Shanghai Star Market or Beijing Stock Exchange, getting funding for Little Giant firms won't be a major hurdle as abundant capital searches for scarcer opportunities.

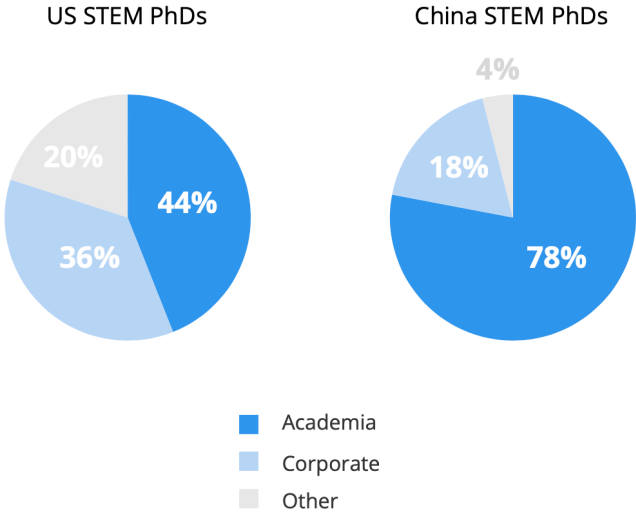
Talent, on the other hand, is a thornier conundrum. In the bookend to this series, we will mainly elaborate on the human capital challenge because overcoming it will determine the success or failure of the pivot over the next decade.

“Getting to Hefei?”

Although financing alone won't solve the entirety of the commercialization problem (see [Part III of the series](#)), it goes a long way toward getting startups across the “valley of death”. When it comes to human capital, however, the problem is both scarcity of talent and scarcity of opportunities.

The geographic mismatch between the supply and demand of talent highlighted in [Part II of the series](#) is only part of the story. For core innovation firms, highly specialized talent and STEM PhDs are needed. Yet Chinese STEM doctorates appear to have a strong preference for academia over industry, in contrast to the United States where a much larger proportion of PhDs enter the private sector (see Figure 1).

Figure 1. In Contrast to The US, Chinese PhDs Don't Jump Ship into Private Sector



Note: Chinese data based on doctorates graduating between 2016 and 2020. "Other" includes administrative, government, and military jobs. US data is based on existing doctorates residing in the US as of 2019. "Other" includes government and nonprofit jobs, as well as self-employed.
 Source: Ministry of Education; National Science Foundation Survey of Doctorate Recipients, 2019.

The Chinese government has attempted to ease this supply constraint by using talent subsidies targeted at postgraduates and tech workers. But these programs are left to the devices of local governments to implement, which has led to fierce competition across regions on talent subsidies (see Figure 2).

This creates a situation where most regions offer similar subsidies, even in those regions that don't face talent bottlenecks. In effect, this means talent will continue to flow to areas that already have strong talent networks rather than to those that have a talent deficit, usually poorer provinces. Moreover, poorer provinces may not have sufficient resources to sustain these programs, further exacerbating the talent deficit.

Figure 2. Provincial Competition Can Undermine the Intent of Talent Subsidies

	Province	% of total LGs	% of total PGs	Talent Surplus/Dearth	Talent Subsidies
Top 5 Undersupply of Postgraduates	Zhejiang	9.87%	5.05%	-4.82%	13
	Hunan	4.87%	2.53%	-2.34%	16
	Anhui	4.81%	3.18%	-1.63%	7
	Fujian	4.64%	2.06%	-2.58%	14
	Hebei	4.24%	2.65%	-1.59%	12
	Average	5.69%	3.10%	-2.59%	12.4
Top 5 Oversupply of Postgraduates	Shanghai	5.50%	9.95%	4.45%	10
	Beijing	5.40%	13.85%	8.45%	15
	Jiangsu	5.99%	7.64%	1.65%	13
	Hubei	3.61%	4.45%	0.84%	13
	Shaanxi	2.35%	3.52%	1.16%	12
	Average	4.57%	7.88%	3.31%	12.6

Note: Talent subsidies' value is determined by subsidies in a province's top five largest cities (districts in Beijing and Shanghai) across four categories: cash bonus, housing allowance, housing registration access, and family benefits such as children's education and spouse work placement on a 0-20 scale. Also see Part II for geographic distribution of Little Giant firms. Source: Chinese municipal government documents.

But Anhui province may offer another path to acquiring talent. Historically one of the poorest provinces, Anhui seems to have recognized that it couldn't compete on talent subsidies against wealthier neighbors like Jiangsu and Zhejiang. So instead of attracting talent, Anhui decided to attract the companies that will demand the talent.

Its provincial capital Hefei has been a standout in attracting notable hardware and manufacturing firms like LCD panel giant BOE, memory chip champion Changxin, and electric vehicle (EV) startup Nio.

Indeed, the province's hope that talent will follow the companies seem to have borne some fruit. Those investments in promising tech firms [led to a boom](#) in hiring. In fact, Hefei seems to aspire to become the "Detroit" of EV manufacturing, with BYD planning to open an EV plant and Nio aiming to double its annual production capacity to 240,000 vehicles.

Whether Anhui can sustain a solid record in attracting firms and the talent that comes with them remains to be seen. But such a demand-side approach to talent appears difficult to

emulate, which gives provinces and cities that can properly execute such a strategy a leg up. For instance, Wuhan wanted to woo chip firms but lost billions to a fraudster posing as a startup founder. Cities in Jiangsu have also [backed major flops](#) in the EV industry.

A downside of local government activism on the tech pivot is that it could squeeze private capital. At a minimum, it appears that private capital, whether domestic or foreign, will be competing with state capital more fiercely as part of the tech pivot. This will be a different dynamic than during the heady days of the consumer internet, when global investors played a significant role in growing internet giants like Alibaba and Tencent.

This is not to say that private investment will be irrelevant, far from it. In fact, China's entire tech investment community is grappling with how to ride the paradigm shift towards core innovation. And when the successful Little Giants go public or look for financing, new opportunities will emerge.

Their success, however, hinges on whether China can address key obstacles in talent. Relying on the inconsistent results of local governments probably won't move the needle much on talent distribution. Meaningful change will require a longer-term shift in both economic geography and the right local incentives.

It will be up to the next generation of Chinese entrepreneurs and business leaders to build innovative firms in this brave new world. Steps are being taken at all levels of the Chinese government to align the incentives and priorities of research institutions, technology firms, and financing channels. That does not make the realization of China's technological ambitions any less daunting, however. We will be looking more closely at the cohort of Little Giant companies to assess how the very visible hand of industrial policy and the invisible hand of the market conspire to produce the outcome Beijing wants: leading tech companies and supply chain security.

