

Assessments of China's efforts to promote indigenous innovation will be fruitless without clear metrics for technological self-sufficiency. Yet, indicators of indigenous innovation are more ambiguous than other scientific and technological indicators, which complicates such assessments. Indeed, clear-eyed evaluations of China's drive to reduce foreign dependence in information-technology domains are muddled by confusion over the definition of indigenous innovation and the widening "gray zone" between domestic and foreign companies.

“What gets measured gets improved.” Often attributed to management theorist Peter Drucker, this principle for business managers could double as a mantra for the Chinese government’s approach to science and technology planning. Indeed, a defining feature of China’s technology policy making is its establishment of clear measures of success, such as the amount of R&D spending as a proportion of GDP or the targeted size of a particular industry.

Unsurprisingly, when it comes to China’s ambitious goals for promoting indigenous innovation (*zizhu chuangxin*) and technological self-reliance, Chinese policymakers have outlined specific metrics to substantiate the attainment of these goals. For instance, one such target is to reduce China’s dependency ratio on foreign technology to 30 percent (calculated as a ratio of expenditures on technology imports to research and development spending).<sup>1</sup> This target is outlined in China’s National Medium- and Long-Term Plan for the Development of Science and Technology (2006–2020) (MLP), an ambitious science and technology plan that kickstarted China’s emphasis on indigenous innovation.<sup>2</sup>

Yet, in contrast to other performance indicators, Chinese metrics for success in indigenous innovation are more ambiguous. I support this claim by highlighting the lack of clarity over the definition of indigenous innovation, the expanding “in-between” zone between domestic and foreign companies in high-technology sectors, and China’s struggles to achieve self-sufficiency in semiconductors and information-technology domains.

Discussions of China’s efforts to achieve technological self-sufficiency can be grouped into two main threads. One thread speculates about the consequences of China’s growing technological

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<sup>1</sup> A more precise measure is the ratio of expenditures on technology imports to the sum of R&D spending and technology import expenses. Chunlin Zhang, Douglas Zhihua Zeng, William Peter Mako, and James Seward, *Promoting Enterprise-Led Innovation in China*, World Bank Publications, 2009. <https://openknowledge.worldbank.org/handle/10986/2619>

<sup>2</sup> Ling Chen, and Barry Naughton, “An Institutionalized Policy-Making Mechanism: China’s Return to Techno-Industrial Policy,” *Research Policy* 45, no. 10 (December 1, 2016): 2138–52. <https://doi.org/10.1016/j.respol.2016.09.014>

capabilities; the other centers on evaluating whether these efforts will succeed. These discussions are valuable but will ultimately prove fruitless if there is a lack of clarity over the definition of success in the first place.

### **The Contested Meaning of Indigenous Innovation**

What is indigenous innovation? Richard P. Suttmeier, longtime observer of China's science and technology landscape, describes indigenous innovation as "a concept that has led to considerable confusion and controversy internationally as well as in China."<sup>3</sup> Competing understandings of the phrase's first half (*zizhu*) have led to a wide range of English translations, including self-directed innovation, independent innovation, and indigenous innovation.<sup>4</sup> At a conference co-hosted by the Council on Foreign Relations in 2006, a high-ranking official at China's Ministry of Science and Technology was asked "what is *zizhu chuangxin*?" His response: "All such translations are not accurate. The best translation is *chuangxin* (innovation)!"<sup>5</sup>

Yet, indigenous innovation surely does not refer to innovation in all its forms. A narrower interpretation of *zizhu chuangxin* emphasizes China's aims to reduce dependence on foreign suppliers for critical technologies. In this vein, *zizhu chuangxin* is connected with the state's increased control over technological development.<sup>6</sup> A broader view of *zizhu chuangxin* stresses that indigenous innovations can also include integrating and re-adapting imported technologies.<sup>7</sup> As leading technology-policy scholar Liu Xielin told *Science* in 2010: "We don't say that 'indigenous' means developed by China alone."<sup>8</sup> Apparently, as the MLP was being drafted,

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<sup>3</sup> Richard P. Suttmeier, "The Transformation of Chinese Science." Pp, 367–77 in *The Routledge Handbook of the Political Economy of Science*, ed. David Tyfield, Rebecca Lave, Samuel Randalls, and Charles Thorpe (London: Routledge, 2017), at p. 370.

<sup>4</sup> Bradford Waldie, "Lexicon: Indigenous Innovation or Independent Innovation (自主创新, Zìzhǔ Chuàngxīn)." *DigiChina* (blog), March 7, 2022. <https://digichina.stanford.edu/work/lexicon-indigenous-innovation-or-independent-innovation-zizhu-chuangxin/>

<sup>5</sup> Yifei Sun, "What Matters for Industrial Innovation in China: R&D, Technology Transfer or Spillover Impacts from Foreign Investment?" *International Journal of Business and Systems Research* 4, no. 5–6 (2010): 621–47.

<sup>6</sup> Yu Zhou, William Lazonick, and Yifei Sun, eds., "Introduction: China's Transformation to an Innovation Nation." Pp, 1–22, in *China as an Innovation Nation* (New York: Oxford University Press, 2016). <https://doi.org/10.1093/acprof:oso/9780198753568.003.0001>; Waldie, "Lexicon."

<sup>7</sup> Tain-Jy Chen, and Ying-Hua Ku, "Indigenous Innovation vs. Teng-Long Huan-Niao: Policy Conflicts in the Development of China's Flat Panel Industry," *Industrial & Corporate Change* 23, no. 6 (December 2014): 1445–67. <https://doi.org/10.1093/icc/dtu004>

<sup>8</sup> Hao Xin, "Critics Question China's Indigenous Innovation Effort," *Science* 334, no. 6061 (December 9, 2011): 1336–37. <https://doi.org/10.1126/science.334.6061.1336>

Chinese elites were considering whether to replace indigenous innovation with “open innovation.”<sup>9</sup>

Confusion over *zizhu chuangxin* has implications beyond the realm of etymology and semantics. Contested meanings can map onto starkly different policy outcomes and assessments of technological self-sufficiency. Take, for example, China’s high-tech zones (HTZs), which are hubs built to upgrade China’s domestic innovation capacity using favorable investment, trade, and tax policies. According to research by Sebastian Heilmann, Lea Shih, and Andreas Hofem, the zones experienced a “significant mission drift” from domestic technological upgrading to export bases that attracted massive levels of foreign investment. In 2009, foreign-invested enterprises contributed over half of the exports from the HTZs. They conclude that “the HTZs’ contribution to ‘indigenous innovation’ in a narrow sense (that is, home-grown breakthrough innovations that do not rely on technology transfer from abroad) has so far been very limited.”<sup>10</sup>

Indeed, local governments have a substantial degree of autonomy in implementing policies aimed at technological self-sufficiency, in part due to the contested meanings of indigenous innovation. In some provinces and cities where global firms are established and influential, local governments may adopt a broader interpretation of indigenous innovation.<sup>11</sup> In these contexts, supporting foreign investment can help local leaders meet targets in patent applications, high-tech outputs and exports, and other broad performance indicators that do not specify the ownership of the companies contributing to the innovation. In short, what counts as indigenous innovation can be negotiated.<sup>12</sup>

Struggles to define the bounds of a national innovation system are not unique to China. As U.S. policymakers and thinkers confronted growing Japanese investment in America, a fierce debate erupted over the simple question: “Who is Us.”<sup>13</sup> Robert Reich suggested that foreign-owned companies that conducted most of their research and employed most of their workers in the U.S. were more “American” than U.S.-owned companies that conducted most of their research and employed most of their workers abroad. The heart of the dispute is whether the national boundaries of the U.S. innovation system should be drawn based on a company’s location of production or on its ownership.<sup>14</sup>

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<sup>9</sup> Ling Chen, *Manipulating Globalization: The Influence of Bureaucrats on Business in China* (Stanford: Stanford University Press, 2018).

<sup>10</sup> Sebastian Heilmann, Lea Shih, and Andreas Hofem, “National Planning and Local Technology Zones: Experimental Governance in China’s Torch Programme,” *The China Quarterly*, no. 216 (December 2013): 896–919. <https://doi.org/10.1017/S0305741013001057>

<sup>11</sup> Chen, *Manipulating Globalization*.

<sup>12</sup> Ning Leng, and Cai Zuo, “Tournament Style Bargaining within Boundaries: Setting Targets in China’s Cadre Evaluation System,” *Journal of Contemporary China* 31, no. 133 (2022): 116–35.

<sup>13</sup> Robert B. Reich, “Who Is Us?” *Harvard Business Review*, January 1, 1990. <https://hbr.org/1990/01/who-is-us>

<sup>14</sup> Laura Tyson, “They Are Not Us: Why American Ownership Still Matters,” *The American Prospect* (blog), January 1, 1991. <https://prospect.org/api/content/2b7b977c-d3dd-5918-a69e-5a976cf3ecdf/>

## **An Expanding Gray Zone between Domestic and Foreign**

The “Who is Us” question is also relevant, in different ways, to China. In his study of the firms that have been the most successful in China’s information-technology industries, Douglas B. Fuller identifies a particular type of foreign-invested enterprise, which he calls a “hybrid,” i.e., a company that bases its headquarters and key business activities in China but heavily relies on foreign investment and foreign leadership (often ethnic Chinese with citizenship abroad).<sup>15</sup> These hybrids thrive because they can both integrate into China’s innovation system and leverage the benefits of international ties, such as the financial discipline that comes with being beholden to offshore investors.<sup>16</sup>

China depends on these hybrids to meet its indigenous innovation goals. In semiconductors, for instance, the oft-cited benchmark for independence in this technological domain is whether China can domestically produce 70 percent of the chips it uses by 2025.<sup>17</sup> Yet, China’s leading chipmaker, Semiconductor Manufacturing International Corporation (SMIC), is not an entirely “domestic” firm. It was founded by an American citizen, mostly led by Taiwanese engineers, and supported by venture capital from Silicon Valley.<sup>18</sup> As Fuller points out, “China’s technonationalist ambitions for this sector fit uncomfortably with the existence and prominence of hybrid firms.”<sup>19</sup>

Hybrid firms also thrive in China’s internet sector, even though this industry is highly scrutinized by Chinese regulators and regarded as essential to national security.<sup>20</sup> To skirt around Chinese restrictions on foreign investment in this sector, hybrid firms have used a Variable Interest Entity

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<sup>15</sup> Douglas B. Fuller, *Paper Tigers, Hidden Dragons: Firms and the Political Economy of China’s Technological Development* (New York: Oxford University Press, 2016).

<sup>16</sup> Ibid.

<sup>17</sup> Douglas B. Fuller, “China’s Counter-Strategy to American Export Controls in Integrated Circuits,” *China Leadership Monitor*, March 1, 2021. <https://www.prcleader.org/fuller>; Adam Segal, “China’s Move to Greater Self Reliance,” *China Leadership Monitor*, December 1, 2021. <https://www.prcleader.org/segal>

<sup>18</sup> Yin Li, “State, Market, and Business Enterprise: Development of the Chinese Integrated Circuit Foundries.” Pp. 183–212, in Yu Zhou, William Lazonick, and Yifei Sun, eds., *China as an Innovation Nation* (New York: Oxford University Press, 2016); Dan Nystedt, “CEO of Chip Maker SMIC Giving up Taiwan Citizenship,” *InfoWorld*, August 23, 2005. <https://www.infoworld.com/article/2669221/ceo-of-chip-maker-smic-giving-up-taiwan-citizenship.html>

<sup>19</sup> Douglas B. Fuller, “Growth, Upgrading, and Limited Catch-Up in China’s Semiconductor Industry.” Pp. 262–303, in Loren Brandt and Thomas G. Rawski, eds., *Policy, Regulation and Innovation in China’s Electricity and Telecom Industries* (New York: Cambridge University Press, 2019).

<sup>20</sup> Can Zhao, “Variable Interest Entity, Offshore Domesticated Foreign Finance, and the Political Economy of China’s Internet Firms: The Case of Alibaba,” *Social Sciences* 11, no. 3 (March 2022): 99. <https://doi.org/10.3390/socsci11030099>

(VIE) structure. This loophole allows foreign entities to channel capital into Chinese companies in industries where the government restricts foreign capital. Basically, the Chinese firm registers a shell company in an offshore financial center, such as the Cayman Islands, into which the foreign investors funnel funds. This shell company controls the China-based entity via a web of contracts.<sup>21</sup>

First pioneered by Sina, the Chinese internet company that owns Weibo (China's Twitter), this approach has been used by many successful Chinese internet firms. Baidu, Alibaba, and Tencent (the well-known BAT firms) have all used a VIE structure to win backing by foreign venture capital.<sup>22</sup> The same applies to SenseTime, one of China's leading AI companies.<sup>23</sup>

It can be confusing to determine the "nationality" of hybrid firms. At an event in Taiwan in March 2015, Alibaba chairman Jack Ma vented: "In mainland China, Alibaba is considered a foreign-invested enterprise. The U.S. Secretary of Commerce says that Alibaba is a Chinese company. Now, Taiwan has given me the identity of a mainland-funded enterprise. I'm confused. Which one is it?"<sup>24</sup>

It is difficult for Chinese bureaucrats to determine whether these hybrids belong to the indigenous innovation system? On the one hand, Chinese leaders perceive these firms to have strong attachments to the Chinese economy, shaped partially by ethnic ties. This makes hybrids different from multinational corporations (MNCs), which are sometimes viewed as not contributing to capacity development in the local ecosystem.<sup>25</sup> Related studies of Chinese returnee-run business in the information-technology sector have found that such firms are regarded as more patriotic and more trustworthy than MNCs.<sup>26</sup>

These hybrids have gained government backing because they have become integral to China's broader industrial ecosystem. China's efforts to meet the 70 percent self-sufficiency benchmark in chips, for instance, will be impossible without an enhanced capacity from foreign-owned firms.<sup>27</sup> As officials seek to meet policy targets connected to overall industrial output, local and

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<sup>21</sup> Can Zhao, "Foreign Assets for Chinese Control: Capital Filtration, New Triple Alliance, and the Global Political Economy of China's Information Industry (1995–2020)," August 2, 2022. <https://dspace.library.uvic.ca/handle/1828/14083>

<sup>22</sup> Jun Zhang, "Venture Capital in China." Pp. 69–98, in Yu Zhou, William Lazonick, and Yifei Sun, eds., *China as an Innovation Nation* (New York: Oxford University Press, 2016).

<sup>23</sup> See SenseTime Global Offering. <https://www1.hkexnews.hk/listedco/listconews/sehk/2021/1207/2021120700017.pdf>

<sup>24</sup> 环球时报[Global Times], "阿里巴巴是中企还是外企? 马云称自己也糊涂了" [Is Alibaba a Chinese company or foreign company? Jack Ma himself is confused], March 4, 2015. <https://tech.huanqiu.com/article/9CaKrnJIq4o>. Ma made this trip to Taiwan because of the government's scrutiny over Chinese investments in Taiwan.

<sup>25</sup> Fuller, *Paper Tigers, Hidden Dragons*.

<sup>26</sup> Lin, Xiaohua. "The Diaspora Solution to Innovation Capacity Development: Immigrant Entrepreneurs in the Contemporary World." *Thunderbird International Business Review* 52, no. 2 (2010): 123–36. <https://doi.org/10.1002/tie.20319>.

<sup>27</sup> Segal, "China's Move to Greater Self Reliance."

regional governments are open to foreign investments in China-based hybrids.<sup>28</sup> These incentives, according to Fuller, have “promoted the firms most capable of IC [integrated circuit] industrial development despite the political suspicion in which they are held.”<sup>29</sup>

However, the foreignness of hybrids still limits the degree to which Chinese bureaucrats can trust them. In an oral history collected by the Computer History Museum, Chiang Shang-yi, a Taiwanese semiconductor industry veteran who joined the board of SMIC in 2016, recounts that he believed that the Chinese government distrusted him because “this guy’s not only Taiwanese, he’s also [a] U.S. citizen.”<sup>30</sup> Motivated in part by this tension, Chinese state funds have supported efforts to de-list hybrid firms from international exchanges.

The main takeaway, for our purposes, is that the firms powering China’s drive for technological self-sufficiency sit in an expanding “in-between” space between domestic and foreign. That this phenomenon exists in the internet and semiconductor domains – two areas that are especially sensitive vis-à-vis the Chinese state – illustrates that the “Who is Us” quandary may have broad applicability.

### **Measuring Foreign Technology Dependence in Semiconductors and Other Information-Technology Industries**

With respect to China’s indigenous innovation efforts, semiconductors is a key industry. The sector’s importance came into stark relief in October 2022, when the U.S. imposed a wide range of export controls on China-bound semiconductor technologies, which leveraged key chokepoints such as semiconductor manufacturing equipment.<sup>31</sup> These controls highlight China’s severe dependence on foreign suppliers for advanced semiconductors.

Notably, these recent U.S. controls also highlight how China’s metrics for indigenous innovation in semiconductors do not reflect genuine progress in reducing foreign technology dependence. The above-cited benchmark for independence in this technological domain, whether China can domestically produce 70 percent of the chips it uses by 2025,<sup>32</sup> likely will not be met, as *IC*

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<sup>28</sup> Chen, *Manipulating Globalization*.

<sup>29</sup> Fuller, “Growth, Upgrading, and Limited Catch-Up in China’s Semiconductor Industry,” p. 301.

<sup>30</sup> *Oral History of Shang-Yi Chiang*, Computer History Museum. Mountain View, CA, 2022. <https://archive.computerhistory.org/resources/access/text/2022/07/102792671-05-01-acc.pdf>

<sup>31</sup> Reva Goujon, Lauren Dudley, Jan-Peter Kleinhans, and Agatha Kratz, “Freeze-in-Place: The Impact of US Tech Controls on China,” The Rhodium Group, October 21, 2022. <https://rhg.com/research/freeze-in-place/>

<sup>32</sup> Fuller, “China’s Counter-Strategy to American Export Controls”; Segal, “China’s Move to Greater Self Reliance.”

*Insights* predicts that China will only produce 21 percent of its semiconductor consumption by 2026.<sup>33</sup>

More importantly, the 70-percent benchmark is a flawed measure of technological independence in semiconductors. To begin, domestic production includes China-based plants owned by foreign chipmakers such as Samsung, SK Hynix, and TSMC. Obviously, these companies are not firmly committed to China's technonationalist ambitions. Additionally, while the U.S. government gave non-Chinese chip manufacturers one-year exemptions to the October 2022 export controls, they may not be renewed in the future.<sup>34</sup>

Furthermore, the 70-percent figure is contested. Some Chinese economists argue that reaching this mark is impossible and will only slow growth.<sup>35</sup> On the feasibility issue, even the U.S., which is the undisputed leader in semiconductors, is not technologically independent according to this benchmark. In 2019, the U.S. accounted for only 11 percent of global semiconductor manufacturing capacity.<sup>36</sup> That same year, U.S. consumption accounted for 25 percent of global semiconductor sales.<sup>37</sup> When it comes to the most advanced chips, U.S. self-sufficiency in semiconductors is even worse. In calls to revitalize U.S. domestic semiconductor manufacturing, U.S. Secretary of Commerce Gina Raimondo has pointed out concerns that the U.S. purchases "90 percent of the most sophisticated chips that are used in the military from Taiwan."<sup>38</sup> Yet, Chinese policymakers seem to be leaning further into this metric, as they recently revised the homegrown proportion of semiconductor consumption to 80 percent.<sup>39</sup>

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<sup>33</sup> Laura Dobberstein, "China Will Produce One in Five of the Chips It Uses in 2026, Says Analyst," *The Register*, May 19, 2022.

[https://www.theregister.com/2022/05/19/china\\_chip\\_production\\_prediction/](https://www.theregister.com/2022/05/19/china_chip_production_prediction/)

<sup>34</sup> Goujon, et al., "Freeze-in-Place."

<sup>35</sup> Xu Lin, "徐林：“双循环”与股权投资的作用" ["Dual Circulation" and the role of equity investment], *Caixin*, September 25, 2020. <https://opinion.caixin.com/2020-09-25/101609494.html>

<sup>36</sup> Zentralverband Elektrotechnik- und Elektronikindustrie (ZVEI), "Semiconductor Strategy for Germany and Europe : The Current Situation, Analysis, and Goals," ZVEI Discussion Paper, October 2021.

[https://www.zvei.org/fileadmin/user\\_upload/Presse\\_und\\_Medien/Publikationen/2021/November/Halbleiterindustrie\\_fuer\\_Deutschland\\_und\\_Europa/Semiconductor-Strategy-for-Germany-and-Europe.pdf](https://www.zvei.org/fileadmin/user_upload/Presse_und_Medien/Publikationen/2021/November/Halbleiterindustrie_fuer_Deutschland_und_Europa/Semiconductor-Strategy-for-Germany-and-Europe.pdf)

<sup>37</sup> Statistics, sourced from the Semiconductor Industry Association, "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," June 8, 2021, are available in the following briefing deck: <https://tac.bis.doc.gov/index.php/documents/public-presentations/484-sia-semiconductor-supply-chain-briefing-deck-vsent-sia-branded-6-8-21/file>

<sup>38</sup> Marketplace Tech, "Commerce Secretary Raimondo on Why We Need to Produce Chips in the U.S." July 27, 2022. <https://www.marketplace.org/shows/marketplace-tech/commerce-secretary-raimondo-on-why-we-need-to-produce-chips-in-the-u-s/>

<sup>39</sup> Congressional Research Service, "Semiconductors: U.S. Industry, Global Competition, and Federal Policy," October 26, 2020. <https://crsreports.congress.gov/product/pdf/R/R46581>

What about the metrics for indigenous innovation in other technological domains? Although semiconductors has become the most visible sector in China’s indigenous innovation drive, China has continued to push localized substitution (国产化替代) in key software and hardware in the information-technology domain. In recent years, Chinese policymakers have emphasized the importance of secure and controllable information technology.<sup>40</sup>

A crucial factor in China’s efforts in this area is the extent to which the indicators of technological independence are followed through during implementation. Just as local governments sometimes negotiate the meaning of indigenous innovation by promoting FDI in order to achieve overall gains in industrial output, companies also have autonomy in strictly following the guidelines for technological self-sufficiency. Even though they may receive some guidance about using a certain proportion of Chinese-made products, employees ultimately want to use the best tools. As Liu Kai, a partner at China-based venture capital firm 5Y Capital, notes, “Especially in software, the usage habits of employees have a lot of influence. Relatively speaking, hardware has more rigid performance indicators to guide purchasing, which makes it relatively better (for employees to accept substituted products).”<sup>41</sup>

To illustrate this point, consider the stark difference between localized substitution in state-owned enterprises (SOEs) compared to that in other companies. Inspur, China’s leading server provider, supplies 56 percent of China’s central SOEs and only 31 percent of China’s top 500 companies. Across all companies, localization rates of mid- to high-end enterprise resource management and computer-aided design software are below 25 percent.<sup>42</sup>

In AI software, China also confronts continued foreign technological dependence. The China Academy of Information and Communications Technology, a think-tank under the Ministry of Industry and Information Technology (MIIT), measures the influence of mainstream AI frameworks such as TensorFlow and PyTorch, which are hosted on GitHub, and Chinese frameworks hosted on Gitee, which the MIIT has tried to push as a domestic alternative.<sup>43</sup> Chinese officials hope that Chinese AI frameworks, such as Baidu’s PaddlePaddle framework and Huawei’s MindSpore framework, can challenge the TensorFlow–PyTorch duopoly.

Yet, these efforts to “nationalize” open-source frameworks have met with limited success to date.<sup>44</sup> In February 2021, in partnership with Deloitte, the China Society of Image and Graphics

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<sup>40</sup> Jeffrey Ding, “Deciphering China’s AI Dream,” Technical Report. Future of Humanity Institute, March 2018. [https://www.fhi.ox.ac.uk/wp-content/uploads/Deciphering\\_Chinas\\_AI-Dream.pdf](https://www.fhi.ox.ac.uk/wp-content/uploads/Deciphering_Chinas_AI-Dream.pdf)

<sup>41</sup> Jeffrey Ding, “ChinAI #123: The Wave of Localized Substitution — Is it Here?” ChinAI Newsletter. December 13, 2020. <https://chinai.substack.com/p/chinai-123-the-wave-of-localized>

<sup>42</sup> Ibid.

<sup>43</sup> China Academy of Information and Communication Technology, “AI 框架发展白皮书” [White Paper on AI Frameworks Development], February 2022. <http://www.caict.ac.cn/kxyj/qwfb/bps/202202/P020220226369908606520.pdf>

<sup>44</sup> Rebecca Arcesati and Caroline Meinhardt, “China Bets on Open-Source Technologies to Boost Domestic Innovation,” MERICS (blog), May 29, 2021. <https://merics.org/en/short-analysis/china-bets-open-source-technologies-boostdomestic-innovation>

jointly published a “China Computer Vision Talent Survey Report.” The report collected 1,578 questionnaire responses from students and researchers in the computer-vision field. While over 70 percent of people employed in the computer-vision field reported using PyTorch, Facebook’s popular machine-learning framework, only 6.5 percent had used a framework developed by Chinese firms and organizations. The corresponding figure is even lower among students in computer vision, with less than 2 percent reporting use of Chinese machine-learning frameworks.<sup>45</sup>

There is also substantial variation among China’s leading AI companies regarding whether their successes count as indigenous innovation.<sup>46</sup> Often grouped together as China’s “four AI dragons,” SenseTime, Megvii, CloudWalk, and Yitu capture almost 60 percent of China’s computer-vision market.<sup>47</sup> In August 2019, China’s Ministry of Science and Technology (MOST) included all four AI start-ups on its AI “national team,” assigning start-ups to spearhead the development of open innovation platforms.<sup>48</sup>

Yet, when it comes to their “domestic-ness” and ties to the state, these AI dragons differ greatly. CloudWalk is considered a “purely domestically funded” company (纯内资), since much of its financing comes from government funds such as the China Internet Investment Fund, which was initiated by the Central Cyberspace Affairs Commission and the Ministry of Finance. Indeed, some Chinese media describe CloudWalk as “a member of the national team unlike the others.”<sup>49</sup>

Industry observers note that CloudWalk’s background could serve as “a protective screen for some security and financial projects that involve national security.” For example, Cloudwalk was one of the only AI firms to be invited to shape technical standards for facial recognition in three

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<sup>45</sup> 机器之能[Synced], “2020 中国计算机视觉人才调研报告” [2020 China Computer Vision Talent Survey Report], February 23, 2021.

<https://mp.weixin.qq.com/s/PL2cIjrlKL98FBSS6IpC3w?fbclid=IwAR1PiB2rIOutjSujhS0-bKoM1cD3tBkDUETivrnTkheMPHCC2yx7xdotFVE>

<sup>46</sup> This section draws from Jeffrey Ding, “Techno-Industrial Policy for New Infrastructure: China’s Approach to Promoting Artificial Intelligence as a General Purpose Technology,” UC Institute on Global Conflict and Cooperation Working Paper, December 9, 2022.

<https://ucigcc.org/publication/working-papers/techno-industrial-policy-for-new-infrastructure-chinas-approach-to-promoting-artificial-intelligence-as-a-general-purpose-technology/>

<sup>47</sup> Shujing He, Shaohui Zhai, Yiyang Wei, and Wei Han, “China’s Quartet of AI Giants Walk through the ‘Valley of Death,’” *Nikkei Asia*, November 9, 2021.

<https://asia.nikkei.com/Spotlight/Caixin/China-s-quartet-of-AI-giants-walk-through-the-valley-of-death>

<sup>48</sup> Benjamin Larsen, “Drafting China’s National AI Team for Governance,” *DigiChina* (blog), November 18, 2019. <https://digichina.stanford.edu/work/drafting-chinas-national-ai-team-for-governance/>

<sup>49</sup> 机器之能[Synced], “后浪可畏：云从科技获国家基金 18 亿元融资，距 A 股上市仅剩临门一” [Respect the Latecomer Wave: CloudWalk Receives 1.8 Billion RMB in Financing from National Funds], May 15, 2020.

[https://mp.weixin.qq.com/s/zsa2v\\_ueijT0HQkxAodKjA?fbclid=IwAR1A5qzVjCiFeAIL9VeGXm8MI-Nw7eziMCbLBQzptRIIdZfAPVFB5NX32msc](https://mp.weixin.qq.com/s/zsa2v_ueijT0HQkxAodKjA?fbclid=IwAR1A5qzVjCiFeAIL9VeGXm8MI-Nw7eziMCbLBQzptRIIdZfAPVFB5NX32msc)

different contexts: standards-setting forums organized by the national government, public security bureaus, and industry organizations.<sup>50</sup>

In contrast, other computer-vision upstarts have much more distance from the state and receive more financing from international sources. Notably, from 2014 to 2019, AI was the technology area that saw the largest increase in the frequency of U.S. venture capital investments into China.<sup>51</sup> Additionally, Chinese AI companies that are narrowly focused on government and security-based projects may struggle to exploit the unique aspect of AI technology — its potential for general-purpose applications. This is why Chinese computer-vision firms are trying to reduce their reliance on government surveillance applications and diversify to other sources of revenue in smart finance and commercial retail.<sup>52</sup>

## Conclusion

Much ink has been spilled over whether China will be successful in its self-reliance drive and its Made in China 2025 goals. Much less attention has been paid to a more foundational question: what counts as success? This article argues that China's measures of technological dependence are more ambiguous than other scientific and technological indicators, such as R&D spending or patents. This argument is supported by evidence from three areas: confusion over the definition of indigenous innovation, the expanding gray zone between domestic and foreign companies in high-technology sectors, and a close examination of China's efforts to achieve self-sufficiency in the information-technology domain.

One implication of this argument is that the figures any analyst employs to make claims about China's technological self-sufficiency can be molded into very different interpretations. Indeed, our claims regarding China's technological independence may say more about us and our own biases and predispositions than about anything that constitutes an objective, clear-eyed analysis of China's technological self-sufficiency.

## About the Contributor

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<sup>50</sup> Ibid.

<sup>51</sup> Adam Lysenko, Thilo Hanemann, and Daniel H Rosen, "Disruption: US-China Venture Capital in a New Era of Strategic Competition," U.S.-China Investment Project, January 2020. [https://publications-research.s3-us-west-2.amazonaws.com/RHG\\_Disruption\\_US+China+VC\\_January2020.pdf](https://publications-research.s3-us-west-2.amazonaws.com/RHG_Disruption_US+China+VC_January2020.pdf)

<sup>52</sup> He et al., "China's Quartet of AI Giants Walk through the 'Valley of Death.'"