The Challenges of Chinese Industrial Policy

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1. Introduction: New Challenger, Old Challenges

Chinese industrial policy has come to be regarded as a major political issue and policy challenge by China's Western trading partners. China's immense size and historically rapid growth, the differences between its political regime and those of the West, and the growing direct foreign policy conflicts between China and its advanced economy trading partners give the current debate important features that may indeed have little precedent. On the other hand, controversy surrounding the industrial policies of a rapidly growing Asian trading partner is not new (Vogel, 1979; Johnson, 1982; Prestowitz, 1986).

The strategic trade literature of the 1980s and the growth-and-trade literature of the late 1980s and early-to-mid 1990s were, to a certain extent, inspired by the widespread belief that temporary Japanese market intervention had allowed Japan to take a lasting lead in technologically dynamic industries (Krugman, 1990). These older literatures carefully considered both potential benefits and challenges of industrial policy, and some of these insights remain salient today (Eaton and Grossman, 1986; Horstmann and Markusen, 1986). A related empirical literature has sought to examine the efficacy of industrial policy in other Asian contexts and has produced results that are relevant for the current controversy.

This essay will stress five major themes regarding the evolution of Chinese industrial policy. The first is that the Chinese central government has consistently maintained the goal of guiding China's industrial evolution at the industry level. Even as markets were given increased latitude to determine prices, output levels, and employment outcomes *within* industries, official policy documents continued to emphasize the decisive role of state plans in determining long-run outcomes *across* industries, even if the coherence and impact of those plans varied over time.

The second theme is that the Chinese government has retained considerable power over the allocation of key resources throughout the "reform" era (Wu, Hatta, and Chen, 2016). In principle, this gives the Chinese government far greater ability to shape the economic outcomes it wants to influence than most Western governments have.

However, the usual principal-agent problems arise, and this is the third theme. Chinese government officials are often not able to precisely measure the attributes they wish to target. Regional governments and firms respond opportunistically to this lack of direct observability, often frustrating the central government's plans and dissipating the theoretical welfare gains from the implementation of industrial policy.

In the early stages of economic reform, one could argue that the economic impact of the policies and challenges stressed in our first three themes was second-order. The dominant direction of Chinese economic policy was toward greater liberalization than had existed under Maoism, and economic growth expanded as this greater freedom was implemented (Lardy, 2014). One can imagine the overall evolution of "industrial policy" as following a kind of "U-shape." From the late seventies through the early 2000s, the impact of extensive economic liberalization *within* industries generated growth in output and productivity even as the government continued to intervene (or seek to intervene) in the allocation of resources *across* industries. And, at a time when every sector of the Chinese economy was starved of capital, technology, and skilled managers, ongoing efforts to influence the flow of inputs across sectors was not much of an impediment to growth. As the low-hanging fruit of microeconomic liberalization within industries was harvested in the 1980s, 1990s, and early 2000s, however, the enduring—and in some ways, increasingly ambitious—effort to intervene in the allocation of resources across industries became more important, and, potentially, more costly in terms of economic efficiency (Lardy, 2019).[1]

That observation leads to our fourth theme, which stresses the growing gap between the Chinese government's industrial policy ambitions and its capacity to realize these ambitions. As the technological goals of Chinese industrial policy have grown, the difficulty of targeting and measuring outcomes has grown, and the scope for opportunistic behavior by firms and local governments has expanded. The Chinese government no longer seeks to merely replicate capabilities that have long existed elsewhere—it now seeks to create capabilities that do not exist anywhere. What is challenging for even the world's most gifted venture capitalists is likely to be at least as challenging for government officials.

The fifth theme stresses another difficult tradeoff that complicates industrial policy everywhere—the often uneasy coexistence of multiple objectives. On the one hand, the Chinese government seeks to promote the emergence of new, potentially disruptive technologies and capabilities. At the same time, the government seeks to promote political, social, and economic *stability*. These two objectives often come into conflict. When governments are trying to promote and mitigate disruption at the same time, policy dilemmas can ensue. Other conflicts can arise when any government, including China's, seeks to target the promotion of a very broad range of different industries at the same time. Even in a market as vast as China's, general equilibrium resource constraints exist. Financial resources and elite human resources are limited.

[1] Lardy (2019) also emphasizes an increased effort to tilt the playing field in favor of state-owned enterprises within sectors, that grew more intense over the course of the 2010s.

Trying to target everything at the same time limits the ability of the regime to target anything, and everything is not of equal strategic value.[2]

2. The Origins of Chinese Industrial Policy

When China began its reform and opening-up policy in the late 1970s, Japan's post-war economic achievements attracted attention from Chinese scholars and the Chinese government.[3] They believed the Japanese government's active intervention through industrial policies was the key to creating the "Japanese miracle."[4] In response, the Development Research Center of the State Council (DRC), the official think tank of the State Council, organized a series of studies on industrial policy issues from 1985 to 1987 and visited the Ministry of International Trade and Industry in Japan. When the State Council issued its China's first industrial policy document, "Decision of the State Council on Key Points of Current Industrial Policies" (国务院关于当前产业要点的决定) in March 1989, which was China's first industrial policy document, it bore clear evidence of Japan's influential example (Wu, Hatta, and Chen, 2016; Jiang and Li 2021).

The document made clear that the Chinese government would not entrust China's industrial evolution to the interplay of market forces. While the importance of enterprise-level and commodity-level economic planning would fade, as the Chinese government increasingly allowed markets to determine prices, factor costs, and output levels within industries, and as it allowed non-state firms to play an increasingly important role in industrial output, the State Council remained determined to guide Chinese growth at the more aggregated industry level. It

[2] This is not just a Chinese problem. Klein (2023) eloquently describes the degree to which this problem seems likely to undermine the Biden Administration's efforts to promote U.S. semiconductor production.
[3] A large literature covers this impressive opening and reform. For one influential and comprehensive study, see Naughton (1995).
[4] Chinese government officials were hardly alone in their enthusiasm for the alleged efficacy of Japanese industrial policy. See Vogel (1979), Johnson (1982), and Prestowitz (1986) for examples of influential endorsements of Japanese industrial policy as a cure for America's economic ills.

established an explicit development sequence of industries. As an attachment to the policy document, the "Directory of Current Industrial Development Sequence" (当前的产业发展序列目录) specifically designated key supported, restricted, and prohibited industries, products, and processes.

This explicit designation of industries into these three categories set an important precedent followed in later policies such as “Catalogs for Guiding Industry Restructuring” (产业结构调整指导目录), which have remained in force until today. These documents continued the practice of explicitly designating industries for significant expansion, restricted growth, or decline/elimination. For the restricted sub-industries, new construction is prohibited and for the eliminated sub-industries, new investment is strictly prohibited and firms are asked to wind down their existing activities. As foreign direct investment was liberalized in the 1990s, the same categories were applied to FDI.[5]

3. The Evolution of Chinese Industrial Policy in the 1990s

In 1993, the Third Plenary Session of the 14th Central Committee of the Communist Party of China passed the " Decision of the Central Committee of the Communist Party of China on Some Issues concerning the Improvement of the Socialist Market Economy" (中共中央关于建立社会主义市场经济体制若干问题的决定),which marked the official beginning of the so called “socialist market economic system” reform in China.[6] The reform aimed to make the

[5] As a contemporary example of the degree to which this policy remains in place, see today’s “Catalog of Encouraged Industries for Foreign Investment” (鼓励外商投资产业目录) and “Special Administrative Measures (Negative List) for Foreign Investment Access”(外商投资准入特别管理措施（负面清单）).

[6] 1993 was a pivotal year. After the political upheaval of July 1989, economic reform dramatically slowed. In his final act as the country’s paramount leader, Deng Xiao-Ping undertook his famous “journey to the South,” visiting the parts of China that had opened up the most, and placing all of his remaining political capital behind an effort to jump-start a return to market-oriented economic reform. By late 1993, it was clear this effort had succeeded.

market play a fundamental role in resource allocation under the macro-control of the state. However, other important policy documents issued at roughly the same time emphasized the importance and scope of the “macro-control” retained by the government. These included the "Outline of National Industrial Policy in the 1990s" (90年代国家产业政策纲要) issued by the State Council in 1994 (Jiang and Li, 2021).

Aggregate statistics suggest that the impact of the microeconomic liberalization pursued in the 1990s outweighed the impact of the decade’s industrial policy efforts. China's efforts to join the World Trade Organization (WTO) further accelerated the country's microeconomic liberalization process over the course of the 1990s, and the terms of its accession agreement required additional openings in the early 2000s. China’s formal trade barriers and its limitations on the activity of foreign firms fell sharply before and after WTO accession. China’s broad-based manufacturing export boom was disproportionately driven by foreign-invested enterprises (FIEs), who integrated Chinese supply into MNC-managed global supply chains (Branstetter and Lardy, 2008). The share of SOEs in total industrial output fell sharply through the 1990s and into the early 2000s, while the economic role of private Chinese firms and FIEs advanced (Lardy, 2014). Large numbers of SOEs were shuttered in the late 1990s, and serious efforts were undertaken to shift the locus of bank lending away from SOEs and towards private firms and consumers (Branstetter, 2007; Lardy, 2014).

However, this liberalization still left ample room for key government agencies to influence outcomes. Financial markets remained dominated by state-owned enterprises (Branstetter, 2007), and institutional arrangements allowed, in principle, for this influence to be centrally directed in pursuit of specific industrial policy goals. The National Development and Reform Commission (NDRC), the successor of the Soviet-style State Planning Commission, formulated the "Interim

Measures for the Approval of Enterprise Investment Projects" (企业投资项目核准暂行办法) in September 2004 and gave itself significant discretion in approving large investment projects (Jiang and Li, 2021). Under this arrangement, the NDRC continued its central role in China's economic policymaking into the 2020s.

What kind of industrial policy was actually pursued? China targeted a wide range of industries for development, including automobiles, steel, cement, coal, aluminum, electric power, ships, and textiles (Wu, Hatta, and Chen 2016). The breadth and diversity of the designated industries mitigates against the notion of a narrowly targeted industrial policy, as they span nearly the entire manufacturing sector and include sectors that are both "upstream" and "downstream," high-tech" and "low-tech," "labor-intensive" and "capital intensive." The regime was keen to ensure broad-based economic growth across multiple regions, industries, and occupational groups, which mitigated against narrow targeting. Within the state apparatus, a diffusion of power and influence among regions, factions, and ministries also mitigated against narrower targeting, as all these groups argued for (and received) a place in the state's growth plans. As a consequence, aggregate industrial investment boomed in the early 1990s, but that investment was broadly distributed across sectors (Branstetter, 2007). Finally, industrial policy goals in this era were less focused on developing new-to-the-world capabilities and more on absorbing technology and techniques already invented outside of China, often with the active cooperation of foreign firms seeking a low-cost location from which to export (Branstetter and Lardy, 2008).

4. A New Era: Innovation-Focused Industrial Policy

The MLP. The trajectory of Chinese industrial policy reached an important inflection point in early 2006, when China's State Council released the "National Medium and Long-Term Plan for the Development of Science and Technology (2006–2020)” (MLP) (国家中长期科学规划). This document provided the first official high-level endorsement of the goal of promoting indigenous innovation, meaning the attainment of frontier technological capabilities by Chinese firms. China’s leaders were not content with the nation’s emergence as a manufacturing powerhouse. The MLP laid out a vision for transforming China into an innovation-driven economy that would rank as one of the world's leading scientific powers over the years 2006-2020, and even set targets for a range of basic science and technology indicators, illustrated in Table 1.[7]

The foundational influence of this document is obvious in hindsight, although it attracted relatively little Western attention at the time. However, the MLP did not specify the means by which these broad goals would be accomplished, nor did it break out intermediate technological targets for individual industries; it was more noteworthy for its stated aspirations than its policy detail.

The aspirational MLP was followed by a State Council implementation document that filled in the details, spelling out a wide array of 99 specific initiatives, with quantitative goals, specific technological targets, responsible agencies, budgets, and designated policy tools. Among these were the 16 “Megaprojects,” described in detail in Appendix Table 1 (Sun and Cao, 2021; Naughton 2021), whose industrial scope collectively spans much of the manufacturing sector, reflecting the broad industrial “targeting” of the 1990s. One illustrative example is China’s longstanding effort to stand up an indigenous manufacturer of wide body commercial aircraft capable of competing with Boeing or Airbus using its own technology (Sun and Cao, 2021).

[7] As the table indicates, many of these targets were met well before 2020.

From a Chinese perspective, these Megaprojects represented the next logical step in China's development. Complete reliance on expensive foreign products like jetliners cost China billions of dollars; cheaper domestically produced versions could make these essential goods more widely accessible to citizens of a still-poor developing country more quickly.[8] From a Western perspective, though, these plans looked like trade-distorting subsidies that violated the rules of the WTO to which the Western nations had recently admitted China. Tensions and misgivings began to build.

Table 1: The Targets set in MLP and Their Fulfillment

Indicators	MLP target	Fulfillment (year)
GERD/GDP	2.5%	2.40% (2020)
Contribution of S&T progress (STP)[9]	60%	59.5% (2019)
Dependence of foreign technology (DFT)[10]	Below 30%	31.20% (2016)
Invention patents granted to Chinese citizens	Top 5	3 (2018)
Citations to Chinese-authored papers	Top 5	2 (2018)

Source: recreated from Sun and Cao (2021) Table 1.

In 2008, China's economy was hit hard by the global financial crisis. Efforts to stabilize the economy temporarily limited the resources and top leadership attention available for investment in industrial policy. However, the apparent success of these stabilization efforts strengthened Chinese policymakers' confidence in the resilience of their economic model and undermined their view of the market-oriented economies of the West as an attractive alternative. Reflecting

[8] This is not only a Chinese perspective. Western trade theorists recognized the desire to lower consumption costs as a potential justification for industrial policy going back at least to Eaton and Grossman (1986).
[9] Calculated based on productivity estimation. Essentially is the ratio of TFP and GDP growth.
[10] Calculated as Total technology import expense/(Total technology import expense +GERD). In 2016, the Chinese government stopped using the degree of dependence upon foreign technology, a pure Chinese creation, on its misleading nature (Sun and Cao 2021).

this growing confidence and ambition, in September 2010, the State Council issued the "Decision of the State Council on Accelerating the Cultivation and Development of Strategic Emerging Industries" (国务院关于加快培育和发展战略新兴产业的决定).

This document selected seven broad industry categories, including energy conservation and environmental protection, new generation information technology, biotechnology, high-end equipment manufacturing, new energy, new materials, and new energy vehicles, as “strategic emerging industries” (SEIs). The SEIs had a significant degree of overlap with the industries that were the focus of the previously designated Megaprojects, demonstrating policy continuity over this period (Chen and Naughton, 2016). The breadth of designated industries mitigates against the idea of a narrowly targeted industrial policy, in keeping with similar policy trends dating back to the 1990s.

Unlike the 1990s, however, the Chinese government was now targeting technological parity with global leaders for indigenous Chinese enterprises. These ambitions were reiterated with the "Made in China 2025" (MIC2025) program, launched with great fanfare in May 2015.[11] While foreign and domestic observers have tended to see MIC2025 as a significant departure from earlier policies, it is, in fact, a further advancement of the innovation-driven industrial policy pioneered by the MLP and the SEI. Innovation has been given utmost importance in this policy initiative (Jiang and Li, 2021), which highlights China's ambition to attain leading positions in the manufacturing sector.[12]

[11] The State Council reiterated the national commitment to the Strategic Emerging Industries in 2012 and the CPC placed the imprimatur of the party on the national commitment to “innovation-driven development” in a joint policy statement with the State Council in 2016.

[12] Industrial policy expanded beyond manufacturing with the “Outline of the Digital Economy Development Strategy” (数据经济战略) released by the Chinese government in May 2016 and the “14th Five-Year Digital Economy Development Plan（“十四五”数字经济发展规划) released by the State Council in 2021. However, these documents were also very broad in their definition of the digital economy and their stated goals for its development, encompassing virtually every product and service that used the internet. A recent study by Beraja,

As the level of technological ambition in its industrial policies was rising, China's economy began to confront increasingly significant headwinds in the 2010s and early 2020s. The measured returns to capital investment, long the linchpin of rapid growth, began to fall. The Chinese stock market stagnated after 2015 and remains today well below the peak reached in 2007. The growth boosts generated by China's extensive microeconomic liberalizations of the 1980s and 1990s began to fade, and TFP growth slowed markedly (Brandt et al, 2020). China's workforce began to shrink substantially, and the reallocation of workers out of low-productivity agriculture and into modern services and manufacturing essentially ended. As the world's largest exporter, China began to reach the natural limits of its potential export growth, and low-wage industrial activity began to migrate to cheaper countries. The global embrace of China and its integration into MNC-managed supply chains began to slow, at best, and, in some dimensions, began to reverse direction. The surge of foreign direct investment that had helped power China's export boom and served as a conduit of advanced technology and management practices slowed. The long-running real estate boom that some economists credit with powering a substantial component of internal demand growth began running out of steam. Finally, as it increasingly targeted the sources of comparative advantage of leading Western economies, China's industrial policies increasingly attracted adverse reactions from the Western nations on whose technology and key inputs China's advancing industries still depended. The increasingly ambitious (and risky) industrial policies of the 2000s and beyond were being implemented in an increasingly adverse economic environment, where past engines of growth were permanently downshifting into a lower gear.

Yang, and Yuchtman (2020) suggested that government procurement and data collection and provision policies might have contributed to the facial recognition AI innovation in China.

5. Chinese Industrial Policy Instruments

Unlike many other countries, where industrial policy is primarily determined by the national legislature and published in legal form, China's industrial policy is predominantly developed by the administrative system and published as administrative regulations. This occurs at both the central and local government levels, with the regulations taking various forms (Jiang and Li 2021).

In addition, China's industrial policies are set at three levels: the State Council, central government ministries operating under the State Council, and local governments at all levels. The policies issued by the State Council are generally authoritative and comprehensive documents that focus on long-term, strategic, and systemic issues affecting national economic and industrial development. The policies issued by ministries mainly serve to implement or refine policies issued by the State Council. However, rivalries between ministries and competition for fiscal resources can introduce tensions between the ministries. Local government policies are issued by provinces, cities, counties, or towns, and are based on the upper-level policies issued by the State Council or the relevant ministries (Branstetter, Li, and Ren 2022). This introduces another set of conflicting objectives—agglomerations of industrial activity in a single center or a few centers may be the most economically efficient outcome, but competition among local governments to attract those agglomerations may complicate their creation (Li and Zhou 2005). [13]

The various levels of the Chinese government use a broad range of policy instruments to achieve industrial policy goals, and the range and potential power of these instruments has been the subject of extensive research, much of it descriptive in nature. For a particularly influential

[13] The situation can be further complicated by the different inventive mechanisms between local and expatriate government officials (Persson and Zhuravskaya 2016).

treatment that emphasizes implications of this array of policy instruments for the global trading system, see Wu (2016). Major policy instruments include the following.

Policies Related to Guidance Catalogs. Guidance catalogs have long been an important policy tool for China's industrial policies. The catalogs are used as a reference book for project approval or confirmation, credit acquisition, tax incentives, and land use policies. The way an industry is treated in these catalogs has a strong impact on its ability to access key inputs (Jiang and Li 2021), including loans (from state-owned banks) and land for large projects.

In China, the government has a degree of control over the supply of land that really has no analog in market economies. Control is exercised through what is known as the primary land market, in which land is allocated by leasehold sales by local government officials (Cai, Henderson, and Zhang 2013). This control provides a basis for the government to either support or restrict the development of specific industries and products by regulating the availability of land. As a result, land policy has become an essential tool for implementing industrial policy. Industries that are prioritized by the government are more likely to obtain land at more favorable prices. Land allocation to priority sectors is often implemented through guidance catalogs, but significant *de facto* discretion at all levels of government still exists (Jiang and Li, 2021). This discretion often leads to corruption (Pei, 2016).

Compulsory elimination or shutdown of "excess production capacity." One of the most important insights from the strategic trade literature of the 1980s came from Horstman and Markusen (1985) and Eaton and Grossman (1986). These theorists showed how the welfare benefit created by industrial policy could be entirely dissipated by excess entry. The policy could "succeed" in the sense that output of the targeted good by the policy-implementing country rises. But the policy could fail because too many domestic firms enter the targeted industry, optimal scale is not achieved, and the welfare benefits actually accrue to the trading partner, who reaps the benefit of cheaper exports while the policy-implementing government bears the cost.

While some care must be taken in applying any theoretical model to the complex reality of the Chinese economy, one of the striking empirical regularities seen in the Chinese practice of industrial policy is its persistent tendency to induce a wave of entry the Chinese government itself later judges as excessive, a lingering period of average capacity utilization the government regards as inadequate, and a period of consolidation the government regards as too lengthy. In the Chinese case, the negative aspects of these waves are often significantly exacerbated by the desire of local governments to make sure their region participates in the central government's policy initiatives and benefits from them.

To promote the structural adjustment of industries suffering from overcapacity, the Chinese government frequently mandates the elimination of excess capacity, often through designation of an industry as "prohibited" in the guidance catalogs. The efficient way to achieve this policy goal is through market mechanisms that eliminate the inefficient producers and leave the most productive in place. However, in reality, the government often forces a designated group of firms to reduce capacity or exit altogether, regardless of whether they are the high-cost producers.[14] In recent years, state-owned enterprises have been increasingly favored in these adjustment episodes, even though they are usually less productive than private sector competitors. Opportunistic behavior by firms and the protection of local governments often slows or diverts

[14] For instance, in August 8, 2010, the Ministry of Industry and Information Technology released a list of 2,087 underperforming companies in 18 industrial sectors that must eliminate their outdated production capacity by the end of September that year. See http://www.gov.cn/jrzg/2010-08/08/content_1673696.htm

efforts by the central government to force this kind of consolidation and lowers the efficiency of whatever consolidation does occur.[15]

Direct subsidies. In China, subsidies are widely used by the government to encourage specific behaviors of firms for a wide range of objectives including expanding business, increasing research and development investments, and supporting technology upgrades and environmental protection (Branstetter, Li, and Ren 2022). Supply-side subsidies provided to firms and demand-side subsidies provided to consumers are both widely used in China to encourage development of targeted industries. Subsidies in China are provided by both the central government and local governments. Branstetter et al. (2022) finds that the subsidy providers involve all hierarchical levels of the Chinese governments, including central, provincial, prefecture, county, township and even village governments.

Tax incentives. China's tax incentive policies mainly include the following types: (1) tax incentives for investment in encouraged industries; (2) tax incentives for encouraging enterprise technology upgrading investment and adoption of advanced equipment; (3) tax incentives for encouraging exports, such as export tax rebate policies for export enterprises; (4) tax incentives for encouraging investment in environmental protection equipment and technology; (5) tax incentives for encouraging R&D (Chen et al., 2021); and (6) tax incentives for small and micro enterprises (Jiang and Li 2021). Given strict limitations in the ability of China's subnational governments to impose taxes or change tax law, tax incentives are generally set at the central level.

Policy loans. Policy loans have always been an important tool in China's industrial policy. Policy loans provide credit support for business operations in encouraged industries. China has

[15] Barwick et al. (2021) show how local government intervention has lowered efficiency and welfare in the Chinese auto sector.

three official policy banks: the China Development Bank, the Export-Import Bank of China, and the Agricultural Development Bank of China. Of these three, the China Development Bank is the most important. In addition to policy banks, the four major state-owned commercial banks, the Industrial and Commercial Bank of China, the China Construction Bank, the Agricultural Bank of China, and the Bank of China, are also required to provide credit support for targeted industries and enterprises in accordance with industrial policies. The majority ownership of the major banks by the Chinese state and the appointment of top bank officials by the Chinese Communist Party (CCP) ensure alignment between bank lending decisions and state policy goals.

Government and SOE Procurement. China's decision to not accede to the Government Procurement Agreement (GPA) has allowed it to utilize government procurement as a significant tool for industrial policy. One notable example is the support for electronic vehicle (EV) development during the early years, when the Chinese government gave priority to EVs in public procurement to stimulate growth in the EV market. As a result, electric buses and passenger vehicles procured through public channels accounted for approximately 65% of total sales between 2012 and 2015, and around 50% of total EV sales in 2018 according to the 2018 Annual Report on New Energy Vehicle Industry in China.

In addition to official procurement by government agencies, the extensive role of state-owned enterprises in critical sectors of the Chinese economy (Lardy, 2019; Branstetter, 2018) and the extensive control exercised over SOEs by the Chinese state and the CCP enable the effective use of SOE purchasing as an instrument of state policy. The potential impact of this on “infrastructure sectors” like civil aviation or mobile telephony, where the Chinese domestic market is dominated by SOEs, is significant.

Talent Policy. China aims to become a global leader in science and technology and regards talent as crucial to achieving this objective. The country's focus on talent started around the turn of the century when its leaders realized the need to shift from a labor-based export economy to a knowledge-based one. In key sectors such as biotechnology, artificial intelligence, and semiconductors, officials perceive a shortage of highly skilled labor as a significant obstacle to national goals. As a result, China's talent drive received the backing of its most prominent leaders, including the Central Committee of CCP, which stated in its 2016 "National Innovation-Driven Development Strategy" that "the essence of being innovation-driven is being talent-driven." To build up its talent pool, China is pursuing a multi-pronged approach. In addition to enhancing domestic education, the Chinese government also seeks to attract overseas Chinese talent and draw in foreign talent in keeping with its industrial policy priorities (Zwetsloot 2020).

Government Guidance Funds. The Chinese government has employed government guidance funds (政府引导基金) to direct investments into strategic industries and accelerate the development of China's technological leadership on a global scale. These funds are venture-capital-like public-private investment vehicles that operate according to the state's industrial policy objectives, aiming to generate financial returns while also supporting specific government priorities, such as promoting emerging technologies or attracting industry to particular regions (Huang, 2019). Public and private sources contribute to these funds, with limited partners (LPs) investing capital and receiving returns while general partners (GPs) make investment decisions and oversee operations. While private investment is encouraged, these funds are predominantly financed by the government, state-owned enterprises, and state-influenced financial institutions. By the first quarter of 2020, 1,741 guidance funds had been established by Chinese authorities, with a combined registered target size of 11 trillion RMB (equivalent to 1.55 trillion USD);

however, the actual amount raised by these funds was 4.76 trillion RMB (equivalent to 672 billion USD) (Luong, Arnold, and Murphy 2021). Since the turn of the 21st century, government guidance funds have emerged as a crucial mechanism for China to implement its industrial policies, and we consider their controversial role in the evolution of China's semiconductor industry later in the paper.

6. Does China's New Industrial Policy Work? A Selective Review of the Recent Empirical Literature

The effectiveness of China's industrial policy has been a subject of debate among economists and policymakers for at least two decades, with conflicting views and varying research findings. One reason for these divergent findings is the evolving relationship between China's industrial policy and its economy. China's initial adoption of a Japanese-style industrial policy from Soviet-style economic management represents a positive step towards a more market-oriented economy during the early stages of reform and opening-up. However, as market mechanisms have become increasingly fundamental to the economy, the once-successful industrial policy is now experiencing diminishing returns. Moreover, while government intervention may be effective during the catch-up phase, its effectiveness in driving innovation-based growth is often limited by the high degree of technology and market uncertainty surrounding the technology frontier.

In this section, we provide an overview of recent research on the effects of China's industrial policy. Despite the aspirations of the Chinese policy makers, our review indicates that the overall efficacy of industrial policy in promoting innovation and innovation-based growth has been limited to date. The limiting factors include corruption and firms manipulating the system to their advantage.

First, creating winning industries through industrial policy seems to be challenging. Wu, Zhu, and Groenewold (2019) utilize a *provincial* panel data set that covers 419 four-digit manufacturing industries from 1999 to 2010. They employ a Difference in Differences (DiD) approach to examine the impact of being targeted by the *provincial* Five-Year Plans on the output of these industries.[16] Their findings indicate that sector-specific industrial policies have a positive effect on industrial output. However, the effect is found to be temporary and does not persist beyond the end of the particular Five-Year Plan. Using more recent data and also employing a DiD approach, Branstetter and Li (2022) examine how the "Made in China 2025" policy initiative has impacted Chinese listed firms' receipt of subsidies, R&D expenditure, patenting, productivity, and profitability. They find that while more innovation promotion subsidies seem to flow into the listed firms targeted by the policy and these firms exhibit an increase in R&D intensity, there is little statistical evidence of productivity improvement, patenting and profitability. Utilizing a sophisticated structural model and comprehensive data on the global shipbuilding industry, Kalouptsidi (2018) *infers* the magnitude of subsidies by monitoring the conduct of subsidized Chinese shipbuilding corporations and finds evidence of large cost and production misallocations. Building on this research, Barwick, Kalouptsidi, and Zahur (2019) reach the conclusion that these subsidies led to substantial growth in production and global market share, but only minimal gains in long-term profits, innovation, or favorable spillover effects to other Chinese industries. These results are summarized in our abbreviated case study below. According to their welfare analysis, the drawbacks of these interventions

[16] The five-year plan in China is a comprehensive strategic plan for development over a five-year period. The plan is proposed by the CCP Central Committee, drafted by relevant departments, and approved by the National People's Congress. It guides the country's economic, social, and environmental priorities, with local governments developing their plans connected to it. The plan sets goals, targets, and resource allocation for sectors of the economy, serving as key performance indicators for government officers. While not technically industrial policy documents, the plans include the most essential goals set by industrial policies.

outweigh the advantages. Barwick, Cao, and Li (2021) and Bai et al. (2020) investigate Chinese industrial policy in the automotive sector, which is now the largest in the world, and find evidence that government intervention has resulted in significant market distortions, with significant conflicts between national and provincial-level policies.

Second, the impact of industrial policy on firm productivity is limited. Branstetter, Li, and Ren (2022) investigate the relationship between the allocation of government subsidies and total productivity (TFP) for Chinese listed firms. Findings show little evidence that the Chinese government consistently “picks winners”. Firms’ *ex-ante* productivity is negatively correlated with subsidies received by firms, and subsidies appear to have a negative impact on firms’ ex-post productivity growth throughout the data window, 2007 to 2018. These findings are in line with those of Howell (2017), who analyzed data from Chinese industrial enterprises with a revenue greater than five million RMB from 2001 to 2007. Howell's research shows that subsidies have a consistent negative impact on TFP (total factor productivity) across firms with varying technological levels, including low-tech, medium-low tech, medium-high tech, and high-tech industries.

Branstetter, Li, and Ren (2022) also find that neither subsidies given out under the name of R&D and innovation promotion nor industrial and equipment upgrading positively affect firms’ productivity growth. This finding implies that factors other than innovative capability or potential may be the primary criteria for the Chinese government to award innovation subsidies. In fact, Cheng et al. (2019), who use data from the China Employer Employee Survey, find that firms with political connections tend to receive a larger share of innovation subsidies. Moreover, these subsidies do not lead to improvements in the quality of patents or productivity.

Despite the limited overall impact, the literature also suggests the heterogeneity of policy effects. For example, utilizing industrial-level data from 2005 to 2012 and employing a Regression Difference in Differences approach, Mao et al. (2021) find that the industrial policy had a positive impact on "strategic emerging industries," while no significant effects were observed on "domestically mature" or "domestically catching-up" industries at the 5% significance level.[17] Du et al. (2023) conduct a study using Chinese industrial enterprise data from 1998 to 2007 and find that government subsidies have a positive direct effect on subsidized firms' productivity but a negative indirect effect on non-subsidized firms operating within the same cluster, and the negative indirect effect tends to dominate. These findings indicate an uncomfortable result of industrial policy: what benefits one industry or firm may harm another, and while the government may be aware of who benefits, those who are harmed may go unnoticed.

Third, the literature suggests that industrial policy has heterogeneous effects on innovation, and corruption and firms' gaming behaviors hamper the efficacy of industrial policy. One subset of this literature focuses on Innofund.[18] Gao et al. (2021) conducted a study using government internal data from manufacturing firms in Jiangsu Province to explore the heterogeneous effects of central and local R&D subsidies on firms' exploratory innovation. Their findings indicate that R&D subsidies generally have a positive impact on exploratory innovation, with local subsidies

[17] However, the study did not test the parallel trends assumption, which raises concerns about potential selection bias. For instance, it is possible that strategic emerging industries were both more likely to experience productivity growth and receive more industrial policies. Therefore, caution should be exercised when interpreting the findings.
[18] Innofund, which is China's primary program focused on supporting early-stage technological ventures, was initiated by the State Council in 1999 as part of the Torch Program. It aims to assist technology-based small and medium-sized firms and is administered by the Ministry of Science and Technology (MOST), with funding from the Ministry of Finance (MOF). Innofund is the largest source of state-supported R&D innovation financing for young, entrepreneurial ventures in China, and shares similarities with the U.S. Small Business Innovation Research (SBIR) program. Innofund's early funding was primarily distributed through non-public export reviews until the past decade when it began to rely more on publicly held innovation and entrepreneurship competitions to select winners (Hong et al. 2022).

showing a more prominent effect.[19] Additionally, they found that the positive effect of subsidies is even stronger for recipients located in highly specialized industrial agglomerations. Guo, Guo, and Jiang (2016) utilize nation-wide data from industrial firms and employed propensity score matching methods to examine the effects of China's Innofund, finding a positive impact on patenting, new product sales, and exports. Using the same data and similar methods, these authors discovered that Innofund subsidies generally assist more productive firms and contribute to their *ex post* productivity improvements (Guo, Guo, and Jiang, 2018). However, using Innofund internal administrative data from Zhongguancun in Beijing and a regression discontinuity design, Wang, Li, and Furman (2017) find that receiving Innofund grants does *not* increase firm survival, patenting, or venture funding. The authors find that companies with political connections have a higher probability of receiving Innofund grants. Moreover, they discovered evidence of bureaucratic intervention, where evaluation scores of some applicants are missing in a non-random manner, and suspicious corruption behaviors, where certain firms that did not meet the funding standards based on their scores still received grants. Fang, Lerner, Wu, and Zhang (2022) directly show evidence that corruption impedes the efficacy of innovation promoting industrial polices. They employ a difference-in-differences approach to investigate the impact of the Chinese anticorruption campaign and unexpected turnover of local government officials on the allocation of R&D subsidies to firms, and find that merit played a more significant role in determining the number of R&D subsidies awarded after the anti-corruption campaign, while corruption had less influence.

Another subset of this literature looks into patent subsidies. Using patent application data in China between 1995-2004, Li (2012) empirically examines the impact of provincial patent

[19] Exploratory innovation is defined as having patents in new-to-the-firm technology fields.

subsidy programs on firms' patent behavior and finds that patent subsidy programs help stimulate patent applications. Long and Wang (2019) analyze Chinese patent data from 1985-2010 and find that patent subsidy policies expanded the number of patent applications and approvals but had a negative impact on the average patent quality, as evidenced by an increase in the patent application withdrawal rate and a decrease in the patent renewal rate. Dang and Motohashi (2015) analyzed merged data on Chinese patents and industrial firms from 1999-2008 and find that although patent subsidies stimulated the quantity and success rate of patent applications, they also induced firms to strategically apply for low-quality and low-value patents to receive the subsidy. Sun et al. (2021) examine the seasonality, quantity, and quality of Chinese patenting, the government's planning and annual targets have incentivized gaming of the system, resulting in an increase in patent counts but a decrease in the quality.

Firms' gaming the system has been found in China's other innovation promoting industrial policies. Chen et al. (2021) showed that in China, companies are reclassifying other expenses as research and development (R&D) expenses in order to obtain R&D subsidies. This might help to explain why some authors have found evidence of a significant misallocation of R&D investment in China (König et al. 2022). Stuart and Wang (2016) find direct evidence that firms "cook the books" in order to receive government innovation grants. By utilizing internal data from China's InnoCom program and employing structural econometric models, Wei et al. (2021) show that subsidies actually decrease the value of patents.[20] This is due to either a decline in the quality of newly granted patents or the inefficient trading of patents, both indicate gaming

[20] The Chinese InnoCom program, initiated in 2008, incentivizes innovation among high-tech firms in China by providing financial aid and favorable policies, including a 15% corporate income tax rate. Only firms in the state-supported High-tech Fields catalogue (国家重点支持的高新技术领域), consisting of eight industries, can apply. Eligibility is determined by the provincial government based on the firm's IPRs, R&D capabilities, science and technology commercialization ability, and growth potential. Subsidized firms undergo a review every three years to remain eligible.

behaviors of the firms. As a result, the subsidy return rate is significantly negative and there is a substantial decline in aggregate welfare. At more macro level, Cao et al. (2022) break new ground by considering the long-run growth implications of subsidies. These authors develop a Schumpeterian growth model featuring innovating firms' quantity-quality trade-off between radical and incremental innovations. They calibrate the model to Chinese firm-level data from the early 2010s and show that the quality channel effects are negative and dominant. As a result, quantity-based subsidies in China during that period reduce the TFP growth rate and welfare.[21] Given the good intention of Chinese government using industrial policy to boost growth, these results are sobering.

7. Illustrative Case Studies

Before concluding this essay, we offer a condensed description of three industry case studies which illustrate important trends in recent Chinese industrial policy. As examples, we focus on the shipbuilding industry, the semiconductor industry and the EV industry.

Industrial Policy and China's Shipbuilding Industry: A Pyrrhic Victory?

In a fascinating study that sets a high bar for future work, Barwick, Kalouptsidi, and Zahur (2019) build on the earlier work of Kalouptsidi (2018) to examine the magnitude and welfare impact of China's industrial policy to build up the shipbuilding industry. Western observers might view shipbuilding as a curious target for an industrial policy increasingly focused on innovation and advanced technology, given its technological maturity, low margins, and high cyclicality. Nevertheless, shipbuilding received special attention in the five-year plans of the early 21st century, and it was formally designated as a strategic emerging industry in the

[21] Quantity-based subsidies are based on quantities such as patent numbers, with little accounting for innovation quality.

early 2010s, providing a useful illustration of the broad definition of "emerging industry" employed by the Chinese government.

Kalouptsidi (2018) notes that the official data record does not fully disclose the full magnitude of subsidies to this sector; in this creative study, their magnitude is inferred by imposing a theoretical model on rich, firm-level data on shipbuilding firms and estimating subsidies based on firm investment and production decisions. This indirect, theory-based approach points to a total subsidies of RMB 550 billion, or nearly $80 billion. These massive subsidies induced increases in investment and entry of 270% and 200%, respectively. Much of the increase in domestic output came at the expense of foreign rivals, especially ones based in Japan and South Korea who were the industry leaders prior to the Chinese subsidies.

However, as the trade theorists of the 1980s pointed out, an increase in domestic production is not the same as an increase in domestic welfare. In their welfare analysis, Barwick et al. (2019) show the extent to which the potential welfare benefits of this industrial expansion were dissipated, first by a vast wave of inefficient entry (needlessly exacerbated by extensive subsidies explicitly designed to encourage the entry of new shipyards) and then by a wave of government-led consolidation that forced shipyards out of business but favored relatively inefficient state-owned entities over the efficient ones. The profits earned by the surviving incumbents were not sufficiently large to offset the enormous sums expended by the inefficient waves of entry and exit. In their concluding section, the authors offer speculation regarding other sources of private or social benefit could conceivably more than fully offset the losses. Given the technological maturity of shipbuilding, the prospects of robust technology spillovers seem limited. One has to appeal to impossible-to-quantify factors like national security concerns or "national prestige" to offset the apparent waste.[22]

The "Big Fund": NICIF and the Chinese Semiconductor Industry

Starting from 2005, the Government guidance funds (GGFs) have played a crucial role in China's technological aspirations, serving as a vital tool for its industrial policy. Between 2015 and 2017, the target capital size of GGFs exceeded the total amount of China's direct government financing in science and technology (Wei, Ang, and Jia 2022). However, despite their importance in China's current innovation-focused industrial policy, there has been minimal academic research on the impact of GGFs.[23] To address this gap, we will provide a case study on the National Integrated Circuit Industry Investment Fund (NICIF) (国家集成电路产业投资基金), which is commonly referred to as the "Big Fund," to shed light on the effectiveness of GGFs.

The NICIF is one of the most well-known government-guided investment funds in China. It was established in September 2014 after the State Council released the "Outline of the Program for National Integrated Circuit Industry Development" in July of the same year. During its first round of fundraising, the Big Fund raised RMB 138.72 billion (US$20.03 billion), surpassing its target of RMB 120 billion (USD 17.33 billion). The Ministry of Finance is the largest shareholder of the Big Fund, owning 36 percent, while other state-owned enterprises such as China Development Bank Capital Corporation (22 percent), China Tobacco (11 percent), Beijing E-Town International Investment and Development Corporation (10 percent), and China Mobile (5 percent) also hold significant stakes (Huang 2019).[24]

[22] While they do not attempt a full welfare analysis, Lam et al. (2018) find a similar pattern of entry and exit in the Chinese solar PV industry.
[23] Two exceptions are Wei, Ang, and Jia (2022) and Luong, Arnold, and Murphy (2021).
[24] These are the "LPs" of the fund.

The Big Fund invests in promising semiconductor companies. As of 2019, the majority of NICIIF's investments, approximately 67%, had gone to semiconductor manufacturing companies including some of China's top semiconductor manufacturers such as SMIC and Hua Hong Semiconductor (Table 4), while the remainder to firms specializing in design, materials, packaging, and integrated circuit equipment (Wei, Ang, and Jia 2022). The fund invested RMB 31.3 billion (USD 4.5 billion) in 19 publicly-traded companies listed on the Shanghai, Shenzhen, and Hong Kong stock exchanges, achieving a 125% return on investment from 2014 to 2019 (Wei, Ang, and Jia 2022). It also invested 102.6 RMB billion (USD 15 billion) in 36 unlisted companies (Caixin 2022). Additionally, it is also a significant shareholder in several local government guidance funds, such as the Beijing Integrated Circuit Manufacturing Fund and the Shanghai Integrated Circuit Industry Fund. In October 2019, NICIIF initiated the second phase of fundraising, and raised another RMB 204 billion (USD 29.4 billion).

Table 4: The NICIF's chipmaking investments

Company	**The Big Fund's stake (%)**
Semiconductor Manufacturing International North China (Beijing) Corp	32
Hua Hong Semiconductor (Wuxi) Ltd	29
Yangtze Memory Technology Holdings Co Ltd	24.1
Unisoc (Shanghai) Technologies Co Ltd	14
Empyrean Technology Co Ltd	8.9
Beijing BDStar Navigation Co Ltd	8.6
NAURA Technology Group Co Ltd	7.5
Advanced Micro-Fabrication Equipment Inc China	4
Goodix Technology Inc	3.6
National Silicon Industry Group Co Ltd	2.7

Source: Recreated from White and Liu (2022).

The NICIF had been regarded as a success (Wei, Ang, and Jia 2022), but a recent series of corruption scandals has cast doubt on its ability to allocate resources. In November 2021, Gao Songtao, the former vice president of Sino IC Capital (i.e., the GP of the Big Fund), a subsidiary of China Development Bank that managed the national chip fund, was arrested for corruption. In July of 2022, a new round of arrests began with the investigation into Lu Jun, the former president of Sino IC Capital. In mid-July, Zhao Weiguo, the former chairperson of Tsinghua Unigroup, was taken away by police from his home in Beijing. Then Ding Wenwu, the former president of the Big Fund, was also detained by police. During the year of 2022, a dozen chip executives, fund managers and government officials related to the Big Fund were detained or arrested. Although there hasn't been any official explanation for the link between the detentions of Gao, Lu, and Zhao, speculation has arisen due to the Big Fund's significant investments in Tsinghua Unigroup. In the first phase of the Big Fund, Tsinghua Unigroup was one of the biggest investees of the fund, receiving at least RMB 28.4 billion from the Big Fund. Tsinghua Unigroup, known as China’s "microchip aircraft carrier," has been in trouble since July 2021, when it announced that it could not repay some of its large debts. Zhao Weiguo was officially charged with “seizing state assets” in March 2023.

While in theory GGFs are expected to adhere to market rules, in reality, state partners tend to meddle in the investment decisions and operations of VC firms. According to a survey by Zero2IPO, government fiscal departments or state asset supervisory bodies served as observers for 31 percent of the surveyed GGFs, while 29 percent had them play the role of final approvers, and 25 percent included them in investment committees (Wei, Ang, and Jia 2022). This combination of significant capital, extensive state intervention, and insufficient transparency creates an environment where corruption is likely to occur.

On October 7th, 2022, the Bureau of Industry and Security (BIS) of the U.S. Department of Commerce announced a new set of export controls that will require U.S. persons to obtain a license for conducting or authorizing the delivery of items used to develop or produce advanced chips at a plant in China. This measure applies to anyone with an American passport, green card, or residency. The new export controls aim to prevent the transfer of sensitive technologies to China that could be used for military purposes. To obtain a license, U.S. persons will have to meet a heavy burden of proof, demonstrating that their work will not be used for military end uses. U.S. allies have cooperated in the imposition of export controls, limiting the access of Chinese semiconductor producers to the most advanced technologies. The effect on the Chinese industry has been dramatic. Firms have experienced a mass exodus of U.S. citizens and green card holders, and thousands of Chinese semiconductor firms have ceased operations. These events cast into sharp relief the speed with which an apparently successful industrial policy in China could be upended or undermined by counter policies implemented abroad. They also showcased the degree to which Chinese semiconductor firms' growth plans relied on foreign technology and even "foreign" technologists.

In 2022, the Chinese chip industry experienced significant adjustments due to the Big Fund anti-corruption campaign and ongoing US restrictions on semiconductor exports to China. The number of chip-related companies exiting the market reached 5,746, representing a 68% increase from the previous year.[25] This decline in industry prosperity resulted in some pessimism about the future of the industry. However, some experts we interviewed, particularly those holding critical technologies, are optimistic about the industry's longer-term future. They believe that the industry is returning to a healthy development track, as some policy-gaming firms exit the market and U.S. export restriction policies create an isolated Chinese niche market that essentially *requires* import substitution. At this point, though, the future of the sector is far from clear.

[25] TMTPOST, https://www.tmtpost.com/6411731.html.

Industrial policy and the rise of the Chinese electric vehicle industry

The success of the Chinese electric vehicle (EV) industry is often seen as a tale of both catching up and effective industrial policies (Xiong et al. 2022). Undoubtedly, industrial policies have played a significant role in creating this industry. We argue that one of the keys to the industry's apparent success so far lies in policies that have effectively enabled *consumers* to allocate subsidies across producers through their product choices. Whereas government entities provided the bulk of their subsidies directly to producers in other sectors, consumption subsidies for EVs played a large role in EVs, and they effectively put consumers rather than bureaucrats in the driver's seat. Such policies have fostered fierce market competition among EV makers, forcing them to innovate, improve car quality, and continually reduce costs. So far, the results appear impressive. However, we also sound a note of caution. The rise of the Chinese EV industry has induced a massive wave of entry, with literally hundreds of firms pouring into the market as demand grew. Many current producers are making razor-thin profits or racking up large losses.[26] It seems all but certain that the vast majority of these new entrants will fail—perhaps over the next few years—and we cannot conduct a final comparison of costs and benefits until we see what the industry looks like on the other side of that inevitable transition. It is possible that future scholars could conclude, as Barwick et al. (2019) did in the case of shipbuilding, that the costs of the entry wave outweigh the returns on investment earned by the survivors.

China's ambition in the electric vehicle (EV) industry started earlier than many might think. Back in 1992, Xuesen Qian (Hsue-Shen Tsien), a highly influential Chinese scientist, advised

[26] For example, in 2020, the best-selling EV in China was the Wuling Hong Guang MiniEV. Reports indicate that the company only makes a meager profit of 89 RMB (about 14 USD) on each Mini EV sold. https://carnewschina.com/2021/07/06/wuling-makes-a-mere-89-rmb-14-usd-profit-on-mini-ev/

Jiahua Zou, the Vice Prime Minister at the time, to formulate a plan to support EV development "immediately." Policy makers quickly heeded Qian's suggestion by launching the country's first national pilot EV research and development project, which continues to this day. China also began promoting the industrialization of EVs during the 10th five-year plan (2001-2005). In 2001, it established the first national EV operation, test, and demonstration zone in Guangdong Province. By 2005, Chinese firms had already developed prototypes of fuel cell vehicles and hybrid electric vehicles. However, these efforts had little impact on auto purchases in China, which remained overwhelmingly focused on conventional gas-powered vehicles.

In 2009, China emphasized for the first time that the industry should focus on EVs "to strengthen independent innovation, cultivate independent brands, and form new competitive advantages" in the Plan on Adjusting and Revitalizing the Auto Industry（汽车产业调整和振兴规划）. However, focusing on EVs meant a shift in focus for makers of internal combustion engine vehicles to the EV sector, which was challenging as the EV market was virtually non-existent. In 2009, while Chinese consumers purchased over 13.5 million passenger vehicles, only 319 of these were EVs.

To stimulate the market for EVs, the Chinese government introduced a series of policies. The main policy, which is well-known internationally, was to provide customers with financial incentives to buy EVs, including consumer subsidies, exemption from purchase tax, and free license plates. The value of a free license plate may be underappreciated by foreign readers who are not aware that some of China's major cities charge fees for new license plates to limit road congestion. In Shanghai, this fee exceeds $10,000, surpassing the market price of an economy or compact car. The total Chinese population resident in Chinese cities with such draconian restrictions exceeded the population of France in the 2010s. As demonstrated in Appendix Table

2, the BAIC EC, the best-selling BEV model in 2017, received a subsidy from the central government and reduced tax, which accounted for over 30% of its price. Furthermore, if the value of the free license plate is taken into account, the total financial support could surpass the price of the car itself for customers residing in cities with limited available license plates, such as Beijing or Shanghai, thereby constituting a level of consumer subsidy for EV purchases that has no parallel outside China. The Chinese government gradually reduced the amount of subsidies over time to avoid the firms becoming overly reliant on these policies, but the free license plate benefit has been retained by local governments, at least until very recently. As shown in Table 5, national subsidies for EV models in each category (not including free license plates in selected cities) decreased over the years. The maximum subsidy amount (not including free plates) decreased from 60,000 RMB (approximately 8,500 USD) in 2013 to only 12,600 RMB (approximately 1,800 USD) in 2022. In addition to reducing subsidy amounts, the Chinese government also tied EV subsidies to vehicle range, providing higher subsidies for models with longer range. This incentivized firms to move up the stepwise range levels through innovation, as higher levels were associated with higher per-km subsidies. As the government continuously increased the range requirement for subsidies, the electric range of EVs sold in China also increased rapidly.

The Chinese central government aimed to make policies clear and predictable for firms as they promulgated and adjusted policies. When designing the subsidy programs, the government established different subsidy standards for different periods. However, it also ensured that the subsidy program for the next period was publicized around six months before the current period ended. For major policy changes, the Chinese government sent signals to the market years in advance. For example, the government informed EV makers in 2016 that all EV subsidies would be canceled in 2020 (this was then extended to 2022 due to COVID-19).

Table 5: **The subsidies for EVs provided by the Chinese central government from 2013 to 2022** (unit: 1,000 RMB).

Minimum electric range for subsidy eligibility	50 KM (PHEV)	80 KM (BEV)	100 KM (BEV)	150 KM (BEV)	200 KM (BEV)	250 KM (BEV)	300 KM (BEV)	400 KM (BEV)
2013/1/1-2013/12/31	35	35	35	50	50	60	60	60
2014/1/1-2014/12/31	33.25	33.25	33.25	47.5	47.5	57	57	57
2015/1/1-2015/12/31	31.5	31.5	31.5	45	45	54	54	54
2016/1/1-2017/12/31	30		25	45	45	55	55	55
2017/1/1-2018/2/11	24		20	36	36	44	44	44
2018/2/12-2018/6/11 (transition period)	16.8		14	25.2	25.2	30.8	30.8	30.8
2018/6/12-2019/3/25	22			15	24	34	45	50
2019/3/26-2019/6/25 (transition period)	13.2			1.5	2.4	20.4	27	30
2019.6.26-2020/4/22	10					18	18	25
2020/4/23-2020/7/22 (transition period)	8.5					9	16.2	22.5
2020/7/23-2020/12/31	8.5						16.2	22.5
2021/1/1-2021/12/31	6.8						13	18
2022/1/1-2022/12/31	4.8						9.1	12.6

Source: Compiled by authors from various government documents.

The Chinese government also invested in building infrastructure for EVs, particularly charging points. From 2013, the central government started providing subsidies to cities to incentivize the construction of charging points. In 2017, the Chinese government implemented the dual-credit system, which combined the corporate average fuel consumption credit and the new energy vehicle credit. Automakers who exceeded the fuel consumption threshold set by the government received negative credits, and needed to offset them with positive NEV-credits or face penalties. This created an incentive for ICEV makers to enter the EV sector or cooperate with EV firms, as they struggled to meet the fuel consumption goals set by the government.

The Chinese government gradually introduced more market competition into the EV sector as it grew. In 2016, wholly foreign-owned companies were allowed to manufacture EV batteries in certain free trade zones, and in 2018, they were permitted to manufacture EVs as well. This led to Tesla building a Gigafactory in Shanghai and delivering Model 3s from the factory in January 2020.

Although Tesla has seen rapid sales growth in China since 2020, its impact on its major Chinese competitor BYD has been only temporary, as shown in Figure 1. That being said, not every domestic EV company is performing as successfully as BYD, which now is the No. 1 EV seller in the Chinese market. With intensifying competition and the gradual fading of subsidies, many EV manufacturers are facing difficulties. These struggling players include once highly regarded EV startups in China, such as NIO, Li Auto, and XPeng.[27]

[27] The reader can refer to a recent *Wall Street Journal* report on this change for more information. https://www.wsj.com/articles/chinas-tesla-killer-stumbles-as-ev-price-war-takes-toll-beadc04c?st=eap9b2yfsaheohf&reflink=desktopwebshare_permalink

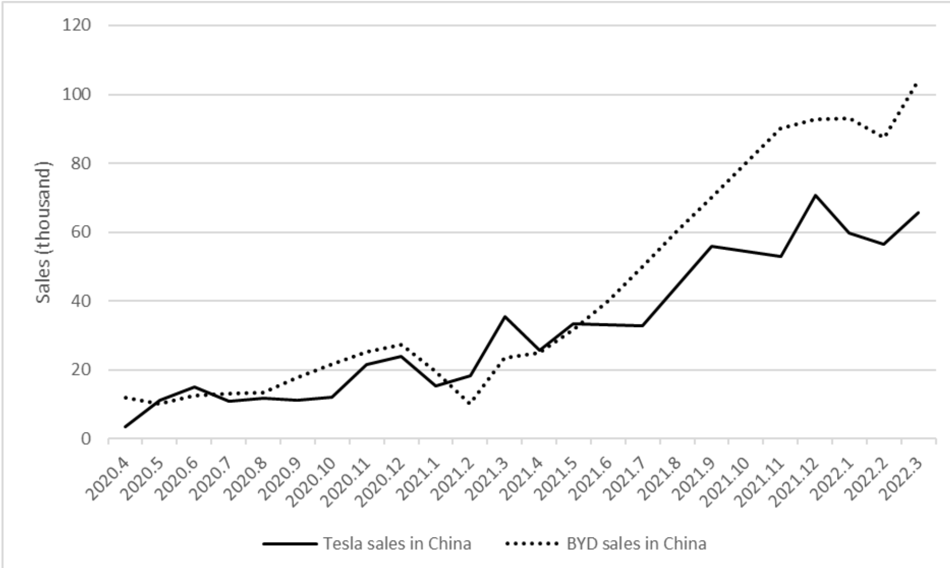

Fig. 1. Monthly EV sales for Tesla and BYD in China.

Despite the high costs[28] and instances of fraud[29] associated with EV industrial policies ,the rapid growth of the sector and its success at competing with leading Western firms in the home market and elsewhere suggests the benefits of government intervention may outweigh the costs. (e.g. Blaschke, 2022; Helveston et al., 2019). In this industry, the most important components of the subsidy were provided to consumers who were free to select the best product, regardless of the identity of the producer. This allowed the market to pick the winners rather than government policymakers.[30] This presents a sharp contrast with the prior case, in which government-linked investment funds literally "picked winners." But a full accounting of the costs and benefits of industrial policy is not yet possible, because the massive wave of entry induced by these generous subsidies has come at a real resource cost. If the vast majority of these producers fail

[28] We estimate the total amount of subsidies given out by the Chinese central government from 2010-2019 is 95 billion RMB, or about 13.6 billion USD.
[29] For example, between 2016 and 2017, the Ministry of Industry and Information Technology exposed 11 new energy vehicle companies for cheating on subsidies. http://auto.sina.com.cn/news/ct/2017-02-13/detail-ifyamkzq1268622.shtml
[30] That being said, regional governments used their own local procurement and subsidy policies to steer business in the direction of local champions, which may have worked against the goal of putting consumers in the driver's seat. For example, almost all of the taxis in Shanghai, Beijing, Shenzhen, Chengdu were EVs produced at a local plant.

and much of the production capacity thereby created has to be liquidated, and if the profit margins of the survivors are razor-thin, then the cost-benefit calculation could appear very different over the next few years. At this point, we are not prepared to issue a forecast regarding the ultimate return on investment to China from this policy experiment.[31] While the current surge of the Chinese EV industry provides some grounds for optimism, past experience also provides ample grounds for concern.

8. Conclusion

Chinese industrial policy has increasingly attracted attention, foreign criticism, and significant policy reactions from key trading partners. However, the policy debate has been inadequately informed by research. This essay provides an historical perspective on the long evolution of Chinese industrial policy and provides a summary of the still limited but growing literature on the efficacy and impact of Chinese industrial policy.

To put it simply, industrial policy is hard for any nation that has attempted it. The challenges that have arisen for China's predecessors are clearly evident in its policy history and in the empirical assessments of that history. Sometimes, policymakers seem to get industrial policy “right,” and often they get it "wrong." This is because industrial policy is hard, even in a political context where the impact of conventional interest group lobbying might appear to be limited. The evidentiary picture of China's success that emerges from the extant empirical literature is, at best, mixed.

[31] The return on investment to the world, inclusive of climate change avoided, could be larger than the return to China itself. Even if the domestic ROI is low, by making low-cost green technology widely available, Chinese firms may be generating a significant social benefit not captured in market transactions. But much of this benefit could accrue to foreign, rather than domestic consumers. This echoes the findings of Eaton and Grossman (1986), who theorized that industrial policy could ultimately transfer welfare from the industrial policy imposing country to its trading partner, rather than the other way around.

Our assessment in this essay is that industrial policy is going to get harder as China's economy continues to mature and the long-lasting boost to economic growth generated by earlier waves of economic liberalization and demographic dividends continue to fade. The gap between policy ambitions and capabilities is likely to grow. The conflicts generated by competing policy objectives are likely to intensify. The challenge of managing the opportunistic reactions of regions, firms, and other "players" in the industrial policy game is likely to become more difficult. Finally, the opportunity cost of policy errors is likely to grow. None of this is unique to China. However, China's size and central role in the global economy suggest that the resolution of these challenges will have significant global impact.

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Appendix Table 1: Overview of the 16 MLP Megaprojects

Project Name	Sector	Project Goals	Total Funding
Core electronics, high-end general microchips, and basic software	Civilian	Develop high-end communication microchips, basic software, and core electronic components	100 billion RMB or about 14 billion USD (estimated)
ULSI manufacturing technology Next	Civilian	Industrialize the 90 nm ULSI, produce sample machinery for the 60nm ULSI and acquire key technologies in making the 45 nm ULSI	18 billion or about 2.6 billion USD
Next generation broadband wireless mobile communication	Civilian	1. Upgrade technologies of the current cellular mobile communication system, including high-speed packet access (hspa), i.e., 4g; 2. Develop Broadband wireless access technology, including WiMax; 3. Develop a short-distance wireless system and censor network	70 billion RMB or about 10 billion USD
High-end CNC machine tools and basic manufacturing technology	Civilian	Improve China's manufacturing abilities of high-end machinery: e.g., high- precision machinery for aviation, space, shipbuilding, and other industries	21 billion RMB or about 3 billion USD
Large-layer oil and gas fields and coal-bed methane development Large-scale	Civilian	Develop exploration and mining technologies for oil, gas, and coal-bed methane resources under complex geological conditions in Western China	60 billion RMB or about 8.6 billion USD
Large-scale advanced pressurized water reactor (PWR) nuclear power plant and high temperature reactor (HTR)	Dual-use	Obtain key technologies in PWR and build the first commercial plant; acquire key technologies and build a demonstration plant using HTR	15 billion RMB or about 2.1 billion USD from central government (11.92b RMB or about 1.7 billion USD to PWR; 3b RMB or about 0.4 billion USD to HTR)
Water pollution control and treatment	Civilian	Control and protect pollution, develop water treatment technologies, support coordination of regional	30 billion RMB or about 4.3 billion USD (estimated)

		water access and ecological planning	
Genetic transformation and breeding of new plants	Civilian	Research transgene technologies to develop new pest- resistant breeds of higher quality and productivity	20 billion RMB or about 2.9 billion USD
Research and creation of major new drugs for China	Civilian	Develop 30 to 40 drugs new to Chinese production with market competitiveness and intellectual property protection	55 billion RMB or about 7.9 billion USD (estimated)
Prevention and control of major infectious diseases, including HIV/AIDS and Viral Hepatitis	Civilian	Develop new vaccines and treatment methods for infectious diseases such as HIV/AIDS and Viral Hepatitis	Unknown
High-resolution Earth observation system	Dual-use	Develop an observation system consisting of satellites, aircraft, and stratospheric airships; build ground facilities such as observatories and data centers to enhance self-supply of spatial data	40 billion RMB or about 5.7 billion USD
Large passenger aircraft (C919)	Civilian	Design and build China's first large passenger aircraft C919	200 billion RMB or about 28.6 billion USD (estimated)
Manned space flight and lunar exploration	Dual-use	Implement the Chang'e lunar probe and Shenzhou manned spaceship	Shenzhou budget 39 billion RMB or 5.6 billion USD until 2013
Shenguang Inertial Confined Fusion (ICF)	Defense	Information not released	Unknown
Beidou Navigation System	Defense	Build a navigation network consisting of 30 satellites by 2020 (s&t Daily 2012)	Unknown
Hypersonic Technology Vehicle	Defense	Information not released	Unknown

Source: recreated from Naughton (2021) Table 3.1. We convert RMB to US using the exchange rate of 7 RMB to 1 USD.

Appendix Table 2: EV subsidies for consumers in Beijing, Shanghai, and Shenzhen.

	2017				After June 2019			
Best-selling EVs (base model)	Subsidy source/city	Beijing	Shanghai	Shenzhen	Subsidy source/city	Beijing	Shanghai	Shenzhen
BAIC EC (BEV)	Central government subsidy	¥ 36,000	¥ 36,000	¥ 36,000	Central government subsidy	¥ 0	¥ 0	¥ 0
	Local government subsidy	¥ 18,000	¥ 30,000	¥ 18,000	Local government subsidy	¥ 0	¥ 0	¥ 0
	Vehicle and vessel tax exemption	¥ 468	¥ 337	¥ 337	Vehicle and vessel tax exemption	¥ 468	¥ 337	¥ 337
Lowest price 2017: ¥ 157,800 2019: ¥ 55,800	Tax exemption on buying vehicles	¥ 13,965	¥ 13,965	¥ 13,965	Tax exemption on buying vehicles	¥ 4,938	¥ 4,938	¥ 4,938
	Value of license plate discount	¥ 130,000	¥ 90,713	¥ 54,937	Value of license plate discount	¥ 130,000	¥ 89,568	¥ 63,329
	Total amount of subsidies	¥ 198,433	¥ 171,015	¥ 123,239	Total amount of subsidies	¥ 135,406	¥ 94,843	¥ 68,604
	Net cost	¥ –40,633	¥ –13,215	¥ 34,561	Net cost	¥ –79,606	¥ –39,043	¥ –12,804
BYD Song (PHEV)	Central government subsidy	¥ 24,000	¥ 24,000	¥ 24,000	Central government subsidy	¥ 10,000	¥ 10,000	¥ 10,000
	Local government subsidy	¥ 0	¥ 10,000	¥ 10,000	Local government subsidy	¥ 0	¥ 0	¥ 0
	Vehicle and vessel tax exemption	¥ 656	¥ 674	¥ 674	Vehicle and vessel tax exemption	¥ 656	¥ 674	¥ 674
Lowest price 2017: ¥ 215,900 2019: ¥ 176,900	Tax exemption on buying vehicles	¥ 19,106	¥ 19,106	¥ 19,106	Tax exemption on buying vehicles	¥ 15,655	¥ 15,655	¥ 15,655
	Value of license plate discount	No license plate discount	¥ 90,713	¥ 54,937	Value of license plate discount	No license plate discount	¥ 89,568	¥ 63,329
	Total amount of subsidies	¥ 43,762	¥ 144,493	¥ 108,717	Total amount of subsidies	¥ 26,311	¥ 115,897	¥ 89,658
	Net cost	¥ 172,138	¥ 71,407	¥ 107,183	Net cost	¥ 150,589	¥ 61,003	¥ 87,242
Roewe eRX5 (PHEV)	Central government subsidy	¥ 24,000	¥ 24,000	¥ 24,000	Central government subsidy	¥ 10,000	¥ 10,000	¥ 10,000
	Local government subsidy	¥ 0	¥ 24,000	¥ 10,000	Local government subsidy	¥ 0	¥ 0	¥ 0
	Vehicle and vessel tax exemption	¥ 656	¥ 674	¥ 674	Vehicle and vessel tax exemption	¥ 656	¥ 674	¥ 674
Lowest price 2017: ¥ 265,900, 2019: ¥ 175,900	Tax exemption on buying vehicles	¥ 23,531	¥ 23,531	¥ 23,531	Tax exemption on buying vehicles	¥ 15,566	¥ 15,566	¥ 15,566
	Value of license plate discount	No free license plate	¥ 90,713	¥ 54,937	Value of license plate discount	No free license plate	¥ 89,568	¥ 63,329
	Total amount of subsidies	¥ 48,187	¥ 162,918	¥ 113,142	Total amount of subsidies	¥ 26,222	¥ 115,808	¥ 89,569
	Net cost	¥ 217,713	¥ 102,982	¥ 152,758	Net cost	¥ 149,678	¥ 60,092	¥ 86,331

Note: We chose these three cities because they were the top three cities in China in terms of EV sales in 2017, according to the 2018 Annual Report on New Energy Vehicle Industry in China. We chose the three EV models for two reasons. First, they are produced by local EV makers in the three cities: the BAIC EC180 is produced by BAIC in Beijing; the BYD Song is produced by BYD in Shenzhen; and the Roewe eRX5 is produced by SAIC in Shanghai. Second, the three models are the best-selling models in China. The EC180 was the best-selling BEV model in 2017, and the BYD Song and the Roewe eRX5 were the top two best-selling PHEV models in 2017.

The data in the Table are calculated using the following methods:

- The subsidy from central and local government is calculated based on the technical information of these EV models, which is obtained from autohome.com.cn, and the subsidy standards of the central government and local government in 2017 and 2019.
- The vehicle and vessel tax exemptions are calculated based on the related tax policy of the three cities.
- The tax exemption on buying the vehicle is calculated based on the tax ratio (1/11.3≈8.85%) and the manufacturer's suggested retail price (MSRP) of the base model of the three cars, which is obtained from autohome.com.cn.
- The value of the license plate discount is calculated in different ways in the three cities because the local policy regarding the license plate varies. In Beijing, private vehicle consumers can obtain a license plate only through a lottery, but it is much easier to get an EV license plate than an ICEV license plate owing to the local policy. A study from the International Council on Clean Transportation (ICCT) found that, in 2015, the value of the license plate discount could be worth as much as 130,000 RMB for EV consumers in Beijing (Cui et al., 2018). We use this data for the value of the license plate discount in Beijing in 2017 and 2019. In Shanghai and Shenzhen, private vehicle consumers need to bid for the license plate for ICEVs through an auction, while they can get a license plate for an EV for free. Thus, we estimate the value of license plate discount at Shanghai and Shenzhen in 2017 and 2019 using the average auction price of the license plate for ICEVs in 2017 and 2019.
- The total amount of subsidies is the sum of the above subsidies, and the net cost equals the price of the model minus the total amount of subsidies.