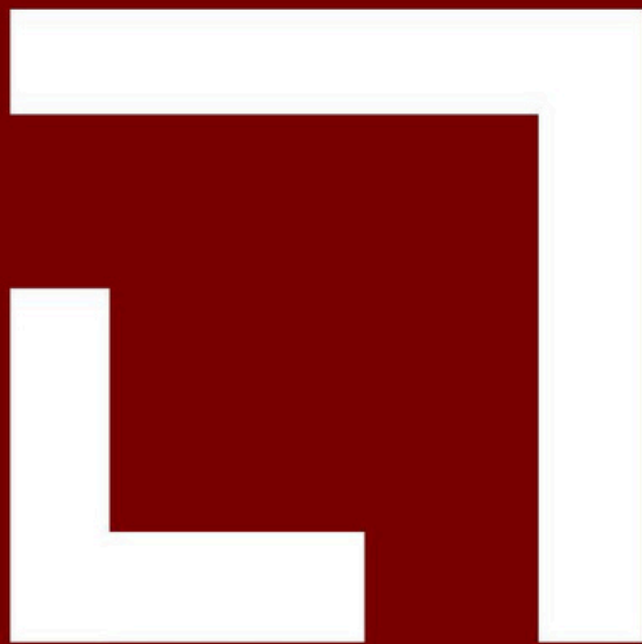




**Global
Sino
Institute**

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Sinnovation: Does China's current Economic Model and Innovation System support its Goal of achieving global Innovation Leadership?

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Introduction

The Chinese government has set itself the ambitious target of becoming a global innovation leader in key strategic industries such as artificial intelligence (AI), green technology, and advanced manufacturing by 2035 (ITIF, 2024a; NDRC, 2022). This essay analyses whether China's innovation capabilities are sustainable and innovation ambitions realistic and contributes to the growing debate about China being an innovation leader. Drawing from Arthur Kroeber's (2016) conceptualisation of "Leninist Capitalism" and McNally's (2012) "Sino-Capitalism" framework, this essay positions China's innovation system within its unique economic and political context. The next step will assess key indicators such as the Global Innovation Index (GII), a case study on how China dominated the solar PV market and a comparison between the American and the Chinese innovation models. Conclusively, it is argued that China has made significant progress in scaling up its innovation capabilities. However, its supply-side innovation focus raises concerns about its ability to develop disruptive innovations, questioning the nation's ability to emerge as a global innovation leader. Findings may offer policy and strategy implications.

Capitalism with Chinese Characteristics

To better understand the space of innovation within the Chinese economy, this section aims to outline the underlying Chinese economic model. Defining China's economy is difficult as it has evolved into a complex and multilayered system (Kroeber, 2024). With over 3000 years of history, China's economic model is deeply rooted in its historical context. Among other things, these influences include institutional structures, cultural values and trade practices. For example, the Han Dynasty brought about the Tribute System, which impacted the Belt and Road Initiative (BRI). At the same time, the Tang Dynasty introduced cosmopolitan trade, which aligned with China's accession of the WTO and the Ming Dynasty state-led economic management, which is mirrored in SOE management. To better position China's innovation capabilities within the Chinese economy, the following paragraph draws on more recent scholarship from Kroeber (2016), McNally (2012) and Huang (2012).

Inspired by the former leader of Soviet Russia Lenin, Kroeber (2016) invites us to regard Leninist Capitalism as a more market-driven economy that strengthens the party's power. In this economic system, the government assumes control over capitalist mechanisms such as production for state goals, regulation of markets, ownership of key industries like utilities. This element becomes evident in Lardy's (2019) analysis of the government's SOE reforms, where political involvement acts as an obstacle to economic growth. In contrast, McNally (2012) argues that Sino-capitalism has emerged, a form of capitalism that relies on informal networks, assigns the state a central role, and is different from Anglo-American capitalism. As part of his comparative study, he examines how China's population size and economic potential challenged the dominance of the Anglo-American model. In addition, McNally (2012) examines how *guanxi*, or network capitalism, has shaped China's political economy by acting as

both a private business incentive and a political lever. Using guanxi, McNally (2012) identifies coexisting forms of capitalism in China where state influence coexists with entrepreneurial activity. Sino-capitalism's strength is its ability to adapt to international frameworks and maintain its distinct governance approach while adhering to WTO regulations.

So, while the Chinese economy has a very entrepreneurial, market and guanxi-driven aspect (McNally, 2012), it also has this vis-à-vis state-led driven approach (Kroeber, 2016). These two forces appear to be in constant fight for winning the upper hand with the latter appearing to have the upper hand, at the moment, which has been observed by Huang (2009). Moreover, with leading production capabilities and supply chain efficiency, China's economy is rooted in supply-side principles. This is reflected in initiatives such as the 14th Five-Year Plan, which prioritises investments in high-tech industries, R&D capabilities, and infrastructure to improve the supply chain's global competitiveness (NDRC, 2022). Consequently, this essay defines the contemporary Chinese economy as Capitalism with Chinese Characteristics, underpinned by a Leninist political structure and a supply-side orientation. The subsequent discussion explores whether this model fosters or inhibits innovation.

China's Innovation Capabilities

Economists are divided on China's ability to lead in global innovation. Critics argue that China's state-led, hierarchical system stifles IP protection and creativity. For example, Kroeber (2016) claimed that innovation will be a severe victim of the Chinese leadership past the year 2022. Some critics will even go as far as to argue that "Peak China" has been reached and that China's innovation capability will enter into a long and slow phase of decline (Bernstein, 2024). On the other side, China's rapid technological advancements in scaling Western technologies may prove critics wrong. This section aims to support the latter view.

In a traditional sense, innovation is defined as creating new ideas to drive economic development, with entrepreneurs being critical agents of innovation (Schumpeter, 1942). A more modern version is proposed by scholars like Krugman (1991) who define it as an internal process within an economy that is driven by technology, human capital and R&D investments, rather than a standalone driver of progress. This essay regards innovation as a nation's capability to gain significant market shares of innovative products, which aligns with the definition suggested by the ITIF (2024a).

In more detail, innovation can be divided into product innovation, supply chain innovation and business model innovation. Supply-side economies like China tend to perform strongly in the field of supply chain innovation which often results in lower production costs and in business model innovations as these can be fairly quick implemented. By contrast, demand-side economies like the US find their strength in product innovation. These innovations come a long way and require a large amount of capital due to their nature of "hit-and-miss" (Kroeber, 2024). Moreover, they can be of disruptive nature like

the digital camera or the iPhone. These innovations can drive economic growth by creating new markets, industries, and business models, leading to significant productivity gains and long-term opportunities. Unlike incremental innovations, which refine existing systems, disruptive innovations revolutionise economies and reshape global value chains (Christensen, 1997). In light of these considerations, this essay defines sustainable innovation as the ability to achieve innovation leadership by creating impactful, disruptive, forward-looking solutions.

Evidence of China's Innovation Capabilities

The GII offers a comprehensive framework for comparing national innovation performances. It is published by the World Intellectual Property Organisation (WIPO). According to the WIPO, the GII ranks economies on their innovation system based on 81 indicators from international and private sources, and it envisions capturing “as complete a picture of innovation as possible” (WIPO, 2024).

A look at the Global Innovation Index (GII) for 2024 already suggests that, unlike Kroeber's (2016) prediction of China's innovation capabilities being victim to Xi's leadership, the nation's innovation capabilities remain stable, and if anything, continue to grow (Figure 2). Additionally, for 2023 it even increased to 56.3 points from 55.3 points, ranking China as the first country in the upper middle-income category, followed by Malaysia and Turkey. In the global ranking, it is ranked 11th out of 133 countries, being the only middle-income economy within the GII top 30. The US is third, slightly behind Sweden and Switzerland (Dutta et al., 2024). Critics might claim that the ranking is invalid as the GII takes scale into account. The GII is computed in the following way. The two major components of the GII are innovation input and innovation output. The first domain is based on five pillars: institutions, human capital and research, infrastructure, market sophistication and business sophistication. The second domain consists of knowledge and technology outputs and creative outputs. The overall GII score is based on the average scores from both domains. While the GII does incorporate both innovation scale and efficiency in its calculations, it normalises these with factors such as population or GDP (Dutta et al., 2024).

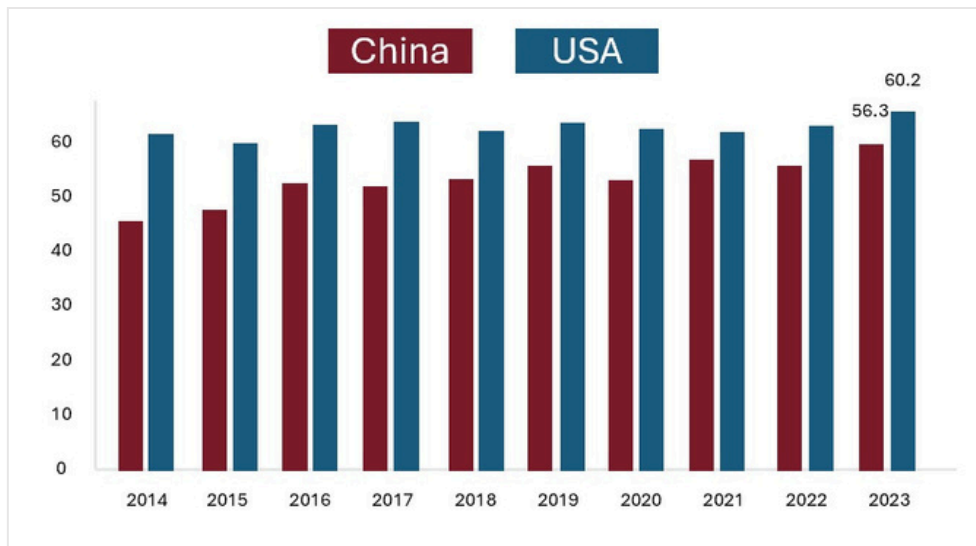


Figure 2: Global innovation index from 2014 to 2022 (Statista, 2023; Dutta et al., 2024)

Case Study: Solar PV Production

The solar PV production example illustrates differences in how the US and China approach innovation. A detailed discussion of the different models shall be presented after this case example. Solar PVs are essential for generating electricity using the sun as a main energy source. This type of energy generation is considered green energy and has gained great popularity among private households and firms around the globe (European Commission, 2020).

While the US pioneered solar PV technology in 1954 with Bell Laboratories, China has since surpassed it by leveraging its supply-driven innovation model. By focusing on cost reduction and scaling production, China now accounts for 83% of global solar panel output, compared to the US's less than 2% (IEA, 2022). Although China did not invent solar PV it mastered the concept of incremental innovation, which involves optimising existing technologies rather than inventing new ones. Other examples where China is quickly innovating and gaining market share are summarised in Table 1. As the table suggests, China demonstrated rapid progress in eight out of ten industries and leads in industries

nuclear energy and at par with EVs and batteries. Again, incremental innovation efforts are widely deployed to improve production capabilities in existing markets of which China has acquired a clear understanding of the customer's problem (ITIF, 2024a). These examples illustrate that China can be regarded as highly innovative concerning incremental innovation. Moreover, they demonstrate that breakthrough leaders do not always become ultimate leaders. As captured by Christensen (1997) in the "The Innovator's Dilemma", it is simply not enough to be successful in generating new ideas.

Industry	Position vs. World Leaders	Pace of Progress
Robotics	Near	Rapid
Chemicals	Lagging	Rapid
Nuclear Power	Ahead	Rapid
Electric Vehicles/Batteries	At Par	Rapid
Machine Tools	Lagging	Rapid
Biopharmaceuticals	Lagging	Rapid
Semiconductors	Lagging	Modest
Artificial Intelligence	Near	Rapid
Quantum	Near	Modest
Display Technology	Near	Rapid

Table 1: Industry innovation study on China (ITIF, 2024a)

How China innovates

Having established that China does exceptionally well in the GII ranking and dominating industries such as solar PVs, this essay now closely examines how the Chinese innovation system works. Figure 3 illustrates a comparison of the US and the Chinese innovation model. As for the US, it is characterised by a linear sequence of discovery, invention, and production. This model thrives on disruptive, demand-driven innovation. It often leads to groundbreaking technologies but comes with high risks, as businesses may face failure or offshoring if unable to sustain competitive advantages, as discussed earlier. By contrast, the Chinese innovation model resembles a lean approach, emphasising incremental improvements and scaling through a cyclical process of copying, learning, and refining. This supply-driven strategy has enabled China to dominate technology markets by prioritising cost efficiency and rapid implementation (ITIF, 2024a).

On the lean approach, while both nations employ lean methodologies, their purposes are fundamentally different in the present context. To drive radical innovation and market disruption, the US uses demand-driven approaches within a lean framework that focuses on consumer feedback. Conversely, China focuses on scalability and efficiency, refining existing technologies rather than developing new ones to dominate the market (ITIF, 2024a). In addition to aligning with Made in China 2025, the top-down strategy highlights China's focus on capturing market share rather than fostering disruptive innovations.

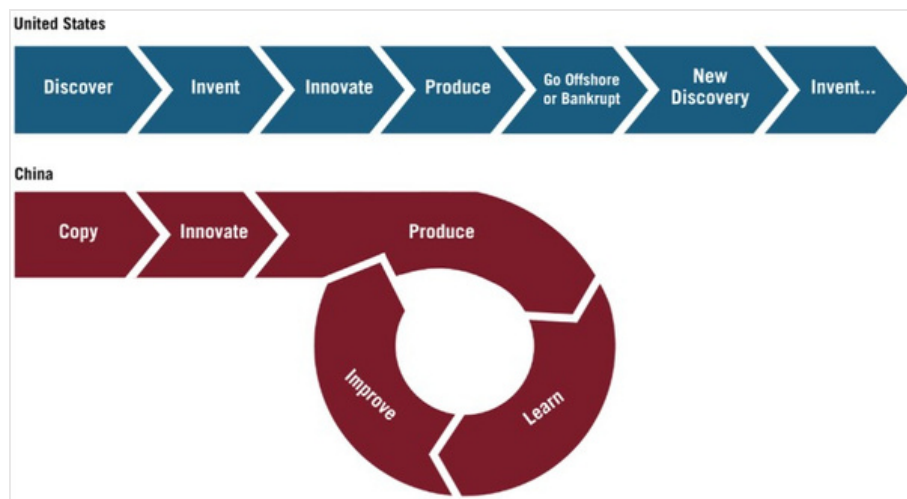


Figure 3: US and China innovation processes (ITIF, 2024a) So, while the US excels in creating novel technologies, China’s iterative process suggests scalability and market leadership. This comparison further highlights why the Chinese government may prefer and has deliberately chosen a supply-side innovation process. Rather than working with customer feedback and being on the lookout for the next significant innovation in very creative terms, efforts are directed at what has already been invented and tested. As a result of this approach, the government has the time to understand the implications of disruptive innovations, which enables it to make informed decisions. Moreover, it exemplifies state-led innovation. Once an innovation area is selected, production capabilities are rapidly scaled to secure significant market share. Using this model, we can see the government’s strong control over innovation in China (Kroeber, 2022). However, such control has limitations. Table 1 further highlights that the Chinese model lacks the capabilities for disruptive breakthroughs, which are essential for sustainable innovation leadership. For instance, China still struggles to compete in industries requiring deep research ecosystems, such as semiconductors and quantum computing (ITIF, 2024b). Moreover, while the pace of progress is rapid in most industries, which aligns with the observation made in its lean model, it is behind in eight out of ten key industries. Since China lacks the demand-driven dynamics found in economies like the US, most of its innovation relies on replication rather than original breakthroughs. As a result, China risks remaining an innovation follower if it does not prioritise innovation performance over government control, which is unlikely to occur (Kroeber, 2024; Lardy, 2019).

Taking stock, China’s continued rise in building its innovation capabilities challenges Kroeber’s 2016 prediction that state-led policies would stifle innovation. For him, it was evident that China demonstrated convincing advancements in its manufacturing system as we have seen with the recent domination of global EV markets (Yang, 2023). Furthermore, he denotes that China has become a leading producer and transitions from relying on imports to producing its own goods which highlights a rise in China’s

technological innovation, which is underpinned by a dynamic and iterative innovation culture (Kroeber, 2024). This also highlights the complex nature of predicting the future of the Chinese economy, tying it back to the challenge of defining the Chinese economy. Over the past decades, China has developed a great track record of leaving China experts puzzled about future developments of the Chinese economy. This time, Kroeber was one of them.

Whether the US or the Chinese innovation model is superior depends on the goal. The US model should be preferred when disruptive innovation is the goal. By contrast, when incremental innovation at scale is the goal, the Chinese model should be the first choice. In the context of innovation goals, the next section discusses the role of the Chinese government in shaping Chinese innovation leadership.

Xinnovation and Goodhart's Law

China has set an ambitious goal to become a global innovation leader. The government made this goal known and aims to reach this goal through various policies such as the *13th Five-Year Plan for Science and Technology* (CNIPA, 2024), *The National Cybersecurity Strategy* (USITO, 2024), *Made in China 2025 Strategy* (ISDP, 2018) and the *14th Five-Year Plan* (NDRC, 2022). Moreover, at the 20th Party Congress, Xi also emphasised the need to invigorate China through science and education as part of the strategy for innovation-driven development (Xi, 2022). It follows that Xi's government is ready to employ a set of mercantilist policies to advance further Chinese technological dominance at the expense of global technology leaders.

One government policy that has proved to be highly successful in building Chinese innovation capabilities is the development of entrepreneurial ecosystems. By leveraging networks of firms to innovate under competitive pressures, China has built global market dominance in industries such as solar PV, basic metals, and electric equipment (ITIF, 2024a).

The government's ambitious target and aggressive innovation policies invite a discussion about the applicability of Goodhart's law which states that as soon as a metric becomes a target, it risks losing its effectiveness as a good measure. For example, China made its GDP growth rate an official target (Global Times, 2024). This also means that GDP growth has less explaining power and draws a somewhat blurred picture as a metric of the Chinese economy. For example, China demanded countless unnecessary infrastructure projects to keep economic output high (McLaughlin, 2024).

While China leads in global patent applications in fields like AI, 5G and green technologies, critics might argue that this focus on quantity results in "patent inflation" (ITIF, 2024a). Many of these patents are very incremental and low-impact, raising concerns whether China's innovation targets truly foster groundbreaking advancements or merely inflate metrics for political and economic prestige.

Goodhart's law can be addressed by arguing that measuring innovation targets is inherently different from GDP growth rate metrics. That is, innovation instead uses quantitative metrics as proxies. This means that the success of an innovation is ultimately measured by its outcome in the form of technological breakthroughs and global competitiveness, which are much harder to falsify than GDP growth rates. Moreover, while the GDP growth rate is precisely defined, this essay has shown earlier how tricky it might be to define innovation.

What does defence from Goodhart's law mean for Chinese innovation? This likely means that the Chinese innovation model possesses some capability for building innovation leadership. Significant advances in AI technology show the potential to break away from the copy and then innovate features of the model (ITIF, 2024c). Nevertheless, the difficulty of replicating high-tech industries like semiconductors remains, especially when critical information is withheld. Unless China changes its innovation model, the inherent tensions of a supply-driven economy reliant on incremental innovation and copying persist, raising serious doubts about China achieving innovation leadership. Moreover, with slowing economic growth, it remains uncertain how China can convert its technological progress into sustained, economy-wide growth (Kroeber, 2024). The real test for the Chinese innovation model lies in whether it can maintain its competitive advantage in cost-efficient production through supply chain and process innovation amidst rising geopolitical tensions and a World Trade Organisation (WTO) system that increasingly needs reform. The outcome will ultimately determine whether China can transition from being a global follower to a true innovation leader.

Conclusion

This essay has analysed China's innovation capabilities within its unique economic model, defined as Capitalism with Chinese characteristics underpinned by a Leninist political structure and supply-side orientation. Having positioned China in the GII of 2024 and contrasted its innovation model to the US model, the analysis used a solar PV case example to highlight China's remarkable ability to scale incremental innovations. The essay also highlighted structural tensions in China's approach, such as its reliance on state-led directives and the difficulty of fostering disruptive innovation. While Goodhart's Law raised concerns about the pitfalls of setting quantitative targets for innovation, China's success in scaling and iterating on existing technologies can address the law and underscore its strong innovation capabilities. Even though China may continue to lead in scaling up existing technologies and defend its innovation goals from Goodhart's law, the long-term leadership of innovation will depend on addressing IP protection, geopolitical pressures, developing disruptive innovations and balancing quantitative targets with qualitative outcomes. Future research should examine whether China's evolving strategies can reconcile these tensions.

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