

Innovation

## Decoding China's Innovation Black Box: How Learning, Constraint, and Chaos Drive Creativity

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*Scarcity drives creativity, making constraint a source of innovation rather than a barrier.*

“Yeah, the Chinese can take a test, but... they’re not terribly imaginative. They’re not entrepreneurial. They don’t innovate—that’s why they’re stealing our intellectual property.”

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When former Hewlett-Packard CEO Carly Fiorina made the above claim in 2015, she echoed the Western business world’s assumption that imitation rather than imagination has fueled China’s rise<sup>1</sup>. This belief has shaped the global narrative that China is a nation of disciplined engineers and diligent test-takers but not true innovators<sup>2</sup>. As *The Economist* wrote in its report “Calibrating Chinese Creativity,” “Sceptics make two arguments: They point to the historically lax protection of intellectual property...[and] the proliferation of

copycat business models.” Critics have argued that China is merely an “innovation sponge”: it absorbs foreign technologies but fails to craft its own breakthroughs. Even as recently as 2025, *The Economist* noted how Western analysts once dismissed China as a “fat tech dragon”—a follower that devours capital and manpower but seldom takes flight.

Such descriptions do not hold today, although some voices remain cautious. Certain scholars have questioned whether China can sustain its diffusion-based advantages over time. Being able to continually absorb external knowledge, outside of an initial catch-up period, arguably determines long-term technological leadership<sup>3</sup>. Others have described China as “state-accelerated but systemically constrained”; they warn that innovation can flourish under direction but not indefinitely under constraint.<sup>4</sup> A different, growing line of research suggests that China’s institutional context (i.e., state coordination and a flexible approach to intellectual property [IP]) has enabled systematic learning and technological upgrades. Government leverage and permissive IP practices facilitate co-innovation between multinational firms and domestic suppliers. These collaborations have caused production know-how to be transferred in such a way that domestic firms pivot from adaptation to original design.<sup>5</sup> Additional studies have shown that foreign subsidiaries in China nurture domestic innovation capability: local suppliers learn and internalize systems integration techniques, iterative design practices, and process optimization methods through long-term embedded cooperation. This progression appears to have arisen from China’s ability to effectively learn, upgrade, and scale operations. According to them, the government’s habit of “keeping one eye shut and one eye open” permits experimentation while maintaining strategic oversight. Authors have also contended that novel forms of innovation in China are often *unintended outcomes* of these collaborations. Local firms modify transferred knowledge to suit their production contexts and market demands<sup>6</sup>. Some scholars have clarified this difference by framing China as an “engineering state” that is willing to rapidly experiment at scale. The United States is a more “lawyerly society” by contrast, in that it is inclined to scrutinize and regulate various types of projects.<sup>7</sup>

Yet empirical evidence paints a more complex picture. The Australian Strategic Policy Institute reported that China currently leads in 57 of 64 critical technologies, a drastic rise from just three in 2003–2007. The United States, by contrast, led in 60 of 64 technologies from 2003 to 2007 but later led in only seven (2019–2023). These trends suggest a stark

shift in global technological leadership. China ranks tenth worldwide in the *2025 Global Innovation Index*, having risen 25 places since 2013 to reach its highest position ever. This ascent has permeated academia as well as industry: a Japanese research institute recently confirmed that China produces more of the world's most highly cited scholarly papers than the United States. The October 2025 meeting on China's next five-year plan only reinforced this momentum, bringing a renewed focus to self-reliance on advanced semiconductors, artificial intelligence (AI), and basic research. The plan further underlines efforts to reduce dependence on foreign technologies through stronger domestic supply chains. China also hopes to attract world-class talent to better promote long-term innovation.

These developments present a paradox for global executives. How can a system still viewed as derivative make such extraordinary gains? The answer lies in China's distinctive innovation engine<sup>8</sup>. The country's progress has not been solely driven by isolated invention or top-down design but by what might best be called a *directed syncretic innovation system* (DSIS): a network of feedback, recombination, and constraint in which state direction, market dynamism, and grassroots ingenuity converge to transform exposure into capability and scarcity into discipline. The subsequent sections delineate these dynamics.

## Beyond the State: Innovation as Chaotic Order

The dominant story about Chinese innovation has largely centered on the state. Scholars have emphasized national missions, industrial policy, and a *jǔ guó* ("whole-of-nation") approach that orients universities, research institutes, and corporations toward common goals<sup>9</sup>. Some analysts describe this architecture as a state-led synchronization. The notion portrays China as a managed innovation state where direction replaces discovery.

Field-based studies reveal a more layered reality where innovation principally emerges from coordinated experimentation instead of centralized control. Rather than dictating outcomes, national strategies constitute directional cues that leave room for local interpretation. Entrepreneurs respond to these signals through pragmatic trial and error. Broad policy goals can then be translated into on-the-ground experimentation that is implanted in production processes<sup>10</sup>.

This structured yet fluid method reflects what economists term ‘absorptive capacity’<sup>11</sup>: the ability to internalize external knowledge and reconfigure it for local benefits. China’s innovation system is thus based on cumulative recombination rather than invention *ex nihilo*. The state provides scaffolding; firms spark forward motion. Like a biological ecosystem, this reciprocity thrives on feedback loops, local variation, and adaptive evolution—not centralized control.

## Secondary Innovation: The Discipline of Learning

The concept of *secondary innovation*, which Xiaobo Wu<sup>12</sup> introduced, demonstrates how imitation becomes capability. This form of learning through ‘mimicry’ is unique from the more negative imitation tied to weak IP enforcement and copycat business practices; the latter phenomena, often appearing in discourse on corporate “capture,” have been estimated to yield substantial annual losses for U.S. firms. Secondary innovation is also not what David Sacks, Chair of the President’s Council of Advisors on Science and Technology, derided as “theft, not ingenuity” when commenting on DeepSeek. Nor is it what McKinsey dubbed an “innovation sponge.” Secondary innovation is in reality the *discipline of learning*: a structured process of assimilating external knowledge, re-engineering it for local use, and extending it into new forms<sup>13</sup>. As Everett Rogers’ diffusion-of-innovation framework suggests, innovation rarely moves as a finished product; it evolves as it spreads. Firms learn about, modify, and upgrade technologies during diffusion. This process opens windows of opportunity. Involved parties can accordingly do more than merely chase the frontier.

In practice, Chinese firms acquire technologies through lawful means, licensing, joint ventures, and supplier collaboration<sup>14</sup>. Companies then redesign these inventions via iterative feedback. The results are original rather than replicative; solutions emerge from learning, re-learning, fitting, and expanding. Haier Group exemplifies this logic. Beginning in the 1980s as a small refrigerator maker partnered with Germany’s Liebherr, Haier initially focused on imitation and quality control. It gradually advanced through four developmental stages: imitation, creative adaptation, improvement, and post-secondary innovation based on digital integration. In a defining moment, engineers discovered that

rural customers were using washing machines to clean potatoes. Instead of treating this case as one of misuse, Haier redesigned its product and launched the world's first potato-washing machine. That decision, born of listening and learning, transformed observation into innovation<sup>15</sup>. Alibaba followed a similar trajectory. Inspired by Western e-commerce models, it subsequently attended to China's institutional realities. Alipay's escrow system solved the problem of trust in a low-trust market; data-driven logistics addressed infrastructure gaps at the same time. These inventions were not derivative but context-driven.

This learning-centered logic endures in the technology sector as well. For instance, DeepSeek shows how optimization can become innovation: the firm re-engineered model architectures and resource use to realize breakthrough AI performance on minimal budgets, an exemplar of frontier performance through frugality. Likewise, chemist Wang Chuanfu's firm BYD reverse-engineered Japanese batteries but replaced labor with automation. The company ultimately achieved equivalent quality at a 40% lower cost. This substitutional strategy built cumulative capacity, eventually propelling BYD into electric vehicles and leadership in battery research and development. The "upgrade" represents the core outcome of secondary innovation. It also encapsulates China's trajectory as *moving beyond catch-up*, hence differentiating the country from latecomer models such as Japan and Korea. In short, secondary innovation entails evolution, not compromise: it transforms dependency into self-reliance and imitation into ingenuity.

## Fast, Frugal, and Cost Innovation: The Power of Constraint

If secondary innovation is about learning, then cost innovation is about design philosophy. The emphasis on "doing more with less for more" positions resource constraints as catalysts rather than hindrances. Early strategic analyses showed that firms could reconfigure product architectures and production to deliver reliable, high-quality goods quickly and at strikingly lower prices. This faster time to market spurred a "cost innovation" model in China<sup>16</sup>, which BYD exemplifies<sup>17</sup>. Speed and cost are each central to this framework. The third pillar, *frugality*, has become equally vital. The art of repurposing, recombining, and rapidly iterating is essentially innovation through bricolage<sup>18</sup>.

Consider the case of Xiaomi. The firm entered a saturated smartphone market in 2010 and opted for agility over novelty. Its modular, open-source designs enabled constant iteration at low marginal cost. The company's direct-to-consumer model collapsed the value chain, creating unmatched price-performance ratios. Xiaomi earned a spot as the world's third-largest smartphone maker in 2025.

In China, three distinct archetypes of cost innovation can be identified: high-tech democratization, mass customization, and niche-to-volume transformation. The supply chain functions as an innovation laboratory in all of these cases. It is feedback-rich, swift, and cost-efficient. The takeaway for global firms is clear; *constraint breeds creativity*. In an era defined by sustainability pressures and resource volatility, being able to innovate within limits—using less, faster—typifies the new competitive frontier.

## Grassroots and Mass Innovation: Distributed Dynamism

Nobel laureate Edmund Phelps argued that prosperity stems from *mass flourishing*. Basically, innovation does not belong to elites; it blooms when ordinary people have chances to explore and create through genuinely engaging work.<sup>19</sup> China's policy of "mass entrepreneurship and mass innovation" (dàzhòng chuàngyè, wànzhòng chuàngxīn), launched in 2014 and reinforced through successive State Council directives, mirrors that ideal. More than 30 national documents had endorsed this participatory model by 2018. Different from conventional industrial policy concerning "national champions," dàzhòng chuàngyè, wànzhòng chuàngxīn democratizes innovation<sup>20</sup>. It invests in makerspaces, incubators, and digital platforms that empower local entrepreneurs to experiment and scale. The results are visible everywhere. The township of Hangji in Jiangsu makes one-third of the world's toothbrushes; Qiaotou in Zhejiang produces 70% of global buttons; Shaodong in Hunan, a similar share of disposable lighters. These specialized clusters grew from informal workshops into sophisticated ecosystems via continuous learning, imitation, and sharing.

As *The Economist* points out, the *breadth of innovation* across China has become the country's defining advantage. Xiaomi's leap from smartphones to electric vehicles in just three years shows how networks, suppliers, and open architectures enable bottom-up diversification. The same recombinant logic has given rise to entirely new sectors, from flying taxis combining electric vehicle and drone technologies to rural factories adapting industrial know-how to local needs. Small and medium-sized enterprises drive this system. Representing 98% of all Chinese firms and contributing 60% of GDP, they are engines of employment, inclusion, and experimentation. E-commerce platforms like Taobao, Pindoudou, Xiaohongshu (Little red book) and JD.com have extended their reach to rural entrepreneurs, including women. Local ingenuity has consequently facilitated scalable value creation. In essence, grassroots innovation does not compete with but rather complements state policy. It also adds resilience and redundancy to the national innovation fabric.

## The Open Ethos: From Copying to Co-Creation

OECD, in its 2025 *Global Trade in Fakes* report, notes that China continues to account for the highest value of seized counterfeit goods worldwide. This stands in contrast to China's recent emphasis on strengthening intellectual property rights protection. China has recently emphasized IP rights protection. Fake videos, counterfeit goods, and IP infringements are increasingly penalized, conveying the state's effort to align with global innovation norms. Yet an open ethos endures in certain peripheral regions and within specific sectors, a culture where free sharing and collaboration are paramount for creativity. Contrary to the Western belief that innovation thrives only under stringent IP regimes, many Chinese industries' creative strength grows through openness, collective learning, and reciprocal exchange.

This ethos has philosophical roots. In Confucian and Taoist traditions, knowledge is a shared good instead of private property. Imitation is not theft; it is apprenticeship. As the saying goes, 'To learn from others is the beginning of wisdom.' Copying is in fact a means of mastery, with replication serving as a route to originality. Nowhere is this more apparent than in Shenzhen, the world's most dynamic hardware hub. Its open-source

manufacturing ecosystem enables schematics, blueprints, and production methods to circulate freely. Factories and startups co-create and iterate at astonishing speed: new devices move from concept to market in mere weeks.

The same principle is behind China's AI revolution. DeepSeek upended the world's tech landscape in January 2025 by releasing an advanced large language model free of charge. *The Economist* noted in August of the same year that, whereas American firms spend billions to safeguard their IP, Chinese developers engage in a "Darwinian life-or-death struggle" through open collaboration. Chinese open-source models have come to outperform their U.S. counterparts on several benchmarks. Venture capitalists are even estimating "an 80 percent chance" that startups pitching in Silicon Valley will rely on Chinese open models.

## The Directed Syncretic Innovation System

China's trajectory around secondary, frugal, grassroots, and open innovation reveals an integrated system: the DSIS (Table 1). It operates through loops of learning and feedback rather than linear research and development. Direction is hence fused with discovery to enable continuous (vs. episodic) innovation. The system's components are summarized below.

First, absorptive capacity transforms exposure into advantage. Chinese firms excel at internalizing external knowledge and tailoring it to local contexts. What begins as imitation evolves through recombination: dependency becomes capability, and external diffusion becomes self-sustaining progress. Second, constraint serves as a creative catalyst. Limited resources and institutional gaps do not impede innovation; they intensify it. Scarcity drives efficiency, while regulatory and market constraints stimulate ingenuity. Solutions are therefore fast, frugal, and fit-for-purpose. Third, networks outperform hierarchies. China's innovation ecosystem functions less as a command structure and more as a distributed network. Dense collaboration among firms, suppliers, universities, and digital platforms promotes quick feedback and iteration. Discovery then goes far beyond what top-down systems allow.

Fourth, feedback institutionalizes learning, with continuous experimentation being an organizational norm. Real-time data, user input, and iterative design spawn learning loops that refine products and business models as they scale. Adaptability is infused into the system as a result. Finally, direction and discovery coexist as a form of “chaotic order.” The state signals broad priorities, which firms interpret through local experimentation. This blend of guidance and autonomy sustains equilibrium between structure and spontaneity, stability and evolution.

<b><i>Dimension</i></b>	<b><i>Description</i></b>	<b><i>Mechanism/ Process</i></b>	<b><i>Outcome</i></b>
<b>Absorptive Recombination</b>	Firms internalize and reconfigure external knowledge	Transforms imitation into recombination; converts exposure into capability	Builds endogenous technological capacity
<b>Constraint as Catalyst</b>	Resource scarcity and institutional gaps stimulate creativity	Breakthroughs emerge from backwardness; necessity drives efficiency and improvisation	Generates fast, frugal, fit-for-purpose innovation
<b>Networked Learning</b>	Collaboration across firms, suppliers, universities, and digital platforms	Distributed feedback loops and shared experimentation	Accelerated discovery beyond hierarchical systems
<b>Institutionalized Feedback</b>	Experimentation and iteration become organizational norms	Real-time data, user feedback, and adaptive design	Continuous learning and system-level adaptability
<b>Directed Emergence</b>	Government provides broad missions; firms innovate locally within them	Balance between top-down guidance and bottom-up exploration	Sustained equilibrium between stability and evolution

**Table 1.** Core dynamics of the directed syncretic innovation system.

## Managerial and Policy Implications

China's journey represents a wake-up call for multinational corporations. Competing effectively requires recognizing that low cost and high sophistication can and do coexist. It demands *reverse learning*: firms must adopt cost-innovation logics, rethink supply-chain flexibility, and empower local research-and-development teams to respond contextually. As the *Financial Times* remarked, "With DeepSeek, China innovates and the U.S. imitates." This telling reversal shows that the time has come for the West to emulate China's DSIS.

China also offers a pragmatic blueprint for other emerging economies. Institutional gaps embody design spaces for experimentation and not just barriers. Entrepreneurs from Nairobi to New Delhi can apply the same recombinatory logic to convert constraint into advantage. For policymakers, China's experience reveals that innovation ecosystems thrive on pluralism, experimentation, and a tolerance for failure. Instead of copying Silicon Valley's playbook, countries can cultivate mission-driven diversity in which state direction is balanced with decentralized initiative. Mariana Mazzucato observed that a mission orientation and entrepreneurial experimentation are complementary rather than opposing forces. For scholars, China's rise challenges linear models of innovation that separate science from application. Subsequent studies should unpack the micro-foundations of learning, coordination, and bricolage that render the DSIS scalable and self-reinforcing.

## Conclusion: Innovation's Next Frontier

China's ascent does not invalidate Western models of science-led innovation; it expands them. It indicates that originality and imitation are not contradictions but parts of a learning continuum. China has turned necessity into strategy by embedding experimentation in production and learning in governance. In a world defined by scarcity, uncertainty, and transformation, the prime advantage lies no longer in invention but in the abilities to adapt, iterate, and synthesize.

The lesson for global executives is clear: 21<sup>st</sup>-century innovation will be shaped less by isolated breakthroughs and more by systems that can learn under constraint. The DSIS depicts how strategic direction and distributed creativity can coexist and encourage speed, resilience, and inclusivity at scale.

Innovation from the edge may matter most for a global economy facing climate transition, AI disruption, and geopolitical fragmentation. China's experience illustrates that transformation can emerge from avenues other than abundance: improvisation; recombination; and the relentless will to learn and evolve. The next frontier of innovation will belong to actors who can convert uncertainty into discipline and constraint into momentum.

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