

Reframing China's Theoretical Framework for Innovation: A Critical Examination of China's Approach to an Innovation-driven Economy

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Short Bio:

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Abstract

This study analyzes China's transformation towards a technology-driven economy and the influence of politics on innovation directives.

The empirical analysis approach was founded on three paradigms: the Innovation Theory of Profit, the Indigenous Innovation Model, and the Innovation System Theory to evaluate their applicability to China's innovation landscape. The results of the empirical analysis suggest that the current theories are not sufficient to understand China's innovation landscape because they are constructed based on economic studies. Thus, reframing China's Theoretical Framework for Innovation by adopting multilevel, multidimensional, and multidisciplinary perspectives is pertinent and necessary.

Keywords: china, innovation, digital economy, public-private partnerships, public policy

1. Introduction

The Digital Economy is defined as the digitalization of economic activities through an intensive and integrated usage of cloud internet technology, computing, big data, and fintech (Huang et al., 2018) within the Web 3.0 concept, being internet penetration one of the main metrics to enable infrastructure development to connect urban and rural areas. Although there is an ongoing debate on the positive and negative impacts of technology implementations, it is a common understanding that it improves overall efficiency and productivity across industries.

Digitalization, due to its high costs at the development and implementation stages, has been employed dissimilarly by nations, widening the gap between developed and developing nations. While it is more prominent in developed nations because of strong innovation initiatives between governments and private companies, including startups, including infrastructure and capacity building, the operations shifting to developing nations resulted in significantly lower costs, and that was one of the main reasons that increased the gap between developed and developing in terms of both economic innovation and technology disruption.

Developed nations have thus leapfrogged the least developed ones because of the high costs involved in the R&D and deployment and the deployment of these new technologies, China being one of the few exceptions (Congressional Research Service, 2022).

Historically, developed-developing nations technology transfer has been the main catalyst for technology improvements in developing through mostly bilateral agreements, while investment mobilization to build infrastructure and affordable access to overall technology were the main concerns, underscoring deficiencies in the creation of a framework to generate economic growth. Additionally, Research and Development (R&D) investments through public-private cooperation became one of the main solutions to this objection. The costs of investments in technology widened the gap between nations over the years.

This paper is fundamentally based on a methodologic approach that investigates different theoretical approaches to innovation. First, a thorough review of existing literature on innovation, including Schumpeter's Theory of Innovation, the Indigenous Innovation model, and the Innovation System Theory will be given special attention. This review helps identify gaps in the literature and debating the applicability of Western theories in China as well as the need to 're-think' the current Chinese theories on the topic.

Second, primary research will be conducted to gather data on the government's role in promoting innovation in China, including national policies and initiatives, in addition to the investigation over the role of public-private partnerships in the indigenous innovation development in the country and abroad.

After reviewing the literature and conducting primary research, a theory of innovation based on the role of the government could be developed, aiming to identify main factors that contribute to innovation in China as well as China's role in supporting other developing countries in their innovation efforts, including funding mechanisms, institutional support, and policy decisions. It would also identify the challenges and barriers that must be overcome to foster innovation and provide recommendations for how the central government can best support innovation in the future. The theory will then be tested and refined through additional research and empirical analysis to ensure its validity and relevance to the Chinese economic context.

2. Research Methods and Analysis

Innovation theory methodology is described as a research method in which the theory is developed from the empirical analysis of how innovation can be developed as well as the positive and negative impacts of technology developments in a specific country. This is an inductive approach that takes into consideration the main political and economic characteristics of a country.

The method of study is thus based on three elements: concepts, applicability, and propositions. Conversely, concepts are one of the main elements of analysis being formed as ways of technological advancements applied to different development needs.

The concept of innovation has evolved according to different development needs. Its straightforward and pragmatic definition is a "new idea, method, or device: NOVELTY. Innovation, for its part, can refer to something new or a change made to an existing product, idea, or field" according to Merriam Webster (Innovation, 2023). This definition is intrinsically related to technological innovation.

The United Nations Development Programme (UNDP) has advocated for fostering Innovation and for social changes, bringing about a new concept of social innovation as follows:

"Social innovation refers to new ideas that work in meeting social goals. A social innovation approach puts capacity to harness innovation at the core of public service. As a field, social innovation is new, practice-led and under-theorized. It should be considered more of a movement than a particular methodology, as might be the case for design thinking. Indeed, a feature of social innovation is that it combines multiple disciplines, types of actors and sectors. Social innovation is also more than just invention; it describes a process from initial prompt through to scale and systemic change" (UNDP, Social Innovation for Public Service Excellence, 2016).

Other terms have then emerged like eco-innovation or sustainable innovation to define an environmentally friendly business approach: “Eco-innovation is a new business approach which promotes sustainability throughout the entire life cycle of a product, while also boosting a company’s performance and competitiveness” (UNDP, Eco-innovation).

As underscored in the social innovation definition, innovation theories - and not only social innovation - should combine multiple disciplines (economic, environmental, technological, and societal), and multiple actors, aiming to promote sustainable development. It is correct to affirm that this innovation as a field of study is under-theorized.

Schumpeter’s Innovation Theory of Profit¹ proposes that economic growth and development are driven by diverse types of innovations to disrupt new technologies and lead to creative destruction. The theory was formulated based on capitalist economic concepts, hence its limitations to explain China is evident.

Chinese theories of innovation, including the Indigenous Innovation Model and the Innovation System Theory, were developed based on different phases of China’s economic development since the ‘Open Up’, hence they are better equipped to further understand the country’s economic sphere. The Indigenous Innovation Model emphasizes the need for China to develop its indigenous technologies to reduce the reliance on foreign technologies, while the Innovation System Theory focuses on the importance of collaboration among and between different actors to promote innovation.

The major difference between the Innovation Theory of Profit, the Indigenous Innovation Model, and the Innovation System Theory relies on how the empirical analysis is built, with an emphasis on the economic environment, directives to develop indigenous technologies or institutional analysis in this order, and as they all have relevance to the innovation theory scholarly, they lack thoroughly multidisciplinary approach.

To better understand the applicability of these theories on China’s innovation landscape particularly in achieving the Yearly plans’ goals, the historical background of the Chinese government’s approach to the theme is necessary. China, a socialist market economy (SME), has a very strong political influence on its economic and developmental directives, and this needs to

¹ Schumpeter's Innovation Theory of Profit is also known as “Profit is the Reward for Successful Innovation”.

be taken into consideration when analyzing the applicability of the theories. Therefore, “Western” theories often are not adequate to study China. This applicability assessment is crucial for policymakers to draft national-level and local government-level policies that can be tailored-made to China's unique developmental context.

One gap in the research field is the need for more in-depth analysis of the effectiveness of innovation policies, such as the “Made in China 2025”, how it can better coordinate with other local policies, particularly sectorial policies, and programs, and to what extent these policies drive innovation that result in economic growth. In addition, currently, no studies show the correlation between innovation and international relations, and the role and effectiveness of international collaboration to drive China’s innovation.

Overall, there is a need for continued research into China's innovation landscape to fully understand the challenges and opportunities facing the country as it seeks to transition to an innovation-driven economy. This research can help inform policy decisions and support the development of effective innovation strategies.

The literature review will be conducted to provide a comprehensive overview of the main political approach to innovation since the ‘Open Up’ in the late 1970s, including relevant academic articles, policy reports, and official documents. An analysis of the theoretical framework applied to innovation will follow to provide enough argument on the need for the central government to adopt a multilevel and multidisciplinary approach to sciences and technology, which may be included in national and local directives.

The suggested theory for innovation will be then drafted underlining the importance of projecting China as a global innovative economy, having as main pillar public-private partnerships that can be helpful to advancing the bilateral relationship between emerging economies.

The recommendations provided are thus valuable inputs to policymakers and scholars interested in understanding the new drivers of China’s economic growth and how a new innovation strategy can further improve current policies and directives.

3. The Impact of the “Made in China 2025” to China’s innovative economy

China’s ‘Fourth Industrial Revolution’² resulted from radical changes to processes and systems caused by the application of technologies, which improved the efficiency of business processes with significant overall cost reduction.

Although technology transfer has been the main catalyst for technological innovation in nations such as China, it enabled the creation of a strong manufacturing sector - a common practice in low- and middle-income economies -, hence attracting global companies to cooperate and transfer their production capabilities to the country after the ‘Open-Up’ policy was implemented in the late 1970s. The development of several industries alongside manufacturing, which includes but is not limited to heavy machinery and energy, happened consequently with strong government support and policies to enable R&D investments (Huang et al., 2017). It was within this context that e-commerce emerged, becoming an expanded sales channel for manufacturers to reach more customers in mainland China.

In recent years, the central government has enacted several policies to strengthen the country’s digital economy, amid its growing importance to the overall GDP growth, which in 2021 totalized 39.8% (Xinhua, China's digital economy more than quadruples in past decade, 2022). The main policies are i. “Internet Plus” Action Plan³: it was launched in 2015 to integrate the internet with traditional industries to drive economic growth and enhance competitiveness; ii. “Made in China 2025” (MIC 2025) policy: it was launched in 2015 to upgrade China’s manufacturing sector; iii. Cybersecurity and data laws: the Laws aim to outline personal data protection and cybersecurity regulations to safeguard personal information, critical data, and cross-border data transfers, including the Cyber Security Law, (1/6/ 2017) updated in 2022, Data Privacy Law (PIPL) (1/11/2021), New Data Security Law (1/9/2021), Data protection law - The Personal Information Protection Law (“PIPL”) (10/8/2021)⁴; iv. “New Generation Artificial

² The concept of the ‘Fourth Industrial Revolution’ is the development and integration of cutting-edge technologies including artificial intelligence, and the Internet of Things into traditional industries to foster the digital economy growth.

³ The Internet Plus aimed to improve China’s broadband connectivity particularly in remote areas, through several initiatives which include technologic disruption and financing schemes.

⁴ The cyber security and data laws brought positive changes to network security and data protection amid international distrust that they are ineffective to prevent the government from having access to these data from citizens, local and foreign countries, which contributes to a growing skepticism against Chinese technology companies in foreign markets.

Intelligence Development Plan”⁵: the plan was launched in 2017, aiming to support the country to become the leading developer of artificial intelligence by 2030. It acknowledges areas that need further development, which are core algorithms, key equipment, high-end chips, major products, foundational materials, software interfaces, international influence of Chinese research institutions and enterprises and a systematic R&D layout (Stanford University, 2017).

These policies and regulations are in line with the yearly development plan which outline technology and innovation to drive economic growth through the Digital Economy, as they support overall efforts to develop high-tech industries by strengthening data protection and cyber security mechanisms.

In 2015, the central government defined a new agenda centered on technology deployment, announcing the “Made in China 2025” national strategic plan and industrial policy (Popper et al., 2020); and the Internet Plus plan to promote China’s participation in global value chains through the promotion of industrial modernization across ten main sectors and through the reduction of reliance on foreign technology imports (ISDP, 2018).

Likewise, the internet industry strongly benefited from the new agenda, since “(I)ntellectual property and capacity appears to have been developed in telecommunications, ‘wireless-sensor networks, 3D printing, industrial e-commerce, cloud computing, and big data’ (...)” (ISDP, 2018). Furthermore, internet companies have largely contributed to the increase of patent applications (Babenk et al., 2020) since the Beijing government defined targets for these companies (ISDP, 2018).

The correlation between China’s innovation environment and patent application is two-folded:

“Patents play an increasingly important role in innovation (...) Scientific and technological advances have created new waves of innovation, notably in information and communications technology (ICT) and biotechnology, and innovation processes themselves have become centred less on individual firms and more dependent on interactions among global networks of actors in the public and private sectors” (OECD, 2004).

⁵ The New Generation Artificial Intelligence Development Plan lays out ambitious objectives for the development of artificial intelligence in China, which also includes nurturing top talent and supporting AI-related research and education. The plan contains guidelines and specific goals in the fields of robotics, artificial intelligence in vehicles, and natural language processing. The full text in English can be accessed at <https://digichina.stanford.edu/work/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/>.

Patents are used to establish and maintain connections between businesses and organizations around the globe as well as to protect specific inventions. They are an essential component of the innovation ecosystem because they encourage business investment in R&D while also promoting communication and cooperation among participants in the global innovation network. In recent years, patents have become increasingly important in the innovation process, and for China it represents a decrease in reliance of foreign-owned technologies, yet a relatively successful effort to develop local indigenous technology.

China did not only become one of the most innovative economies but also ranked number one in the patent application: In 2021, China had 69,540 patent applications, while the U.S.A. had 59,570 (WIPO, “Innovative Activity Overcomes Pandemic Disruption – WIPO’s Global Intellectual Property Filing Services Reach Record Levels”, 2022).

In 2015, when the “Made in China 2025” Policy was announced, China ranked 43rd in the Global Innovation Index (Weinstein, 2022), climbing to the 25th position in the following year. According to Fitch Ratings, over 200 billion Chinese yuan (28.1 billion American dollars) in government subsidies were deployed to tech companies through the “Made in China 2025” (Kawase, 2022), largely contributing to the overall improvement in the Index. In 2022, China ranked 11 in the GII and ranked 1 in the upper middle-income group categorization of the same Index (WIPO, “Global Innovation Index 2022,” 2022).

The index is calculated based on the evaluation of 7 factors: i. Institutions (42), ii. Human capital and Research (20), iii. Infrastructure (25), iv. Market Sophistication (12), v. Business Sophistication (12), vi. Knowledge and Technology outputs (6), and vii. Creative outputs (11). China ranks 42 in Institutions, revealing the need to improve political, regulatory, and business environments.

The World Intellectual Property Organization (WIPO) highlighted the following concerns regarding China’s low scores on Institutions, Human capital and Research, and Infrastructure, summarized from the Global Innovation Index 2022 (*ibid*).

The Institution indicator analyzes the regulatory environment, rule of law, and the cost of redundancy dismissal. The low score indicates that the current legal framework is both complex and inefficient to support innovation. As previously mentioned, many of the laws were

promulgated in recent years, which means that they still lack mechanisms to contribute to technological development across-industries. Within Institutions, redundancy dismissal is the most subject of concern, ranking 111. It is indeed a barrier to innovation, as it discourages particularly startups and SMEs from investing in new talents, due to the uncertainties of human resources regulations.

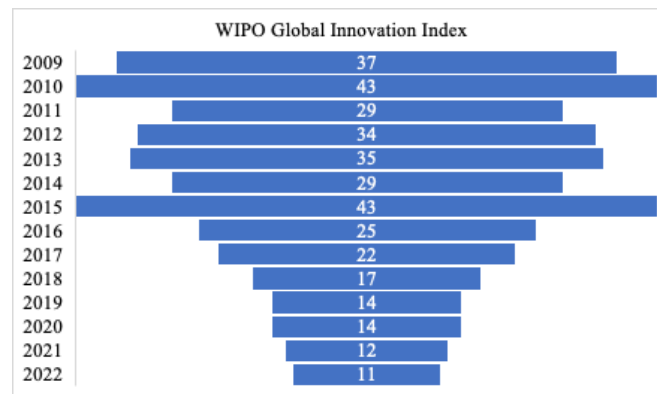
The Human capital and Research indicator highlights that China's tertiary education needs restructuring since it does not seem to be effective in providing enough innovation and technology-related education. The Thousand Talents Program inaugurated in 2008 aims to fulfill human resources gap by attracting Chinese talents (scientists and researchers mostly from science and technology fields) from overseas countries as well as non-Chinese talents, which suggests that there are needs for both high-qualified resources and high-quality education (Jia, 2018).

The infrastructure indicator has low scores for GDP/unit of energy use and environmental performance, ranking 104 and 115 respectively. The contribution of innovation to sustainability requires special attention, which is done through environmental policies, eco-technology, and overall efforts to implement innovation to reduce carbon emissions.

The central government's updated directives need to incorporate strategies to foster innovation taking into consideration China's low scores in the Global Innovation Index.

Finally, Knowledge and Technology includes metrics related to knowledge creation, impact, and diffusion through intellectual property applications, scientific research, indicators of exports of ICT services as a percentage of total trade, and net outflows of foreign direct investment (FDI) as a percentage of GDP. This ranking shows the success of "Made in China 2025" to transform the economy into a technologic and digital one. Knowledge and Technology output rank 6 globally, the highest rank and score achieved so far.

Chart 1. The Global Innovation Index (2009-2022)



Source: WIPO, “Global Innovation Index 2022,” 2022.

If further analyzing the FDI net outflows, the contribution of the internet industry to the country’s innovation can be further comprehended: the largest internet companies in the country did not only transform the country’s technology landscape but also enhanced China’s tech-power image internationally. These companies have expanded their operations to several countries and invested in R&D cross-border: 25.1 billion of the total 44 billion dollars were invested by Baidu, Alibaba, and Tencent in U.S. technology businesses from 2013 to 2018 (Goldkorn, et al. 2018).

China’s technological and innovative transformation was positively impacted by national policies and public-private partnerships. As a result, after the implementation of the “Made in China 2025” Policy in 2015, the country has shown important results across different sectors. Xi Jinping’s announcement of the eradication of extreme poverty in the country in 2021 highlighted the “(...) “institutional advantage” of the Chinese party-state political system (...)” (Li, 2021), and several improvements in the rural areas, such as infrastructure, financing, and innovation were met. Within the “Made in China 2025”, the Smart Agriculture project modernized production, provided training and capacitation for farmers to eliminate “the middleman” to reduce operational costs, as well as funding from different local and international banking institutions.

Alibaba, JD.com, and Pinduoduo - the country’s three largest internet and e-commerce companies - have supported farmers to sell directly to consumers through their online marketplaces through online business or live commerce. Moreover, these companies have been important in building logistics infrastructure in remote areas, and their partnership with local

governments, educational institutions, and banking institutions helped disrupt several agri-technologies, for instance, AI-powered technologies to increase productivity yet decreasing the use of chemical and water (Jiang, 2022). Hong added that the Internet Plus policy contributed to the expansion of China's largest internet companies "(...) making unfettered access to global financial capital an all-time importance" (Hong, 2017).

Another example is Alibaba's cooperation with the Asian Development Bank (ADB) established in 2019 aiming to promote "(...) smart farming and internet-plus agriculture technology applications in food and agriculture value chains; promoting ecological management through forest restoration, rural financial services, and crowd sourcing solutions to distribute funds to target beneficiaries; and digitizing and generating rural solid waste value streams" (ADB, 2019). Digital technologies can optimize crop yields, reduce waste, and improve the quality and safety of agricultural products. Farms could sell their products directly to final consumers through e-commerce by leveraging Alibaba's ecosystem, online payment solution, marketplace, and logistics. This multi-stakeholder approach was fundamental to support the central government's key national directives, being the pillar of China's innovation landscape both domestically and internationally.

The "Made in China 2025" brought about another aspect to diversify the tech industry. Although the role of the countries' largest companies could not be denied, a premise of the national program was to create a propitious environment for startups and small and medium-sized enterprises (SMEs). Government-backed innovation centers alongside several fundings formed one of the main pillars of the plan. According to the "Made in China 2025" document, article 6. (6) Improve policies for micro-, small, and medium-size enterprises, the following funding initiatives and partnerships were proposed: credit investigation system, financial leasing, IP pledge loans, and credit insurance policy pledge loans. It is important to add that the document encouraged educational institutions and large corporations to support and partner with these SMEs (Center for Security and Emerging Technology, Notice of the State Council on the Publication of "Made in China 2025").

The "Made in China 2025" is indeed China's main innovation document, guiding the current government on directives to achieve, helping to form Xi Jinping's innovation approach based on

the development of its own indigenous innovation, the promotion of mass entrepreneurship and innovation as well as to project the country as a global leader in sciences and technology.

4. The role of the Chinese tech giants in China's innovation

The role of the “Made in China 2025” created a framework to foster innovation with a prominent contribution from Huawei, Baidu, Alibaba, JD.com, and Tencent (Weinstein, 2022). These companies have profited from the directives to increase their technology capabilities. Tencent re-structured its offering to include software and hardware technologies, shifting from consumer internet to industrial internet (Tencent, 2021). By supporting these companies, the government can effectively achieve technological independence and diminish and, in the near future, eliminate the reliance on Western technologies (Obe, Liu, 2018).

These companies played a significant role in China's innovation leadership, projecting themselves beyond Chinese territory. According to LexisNexis PatentSight, Tencent was the company with the highest number of active AI and machine learning patent families in 2021 with 9,614 patents, followed by Baidu, with 9,504, and IBM with 7,343 patents (Buchholz, 2023).

The global expansion of the main Chinese technology-driven companies is two-folded: from the commercial aspect, it generates revenues through market expansion across the globe, and it contributes to project China as a global innovator.

4.1 Public-Private Partnerships (PPPs) in Bilateralism

China's *status quo* has shifted recently, gaining a more prominent position in the international arena. Its relations with regional blocs and bilateral relations with emerging economies have as pillar trade and infrastructure building, mostly in Africa, South East Asia, and Latin America. Recent efforts to strengthen relations with Gulf Cooperation Council (GCC) members have marked new opportunities for PPPs in that region beyond petroleum trade: the Saudi Arabia-China Entrepreneur Association (SCEA) was founded in 2023, having Alibaba Cloud, China Mobile and Tencent one of the key members, being a platform to boost investments and innovation between China and Saudi Arabia (Zawya, 2023).

Furthermore, it is worth noting that China's foreign affairs strategy is intrinsically connected with political and trade conflicts with countries like Australia and the United States: the

relevance of China to the global economy, as well as sensitive topics related to Taiwan relations strongly influence bilateral relation decisions.

Several Chinese companies have had their global business impacted due to political controversies and claims regarding controversial data protection mechanisms. Huawei's 5G technology applications in different nations and Tencent APPs banning are some examples of the challenges Chinese companies face in their international expansion journey (Babenko et al, 2020).

While there is a need for emerging economies to enhance digitalisation initiatives, which in many of them started with the Covid-19 pandemic, Chinese companies saw a growing opportunity to either enhance or establish their presence in global markets, contributed by the government support to project domestic companies in overseas markets. For emerging economies, China poses a successful example of economic development done in a relatively short period.

The World Bank defines PPPs as government mechanisms to procure and implement public infrastructure and services using the resources and expertise of the private sector. Emerging industries, such as online gaming and cloud computing can be particularly benefited since several nations have a strong reliance on foreign technology and have not yet developed their local industries (The World Bank, 2015). In other words, governments cooperate with the private sector to improve public infrastructure and services, drive innovation and create diverse financing mechanisms.

The authors H.E. Amel Karboul, Emily Gustafsson-Wright, and Max McCabe discuss a new conceptualization for PPPs, named partnerships for a public purpose, "(...) which emphasizes not whether the partner is from the public or private sector, but whether these collaborations and their impact have a publicly oriented purpose" (Karboul et al., 2021), aiming at achieving social benefits, instead of having private purposes to only generate financial or commercial outcomes.

Within this argument, multilateral relationships with multiple-stakeholders, governments, non-governmental organizations (NGOs), social enterprises, donors, and investors collaborate in the same project to better achieve desirable results. Such partnerships have increased importance to

the society, being of extreme significance to provide a series of positive changes, including job creation and economic growth.

As this model requires strict coordination between stakeholders, PPPs in bilateralism involving Chinese internet companies in foreign markets are, in its majority, project-based through servicing contracts. The role of Beijing to support internet companies' internationalization exists but thanks to their own efforts the development of governmental partnerships - which is also implemented through servicing contract arrangements -, is done more efficiently.

PPPs in bilateralism is no longer a funding model - though they may still contain funding elements - but a mechanism for governments to coordinate with select private companies with existing know-how on how to implement or improve digitalization in different sectors (Witters et al., 2012). For China, projecting itself as a leader in technology, and somewhat, an example for other developing economies, can be a soft power strategy.

The top-down and bottom-up approaches used by the central government to work with internet companies to further implement the "Made in China 2015" and Internet Plus plan highlighted the relevance of the nation's main internet companies to not only contribute China to becoming one of the most innovative economies, but also to enhance bilateral cooperation including technology transfer, joint-research, mutual investments and development programs.

5. Theoretical Approach to Innovation

For a theory to have applicability, it should have the hypothesis tested considering several variables, including, but not limited to, the economic context and the political conjuncture of a defined country. Accuracy is also innately related to the level of adaptability and contemporaneity it has as to identify eventual bottlenecks.

Undeniably, innovation leads to higher productivity and consequentially, economic growth (Witters et al., 2012). However, current innovation theories adopt a linear analysis, having economics as the key focus of its study.

To suggest an adequate theory suitable for China, the most prominent 'Western' theory, the Innovation Theory of Profit, and the Chinese theories, the Indigenous Innovation Model and the Innovation System Theory will be analyzed.

5.1 Main Theories of Innovation

i. The Innovation Theory of Profit

One of the most observed theories of Innovation was developed by Professor Joseph A. Schumpeter in 1932, titled The Innovation Theory of Profit. It was observed that innovation results in economic growth - due to increased efficiency and productivity -, having entrepreneurship as its main enabler (Slezik, 2013). To evaluate The Innovation of Theory of Profit and its applicability to China, it is important to summarize the main ideas, which are: conceptualization, development process, and the function of the government.

Innovation, which for the author is the ‘setting up of a new production function’, (Hagedoorn, 1996) an unclear definition that was thus understood as the development of new technologies or technological products, through which the implementation of a new idea is related to the process of creativity. The conceptualization of innovation can be supported by patent application, novelty, and customer value. To have an impact on the overall economy, it must be applied on a large scale, by first transforming an industry and then generating economic growth. So, the development and implementation processes of the same technology is not continuous⁶, like Schumpeter yet fragment and sectoral based. However, the overall innovation of an economy must be long-term.

The Global Innovation Index on how the combination of several improvements together to innovation progressions, such as the increase of patent applications, and investments, led to countries like China to climb several positions. The Index is accurate to analyze the several enablers of innovation - instead of entrepreneurship alone -, and the combination of seven metrics (Institutions, Human capital and Research, Infrastructure, Market Sophistication, Business Sophistication, Knowledge and Technology outputs, Creative outputs) create a favorable environment for innovation.

The Innovation Theory of Profit brings that entrepreneurship is the main pillar of innovation, with the government supporting both innovation and entrepreneurship through funding for R&D without successive regulation, which can be justified by capitalism premises that favors

⁶ The innovation process is not continuous, as new innovations disrupt and ultimately replace existing technologies, defined as “creative destruction”, in a process which is divided into invention, innovation, diffusion and imitation (Slezik, 2013).

individual initiatives and market mechanisms over government intervention (Slezik, 2013). By way of explanation, the theory perceives entrepreneurs, as creative individuals, are responsible to develop innovations, funded by diverse public incentives.

Being a socialist market economy⁷, it is undeniable to consider government intervention as the main driver of the country's innovation, as to prioritize the topic in the country's national documents like the "Made in China 2025", developing a both framework and roadmap to facilitate the overall improvement of above-mentioned 'seven metrics'. Though innovation has economics as its main field of study, it is also a political and social thematic which has gained in complexity in global scholarship.

ii. The Indigenous Innovation Model

The Indigenous Innovation Model studies the development of innovation as a public policy since the 1990s. In a newly opened economy to the foreign market, innovation happened through technology transfer, which largely benefited from the manufacturing capabilities that served foreign companies due to lower operational and labor costs (Liu, 2011, Lee, 2013). It was only in 2006 that indigenous innovation was part of the national strategy, in the "2006-2020 Medium and long-term National Sciences and Technology Development Plan"⁸ (Liu, 2014). Ever since, the government played the leading role to elaborate a framework to transform China into an innovative economy, however, there was a growing importance of local governments to implement these directives in cooperation with educational institutions (Lundvall et al., 2013, Xu, 2022), SOEs, and private companies. Local governments have increasing importance in the execution of national policies (Popper et al., 2020).

Local governments thus developed their own systems to support innovation which brought in disparities between regions: wealthier provinces such as Jiangsu, Guangdong, Shandong, and Zhejiang together with Shanghai and the capital, Beijing, prioritized innovation-driven policies to inaugurate research centers alongside with several funding schemes (Liu, 2011, Xu et al, 2022). Today, Shenzhen, in Guangdong Province, is known as the Silicon Valley of China. The

⁷ The term Socialist market economy with Chinese characteristics was first coined by the 12th National Congress of the People's Republic of China in 1982 and it is still in use to denote the Chinese economic regime.

⁸ The 2006-2020 Medium and long-term National Sciences and Technology Development Plan was an important document to address the need to strengthen China's innovation system, as well promoting sustainable economic and social development, enhance China's international technological competitiveness. The plan's emphasis on combining innovation sustainability and societal changes underscores the author's proposal in this study.

city, a former fishing villa, was one of China's first special economic zones (Santosdiaz, 2022) and today, it is the home of Tencent, Huawei and partially state-owned company, ZTE.

Unlike in capitalist economies, private companies and SOEs (state-ownership holding enterprises, state joint ownership enterprises and solely state funded corporations) were not well-equipped to drive the country's innovation (Weinstein, 2022). As a matter of fact, SOEs' capacity to drive innovation was lower than in private companies (Liu, 2014), though they have received strong financial support from the government, which shows that the main drivers of innovation are the hidden market forces. Some of the reasons are the ownership structure, competitiveness, and skilled labor (Liu, 2011), but also a higher competition level faced in the private industry (Lundvall, et al., 2009). Moreover, China's most innovative companies as previously mentioned (Huawei, Tencent, Alibaba, among others) are privately owned.

Xuelin Liu succeeded to develop an empirical analysis of the formation of China's innovative economy based on three steps technology transfer, catch-up and indigenous innovation model, which reflected the economic challenges and levels of maturity of the market until the country was finally able to decrease the reliance of foreign technology. Currently, despite the country ranking 11 in the Global Innovation Index, certain industries are still in the process of producing their own technologies. The development of the semiconductor industry is the government's priority since Taiwan and the United States have leapfrogged China in advanced semiconductor technology (Lundvall, Rikap, 2022) also impacted by the fact that "(...) leading companies tend to dominate patent portfolios to restrict latecomer companies from acquiring recent technologies" (Lee et al., 2016). The reliance on foreign technology amid political frictions with Taiwan and the United States is a feasible reason for the Chinese central government to develop indigenous technology.

iii. The Innovation System Theory

The Innovation System theory applied to the Chinese context is an adaptation of the Innovation System Theory from the British economist, Christopher Freeman. Bengt-Åke Lundvall and Keun Lee and other authors have published several academic articles that analyze the institutionalization of the innovation system.

The innovation system is grounded in the understanding that governments - central and local governments -, private companies, universities, and research institutions are part of a system founded on three-pillar, national, regional, and sectoral (Lundvall et al., 2013). The ‘division of labor’ between central and local governments need to be complementary, as national policies have more generic frameworks and aims to be achieved, while local policies may contain actionable policies, which are often regional and sectoral (Lundvall et al., 2009). However, the responsibility of each of the institutions involved, particularly central and local governments, need to be well-aligned to avoid conflicts as well as create deeper development disparities in different provinces.

Lee argues that often, there is miscoordination between both, laying out policies changes in the auto sector upon China’s accession to the World Trade Organization (WTO):

“ (...) the central government changed the policy line and prohibited the formation of new JVs after realizing the ineffectiveness of JVs in assisting the catching up of local firms. However, in conflict with the central government with limited capability in coordination across the nation local governments refused to follow the policy change of the former, and allowed some foreign automobile firms to establish new or additional JVs” (Lee et al., 2016).

China’s technology ‘catch-up phase’ was based on central government’s acceptance for foreign companies to form joint ventures (JVs) with Chinese companies, however, these JVs were not as effective in helping local firms to develop their own technologies. With it, local governments were given due importance to provide start-ups with subsidies, financial mechanisms, training, and capacitation alongside several other support necessary for indigenous innovation. This shift has largely contributed to build the foundations of innovation system theory and to recommend better synergy and collaboration between research institutions, universities, SOEs and private companies to build a cohesive innovation system. It was only with the accession to the WTO that market economy gave place to innovation-driven economy (Wonglimpiyarat, Khaemasunun, 2015).

The Innovation System Theory takes a holistic approach to innovation grounded on China’s economic and societal context. It takes into consideration the challenges of building a system that will result in better implementations of government policies.

Compared to the Innovation Theory of Profit and the Indigenous Innovation Model, it provides with a better understanding of the role of each actor and acknowledges that innovation must be guided by a broader set principles, policies, and directives for a long-term this innovation to benefit the development of the economy, society, and the environment as a whole.

6. Recommended Theoretical Approach to Innovation

The Chinese government's approach to innovation has solidified as the country has faced different levels of economic development. Being an agricultural country until the 1970s, the 'Open-Up' policy enabled the manufacturing industry to flourish but innovation as national priority depended upon the economic conjuncture and the prioritizing of each of the leaders from Deng Xiaoping to Xi Jinping. Under Hu Jintao, there was a timid emphasis on Indigenous Innovation, which was given continuation during Xi Jinping ruling in his first mandate, to both decrease the dependence of imported technology and support China's global leadership in sciences and technology. Under Hu Jintao, the SME Development Fund was established with an approximately USD 2.4 billion budget (Wonglimpiyarat, Khaemasunun, 2015).

China's innovation development was divided into phases, having the 'catch-up' model as the main catalyst of the innovation in the 1980s and 1990s (Lundvall et al., 2013). Back then, the economic growth was based on the establishment of a manufacturing-driven industry, and along the years, from the early stage to being a fundamental part of the country's harmonious growth, which means that innovation is an important driver of economic growth promoting social changes and stability and fostering environmental protection.

The Chinese Communist Party (CCP) is traditionally fundamental in ideology to base its both governance and decision-making, also being paramount to draft the 5-year goals and national policies. Intrinsically, Marxism-Lenist-Maoist ideology predominated since the foundation of the People's Republic, but as there were government changes, the ideologies and views on innovation evolved accordingly.

It is thus paramount to draw a timeline of different leaders since the opening-up of the economy to understand their approaches to innovation and the different political ideologies that most influenced their governments.

Table 1. Summary of China's governments' approach to innovation

Leader	Year	Most influential Ideologies	Approach to Innovation
Deng Xiaoping ⁹	1978-1989	Reform and Opening-Up, Socialism with Chinese characteristics	<ol style="list-style-type: none">1. Technology transfer2. Sciences and Technology for economic construction
Jiang Zemin	1993-2003	Building a socialist market economy for economic growth and development	<ol style="list-style-type: none">1. Market-oriented reforms2. Development of the private sector3. FDIs in high-tech industries
Hu Jintao	2003-2013	Harmonious society for social stability and equality	<ol style="list-style-type: none">1. Scientific Development2. Develop local Indigenous Innovation3. Implementation of national innovation funds and programs to foster entrepreneurship of SMEs

⁹ Deng Xiaoping was the Chairman of the Central Military Commission from 1981 to 1989 and the Chairman of the Central Advisory Commission from 1982 to 1987. Though he was not the paramount leader of China during this period, he was responsible for orchestrating the country's economic development directives.

Xi Jinping	2013-Present	<p>First mandate: Chinese dream for a strong, prosperous, and modern nation</p> <p>Second mandate: Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era¹⁰</p>	<ol style="list-style-type: none"> 1. Develop local Indigenous Innovation 2. Mass entrepreneurship and innovation 3. Sciences and technology innovations boards on stock exchanges 4. Project the country as a global leader in sciences and technology 5. Technological self-reliance (this is the emphasis of his third mandate)
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Source: Author’s on design based on Baark, Liu, 1990, Babenko, et al, 2020, The State Council Information Office, The People’s Republic of China. 2023, Xu et al., 2022, Wei, 2023, Wonglimpiyarat, Khaemasunun, 2015.

With Deng Xiaoping, as China’s manufacturing industry started flourishing, the development of sciences and technology happened through transfer from foreign companies that established their operations in the country (Baark, Liu, 1990). Science and technology policies were to be in line with economic development needs, and support to the private industry gained relevance with the establishment of Beijing High-Technology Industry Development Experimental Zone (Zhongguancun) in 19888 by the central government. However, there was a fear that the private industry would become a political threat to the Communist Party, as highlighted by Baark and Suying (Baark, Suying, 1990, Wonglimpiyarat, Khaemasunun, 2015).

¹⁰ Xi Jinping’s third mandate started in March 2023 with calls for national rejuvenation. The full text of Xi Jinping’s speech at first session of 14th NPC can be accessed at http://english.scio.gov.cn/m/topnews/2023-03/15/content_85168965.htm

After Deng Xiaoping, the State would be the main driver of innovation by providing several funding mechanisms, but gradually, the role of “(...) corporate, foreign-invested, or joint foreign-Chinese efforts (...)” was more evident (Campbell, 2013). With Jiang Zemin and Hu Jintao, the private sector gained support with foreign direct investments and financing mechanisms for SMEs, setting the foundations for Xi Jinping’s government.

The approach to innovation with Xi Jinping, supports the development of start-ups through mass innovation to encourage their participation in the development of advanced industries. The 14th National People’s Congress of China that took place in Beijing in March 2023, outlined the prioritization of basic R&D for self-reliance in technology (Laha, 2023) through the restructuring of the Ministry of Science and Technology and the launch of the Central Science and Technology Commission for better structural organization and coordination with the central government (Wei, 2023).

China’s unique economic achievements were rooted on the former Soviet Union’s socialism where traditional Marxist economic ideologies with Chinese characteristics - as often emphasized by the government - pose as enough evidence to justify Western theories are not suitable to be applied to study and understand the digital economy and the current innovation development (Huang, 2018).

The suggested contemporary theoretical approach to innovation is thus based on the study of Xi Jinping’s Party ideology, having nationalism as the core of national directives, being the “Made in China 2025” the most current document on the matter for advancement of indigenous innovation (Laha, 2023). For Andrea Braun Střelcová, Stephanie Christmann-Budian, Anna Lisa Ahlers, Lise Meitner Research Group state that “(...) the allusions to independence and indigenization, do not deviate from the previous trajectory. In fact, they are fully in line with the long-term conduct of China’s science policy and the top-down support of home-grown innovation with a strategic industrial focus” (Střelcová, et al. 2022).

Technology independence and indigenization are also a response to the increasing tensions with other countries, particularly developed countries like the United States, as well as the need to promote the growth of strategic industries.

Overall, the country has been particularly successful in advancing innovation with the Beijing government defining goals and directions for future initiatives, while the private industry works closely with the public sector (particularly local governments) to enable, enhance, and meet these goals, which can be summarized as follows:

- National policies and regulations: further alignment with national-level and provincial-level policies and regulations are thus necessary;
- Government-led, yet with a collaborative effort involving the Central and local governments, academic institutions, and the business community. There is an increasing importance to further involve the private industry in a two-folded approach which is top-down and bottom-up;
- Prioritization of investment in research and development (R&D).

For Huang et al.,

“The PRC is striving to transition from an investment-driven to an innovation-driven pattern of industrial development. In this context, the PRC must adjust and optimize its future industrial policy to avoid current problems of policy design and implementation” (Huang et al., 2017).

This means that the central government shifted away from promoting policies based on economic development premises based on low-cost production and large-scale infrastructure investments to implementing high-quality of indigenous technological innovation.

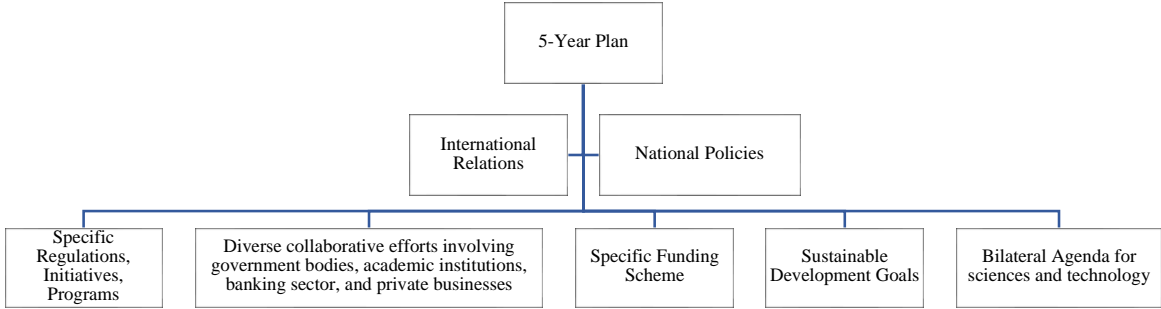
Innovation should not only be investigated through economic lenses, but it should be part of China’s combined domestic and international goals. Domestically, it relies on the importance of bringing positive societal changes such as job creation, poverty reduction and particularly, greater opportunities in rural areas.

The country’s commitments with the Sustainable Development Goals draws a correlation with innovation not only through the ‘Goal 9: Industry, innovation, and infrastructure’, but also on other goals: renewable energy sources, sustainable agriculture, and clean transit, can be drastically improved through the implementation of cutting-edge technologies. Xu et al. adds that “(...) the ultimate goal of innovation is to achieve more coordinated development; the fruits of development are shared by the people; the ecological environment and people’s living quality are improved, rather than simply reflecting the increase in the number of invention patents and scientific papers” (Xu et al, 2022), hence innovation should be regarded as the means for China to achieve better standards on sustainable development.

For instance, in recent years, China developed wind and solar energy technologies, with the support from the State Economy & Trade Commission (SETC) through the National Debt Wind Power Program to provide interest subsidy conditions to build wind farms and finance locally manufactured turbines. The program was part of the 863 Wind Program part of Tenth Five-Year Plan (2001-2005) that aimed to further develop the industry based on investments in R&D (NREL, “Renewable Energy in China: Grid Connected Wind Power in China”). As coal is the primary fossil fuel source in the country, there is an urgent need to further develop other renewable energy sources, hence implementing innovation policies in this segment is paramount to reaching carbon neutrality by 2060.

Internationally, the main premises should be regarded to draft the most adequate Innovation Theory: the role of the country to support other countries particularly in developing nations to develop telecommunication infrastructures and technologies such as 5G, data and cloud computing. It is recommended to develop an international bilateral agenda for sciences and technology to facilitate knowledge transfer and resources to emerging economies, by promoting innovation and sustainable development, investment in research and public-private partnerships as joint efforts, benefiting China’s long-term economic growth and overall global sustainable developments.

Graph 1. Main Pillars of Innovation



Source: Author’s own design

A theoretical approach to innovation allows for a government a deeper understanding of the main principles and mechanisms that drive innovation, combining different efforts that integrate the two fundamental pillars, national and international directives. By aligning both, innovation can be better used to bring about a series of societal and developmental changes.

7. Conclusions

China's increasing shift toward a technology-driven economy started with the 'Open Up' policy, where the manufacturing industry was responsible for attracting foreign direct investments and technology transfer. Since then, the country has faced diverse approaches to innovation, which went from catch-up to the investment on developing its own indigenous technologies.

The "Made in China 2025" was the main enabler of China's innovation transformations, as reflected by the country's impressive climb up the Global Innovation Ranking, to the 11th position. This national strategic plan has contributed to enhanced cooperation between and among multiple stakeholders, including the central and local governments, private industry, and education institutions. A both top-down and bottom-up approach was given shape to achieve better results and diminish the reliance on foreign technologies.

As a matter of fact, public-private partnerships were critical to develop the country's innovation economy (Weinstein, 2022) and provide a platform for bilateral cooperation between China and emerging economies, projecting the largest Chinese technology companies in global markets.

Innovation is thus a pertinent topic widely covered in scholarly through economic studies. Its multilevel, multidimensional, and multidisciplinary characteristics require a more in-depth analysis that include aligning its main directives with the Sustainable Development Goals and China's bilateral agenda for sciences and technology.

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