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Three Essays on the Chinese Economy: Industrial Policy, Real Estate, and U.S.-China Relations

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Three Essays on the Chinese Economy:
Industrial Policy, Real Estate, and U.S.-China Relations

By

Yuhan Zhang

A dissertation submitted in partial satisfaction of the

requirements for the degree of

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in

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and the Designated Emphasis

in

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in the

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of the

University of California, Berkeley

Committee in charge:

Professor Steven K. Vogel, Co-Chair
Professor Kevin J. O'Brien, Co-Chair
Professor Barry J. Eichengreen

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Abstract

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Yuhan Zhang

Doctor of Philosophy in Political Science

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University of California, Berkeley

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Over the past few decades, China's rise as a global economic and technological powerhouse has been driven primarily by a state-led development model heavily reliant on industrial policies and the real estate industry. This paradigm has sparked intense academic and policy debates regarding its long-term sustainability and impact on the global stage, particularly U.S.-China relations. Broad critical questions emerge: Why do some Chinese industrial policies achieve success while others fail, and what policies can ensure balanced industrial development while mitigating risks posed by external sanctions? How can China prevent real estate market fluctuations from undermining its broader economic development? Who truly benefits the U.S.-China trade war, and how can the dynamics shift toward a more positive outcome? This dissertation, structured as three standalone articles, addresses these pressing and interrelated issues.

The first article explores how divergent industrial policies in high-tech industries reveal strengths and weaknesses in China's development model, particularly in terms of technological self-sufficiency and U.S.-China competition. Utilizing machine learning and qualitative content analysis of Chinese official documents and secondary sources, it reveals that while supercomputing policies facilitated technological resilience in the face of U.S. sanctions, 5G development suffered due to unbalanced policies that prioritized infrastructure and equipment investment and downstream applications at the expense of foundational research and development.

The second article examines the effects of Chongqing's land price control policy in 2013 on housing prices and household consumption, employing a regularized synthetic control approach – a quasi-experimental design. It shows that the policy intervention effectively stabilized housing prices and boosted household consumption, offering a potential model for sustainable growth.

The third article models the ongoing U.S.-China trade war, which is deeply rooted in China's development model and U.S.-China rivalry, demonstrating that neither country benefits in its current form. The study suggests that reducing protectionist, restrictive, and retaliatory measures could lead to more positive-sum outcomes.

Collectively, these articles offer a comprehensive analysis of the challenges and risks embedded in China's development model. While the state-led paradigm has yielded impressive achievements, including technological advancements and rapid economic growth, it also harbors significant risks, such as technological dependence, real estate market volatility, and trade imbalances. Addressing these internal and external challenges is crucial for China to achieve sustainable growth and foster more constructive relations with the United States.

Dedicated to my grandfather, in loving memory, and to my family,

whose love and support have made this possible.

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Acknowledgments

Understanding China – and analyzing how its development paradigm affects the domestic economy and foreign relations, especially with the United States – has long been the central focus of my research. My interest in social sciences, particularly China Studies and Political Economy, began during my undergraduate years in Beijing in the 2000s. Later, my graduate work at Columbia University and my professional experiences at the Carnegie Endowment for International Peace, QRI Group, and Cheniere Energy enabled me to deepen my knowledge in political science and economics while honing skills such as modeling, machine learning, and technical writing. However, it was not until my time at UC Berkeley to pursue my Ph.D. that I was able to connect all my knowledge and conduct comprehensive interdisciplinary research.

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Introduction

In recent decades, China's development model has transformed the country into a global economic and technological power. However, its heavy reliance on state-led industrial policies and the real estate industry has sparked academic and policy debates about the model's sustainability and its substantial impact on U.S.-China relations. Three broad critical questions arise from these discussions:

1. Why do Chinese industrial policies achieve success in certain cases but fail in others? What policy measures can ensure balanced industrial development while mitigating the risks posed by foreign sanctions?
2. How can the Chinese government prevent real estate market fluctuations from undermining the country's broader economic development?
3. Who truly benefits from the U.S.-China trade war, and how can the dynamics be altered to create a more positive outcome?

These questions are not only significant in isolation but are interconnected, reflecting the challenges inherent in China's development paradigm. They also form the basis for the three articles presented in this dissertation.

Article 1 of the dissertation challenges the notion that industrial policies always promote development. While China's supercomputing policies were well designed, contributing to the industry's development and resilience, the case of 5G shows that the unbalanced industrial policies distorted industrial growth, leaving the industry vulnerable to U.S. sanctions. Article 2 demonstrates that Chongqing's land price control policy successfully curbed housing prices and supported household consumption, offering a potential model for sustainable growth. Finally, Article 3 examines the eye-catching U.S.-China trade war, which is deeply rooted in China's development model and U.S.-China rivalry. It shows that neither the U.S. nor China truly benefits. Both countries would need to reduce protectionist and retaliatory measures to create a more positive outcome.

For the rest of this Introduction, I will provide a brief overview of China's development model, including its strengths and weaknesses in particular. Then I will outline the dissertation's focus and summarize each article. Finally, I will present the major takeaways.

Overview of China's Development Model

Over the past 30 years, China's gross domestic product (GDP) has soared from $361 billion in 1990 to $17.79 trillion in 2023. [1] Today, China ranks as the world's second-largest economy, following only the United States. Much of the so-called "economic miracle" [2] is attributed to the country's development model.

[1] World Bank 2024.
[2] Rodrik 2018.

A major feature of the China model is the pursuit of extensive industrial policies. In this dissertation, industrial policy refers to broad government policies that aim to promote industrial development, including research, innovation, and the commercialization of scientific discoveries. As a late developer, China adopted a state-led model of industrialization to catch up with already industrialized countries. [3] It has followed in Japan's footsteps using different types of industrial policies to invest in targeted industries such as high-tech and manufacturing. [4] While both Japan's and China's industrial strategies attempt to promote technological development and exports, China's model has been more top-down, marked by expansive central government intervention and a strong reliance on state-owned enterprises to dominate domestic and international markets. [5]

Another pivotal feature of China's development model is its heavy dependence on the real estate industry as a major driver for economic growth. In the past three decades, property developers with capital and political resources have purchased lands at premium prices and poured massive investments into residential, commercial, and industrial real estate. Since the early 2000s, the real estate industry has played a vital role in China's economic expansion.

Strengths

The positive effects [6] of Chinese industrial policies have led many scholars and commentators to argue that China is on the path to becoming a dominant global technological leader. Existing literature shows that, with policy support, the Chinese clean-tech industry witnessed substantial development and manufacturing growth. [7] Some studies even indicate that China has already surpassed the United States based on 20 economic and technological indicators. [8] For instance, Larson (2018) notes that China has shifted from imitation to innovation and become a tech superpower. [9] Lattemann et al. (2020) and Liu (2020) focus on the domain of 5G technology and highlight that Huawei, a Chinese multinational telecom company, became a global leader in the 5G network in 2018. [10] Radu and Amon (2021) further suggest that China dominates the global 5G markets and could project cyber power across more than 150 countries. [11] "China's 5G is leading the world", "China's Huawei is winning the 5G race", and alike have been the headlines of numerous Chinese and Western news, as a search on Google can attest.

In addition to industrial policy, researchers have also pointed out the positive impacts of China's real estate industry. Cai et al. (2020) argue that real estate has significantly contributed to China's urbanization and infrastructure construction, both of which promote the country's economic growth and modernization. [12] Indeed, until today, the real estate industry remains a pillar industry

[3] Vogel 2021a; Vogel 2005.
[4] Heilmann and Shih 2013.
[5] Johnson 1982; Vogel 2006; Lardy 2019; Zhang 2023b.
[6] Chen, Meng, and Wan 2024; Wang, Sun, and Xiao 2022.
[7] Andrews-Speed and Zhang 2019; Wang, Qin, and Lewis 2012.
[8] Allison 2015; Allison 2017.
[9] Larson 2018.
[10] Lattemann, Alon, and Zhang 2020; Liu 2021.
[11] Radu and Amon 2021.
[12] Cai, Liu, and Cao 2020.

in China's economy. In the first half of this year, real estate investment totaled 5.3 trillion renminbi (RMB), accounting for approximately 8.5 % of GDP and 21.4% of total fixed asset investment. [13] Employment figures further underscore the sector's importance. According to the Fourth National Economic Census, [14] as of 2018, the real estate sector directly employed 12.64 million people, a 44% increase from 2013. As Zhang (2023) notes, when including the 35.91 million workers in the housing construction industry, nearly 49 million people were employed in real estate-related jobs. [15]

Weaknesses and Challenges to U.S.-China Relations

While many believe that China's model has driven rapid economic growth and success in certain industries, it is not without significant flaws.

First, China's industrial policies, including those in high-tech sectors, have often prioritized infrastructure and equipment investment as well as rapid deployment over foundational research and development, leaving the country heavily dependent on foreign technology for critical components. Such dependency undermines China's technological sovereignty and increases its vulnerability to external shocks such as U.S. technology export controls.

Second, China's industrial policies including subsidies, government guidance funds, and tax incentives have led to significant overcapacity and trade surpluses in various sectors, such as solar, steel, and electric vehicles. [16] The surpluses reinforce China's investment-driven growth path and lead it deeper into a "lopsided entanglement" with the United States, contributing to the ongoing trade war between the world's two superpowers. [17]

Third, China's heavy reliance on the real estate industry, reminiscent of Japan's in the 1980s, [18] increased banks' lending to real estate enterprises and households in speculative activity. Since the 2000s, housing prices have soared across the country, becoming less affordable year after year. As of mid-2024, despite the real estate downturn, the housing price-to-income ratio in China remained over 29, compared to 18.7 in Singapore, 11.3 in Japan, and 3.3 in the United States. [19] This low housing affordability underscores the significant financial burden housing prices have placed on Chinese residents. [20] In an exclusive interview with the Chinse newspaper *Economic Observer* in 2021, Sheng Songcheng, former Director of the Survey and Statistics Department of China's central bank, pointed out that the high housing prices not only squeeze the profit margins of brick-and-mortar businesses but also adversely affect consumer expenditure. [21] Constraints on consumption hinder China's efforts to rebalance its economy

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[13] National Bureau of Statistics 2024.
[14] China's National Bureau of Statistics 2018.
[15] Zhang 2023c.
[16] Pettis 2009; Zhang 2011; Klein and Pettis 2020.
[17] Tooze 2018; Zhang 2018; Eichengreen 2024.
[18] Vogel 2006.
[19] Numbeo.com 2024b.
[20] Eichengreen 2019b; Numbeo.com 2024a.
[21] China Europe International Business School 2021.

towards a more sustainable, consumption-driven growth model, exacerbating trade relations with foreign countries such as the United States.

Dissertation's Focus and Summaries

In this dissertation, I aim to address the central research questions and contribute to the academic and policy debate through three articles. Article 1 suggests the mixed results of China's industrial policies. It delves into divergent 5G and supercomputing industrial policies, emphasizing the importance of appropriate policy design in fostering balanced technological development and resilience. Article 2 discusses the domestic consequences of China's hefty reliance on the real estate industry and focuses on the land price control policy evaluation in promoting housing price stability and consumption. Article 3 analyzes the U.S.-China trade war and strategic decisions made by the U.S. and China, discussing whether – and by choosing what strategies –can both countries enhance or maximize their net benefits. In this article, "benefits" encompass not only economic gains such as trade surplus but also achieving strategic goals like preserving technological leadership. "Net benefits" take into account costs incurred by the trade war.

Collectively, these articles offer a detailed analysis of the challenges embedded within China's development model. While China's large economic scale and the government's ability to mobilize national resources have led to impressive achievements, such as advancements in supercomputing, the model's inherent weaknesses – such as consistently large trade surpluses, technological dependency, and low housing affordability – pose significant risks to the country's economic sustainability and its relationship with the United States.

Below I summarize each article, including their methods, main findings, and intended audiences.

Article 1, "China's 5G and Supercomputing Industrial Policies: A Critical (Comparative) Analysis", explores how divergent industrial policies in high-tech industries reveal strengths and weaknesses in China's development model, particularly in terms of technological self-sufficiency and U.S.-China competition. The study explains why China's supercomputing industry successfully adapted to U.S. sanctions in 2015 by shifting to domestically produced components, while the 5G industry struggled under similar U.S. sanctions in 2019.

Through natural language processing – a machine learning technique – and qualitative content analysis of Chinese official policy documents and secondary sources, this article shows that China's supercomputing industrial policies were well designed, focusing on developing the entire industrial chain and ensuring self-supply of critical components before the U.S. sanctions. In contrast, 5G policies prioritized infrastructure and equipment investment and downstream applications at the expense of upstream research and development, which distorted industrial growth and made the industry vulnerable to external shocks.

Additionally, the article explains the policy divergence through a political-economic lens, underscoring the crucial role of strategic leadership in fostering technological independence.

While the focus is on China, the main findings have broader relevance for any country that pursues industrial policies. The targeted audience of this study includes scholars in the fields of political economy, China studies, industrial policy, and U.S.-China relations, as well as policymakers and experts in the technology sector.

Article 2, “Impacts of Chongqing’s Land Price Control Policy: A Mixed-Methods Analysis”, attempts to address the broader question of how the Chinese government can prevent real estate market fluctuations from undermining the country’s economic development such as price stability and consumption.

Specifically, this article examines the effects of Chongqing’s 2013 land price control policy on housing prices and household consumption, employing a regularized synthetic control approach – a quasi-experimental design. The study shows that in the absence of Chongqing's land price control policy, housing prices would have been 6% higher, while household consumption would have been 5% lower. These findings, corroborated by placebo tests and conformal inference analyses, underscore the policy's effectiveness. To provide more contextual relevance and insights, [22] the quantitative analysis is supplemented by a qualitative case study comparing Chongqing with Tianjin, a city with similar characteristics but without policy intervention. The comparative analysis with Tianjin further illustrates the significant economic impacts of land price regulation, offering a potential model for sustainable urban development.

Furthermore, the article examines the political economy behind the policy, showing then-Mayor Huang Qifan’s critical role in balancing real estate growth with sustainable development and public needs.

While the focus is on China, the main findings have broader relevance for other rapidly urbanizing economies facing similar challenges in managing housing market volatility and fostering economic growth. The targeted audience includes scholars in the fields of China studies, political economy, and development economics, as well as policymakers involved in economic development and real estate regulation.

Article 3, “Modeling the U.S.-China Trade Conflict: A Utility Theory Approach”, examines the ongoing U.S.-China trade war, which is deeply rooted in China’s development model and its rivalry with the United States. It employs expected utility theory, formal modeling, and optimization techniques to explore how the expected net benefits of both countries are influenced by their political-economic preferences – such as China’s state-led development strategy and the U.S. objectives of reducing trade deficits and maintaining technological dominance – and by the constraints imposed by retaliatory actions in the trade war.

Overall, the findings corroborate the core idea of liberalism and free trade. This study shows that reducing protectionist and restrictive measures would benefit both countries during the trade war. China’s optimal strategic response is to end the trade war and maintain the pre-trade war status quo. However, there is no easy or clear-cut optimal strategy for the U.S. While both the Trump and Biden administrations seek to alter China’s policies and shield vulnerable sectors from the

[22] O’Brien 2019.

"China trade shock", [23] China's entrenched development model and countermeasures impose significant costs and make it unlikely for the U.S. to achieve maximum net benefits.

This article is primarily oriented toward an audience in the fields of political economy, international relations, decision theory, and formal modeling, and engages with policymakers and policy experts in crafting and analyzing international trade strategies.

Key Takeaways

The dissertation, as a whole, argues that while China's development strategy has propelled the country from an impoverished and underdeveloped economy to the forefront of the global economy, it also harbors significant problems that undermine its future trajectory. Through the analysis of China's high-tech industrial policies (particularly in supercomputing and 5G), its real estate market interventions, and the U.S.-China trade war, the research demonstrates how specific flaws in China's approach – such as technological dependency, trade tensions, and real estate market volatility – pose serious risks, threatening its economic sustainability and straining its relationship with the United States.

Internally, China must recalibrate its industrial policies and manage its real estate industry more effectively. The contrasting outcomes of its supercomputing and 5G policies illustrate that balanced, well-designed state interventions are crucial for technological development and resilience. Similarly, managing real estate market volatility, as seen in Chongqing's successful land price control policy, can help curb housing prices and boost household consumption. These internal adjustments are vital for China's sustainable growth.

Externally, the dissertation underscores the need for China to reduce aggressive industrial policies and unfair trade practices, which heighten tensions with the United States. Reducing retaliatory measures like imposing massive tariffs on U.S. goods and fostering cooperation could lead to more positive-sum outcomes in U.S.-China relations, mitigating the risks of an ongoing trade war.

China's development model, though powerful in some aspects, is not infallible. Only through internal and external changes can China sustain its economic development and navigate the complexities of U.S.-China relations in the years ahead.

[23] Autor, Dorn, and Hanson 2016.

Article 1

China's 5G and Supercomputing Industrial Policies: A Critical (Comparative) Analysis [24]

Abstract

The Chinese central government has greatly supported two strategic high-tech industries: 5G and supercomputing. However, when both encountered similar U.S. sanctions, the 5G industry failed to make crucial upstream components while the supercomputing industry could. This article argues that the central government-level industrial policies contributed to these divergent outcomes. Using Natural Language Processing and qualitative content analysis of meticulously collected official documents and secondary sources, key policy differences were identified. Before the U.S. sanctions in May 2019, China's 5G industrial policies were significantly unbalanced, with inadequate attention given to research and development of vital upstream components, contributing to a lack of upstream investment. Although recent attempts to rebalance 5G industrial development since 2021, the policy focus remains largely on the mid and downstream segments. In contrast, before the U.S. sanctions in 2015, the supercomputing industrial policies emphasized the development of the entire industrial chain, including crucial upstream components, resulting in China's possession of entirely homegrown supercomputers. Leveraging a tri-level analysis framework rooted in political economics, this study also offers possible explanations for the policy divergence and discusses implications. It contributes to the existing literature and ongoing debate on China and industrial policy amidst great power high-tech competition.

Puzzling Divergence: China's 5G and Supercomputing Outcomes

U.S.-China 5G and supercomputing rivalry has captured increasing attention from policymakers, scholars, and industry practitioners.

5G refers to the fifth-generation wireless communication standard, also known as the fifth-generation mobile communication technology, designed to provide high-speed, low-latency, reliable, and securely enhanced mobile broadband services.[25] It "connects people, things, data, applications, transport systems and cities in smart networked communication environments". [26] Supercomputing technology "comprises supercomputers, the fastest computers in the world", [27] originally designed to perform complex and intensive scientific calculations. Because of its

[24] This article has been published by *Global Policy*, an SSCI-indexed journal. I am appreciative of Vinod Aggarwal, Barry Eichengreen, Michaela Mattes, Huayong Niu, Kevin O'Brien, Michael Pettis, Eric Schickler, and Steven Vogel (in alphabetical order) for their insights and feedback on different versions of this manuscript. I am also thankful to the editorial team and the anonymous reviewers for their constructive comments.
[25] Gohil, Modi, and Patel 2013.
[26] International Telecommunication Union 2022.
[27] IBM 2023.

immense computing power, the technology has also been used in a wide variety of industries, such as finance, automobile, media, city management, and entertainment. [28]

Due to their importance to national security, China's 5G and supercomputing industries have received massive central government support through industrial policies. By industrial policy, this article refers to broad government policies that aim to promote industrial development, including research, innovation, and the commercialization of scientific discoveries. For instance, *the High-Tech Research and Development (863) Program*, which advanced the Chinese supercomputing industry, is categorized as an industrial policy by many scholars. [29]

Interestingly, in contrast to the supercomputing industry, which adjusted seamlessly by replacing U.S. imports with domestic upstream components when facing U.S. sanctions in 2015, China's 5G industry failed to do so when facing similar U.S. sanctions in May 2019. Why could not the 5G industry make crucial upstream components whereas the supercomputing industry could?

Previous scholarship has shown the causal effects of industrial policies on China's domestic industrial development. [30] Recent scholarship and think tank reports have argued that industrial policies can drive the development of Chinese 5G and supercomputing industries.[31] Indeed, in China, the central government controls economic, business, and social activities. [32] As manifested by the official website of the Chinese Ministry of Science and Technology, the central government and its industrial policies play a leading role in China's scientific and technological work, and it is the central government that defines the "functionality and operating mechanism of Chinese companies, universities, science and technology research institutes, and other innovation entities". [33]

Building upon the existing literature that shows the causal relationship between central government-level industrial policy and high-tech industrial development, this article hypothesizes that China's 5G industrial policies, in contrast to the supercomputing industrial policies, overlooked upstream development.

One may posit that upstream research and development (R&D) of supercomputers is not technically challenging so China could make its entirely homegrown supercomputers, including the crucial upstream components. This is simply not true. Making supercomputers is a highly specialized field that requires state-of-the-art technologies, and only a few countries (e.g., the United States, Japan, and the United Kingdom) can.

One could also argue that market demand for 5G applications is high, so the focus of China's research institutes and companies was diverted to the downstream instead of the upstream. Market demand may influence the direction of industrial development to some extent. It is

[28] Jordan 2020; Tynan 2020.
[29] Fuller 2016; Wang, Sun, and Xiao 2022.
[30] Lin 2017; Rodrik 2018; Wei 2018.
[31] Bulletin of Chinese Academy of Sciences 2015; Ren, Lian, and Chen 2020; Triolo 2020; Wang and Wang 2022; Wang, Sun, and Xiao 2022.
[32] Lardy 2020; Lee and O'Brien 2021; Li 2022.
[33] Ministry of Science and Technology 2019.

important to recognize that China's entire economy operates under heavy state intervention through industrial policies. This top-down approach means that the government's policies primarily determine the development trajectories of China's strategic high-tech industries.

A third alternative explanation is that the divergent outcome is due to different local-level industrial policies. It might be true that local policies may play a role in industrial development. However, the development of China's strategic high-tech industries crucial to national security has been primarily driven by central government-level industrial policies.

It should be noted that this article does not mean that only industrial policy accounted for the different upstream outcomes, but instead claims that the divergent outcomes cannot be understood without reference to central government-level industrial policy.

This article aims to examine the key differences in the policies toward the 5G and supercomputing industries and associated results. It also endeavors to provide some insights into the driving factors behind the 5G and supercomputing policies.

Using Natural Language Processing (NLP), a machine learning technique, and qualitative content analysis based on carefully collected Chinese official industrial policy documents and secondary source information, this article finds that the central government-level 5G industrial policies were unbalanced, with insufficient attention to upstream development before the U.S. sanctions in May 2019. Consequently, capital and talent were quickly mobilized to the mid and downstream, and there was a lack of upstream investment. Companies were excessively dependent on foreign companies for key upstream components. Since 2021 four 5G industrial policies, including *the 5G Application Sailing Action Plan 2021-2023*, have attempted to rebalance the industrial development, and companies have begun flocking to the upstream. However, most policies issued since then remain lopsided toward midstream and downstream segments. This may put China at continuous risk amid the ongoing sanctions from the United States. In sharp contrast, the central government focused on developing the entire industrial chain of the supercomputer industry and pushed for indigenous innovation and self-supply of critical upstream components before the U.S. sanctions in 2015. Notably, China could make its homegrown supercomputers, including crucial upstream components.

In addition, this article provides possible explanations for the divergent industrial policies for its two strategic industries. Employing the framework of three levels of analysis and rooted in political economics, it argues that at the domestic level, the potential for rapid GDP growth from 5G infrastructure investment and downstream applications versus the resource-intensive and high-risk nature of upstream R&D influenced the policy choices. Moreover, 5G licenses for commercial applications were not issued until June 2019, perhaps hindering the design and issuance of balanced 5G policies before that time. At the international level, the favorable external environment made it easy for China to import key upstream components. As a result, China's 5G industrial policies from 2015 and May 2019 neglected upstream R&D. Although policies have started to rebalance since 2021, the pandemic, geopolitical tensions, and internal economic problems made infrastructure investment and applications the only two sources of economic growth. In contrast, the appropriately designed supercomputing industrial policies were shaped by the hostile international environment, strategic scientists, and then-paramount leader Deng Xiaoping.

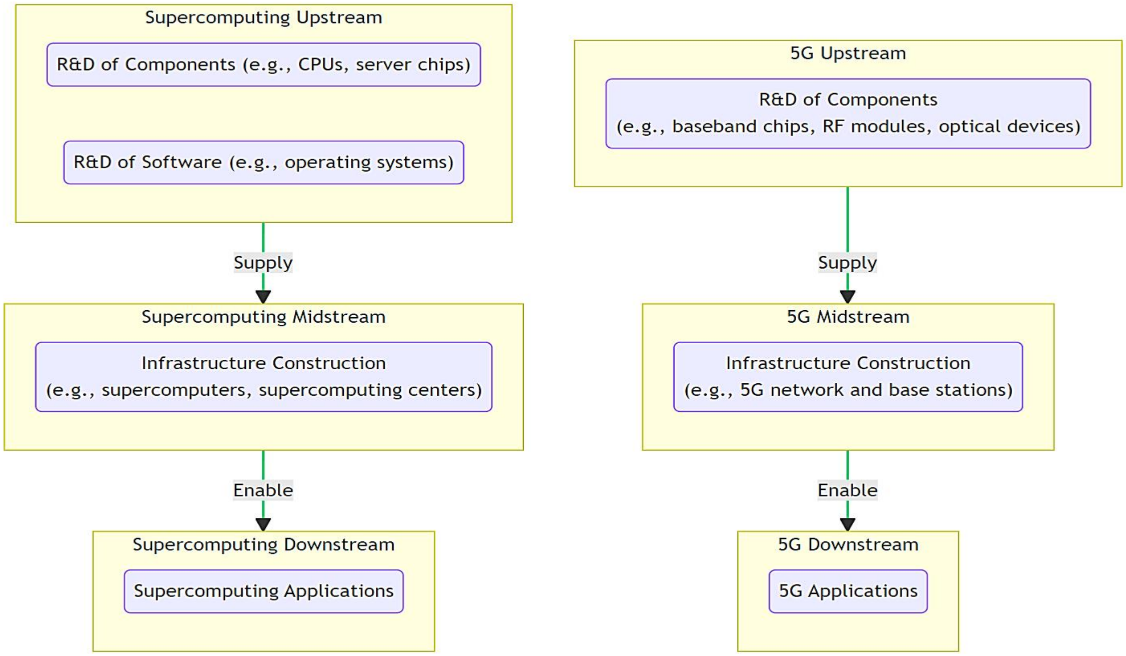
One may wonder about the importance of examining China's 5G and supercomputing industrial policies. There are three main reasons. First, while the Chinese central government has formulated and issued dozens of industrial policy documents concerning 5G and supercomputing, there has been no systemic analysis and comparison of these policies. Second, as industrial policy gains prominence globally, with countries pursuing high-tech industrial policies for foreign policy goals, understanding China's 5G and supercomputing industrial policies is crucial. [34] Third, since China has risen to the world's economic and geopolitical superpower although its economy is expected to slow down, [35] its industrial policies will impact its relations with foreign countries and companies doing business with China. Thus, an in-depth analysis of the Chinese 5G and supercomputing industrial policies is essential for academics, policymakers, and business leaders.

One may also wonder about the basis for comparing China's 5G and supercomputing industries. I recognize the distinctive features of technology in the two industries. As mentioned earlier, 5G technology is designed to provide greater connectivity, faster internet speeds, higher bandwidth, and lower latency while supercomputing technology is originally designed to process massive data and perform complex calculations at extremely fast speeds. This article compares the two industries for five main reasons.

Firstly, both the 5G and supercomputing industries encompass upstream, midstream, and downstream segments (Figure 1.1). In China, upstream refers to the R&D and production of components like 5G and supercomputer chips. Midstream refers to infrastructure construction like 5G networks and supercomputing centers. Downstream means applications and associated services. [36] The upstream segment is critical for enabling both 5G infrastructure construction and deployment, as well as supercomputer operations. It needs science and technology promotion.

[34] Aggarwal and Reddie 2020; Vogel 2021b.
[35] Eichengreen 2018; Eichengreen, Park, and Shin 2011.
[36] Zhu 2020; Baike Cidian 2021.

Figure 1.1: China's 5G and Supercomputing Industrial Chains



Source: Author's analysis based on Chinese online news.

Secondly, both 5G and supercomputing technologies are dual-use in nature, with wide applications in both civilian and military domains. As such, they are vital for both economic development and national security.

Thirdly, due to their strategic importance to national security, both industries have been considered by the Chinese central government among China's most important strategic industries (under the category of "information technology") and have received strong top-down central government support through industrial policy.

Fourthly, both the Chinese 5G and supercomputing industries have connections and interoperability with foreign countries. For instance, Chinese 5G entities have partnered with foreign scientific institutes and companies. Similarly, Chinese supercomputing entities have also engaged in collaborations with foreign entities. For example, by 2012, China had already provided services to over 300 key Chinese and foreign customers in industries such as petroleum, film, biomedical, and manufacturing. [37]

Fifthly, due to grave national security concerns, both industries' upstream segments faced similar technological embargoes by the U.S. Department of Commerce (Table 1.1).

[37] China Central Television 2012.

Table 1.1: Similar U.S. Sanctions on China, 2015 and 2019

	Supercomputing Sanctions (2015)	5G Sanctions (2019)
Agency	Bureau of Industry and Security, U.S. Commerce Department	Bureau of Industry and Security, U.S. Commerce Department
Rationale	Contrary to the national security and foreign policy interests of the United States	Contrary to the national security and foreign policy interests of the United States
Type	Entity List	Entity List
Means	U.S. firms cut off supplies of critical components (multicores and chips)	U.S. firms cut off supplies of critical components (chips)

Source: U.S. Commerce Department. The Entity List imposed a license requirement under the Export Administration Regulations (EAR) regarding the export, re-export, or transfer of any item subject to the EAR.

This study fills in the gap in the existing literature and contributes to key policy debates. First, this article makes the first successful effort to collect the publicly available policy documents on 5G and supercomputing and develops the first systematic analysis of Chinese 5G and supercomputing industrial policies using machine learning and qualitative content analysis.

Second, many scholars accept the claim that industrial policy can successfully promote the development of specific industries. [38] This study shows that China's 5G industrial policies, especially in 2015 – May 2019, distorted industrial development.

Third and relatedly, getting industrial policies right is crucial. For strategic high-tech industries critical to national security, core components and associated technologies need to be self-built. The case of the Chinese supercomputing industry throws light on what an appropriately designed industrial policy might look like.

Fourth, some international relations scholarship notes that immense economic resources can translate into technological power, [39] and an increasing number of academics and policy analysts contend that China is winning the global 5G race. [40] This study cautions against conventional wisdom.

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[38] Wei 2018; Zhao et al. 2019; Oh 2021.
[39] Mearsheimer 2001.
[40] Liu 2021; Radu and Amon 2021.

The following section explains the method and introduces the data sources. Section 3 presents the key research findings pertaining to the two industrial policies under examination, including their major differences and associated results. Section 4 provides possible political economy explanations for why the Chinese central government pursued divergent industrial policies. Section 5 discusses policy implications. Finally, Section 6 provides a brief conclusion.

Method

No published work systematically examines China's 5G and supercomputing industrial policies. This article employed document analysis – a viable independent research method that requires repeated review, examination, and interpretation of the textual data to gain empirical knowledge of the construct being studied and answer specific research questions. [41]

To begin with, the author carefully collected official policy documents in three stages. First, the author searched 5G and supercomputing industrial policy documents on the websites of various Chinese central government agencies. Second, the author typed keywords such as "中国 5G 产业政策" and "中国超算产业" to search for 5G and supercomputing industrial policy documents on Baidu –the most used online search engine in China – to avoid omitting any key policy document. Third, the author cross-checked Chinese state media reports (e.g., news articles from *the People's Daily*) that often list the names of Chinese 5G and supercomputing industrial policies.

The author found that China's State Council (a.k.a. the Central People's Government chaired by the Premier and includes the heads of ministries), National Technology Leadership Group (chaired by the Premier), and the National People's Congress (a.k.a. China's national legislature) and Ministry of Science and Technology designed and issued supercomputing industrial policies.

In addition, the author found that the State Council, the National People's Congress, the office of the Central Committee of the Chinese Communist Party, the National Development and Reform Commission (a.k.a. the Constituent Department of the State Council), the Ministry of Science and Technology, and the Ministry of Industry and Information Technology formulated and issued the 5G industrial policies. For the industrial policy, *the 5G Application Sailing Action Plan (2021-2023)*, the Chinese ministries of education, finance, housing and urban-rural development, and culture and tourism, the National Energy Administration, and the State-owned Assets Supervision and Administration Commission also got involved in the policy issuance.

The author also found that official documents of 5G industrial policies are publicly available and provide first-hand information on specific policies. However, some important official documents vis-à-vis supercomputing industrial policies are unavailable, perhaps because these documents were created three to four decades ago and have not been digitalized. Hence, the author adopted two separate approaches to uncover insights into the 5G and supercomputing industrial policies.

For 5G industrial policy analysis, the author used NLP to help analyze official policy documents. Although the technical details are beyond the scope of this article, one can think of it as a

[41] Frey 2018.

machine learning tool that helps read and understand textual data by distilling paragraphs down to keywords (tokenization) and counting their frequency (encoding) in a consistent, unbiased manner. The maximum matching method was used to determine the most appropriate segmentation of a sentence. The method starts at the beginning of a sentence and looks for the longest word that matches a word in a dictionary, and then it repeats the process until no characters remain. [42] Moreover, the author used "stop words" [43] to discard uninformative words such as Chinese particles. In addition, the term frequency algorithm [44] was also used to compute how often a word appears in a document divided by the total number of terms. The intuition is to give high weight to any term that appears frequently. To complement the NLP analysis, the author also anatomized the sentences where the frequently used keywords are embedded and evaluated which segment(s) each policy document covers.

For supercomputing industrial policy analysis, the author began by employing the same procedure to examine the official policy documents available to us. To ameliorate the problem of missing documents and obtain additional information, the author also referred to secondary sources including scholarly books and articles, contemporary news accounts, and policy briefs.

To investigate the industrial development results associated with China's 5G and supercomputing industrial policies, the author collected textual and numerical data from company reports, industry news, history books, and academic papers. The analysis primarily involved qualitative content analysis and interpretation of descriptive data to identify industrial development patterns after the formulation and issuance of 5G and supercomputing industrial policies.

Finally, this article employed a systematic approach to study the underlying factors behind the formulation of China's divergent 5G and supercomputing industrial policies. First, qualitative data was collected from various sources, including leaders' statements, historical narratives, anecdotes from historical documents, Selected Works of Deng Xiaoping, policy briefs, news accounts, and scholarly works. Second, this article borrowed the framework of three levels of analysis in international relations and grounded the analysis in political economy. It focused on the role of top Chinese leadership, state interests, and domestic economy, and systemic dynamics that influenced state behavior, allowing for a multi-dimensional understanding of Chinese central government-level industrial policies and facilitating a deeper analysis of the complexities involved in Chinese high-tech policymaking.

Main Findings

Unbalanced 5G Policies (2015 – May 2019)

The Chinese central government started to release 5G industrial policies in 2015 by publishing the *Made in China 2025*. [45] The U.S. began to bar Huawei from acquiring upstream components in May 2019. So far, 35 official documents are available, 12 of which were published between 2015 and May 2019.

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[42] Pei 2020; Sun 2020.
[43] Müller and Guido 2016.
[44] Sun 2020.
[45] Xinhua News 2021a.

Chinese 5G industrial policies prior to May 2019 were significantly unbalanced. In the 12 official documents concerning 5G (Table 1.2), the most frequently used words (Figure 1.2) indicate that the Chinese central government put much less weight on the upstream than the midstream and downstream. Words related to the mid and downstream, such as “商用” (commercial application), “技术” (technology), “标准” (standard), “研发” (R&D), “网络” (network), “产业化” (industrialization) were predominant (Figure 1.2). One may misconstrue that “technology”, “standard”, and “R&D” in the 5G documents referred to the upstream. Yet, according to the official documents, they all referred to 5G wireless technology improvements such as speed, latency, bandwidth, and reliability, which are unrelated to the R&D and production of upstream components.

Table 1.2: Chinese Industrial Policy Documents Concerning 5G, 2015 – 05/2019

	Date	**Government Institutions**	**Document Name (Chinese)**	**Document Name (English)**
1	May 2015	The State Council	中国制造 2025	Made in China 2025
2	Mar 2016	National People's Congress	中华人民共和国国民经济和社会发展第十三个五年规划纲要	Outline of the 13th Five-Year Plan for National Economic and Social Development
3	Jul 2016	The Office of the Central Committee of the Communist Party of China	国家信息化发展战略纲要	Outline of the National IT Development Strategy
4	Dec 2016	The State Council	国务院关于印发“十三五”国家信息化规划的通知	Notice on issuing the National Informatization Plan of the 13th Five-Year Plan
5	Jan 2017	Ministry of Industry and Information Technology	《信息通信行业发展规划（2016－2020 年）》	Information and Communication Industry Development Plan (2016-2020)

6	Jan 2017	The State Council	关于促进移动互联网健康有序发展的意见	Opinions on Promoting the Healthy and Orderly Development of the Internet
7	Mar 2017	The State Council	2017 年政府工作报告	Government Work Report (2017)
8	Apr 2018	Ministry of Industry and Information Technology	5G 发展前景及政策导向	China 5G Development Prospects and Policy Orientation
9	Jul 2018	Ministry of Industry and Information Technology; National Development and Reform Commission of China	扩大和升级信息消费三年行动 计划 (2018-2020 年)	Three-Year Action Plan for Expanding and Upgrading Information Consumption (2018-2020)
10	Sep 2018	The State Council	完善促进消费体制机制实施方案（2018—2020 年）	The Implementation Plan on Improving Consumption-Promotion Systems and Mechanisms (2018-2020)
11	Jan 2019	National Development and Reform Commission; Ministry of Industry and Information Technology, Ministry of Civil Affairs and Other Government Agencies	进一步优化供给推动消费平稳增长 促进形成强大国内市场的实施方案（2019 年）	Implementation Plan for Further Optimizing Supply to Promote the Stable Consumption Growth and Facilitating the Formation of a Strong Domestic Market (2019)

12	May 2019	Ministry of Industry and Information Technology; State-owned Assets Supervision and Administration Commission	关于开展深入推进宽带网络提速降费支撑经济高质量发展 2019 专项行动的通知	Notice on Carrying Out the 2019 Special Action for Promoting Broadband Network, Reducing Fees, and Supporting High-quality Economic Development

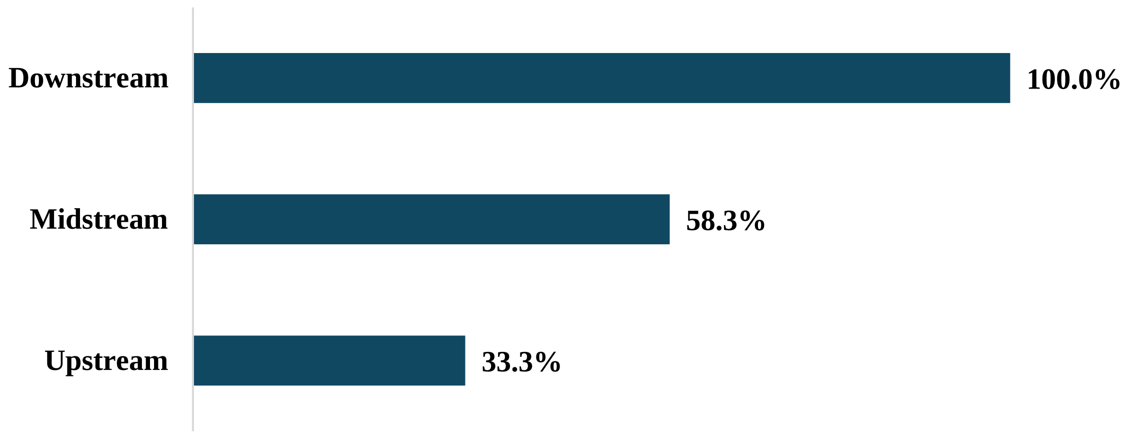
Source: Author’s collection from Chinese central government agencies and online news.

Figure 1.2: Most Commonly Used Words in 5G Policy Documents, 2015 – 05/2019

Source: Author’s analysis based on published Chinese policy documents. Words are scaled by frequency; the circled ones refer to the upstream.

Admittedly, the 5G industrial policy documents mentioned 5G “芯片” (5G chips) and “零部件” (5G parts) several times, suggesting that the upstream development was not entirely ignored. However, for the 12 industrial policy documents published between 2015 and May 2019, only four (33.3%) mentioned to develop the upstream, while seven (58.3%) and twelve (100%) pushed for developing the midstream and downstream, respectively (Figure 1.3).

Figure 1.3: Industrial Policy Attention by Segment, 2015-05/2019



Source: Author's analysis based on published policy documents.

Worse yet, those documents that mentioned the development of 5G chips stipulated generic policy terms without clarifying what kinds of 5G chips China should prioritize.

It is worth noting that *Made in China 2025* set clear goals for the upstream segment: China will raise the domestic content of core components and materials to 40% by 2020 and 70% by 2025. Although these goals could increase self-supply, they were very modest, showing China will continue relying heavily on foreign suppliers for a long time.

When the Chinese government neglected the 5G upstream segment and promoted the midstream and downstream segments, capital and talents quickly mobilized to the midstream and downstream rather than the upstream. As mentioned in Section 1 "Puzzling Divergence: China's 5G and Supercomputing Outcomes", Chinese high-tech industrial policies formulated by the central government directly intervene and drive tech industries' development trajectory. Hence, with strong policy support, 5G infrastructure construction and applications became low-hanging fruits, and investments in the midstream and downstream had relatively lower risks. Indeed, as a result of the central government's policies, China Telecom, China Unicom, and China Mobile invested over 30 billion yuan in 2019 alone, 5G infrastructure investment in China is estimated to reach 1.2 trillion yuan within the next few years, and 5G application will increase national economic output by 10.6 trillion yuan. [46] By contrast, research and production of core upstream components became considerably time-consuming, and once failed, the upfront investment would turn into huge sunk costs if state back is absent. Without appropriate industrial policies, upstream companies lacked incentives and sufficient resources and had no choice but to either focus on the production of labor-intensive products or rely on buying foreign core components. Consequently, Chinese companies generally shunned 5G upstream investment and depended heavily on foreign suppliers. Huawei, for example, had excessively relied on numerous foreign companies for key upstream components. Of the 92 core upstream suppliers, approximately 70% came from foreign countries. These suppliers provided Huawei with technology-intensive 5G

[46] China Daily 2019.

upstream parts and services. It is undeniable that Huawei, too, purchased upstream components from companies in mainland China and Hong Kong SAR. Yet, most Chinese companies specialize in low-end upstream products, such as chargers, screens, and glass covers. [47]

Appropriately Designed Supercomputing Policies

Unlike the 5G industry, supercomputing industrial policies were well-designed. To begin with, official policy documents published by the central government in the 2000s and early 2010s, such as the five-year plans and *The National Medium- and Long-Term Program for Science and Technology Development (MLP)*, showed comprehensive coverage of China's entire supercomputing industrial chain. The predominantly used words in these documents were "知识产权" (intellectual property rights), "研究" (research), "科技" (technology), "自主" (independent), "基础设施" (infrastructure), and "产业化" (industrialization). These published official documents also highlighted the development of "元器件" (essential parts), "软件创新" (software innovation), and "集成电路" (integrated circuit), further illustrating attention to upstream activities (Figure 1.4).

Figure 1.4: Most Commonly Used Words in Supercomputing Policy Documents, 2001 – 2011

Source: Author's analysis based on published Chinese policy documents. Words are scaled by frequency; the circled ones refer to the upstream.

Notably, in the MLP published in 2006, the Chinese central government directed that the supercomputing industry accelerate upgrading the entire industrial chain by making "a

[47] People's Daily 2018.

breakthrough in core electronic devices, high-end generic chips, and basic software", "developing supercomputers capable of performing tens of trillions of floating-point operations per second and demonstrating high-efficiency and reliability", and facilitating applications. [48] In the *12th Five-Year Plan*, the central government also required the supercomputing industry to independently develop domestically produced CPUs, operating systems, and software platforms, as well as to achieve large-scale applications. [49]

In addition, secondary sources further suggest that the Chinese central government had already started flagging ambitious goals to develop homegrown supercomputers by the 1980s. There is a consensus among scholars and policy experts that *the 863 Program* – a national-level industrial policy initiated in 1986 and ended in 2016 – played an indispensable role in achieving technological independence in the supercomputing industry. [50] The Program was different from 5G industrial policies in three main ways.

First, *the 863 Program* was China's most important high-tech industrial policy in four decades. In Chinese history after 1949, the only other high-tech program comparable to the 863 Program was *The Science and Technology Development Plan* (*1956-67*) – a national-level industrial policy to independently develop nuclear and hydrogen bombs and satellites.

Second, the Program also established an expert responsibility system, which held technical decision-makers in the supercomputing industry accountable to the top leadership in China. [51] This institutional design helped ensure the supercomputing industrial policy advice and design by the subject-matter experts to align with the best interests of the central government.

Third, the supercomputing R&D was conducted mainly by China's government-funded public entities such as the National University of Defense Technology and National Supercomputing Centers (the so-called 'national team'). Chinese private companies were allowed to participate in the Program. However, only those who possessed strong technical capability and financial resources and passed strict screening by the Chinese government could get involved. [52] Such arrangements successfully prevented the problem we have witnessed in the case of 5G development. Public entities' objective was not to reap short-term economic profits; instead, they served Chinese national interests and focused on long-term technological advancement.

Because of the appropriately designed supercomputing industrial policies, by the mid-2000s, China had witnessed successful development in multi-core CPUs in tandem with breakthroughs in supercomputing technologies. In those years, China maintained the speed of producing a chip every two years and relentlessly improved its performance. In 2004, the Loongson II was on par with Intel's Pentium III, and the technology gap between China and the global technology frontier was shrinking. In 2014, China's TianHe-2 was the world's No. 1 system. [53]

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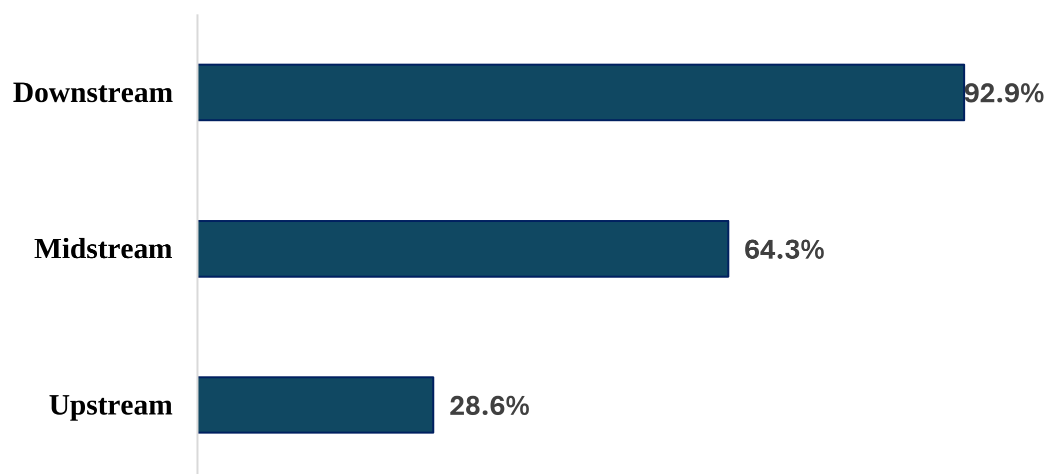
[48] The State Council 2006.
[49] The National People's Congress 2011.
[50] Li 2019; Zhao 2017; Weinstein 2022.
[51] Chinese Embassy in Norway 2010.
[52] Zhang 2009.
[53] Top500.org 2014.

It is indisputable that China experienced significant external challenges during its development of the supercomputing industry. However, China had alternatives to weather external shocks. [54] Notably, China unveiled another supercomputer, Sunway TaihuLight, which became the world's fastest computer in 2016 and 2017 and still ranks No.6 globally today. On the technical front, its system had over 10 million cores and a peak performance of approximately four times faster than TianHe. [55] More impressively, the machine including the SW26010 chip, the operating system, and the parallel compilation tool was entirely homegrown. [56]

5G Industrial Policy Shift Since 2021

Since 2021, the 5G policy documents published have specified the types of 5G chips China needs to self-build and leapfrog to the technological frontier. For example, *the 5G Application Sailing Action Plan (2021-2023)* stressed to "intensify inputs into baseband chips and RF chips" and "accelerate R&D and industrialization of lightweight 5G chip modules". This official document was co-published by ten Chinese ministries, indicative of the urgency and importance to develop the country's upstream segment. In addition, we have witnessed that some policy documents have demanded R&D of not only 5G chips but also other advanced components. This policy shift had immediate effects: more Chinese companies started to flock to the upstream and pushed to develop their own components, and companies that focused on radio frequency-related components secured funding through venture capitalists in 2021. [57] However, despite non-trivial policy changes, in the last two years, the overall attention devoted to the upstream remains much lower relative to the midstream and downstream of China's 5G industrial chain (Figure 1.5).

Figure 1.5: Industrial Policy Attention by Segment, 2021-Present



Source: Author's analysis based on published policy documents.

[54] Xinhua News 2015.
[55] Top500.org 2022.
[56] Dongarra 2016.
[57] ee.ofweek.com 2021.

Rationale Behind the 5G and Supercomputing Industrial Policies

The significance of industrial policies concerning 5G and supercomputing begs the question: what were the motivations of the Chinese central government? Although a causality test of why the Chinese central government pursued different 5G and supercomputing industrial policies is beyond the scope of this study, this section provides possible political economy explanations.

Motivations for Lopsided 5G Industrial Policies

Internally, maintaining strong economic growth can sustain the Kuznetsian modern development and the political legitimacy of the Chinese Communist Party. 5G infrastructure investment, construction, and applications can quickly boost China's GDP.

Over the past several decades, China's economic growth "miracle" has been driven significantly by infrastructure investment. [58] Targeting and furthering infrastructure development remains the core of the Chinese economic development model. [59] Since the late 2000s, Chinese policymakers have attempted to improve China's economic structure and increase domestic consumption as a percentage of GDP. [60]

Given the technological nature of 5G, any industrial policy emphasizing the 5G application will likely have a profound impact on the economic sector. This is a key consideration for policymakers looking to stimulate growth. Hence, the efforts to promote 5G midstream and downstream were not a policy surprise and aligned with the national economic development strategy.

In contrast, 5G upstream R&D typically requires massive economic and human resources, takes quite a long time, and has risks of failure. Therefore, policymakers were incentivized to promote the mid and downstream and neglected the upstream development. It is also worth noting that the 5G licenses for commercial use in China were not granted until June 2019, [61] perhaps making it difficult for the Chinese central government to design and issue balanced 5G industrial policies before that time.

At the international level, many Chinese 5G companies have long enjoyed integration into the liberal international order and the division of labor in global supply chains. China's neighboring countries such as South Korea have pursued industrial policies that consistently focus on technological innovation. [62] As a result, they have much more strength in the upstream segments than China. South Korea, a 5G leader in the Asia-Pacific region, has more than 20,000 chip-related companies, including 369 IC manufacturing enterprises, 2,650 equipment enterprises, and 4,078 material enterprises. A typical South Korean 5G chip factory is surrounded by a variety of supporting enterprises. [63] Embedded in an environment where China could import something

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[58] Zhang 2011.
[59] Pettis 2021.
[60] The National People's Congress 2009; Xinhua News 2020b.
[61] www.gov.cn 2019.
[62] Massaro and Kim 2021.
[63] Deloitte 2020.

already developed by foreign suppliers, Chinese 5G upstream companies did not have incentives for indigenous innovation and self-reliance. As some scholars put it, because advances in science and technology were easy to access in the globalized world, China focused on deploying rather than developing cutting-edge science capabilities. [64]

While the domestic and international factors can explain why the Chinese central government pursued such 5G industrial policies between 2015 and 2019, they beg the question of why policies have started to change since 2021. The 5G industrial policy shift occurred because the Chinese top leadership had discerned the risks of the country's unbalanced 5G industrial development to national security and sought to strengthen the technical capability of insulating China more from the harsh external environment. After the U.S. sanctions and Huawei's malaise surfaced, in September 2020, President Xi Jinping summoned prominent Chinese scientists to Beijing, stressing that:

> In the face of fierce international competition and against the backdrop of rising unilateralism and protectionism, we must find an innovative path that suits our national conditions. In particular, we need to place an even greater emphasis on improving our capabilities in original innovation, striving to achieve more breakthroughs 'from 0 to 1'. It is hoped that the vast number of scientists and scientific and technological workers will shoulder the historical responsibility…and continue to advance into greater breadth and depth of science and technology. [65]

Still, economic growth is the priority of China's policy agenda. With geopolitical tensions and internal structural problems affecting the Chinese economy, the only sources of growth are domestic infrastructure investment and downstream applications. [66] This might explain why Chinese 5G industrial policies remain focused more on the midstream and downstream than the upstream.

Motivations for Appropriately Designed Supercomputing Industrial Policies

While the factors that might affect China's supercomputing policymaking are nearly endless, the most significant ones can be narrowed down to the hostile international environment, domestic impetus, and Deng Xiaoping's endorsement. Each of these elements shapes the narrative of China's supercomputing trajectory in its own unique way.

At the international level, the Cold War did not end in the 1980s, and the U.S. launched the Strategic Defense Initiative, a program heavily centered around the development of dual-use technologies, including high-performance computer systems. [67] The adversarial global landscape forged a unified resolve among the Chinese Communist leaders and strategic scientists. The consensus was succinctly captured in the sentiment:

[64] Zhao 2022.
[65] Xinhua News 2020a.
[66] Pettis 2021.
[67] Yonas 1985.

> [We must] have a sense of urgency to develop [our own] high technologies. If we catch up late, we will be left behind, and it will be difficult to start again.[68]

Critical to the formation of this consensus was Deng Xiaoping, who served as China's paramount leader from 1978 to 1989. Deng experienced China's backwardness, witnessed state-of-the-art technologies during official visits to industrialized countries, and possessed a strategic vision. [69] He decisively initiated *the 863 Program*, which spanned 30 years and cast a long shadow over China's supercomputing-related industrial policies.

Policy Implications

Immense Resources and State Intervention Do Not Necessarily Work

As suggested by the Chinese 5G case, inappropriate industrial policies mislead companies and investors and misallocate economic resources or hamper efficient resource allocation, ultimately distorting the development of industries. It also implies that immense national economic resources and state intervention may not be effectively converted into industrial advancement and technological superiority. In fact, some countries with abundant resources have also adopted problematic industrial policies that led to various problems. For example, Malaysia and Indonesia, endowed with significant natural resources, have targeted the exporting industries but paid little attention to continual industrial upgrading. [70] Such industrial policies, unfortunately, distorted industrial development and hindered technological advancement.

Getting the Policies Right is Crucial

Getting industrial policies right is crucial. For strategic industries critical for national security, industrial policies should not overlook the development of any segment of the industrial chain. Core components and technologies need to be self-built, as clearly demonstrated by the case of China's supercomputing industry.

The case of the Chinese supercomputing industry also sheds some light on what an appropriately designed industrial policy might look like. Strategic industries require enormous input from the government rather than relying on market forces to develop new technologies and products. Mobilizing national resources, utilizing national labs and state-endorsed research universities to concentrate on the industry's weaknesses (i.e., R&D of crucial components and novel technologies), establishing monitoring and accountability mechanisms, as well as bringing in capable companies for technical collaboration, combined together, can tremendously help the balanced industrial development.

Continuing Vulnerability of the 5G Industry

In a liberal international system, China could easily import materials and core components from international 5G suppliers such as the U.S., Netherlands, Japan, and South Korea, advance its

[68] Deng 1995; Xinhua News 2021b.
[69] Deng 1995; Kissinger 2012; Vogel 2020.
[70] Pempel 2021.

domestic economy, and export manufactured products. Yet, in the wake of rising international protectionism, China's 5G industrial policies that overlooked the upstream segment's development were detrimental to the industry and might put China at continuous risk amid the ongoing U.S. sanctions.

5G and Supercomputing Competition Undermines Liberal International Order

With the U.S. pressing sanctions against China's 5G and supercomputing industries, Beijing has further leveled up its industrial policies. The Chinese central government has looked inward to develop its own exascale supercomputers, making them a thousand times faster than the first of the petaflop systems that preceded them more than ten years ago. [71] Although the 5G policies remain unbalanced, the government has vowed to increase domestic content requirements. Such measures hinder foreign companies from accessing the Chinese market and undermine the liberal international order that highlights "openness" and "cooperation". [72]

Meanwhile, amid the great power competition, the continuing U.S. export restrictions rules thwart China's access to U.S. 5G and supercomputing components, discourage the free flow of knowledge and technology, and invite China's retaliation, thereby challenging the liberal international order it built after World War II.

Conclusion

Despite the importance of China's 5G and supercomputing industrial policies, there has been a lack of systematic analysis of these policies in published works. This article has made the first successful effort to collect publicly available Chinese official documents and developed the first systematic analysis and comparison of the central government-level Chinese industrial policies concerning 5G and supercomputing. The findings reveal that Chinese 5G industrial policies were unbalanced whereas China's supercomputing industrial policies were carefully designed to balance the development of the entire industrial chain, contributing to different upstream outcomes. Admittedly, since 2021 the Chinese central government has issued more balanced 5G industrial policies, and companies have started flocking to the upstream. Still, these policies remain lopsided toward the midstream and downstream segments.

This article has also provided possible reasons why the Chinese central government pursued divergent 5G and supercomputing industrial policies. The development of midstream and downstream segments can allow China to achieve its economic growth goal quickly, and before the U.S. sanction in 2019, China had easy access to foreign technologies and components. Additionally, China's 5G licenses for commercial use were not issued until June 2019, making it challenging for the central government to design and issue a balanced 5G industrial policy earlier. Therefore, the industrial policies of 2015 – May 2019 were primarily focused on 5G infrastructure investment and application. Although China's leadership has discerned the industry's vulnerability and attempted to change the 5G industrial policies since 2021, with the pandemic and geopolitical tensions impacting the Chinese economy, the only sources for

[71] China News 2019.
[72] Ikenberry 2018.

maintaining economic growth in the short run are infrastructure investment and downstream applications. In the contrasting case, the appropriately designed supercomputing industrial policies were attributed to the hostile external environment in the 1980s, petitions from Chinese elite scientists, and Deng Xiaoping's political will, which shaped the central government's determination to develop China's entirely homegrown supercomputers.

The implications are profound. Immense national economic resources and strong state intervention do not guarantee balanced industrial development or technological superiority. It is crucial to get industrial policies right. For strategic industries critical for national security, policies should aim for self-reliance on core technologies and components. Additionally, China's 5G industrial policies, which are still heavily focused on the midstream and downstream segments, may leave China vulnerable to ongoing technological sanctions from the United States. With a technology lever at hand, the U.S. embargo over China is not likely to be reversed in the foreseeable future, even if such protectionist measures are not optimal and perhaps even counterproductive. [73] Great power rivalry in 5G and supercomputing will ultimately challenge the liberal international order established by the United States decades ago.

This article contributes to the existing literature and policy debates on China's 5G and supercomputing industrial policies in the context of U.S.-China high-tech competition. The lessons learned from this study can travel to other countries. There are two natural extensions of this research. First, a causality test may be needed to further deepen our understanding of the motivations behind divergent 5G and supercomputing industrial policies. Second, several 5G industrial policies since 2021 have gravitated more toward the upstream. However, the efforts have been jeopardized by the pandemic and other factors. In the foreseeable future, Beijing will likely accelerate the development of 5G upstream. Still, we cannot speculate when China's 5G industry can achieve well-balanced development and possess its own crucial upstream components. This requires continued attention and further research.

[73] Zhang and Chang 2021; Zhang 2018.

Article 1 explores the divergent outcomes of China's industrial policies in the high-tech sectors of supercomputing and 5G, emphasizing how imbalanced policies can lead to vulnerabilities, particularly when facing external pressures such as U.S. sanctions. This study reveals a broader issue within China's development model, which seeks rapid industrial growth but often overlooks long-term sustainability. This weakness is not confined to high-tech industries but is also evident in other key areas, notably its real estate market. Article 2 shifts to this sector and focuses on how Chongqing's land price control policy helped mitigate market fluctuations and support sustainable growth. The lessons from Article 1 about the importance of well-designed policies carry through Article 2.

Article 2

Impacts of Chongqing's Land Price Control Policy: A Mixed-Methods Analysis

Abstract

This paper examines the impact of Chongqing's land price control policy implemented in 2013 on housing prices and consumption. Using a regularized synthetic control method, findings reveal that without the policy, on average, housing prices in Chongqing would be 6% higher, and total retail sales of consumer goods, a proxy for household consumption, would be 5% lower. The robustness of these results is confirmed through placebo tests and conformal inference analyses. A comparative case study with Tianjin, which did not implement the policy, further shows divergent outcomes during Chongqing's post-treatment period. From a political-economy perspective, this research also underscores the critical role played by Chongqing's former mayor in formulating effective economic policies. This study contributes to the literature on China's development and provides insights into the broader applicability of land price regulation in rapidly urbanizing economies. The findings offer evidence-based guidance for policymakers aiming to balance growth objectives with housing affordability and robust household consumption, fostering sustainable development and enriching the discourse on real estate policy and economic growth.

Introduction

On August 31, 2003, the State Council of China issued the *Notice on Promoting Sustainable and Healthy Development of the Real Estate Market*, highlighting that the real estate industry had become a pillar industry of the national economy. [74] Following this announcement, China's real estate sector entered a long period of spectacular growth characterized by increased land sales, heightened construction activities, and a significant rise in housing prices. This growth extended beyond major urban centers to include third-, fourth-, and fifth-tier cities. Notably, during the 2010s, China's average housing prices increased by approximately 68.3%. [75] Despite the

[74] The State Council 2003.
[75] CEIC 2024.

COVID-19 pandemic, the average housing prices still recorded a growth of about 7% in the subsequent two years. [76]

This rapid expansion, initially hailed for contributing to China's economic boom, has, over time, drawn increasing scrutiny. Scholars and policy experts have questioned the sustainability of this model of development, labeling it as "unbalanced" and "unsustainable". [77] Even as household incomes rise, housing remains prohibitively expensive. The dream of homeownership remained elusive for many, with the housing affordability index plummeting from 0.8 in 2010 to 0.4 by mid-2024.[78] This decline underscores the significant financial burden housing prices have placed on Chinese residents. [79] In an exclusive interview with the Chinse newspaper *Economic Observer* in 2021, Sheng Songcheng, former Director of the Survey and Statistics Department of China's central bank, pointed out that the high housing prices not only squeeze the profit margins of brick-and-mortar businesses but also adversely affect consumer expenditure. [80]

Modern market systems are governed by the state. [81] China is no exception. The Chinese government controls economic, business, and social activities. [82] The real estate market serves as a quintessential example of such state regulation, wherein government policies are instrumental in shaping the trajectory of the housing market and, by extension, consumer behavior. Thus, an in-depth examination of pertinent policies and their effects on China's real estate landscape and consumer spending becomes imperative.

Recent scholarly endeavors have delved into the effects of talent attraction policies post-2017 on housing prices. Wen and Zhao (2019) underscored a positive relationship between China's competition policy for talent introduction and rising housing prices, suggesting the talent attraction policy pushed up housing prices. [83] In contrast, Peng et al. (2021) argued that talent attraction policies do not significantly impact urban housing markets, revealing a contentious debate on policy effectiveness. [84] Notably, both studies largely overlook the effects on household consumption, leaving a critical area unaddressed.

A few scholars consider land supply policy as an important contributing factor. Fan et al. (2013) showed that a lower proportion of land supply correlates with higher housing prices. [85] Similarly, Zhang et al. (2013) found that policies that reduced land supply for housing development led to higher prices. In addition, they noted that higher housing prices adversely affect consumer welfare through reduced affordability, especially for those in lower income brackets who are disproportionately affected by the increased housing prices. [86]

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[76] Ibid.
[77] See, for example, Zhang 2011; Eichengreen 2013; Pettis 2013; Yu 2018; Yao 2023.
[78] Numbeo.com 2024b.
[79] Eichengreen 2019b; Numbeo.com 2024a.
[80] China Europe International Business School 2021.
[81] Vogel 2019a; Vogel 2019b.
[82] Lee and O'Brien 2021; Roland 2018; Zhang 2023a; Barma and Vogel 2008.
[83] Wen and Zhao 2019.
[84] Peng, Liu, and Tian 2021.
[85] Fan et al. 2021.
[86] Zhang, Cheng, and Ng 2013.

Some scholars have studied the consequences of the home purchase restriction policy with mixed results. Deng et al. (2021) argued that the home purchase restriction of 2016 and 2017 was effective in containing the surge in local house prices but triggered rising house prices in nearby unregulated markets and raised the consumption of automobiles. [87] Wu and Li (2018) showed that such a policy can reduce housing prices but is less effective in curbing speculative demand, though they did not investigate the policy's effect on consumer behavior. [88] By contrast, Li et al. (2020) questioned the policy's effectiveness and emphasized the housing purchase restriction policy failed in a typical suburb of Beijing. [89]

Some other scholars have emphasized the influence of monetary policies, in particular interest rate policy, at the national level on housing prices. Zhou et al. (2023), for example, suggested that lower interest rate influences borrowing activities in real estate, thereby affecting housing prices. [90] Similarly, Wu and Bian (2017) showed that raising interest rates has a strong negative effect on housing prices. However, they cautioned that such a contractionary monetary policy leads to a considerable decline in private consumption. [91]

While existing literature has provided some insights into the roles of talent attraction policy, land supply regulation, home purchase control, and monetary policy, there is a noticeable gap in understanding the direct and nuanced effects of land price control policy on the housing market and consumer spending patterns.

In this article, I concentrate on this underexplored area. Specifically, the research focus is to unravel the impact of land price control policy on housing prices and, by extension, household consumption in a Chinese city. My hypothesis posits that implementing restrictions on land prices can effectively limit housing prices and foster an increase in household consumption.

This hypothesis rests on two rationales.

The Land Value–Housing Price Nexus

The first rationale is grounded in neoclassical rent theory, which provides a theoretical framework for understanding the relationship between land and housing prices. [92] Specifically, housing, inherently a form of immovable property, is inextricably linked to the value of the land on which it stands. Consequently, elevated land prices invariably precipitate increased housing costs, whereas a reduction in land prices usually leads to more affordable housing. The price of land is, therefore, a pivotal determinant in the valuation of housing, representing an intrinsic factor.

[87] Deng et al. 2022.
[88] Wu and Li 2018.
[89] Li et al. 2020.
[90] Zhou et al. 2023.
[91] Wu and Bian 2018.
[92] Needham 1981; Du, Ma, and An 2011.

Analysts have analogized the correlation between land and housing prices to the relationship between the cost of raw materials and finished goods, exemplified by the direct impact of flour prices on the cost of bread. This analogy underscores the foundational influence of land costs on housing prices. Notably, Du et al. (2011) quantified the potential impact of land prices on housing prices, finding a unidirectional Granger causality from land to housing prices in the short run. [93] This suggests that changes in land prices can predict changes in housing prices, but not vice versa.

Real estate developers share a similar view. Chinese property magnate Wang Jianlin articulated in 2010 a contemplation on the relationship between land and housing prices. According to Wang, the rapid surge in housing prices since 2009 strongly supports the premise that land prices are a critical driver in the appreciation of housing values. In the composition of housing prices, land costs account for a substantial proportion, ranging from 40 to 50 percent, overshadowing construction costs, which amount to less than 20 percent. [94] Although estimates by practitioners in the real estate industry rely on back-of-the-envelope calculations and lack rigorous analysis, they provide some assessment of the impact of land prices on housing prices.

The Housing Price-Consumption Pattern Linkage

The second rationale underpinning the hypothesis is that housing prices, influenced by land price control policies, can impact consumption patterns. In the context of China, high housing prices often compel Chinese parents, and sometimes even grandparents, to help pay the down payment for their adult children, which will create pressure on both young people and their elders to increase their precautionary savings, with a "crowding out effect" on consumption. [95] From a class-based economic perspective, high housing prices affected by land control policies can also influence the spending behavior of both capitalists and workers in China. For capitalists, high housing prices divert investment away from productive capital towards housing, thereby reducing their overall consumption. [96] For workers, high property prices lower lifetime utility and consumption, as their wage income depends on the capital stock of capitalists' firms, which is negatively affected by the high housing prices. [97] Therefore, implementing land price control policies can positively impact consumption.

On the methodological front, I employ the synthetic control method, a quasi-experimental design, to quantify the effect of the land price control policy on housing prices and household consumption in Chongqing. The synthetic control approach is a generalization of the difference-in-difference model. It has multiple advantages. First, it can maximize the similarity between control and treatment in the pre-intervention period based on key characteristics and impute the counterfactual outcome. Second, it can significantly reduce the selection bias since the control units in the donor pool are constructed on data-driven procedures. Third, it has been successfully applied in various fields, including economics, political science, public policy, and energy, demonstrating its versatility and adaptability to different types of interventions and settings.

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[93] Du, Ma, and An 2011.
[94] Sohu Finance 2010.
[95] Sun et al. 2022.
[96] Chen and Wen 2017.
[97] Ibid.

In addition to the synthetic control method, I will also supplement it with a case study of Chongqing and Tianjin. The addition of the qualitative approach is useful, as it provides more contextual relevance and insights into the causal effects of land price control policy on housing prices and consumption. [98]

I focus on Chongqing as our case study for several compelling reasons. Notably, Chongqing introduced a formal policy at the end of March 2013 that explicitly limited land prices to a maximum of one-third of the current housing prices. This policy treatment provides a unique opportunity to study the direct impacts of land price controls on both the housing market and household consumption. In addition, this regulatory intervention stood out, especially when compared to other first-tier and second-tier cities in China, which experienced significant fluctuations and upward trends in housing prices in 2013 and 2014. In contrast, the housing market in Chongqing demonstrated remarkable stability post-implementation of this policy. [99] Moreover, alongside this stability, Chongqing maintained a leading position in consumer spending across China despite its relatively low-income levels among residents, showcasing a robust and resilient economic dynamic. [100] The city's growth rates of total retail sales of consumer goods, which were among the highest in the country, [101] further underscore the unique and successful balance Chongqing achieved between controlling real estate prices and fostering consumer expenditure.

In my qualitative case study, I select Tianjin to compare with Chongqing due to the following reasons. First, both cities are direct-controlled municipalities in China. Second, both cities, according to China's National Bureau of Statistics, are the same tier cities based on multiple political and economic factors. Third, both cities witnessed similar housing price trends and comparable retail sales of consumer goods in the pre-treatment period and divergent trajectories afterward.

I find that in the absence of the policy treatment in Chongqing in March 2013, on average, the housing prices would increase by 6% until June 2014. Further, I find that the policy treatment resulted in an average increase of 5% in total retail sales of consumer goods, a proxy for household consumption. The comparative case study of Chongqing and Tianjin corroborates the empirical findings. In the post-treatment period, Tianjin's land prices increased significantly and were much higher than Chongqing's, which were associated with the salient increase in housing prices and relatively lower total retail sales of consumer goods. Both the quantitative and qualitative analyses provide strong evidence for the negative impact of land price control policy on housing prices and the positive impact on domestic consumption.

Additionally, I provide possible explanations for why Chongqing adopted strict land price control. Rooted in political economics, I argue that Chongqing's land price control policy was a carefully orchestrated response by former mayor Huang Qifan to both local and national

[98] O'Brien 2018.
[99] 21st Century Business Herald 2016.
[100] National Bureau of Statistics n.d.
[101] Chongqing Daily 2015.

imperatives, balancing economic management with political acumen to support housing affordability and sustainable urban development.

This study contributes to a deeper understanding of how land price regulation policies influence housing prices and household consumption. Employing the synthetic control method combined with a qualitative comparative study, this research provides new evidence for scholars. The nuanced insights gained from the Chinese context not only fill a significant gap in the literature but also provide a grounded basis for evaluating the efficacy and consequences of land management strategies.

By examining the motivations and actions of the former mayor of Chongqing, this study underscores the critical role of political leadership in the design and implementation of economic policies. It highlights how individual leaders' economic literacy and strategic vision can profoundly impact policy effectiveness and urban development trajectories. This case study enriches the discourse on political economics by providing a concrete example of how political incentives and personal career objectives can intersect with broader economic and developmental goals.

While this study is focused on China, its findings have broader applicability to other countries experiencing rapid urbanization, economic transition, housing market volatility, and policy challenges. By delineating the causal pathways through which land price regulation impacts economic outcomes, this research provides policymakers with evidence-based guidance to balance growth objectives with housing affordability and robust household consumption. The study's recommendations aim to foster a more sustainable development framework, contributing to the global discourse on real estate policy and economic growth.

The rest of the article is organized as follows: Section 2 describes the methods and data used in this paper. Section 3 provides the empirical results and robustness check. Section 4 compares and analyzes the divergent results of Chongqing's and Tianjin's housing prices and household consumption. Section 5 provides possible explanations for Chongqing's policymaking. Section 6 discusses policy implications and lessons learned. Finally, Section 7 concludes.

Methodology and Data

This section introduces the methods and data. I employ two primary methodologies: the synthetic control method with regularization (or penalization) and a comparative case study. The regularized synthetic control method is used to quantitatively assess the policy effects on housing prices and household consumption. Complementing this, the case study delves deeper into the nuances of land price changes in Chongqing and Tianjin and compares the divergent trajectories of housing prices and total retail sales in these two major cities in China. This dual-method approach ensures a comprehensive analysis, offering valuable insights into the complex dynamics at play.

Methodology

Regularized Synthetic Control Method

Originally developed by Alberto Abadie and Javier Gardeazabal in 2003, the synthetic control is a statistical approach widely used in the field of social sciences to evaluate the effects of policies, interventions, or treatments when traditional experimental designs, like randomized control trials, are not feasible. [102] It appears particularly well suited for the evaluation of relatively rare policy interventions that affect one specific unit. The basic idea of the synthetic control method is to impute the counterfactual outcome under nontreatment based on a combination of other units that are similar to the treated unit before the intervention. [103]

Without loss of generality, consider T periods of observation, where $1, \ldots, T_0$ are pre-intervention periods and $T_0 + 1, \ldots, T$ are post-intervention periods. Suppose a set of $J + 1$ cities, indexed by j where $j \in \{1, \ldots, J + 1\}$. Among these cities, one specific city (designated as city 1, with j =1) is exposed to a land price control policy starting at time T_0 + 1. The remaining cities, indexed as j =2, $\ldots, J + 1$, do not receive the policy intervention. The collection of these untreated cities is referred to as the "donor pool".

For each city and period, define Y_{jt}^N and Y_{jt}^Y as the potential outcomes without and with intervention, respectively. Then, the policy effects for the treated city j =1 at time t for $t > T_0$ are defined as the following:

$$\Delta_{1t} = Y_{1t}^Y - Y_{1t}^N, \forall t \geq T_0 + 1$$

To estimate Y_{1t}^N, the synthetic control method suggests using a weighted average of untreated cities in the donor pool to resemble the treated city in the pre-intervention period, satisfying:

$$\hat{Y}_{1t}^N = \sum_{j=2}^{J+1} w_j Y_{jt}, \forall t = 1, \ldots, T_0 \quad \text{and} \quad \sum_{j=2}^{J+1} w_j Z_j = Z_1$$

Where w_j refers to the weights assigned to each city in the donor pool that are non-negative and sum up to one. Z_1 and Z_j are vectors of observed covariates (or predictors).

To avoid overfitting the data and entail greater accuracy of the estimated effects than the traditional synthetic control method, I also add regularization. Specifically, I choose the L2 norm regularization, which helps in managing the bias-variance trade-off and making the synthetic control estimates more robust against random fluctuations in the data. By penalizing the sum of the squared weights, the number of features used in training is kept unchanged, yet the magnitude of the weights is reduced.

In the implementation, we can define X_1 as the vector of Z_1 and pre-treatment outcomes for Chongqing, and X_0 as a matrix that combines Z_j and pre-treatment outcomes for the donor pool cities. $\widehat{W}$ represents candidate values for the weights.

[102] Abadie and Gardeazabal 2003; Abadie, Diamond, and Hainmueller 2015.
[103] Abadie and Gardeazabal 2003; Abadie, Diamond, and Hainmueller 2010.

V is a symmetric and positive semidefinite matrix accounting for the differential importance of each variable. Sometimes V can be obtained based on subjective assessments of the predictive power of the variables in X_1 and X_0. I employ a data-driven approach inspired by Abadie et al. (2007).[104] I apply the k-fold cross-validation technique to enhance the robustness and generalization capability of the model by systematically testing and selecting V across different data subsets.[105] It takes higher values for more important variables and a value for zero that should not be considered at all.

The choice of the penalization parameter, denoted as λ, plays an important role in balancing this trade-off between bias and variance. While λ can be calibrated manually, it is also more effective and efficient to apply a more automated way to find optimal value through the k-fold cross-validation.

With the optimal V and λ, by minimizing the discrepancy between the treated city and the synthetic control in the pre-treatment period, typically through the following sum of squared prediction error criteria, we can obtain the weights assigned to the donor pool cities, and then the processing effect estimator Δ_{1t} can be determined.

$$\widehat{W} = arg\ \min_w (X_1 - X_0W)^{\mathrm{T}} V (X_1 - X_0W) + \lambda W^{\mathrm{T}} W, \text{ subject to}$$

$$W_j \geq 0 \text{ for } j = 2, \dots, J+1 \text{ and } \sum_{j=2}^{J+1} W_j = 1$$

Qualitative Comparative Case Study

This study employs a comparative case study design to examine the impact of the land price control policy introduced in March 2013 on housing prices and consumption in two Chinese cities, designated as Chongqing and Tianjin. Chongqing serves as the treatment group, which implemented the policy, while Tianjin functions as the control group, with no such policy introduced. This research design allows for a robust analysis of the causal effects of the policy intervention by comparing the trajectories of housing prices and consumption patterns between the two cities.

The case study approach is particularly suited for this research due to its ability to provide in-depth insights into complex phenomena within their real-life context. By focusing on two carefully chosen cities, the study aims to examine the specific effects of the policy intervention qualitatively.

The selection of Chongqing and Tianjin is conducted using a matching process to ensure that the cities are comparable across several critical dimensions. The following criteria are used in the selection process.

[104] Abadie, Diamond, and Hainmueller 2007.
[105] Jung, Patnam, and Ter-Martirosyan 2018.

First, both cities are direct-controlled municipalities in China. This status ensures a similar administrative framework and governance structure, reducing variations in local policy implementation and regulatory environments. Direct control by the central government also implies comparable political and administrative influence, which is critical for isolating the effects of the land price control policy.

Second, in the real estate market assessment, both Chongqing and Tianjin are second-tier cities, according to China's National Bureau of Statistics. [106] In the evaluation of the city's popularity and consumption trends, Chongqing and Tianjin are categorized by Yicai as the new first-tier cities. [107] Selecting cities within the same tier ensures a more accurate comparison of housing market dynamics and policy impacts.

Third, both cities exhibited similar housing price trends before March 2013, which is crucial for establishing a comparable baseline. This similarity suggests that any significant divergence in housing prices post-policy implementation can be more confidently attributed to the policy rather than pre-existing trends.

Fourth, both cities had comparable retail sales of consumer goods before the policy intervention, indicating similar levels of consumer economic activity. The variation in consumption trends post-policy offers an additional dimension for analyzing the policy's differential effects on consumer behavior.

Data

Data Used in the Regularized Synthetic Control

Considering Chongqing as the treated city, I choose the donor pool cities from China's major and medium-sized cities listed by the National Bureau of Statistics. The selection of donor pool cities is mainly determined by the availability of data. Since the synthetic Chongqing is meant to reproduce the housing prices that would have been observed for Chongqing in the absence of the explicit land price control policy, I remove Beijing, Shanghai, Guangzhou, and Shenzhen from the donor pool which introduced other types of land price restriction policies during the period.

In the synthetic control analysis of the policy effect on housing prices, I choose the monthly housing prices in Chinese cities as the outcome variable. I extract housing price data primarily from Anjuke and Wind Terminal. Anjuke is a leading real estate rental and sales service platform established in 2007 in China. When searching on Baidu – the largest online search engine in China – for "buying a house" or "housing prices", Anjuke ranks first. The Wind Terminal provides substantial and first-class economic and financial data including average housing prices. I also cross-check Chinese news that offers information on specific housing prices in certain cities in China.

The predictor variables in this analysis include GDP per capita, average income of urban residents, average income of rural residents, population density, lending rate, and average floor

[106] Statistics Bureau of Fuzhou City 2017.
[107] Yicai 2013.

space purchased per household. I also incorporate dummy variables into the predictors combining both the city tier and geographical location. The city tier is classified into three tiers defined by the National Bureau of Statistics of China which capture the real estate market differences across cities. The geographical location is categorized into north and south which reflect variations like cultural factors. For example, Chongqing is under the classification of “second tier south” and Zhengzhou belongs to “second tier north”. The data of these covariates are extracted primarily from CEIC and Wind Terminal. Founded in 1992 by a team of expert economists and analysts, CEIC provides expansive and accurate data insights into both developed and developing markets including China. In addition, I cross-check the Gotohui online platform that offers comprehensive China’s macroeconomic data.

In the synthetic control analysis of policy effect on household consumption, I choose the monthly total retail sales of consumer goods in Chinese cities as the outcome variable. Total retail sales of consumer goods can be an appropriate proxy for household consumption for several reasons. First, total retail sales of consumer goods include not only the sales of physical goods but also the income from service activities like catering, which are part of everyday consumer expenditures. Second, this indicator directly measures the amount spent by individuals and social groups on non-productive and non-business goods and services, reflecting the actual spending behavior of households. Third, total retail sales of consumer goods data are available on a monthly basis, offering a timely and frequent measure of consumption trends. Fourth, in the context of China, the total retail sales for consumer goods are found closely related to household consumption, both in terms of magnitude and growth trends, [108] further supporting its use as an appropriate proxy for household consumption.

I extract total retail sales of consumer goods data primarily from CEIC and Wind Terminal. I also cross-check reports from the Chinese local Bureau of Statistics if they provide official data.

The predictor variables in this analysis include GDP per capita, average income of urban residents, average income of rural residents, population by usual residence, lending rate, average floor space purchased per household, and investment-GDP ratio. I also incorporate dummy variables of city tiers into the predictors The city tier is classified into the tiers defined by the Yicai based on five primary dimensions: business resource concentration, city hubness, urban population activity, lifestyle diversity, and future potentiality, which capture the city’s popularity, the atmosphere of urban commercial consumption, and consumer philosophy. [109] In addition, I added the “first-tier centrally administered municipality” dummy variable, as direct-administered municipalities in China have distinct economic structures and demographics compared to other first-tier cities, which can help capture the differentiation. For example, Chongqing is under the classification as a “first-tier centrally administered municipality” and Nanjing belongs to a “first-tier city”. The data of these covariates are extracted primarily from CEIC and Wind Terminal. In addition, I cross-check the Gotohui online platform.

Finally, the period under consideration in this study is October 2011 – June 2014. I cut off the post-intervention period in June 2014 because the Chinese government introduced policies to boost the real estate market in the second half of that year. In assessing the impact of the land

[108] Lu 2022.
[109] Yicai 2013.

price control policy on housing prices and consumption, it is essential to consider different post-treatment periods for each analysis. For housing prices, the post-treatment period begins in March 2013, the same month as the policy's implementation. This immediate start is justified because the real estate market in China tends to react swiftly to changes in land policy, as these can directly and quickly alter property values and increase speculations. For household consumption, the post-treatment period starts in April 2013. The rationale here is that changes in housing prices influenced by land price control policies typically take some time to affect consumer behavior and retail sales. Consumers may adjust their spending habits based on changes in their housing costs, which is reflected in retail sales data with a slight delay. By setting the post-treatment periods this way, we reflect the sequence and timing of policy impacts on different economic variables, ensuring that the analyses capture the true effects of the land price control policy.

Data Used in the Comparative Case Study

To analyze city-level changes in land prices, housing prices, and consumption before and after the policy intervention, data were carefully collected from the National Bureau of Statistics, databases such as CEIC and Wind, as well as various online news sources based on their relevance and credibility suggested by senior policy experts and business practitioners in China. Major news sources included Fang.com, a leading real estate and home network platform in China, which provides detailed reports on Tianjin's real estate trends and land reports. Jiemian News, a financial and business news media established by Shanghai United Media Group, offers insights into housing price trends. Anjuke provides comprehensive statistics on housing market dynamics. The collected were then categorized by themes – land price changes, housing market fluctuations, and patterns of total retail sales for consumer goods – facilitating easy retrieval and comparative analysis.

Empirical Results

This section discusses the results of the land price control policy's effects on housing prices and total sales of consumer goods in Chongqing. Besides, I will conduct the robustness test of the empirical results.

The Average Treatment Effect

Effect on Housing Prices

Based on the calculation of the regularized synthetic control method, Table 2.1 shows the comparison of the covariates (or predictors) between real Chongqing and synthetic Chongqing in the pretreatment period. The results show that the variables are matched very well.

Table 2.1: Comparison of Covariates of Real and Synthetic Chongqing

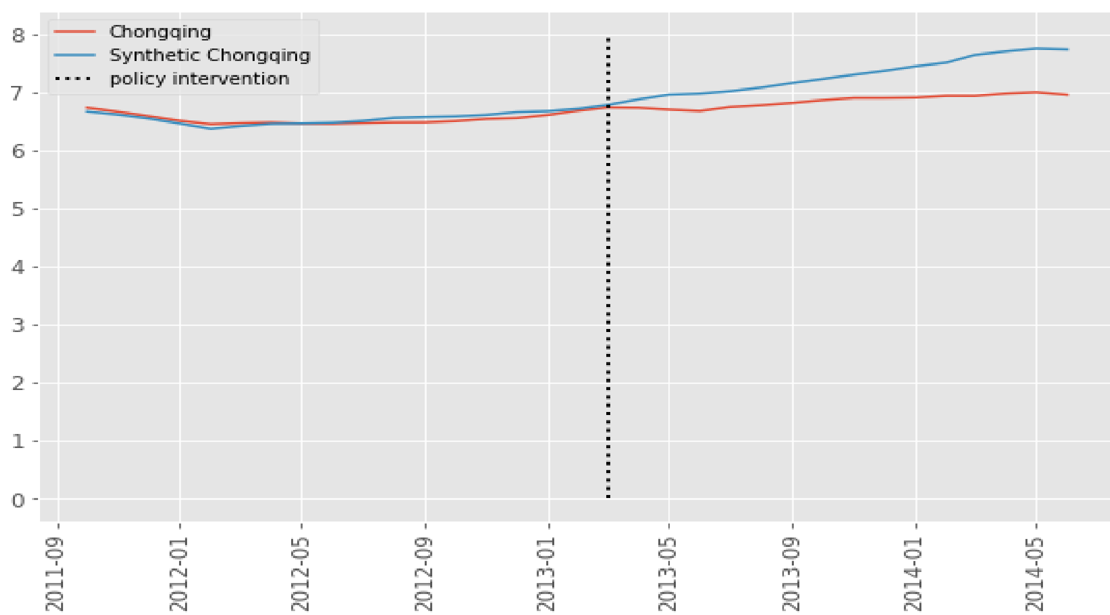
Variables	Real Chongqing	Synthetic Chongqing
Average Floor Space Purchased per Household	0.6	0.6
GDP per Capita	3.5	3.7
Lending Rate	7.2	7.1
Population Density	3.8	3.7
Average Rural Income	2.8	2.9
Average Urban Income	3.2	3.3
First Tier City in the North	0.0	0.0
First Tier City in the South	0.0	0.0
Second Tier City in the North	0.0	0.0
Second Tier City in the South	1.0	1.0
Third Tier City in the North	0.0	0.0
Third Tier City in the South	0.0	0.0

Source: Author's analysis based on data from CEIC, Wind, and Gotohui.

Furthermore, Figure 2.1 displays the actual housing prices in Chongqing and the synthetic counterpart from October 2011 to June 2014. We can see that in the pretreatment period, housing prices of synthetic Chongqing reproduce well the price trajectory of actual Chongqing.

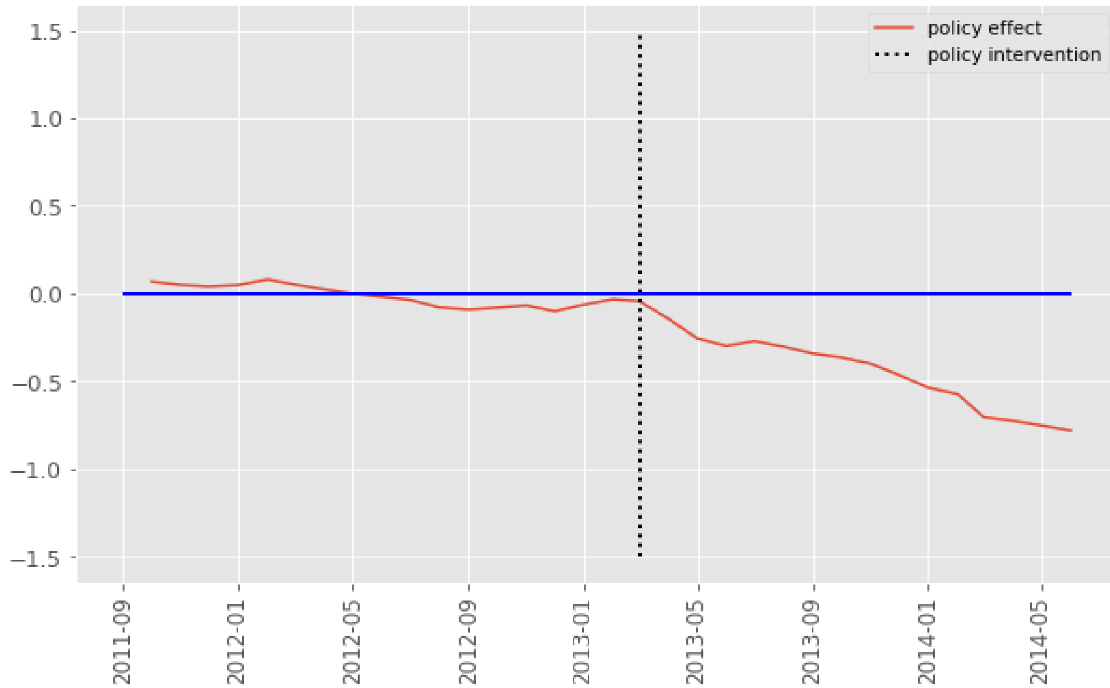
Figure 2.2 shows the difference between synthetic and real Chongqing more intuitively than Figure 2.1. In the post-treatment period, obvious policy effects appeared. On average, in the absence of the land price control policy, Chongqing's housing prices would be 436 yuan per square meter higher between March 2013 and June 2014, a noteworthy increase of approximately 6%.

Figure 2.1: Trends in Housing Prices: Real vs. Synthetic Chongqing



Source: Author's analysis based on data from Anjuke, Wind, and various online news.

Figure 2.2: Treatment Effect on Housing Prices



Source: Author's analysis based on data from Anjuke, Wind, and various online news.

Effect on Total Retails of Consumer Goods

Based on the calculation of the regularized synthetic control method, Table 2.2 shows the comparison of the covariates (or predictors) between real Chongqing and synthetic Chongqing in the pretreatment period. The results show that the variables are matched very well.

Table 2.2: Comparison of Covariates of Real and Synthetic Chongqing

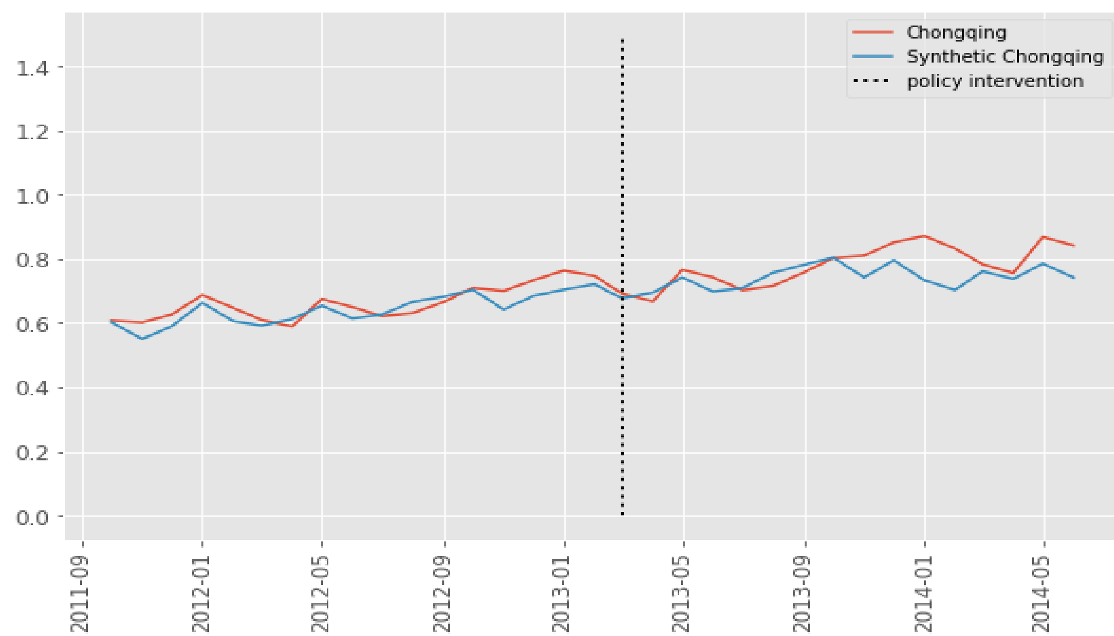
Variables	Real Chongqing	Synthetic Chongqing
Average Floor Space Purchased per Household	0.6	0.4
GDP per Capita	3.5	3.9
Investment-GDP Ratio	1.9	2.0
Lending Rate	7.2	7.1
Population	4.5	4.2
Average Rural Income	2.8	3.1
Average Urban Income	3.2	3.4
New First Tier City	0.0	0.1
New First Tier City (Direct-Administered Municipali	1.0	0.9
New Second Tier City	0.0	0.0
New Third Tier City	0.0	0.0

Source: Author's analysis based on data from CEIC, Wind, Yicai, and Gotohui.

Figure 2.3 shows the paths of total retail sales of consumer goods between real and synthetic Chongqing. Figure 2.4 reveals the difference between the real Chongqing and synthetic Chongqing. In the pre-treatment period, both figures suggest that the differences are mostly small and centered around 0, which is a strong indicator of a good fit. The differences fluctuate around 0, meaning that there are both positive and negative deviations without a consistent trend upward or downward. This lack of systematic bias indicates that the synthetic control unit is not skewed in one direction and is a good approximation of real Chongqing.

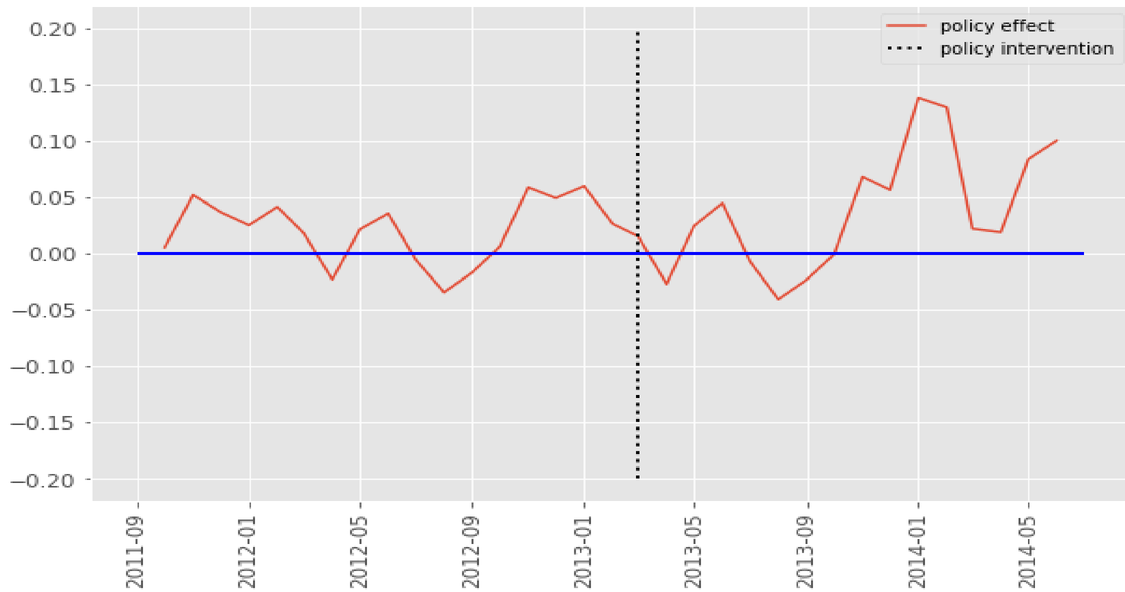
After the intervention, the overall trend of differences suggests the intervention had a notable impact on the real outcomes. Figure 2.4 shows that especially after September 2013, the actual total retail sales of consumer goods diverged more saliently from the synthetic ones. In addition, the ratio of the post-treatment root squared mean prediction error to the pre-treatment RSMPE is approximately 2, which further indicates the land price control policy was effective in altering the total retail sales, leading to a discernible treatment effect. On average, with the land price control policy, Chongqing's total retail sales of consumer goods resulted in an additional 1.95 billion yuan from April 2013 and June 2014 compared to a synthetic control city that did not implement the policy. This means Chongqing's policy contributed to a 5% increase during the post-treatment period.

Figure 2.3: Trends in Total Retail Sales of Consumer Goods: Real vs. Synthetic Chongqing



Source: Author's analysis based on data from CEIC, Wind, and the Chinese local Bureau of Statistics.

Figure 2.4: Treatment Effect on Total Retail Sales of Consumer Goods



Source: Author's analysis based on data from CEIC, Wind, and the Chinese local Bureau of Statistics.

Robustness Check of The Policy Effect on Housing Prices

Placebo Tests

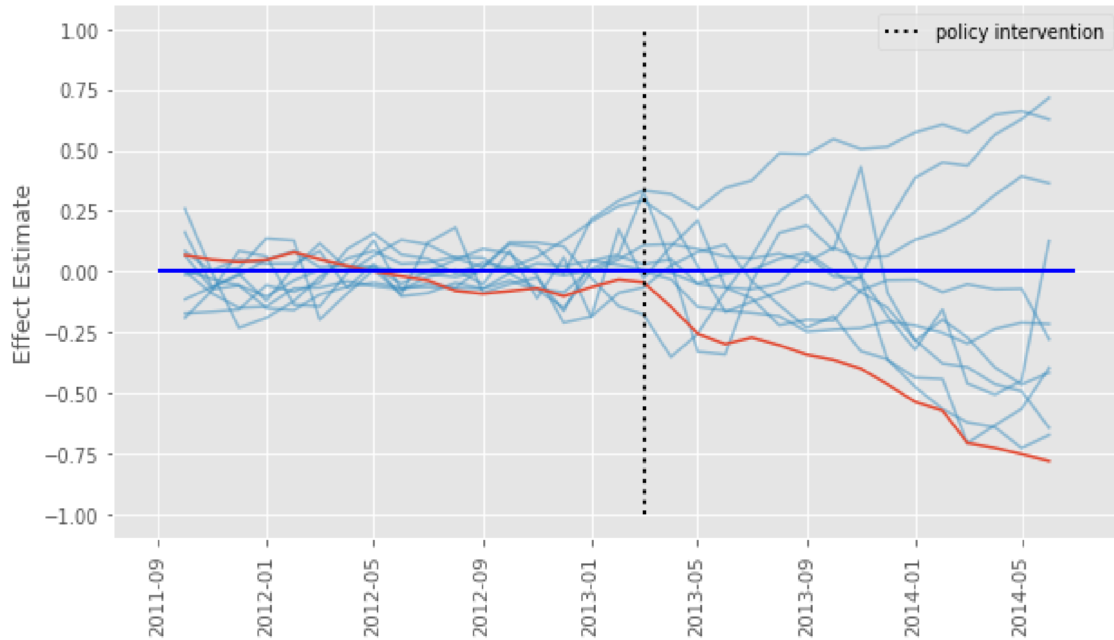
Concerning causal inference, determining the statistical significance of treatment effects using the synthetic control method is "not straightforward" due to the "peculiar setup" of only one treated unit for which the effect is to be evaluated.[110]

The first feasible approach I will employ here is to conduct a placebo test where each of the nontreated units is iteratively considered as the pseudo-treated unit while all remaining nontreated units are used as the donor pool.[111] What this does is it pretends that the treatment happened in another Chinese city, not Chongqing, and see what would have been the estimated effect for this treatment that didn't happen. This approach permits assessing how extreme the treatment effect in Chongqing is relative to the placebo effects.

I excluded cities that have a preintervention mean squared prediction error (MSPE) more than 5 times larger than the MSPE of Chongqing. Figure 2.5 and Figure 2.6 exhibit the results of the placebo test. We can see the estimated housing price gap for Chongqing in the post-treatment period is larger than the gaps for other cities, which suggests that the actual policy effect was not a result of random variation and supports the significance of the results that the impact of the land price control policy in Chongqing on the housing price was negative.

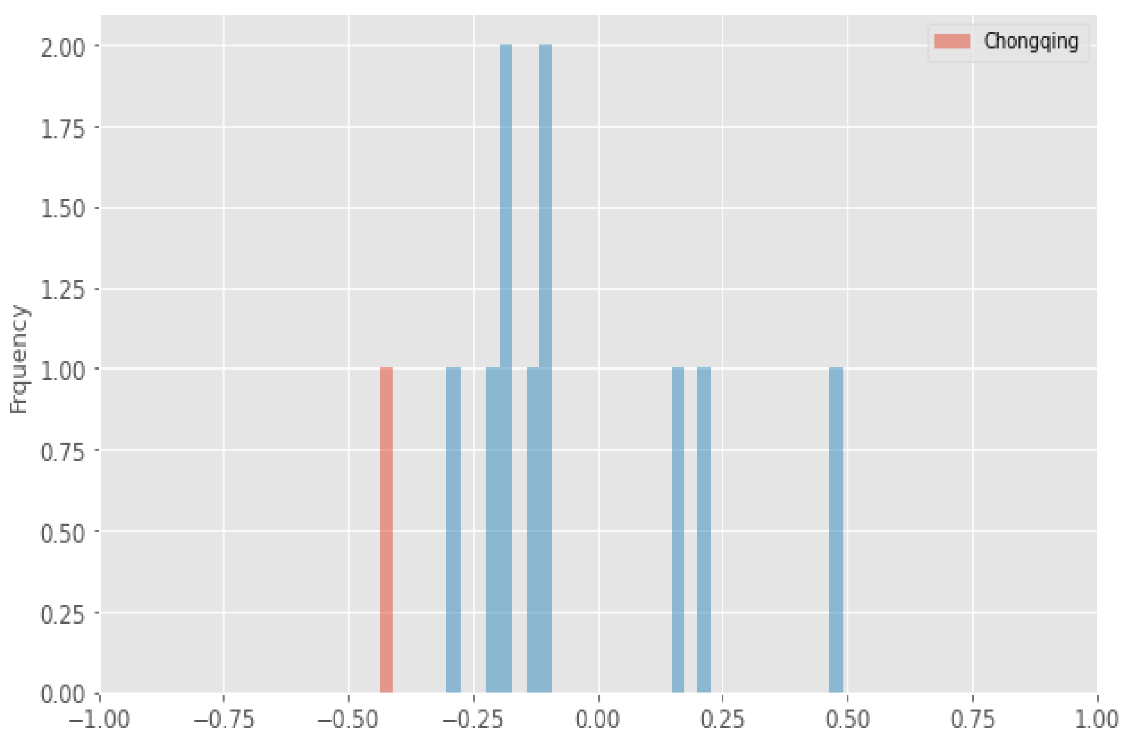
[110] Huber 2023.
[111] Abadie, Diamond, and Hainmueller 2010.

Figure 2.5: Housing Price Gaps in Chongqing and Placebo Gaps in Donor Pool Cities



Source: Author's analysis.

Figure 2.6: Distribution of Effects: Chongqing vs. Donor Pool Cities

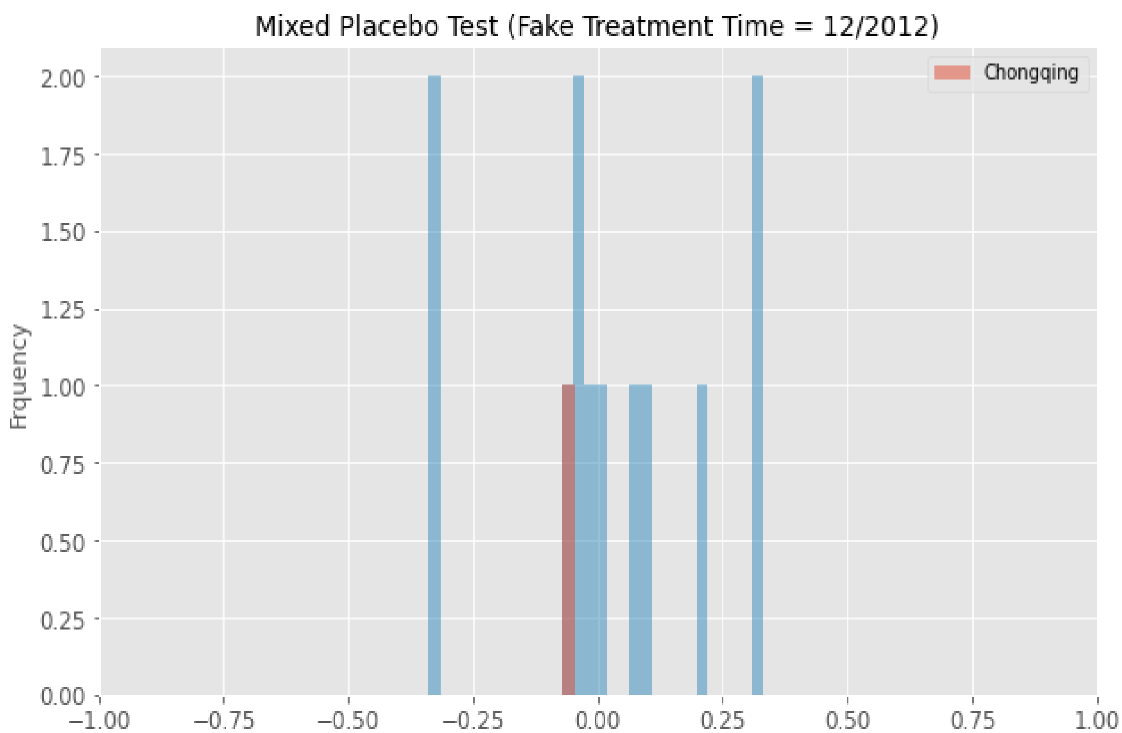


Source: Author's analysis.

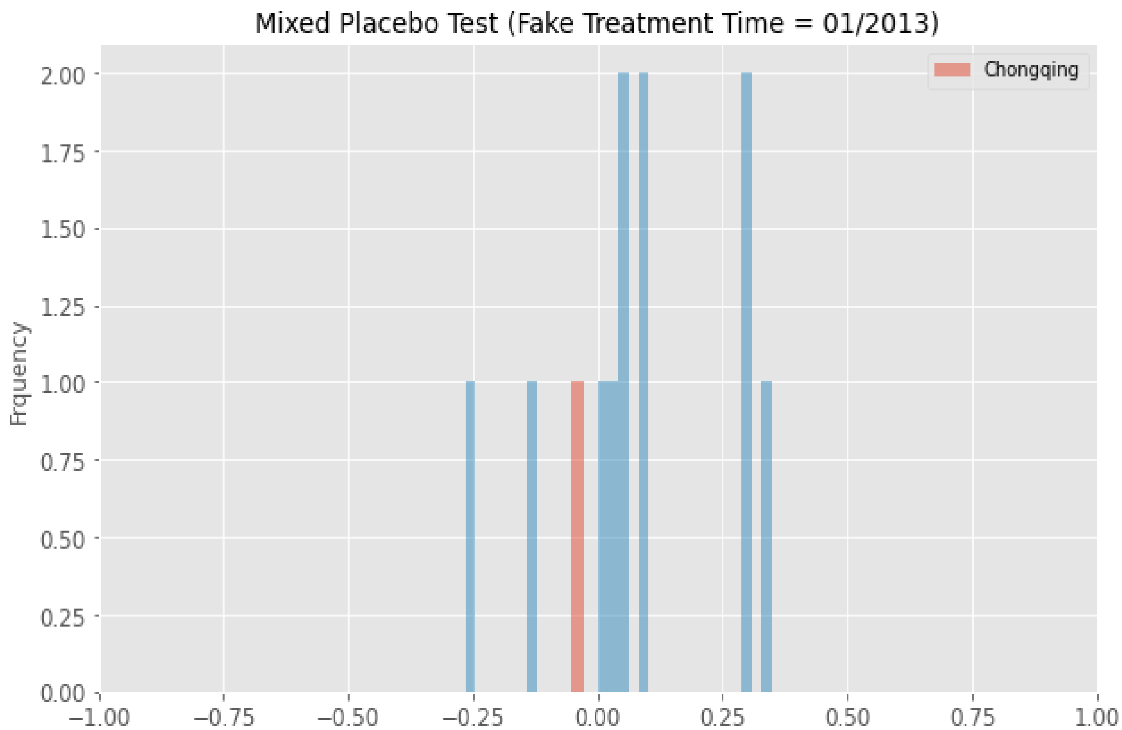
Furthermore, I will conduct a mixed placebo test, which combines the abovementioned placebo test with an in-time placebo test. As Chen and Yan (2023) elucidated, in contrast to the in-time placebo test that "does not do inference", the mixed placebo "uses a fake treatment time and fake treatment units simultaneously" and "suffices to discuss the validity of statistical inference".[112]

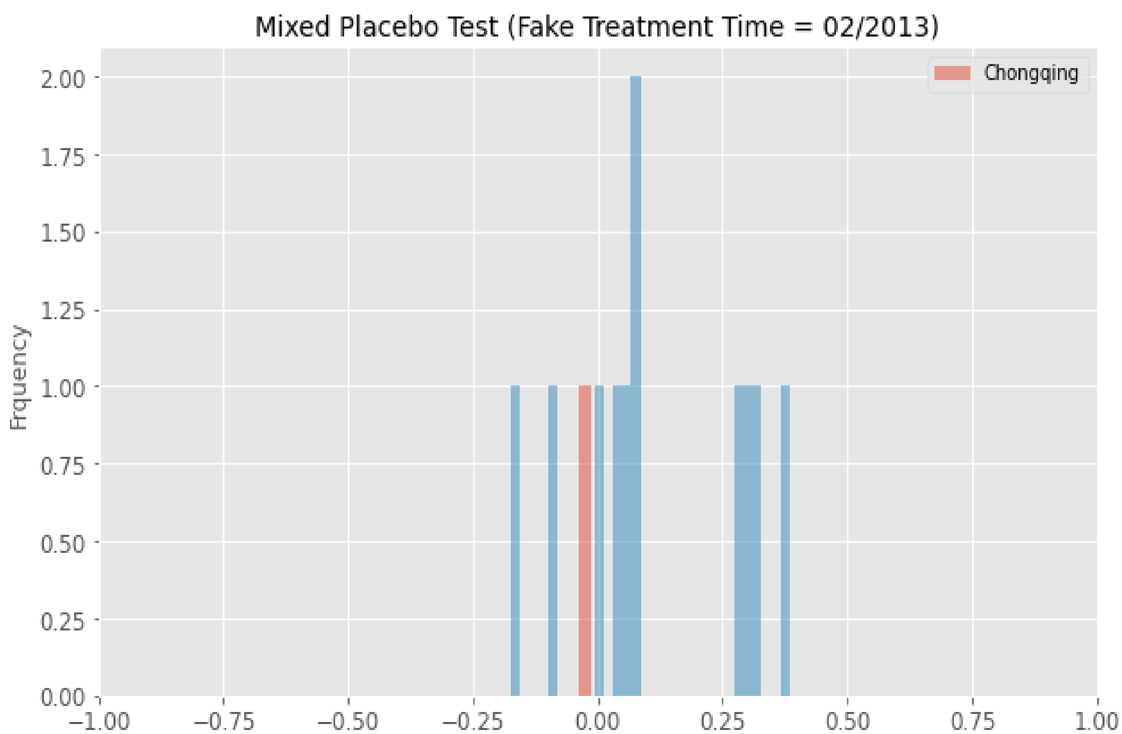
As Figures 2.7 – 2.9 show, for each of the fake treatment times (i.e., 12/2012, 01/2013, 02/2013), the mixed placebo test did not find significant placebo effects, which supports the robustness of the actual policy effect of Chongqing. This means that the negative impact of the land price control policy on housing prices was likely a true effect, not confounded by pre-existing trends or placebo effects.

Figures 2.7-2.9: Distribution Effects in Mixed Placebo Tests



[112] Chen and Yan 2023.





Source: Author’s analysis.

Conformal Inference

In addition to the placebo tests mentioned above, I also employ conformal inference to compute the p-value, which focuses on the placebo effects of the treated unit, Chongqing, rather than the nontreated donor pool.

Firstly, I calculate the test statistic for the original unpermuted data based on the following equation proposed by Chernozhukov et al. (2021): [113]

$$S(\hat{u})_q = \left(\sum_{t=T0+1}^{T} |u_t|^q \right)^{1/q}$$

Where, u_t represents the residuals at time t, T_0 is the last pre-treatment time point, and T is the last time point in the dataset.

Secondly, I generate a set of permuted datasets by applying block permutation to the data. In block permutation, the entire sequence of data points is shifted circularly, maintaining the temporal structure.

Thirdly, for each permutated dataset, I calculate the test statistic using the same equation as for the original data. Then I compare the test statistic of the original data with those obtained from the permutated datasets and count how many permuted test statistics are as extreme as or more extreme than the original test statistic.

Finally, I compute the P-value using the following equations:

$$\text{P-value} = \frac{1}{|\Pi|} \sum_{\pi \in \Pi} 1\,\{S(\hat{u}_{\pi_0}) \leq S(\hat{u}_{\pi})\}$$

Where $|\Pi|$ is the total number of block permutations, π is a specific block permutation, and $1\{\}$ is an indicator function that is 1 if the condition inside is met and 0 otherwise. $S(\hat{u}_{\pi_0})$ is the test statistic for the original data and $S(\hat{u}_{\pi})$ is the test statistic for the permuted data.

The empirical p-value is 0.061, indicating the probability of observing a treatment effect as extreme as or more extreme than 436 yuan per square meter under the null hypothesis. If we set the significance level at 0.05 or lower, the empirical p-value is higher than the significance level and therefore we do not reject the null hypothesis that the average treatment effect is 436 yuan per square meter. This conformal inference analysis lends support to the claim that Chongqing's land price control policy had a significant impact on housing prices.

[113] Chernozhukov, Wüthrich, and Zhu 2021.

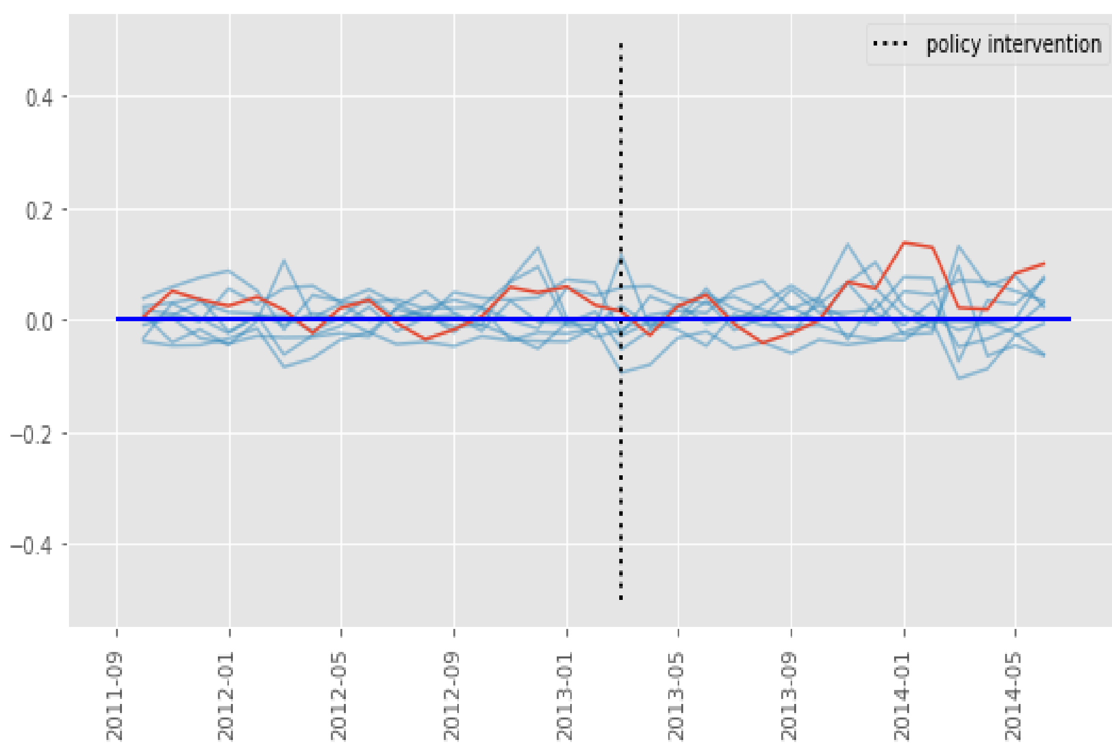
Robustness Check of The Policy Effect on Total Retail Sales of Consumer Goods

Placebo Tests

For the robustness check of the policy effect on total retail sales of consumer goods, I first conduct a placebo test by applying the regularized synthetic control method to estimate the average treatment effect of Chongqing's land price control policy on each other donor pool city.

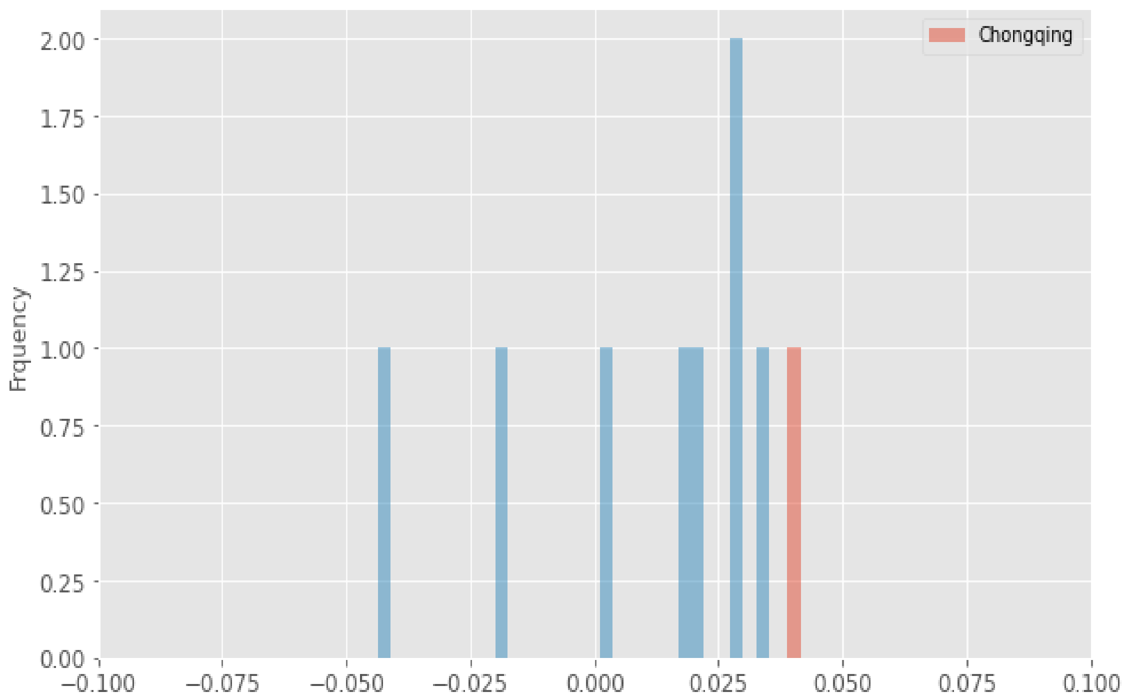
I excluded cities that have a preintervention mean squared prediction error (MSPE) more than 5 times larger than the MSPE of Chongqing. Figure 2.10 and Figure 2.11 exhibit the results of the placebo test. Although the visual deviation in Figure 2.10 may seem slight between Chongqing and other treated units, Figure Y clearly shows that the red bar (Chongqing) is separated from the blue bars (treated units) and is the highest, indicating the observed effect in Chongqing is more pronounced than any of the placebo effects. This confirms that the observed actual policy effect was not a result of random variation and supports the significance of the results that the impact of the land price control policy in Chongqing on the total retail sales of consumer goods was positive.

Figure 2.10: Total Retail Sales Gaps in Chongqing and Placebo Gaps in Donor Pool Cities



Source: Author's analysis.

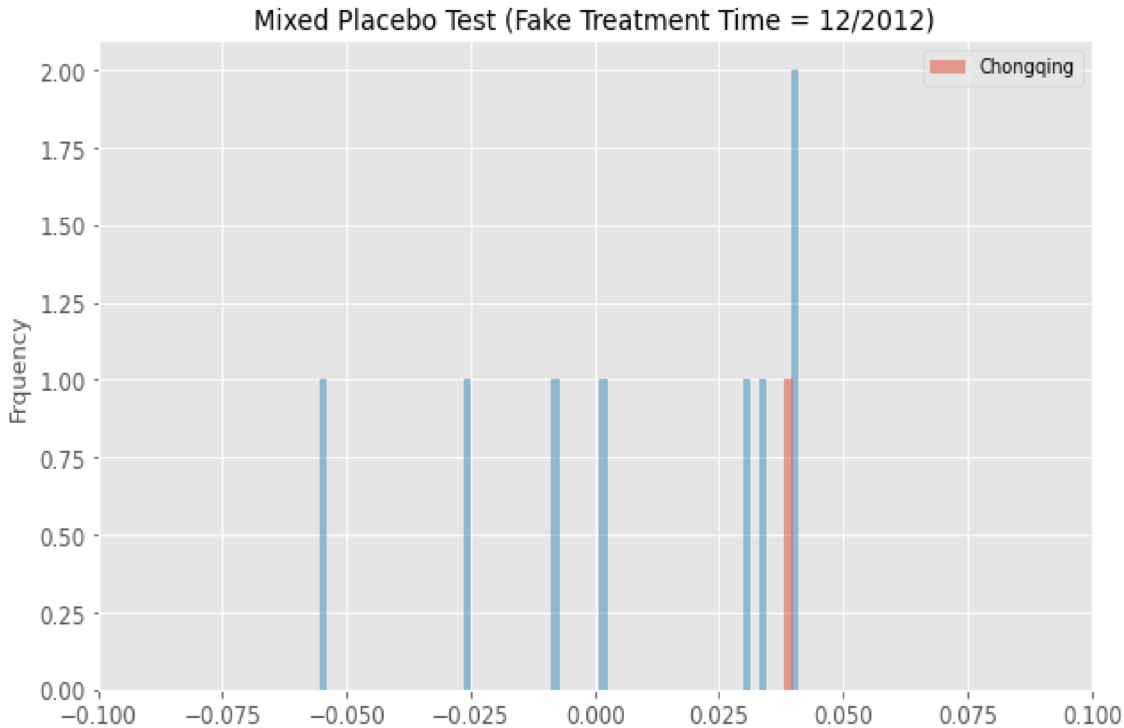
Figure 2.11: Distribution of Effects: Chongqing vs. Donor Pool Cities

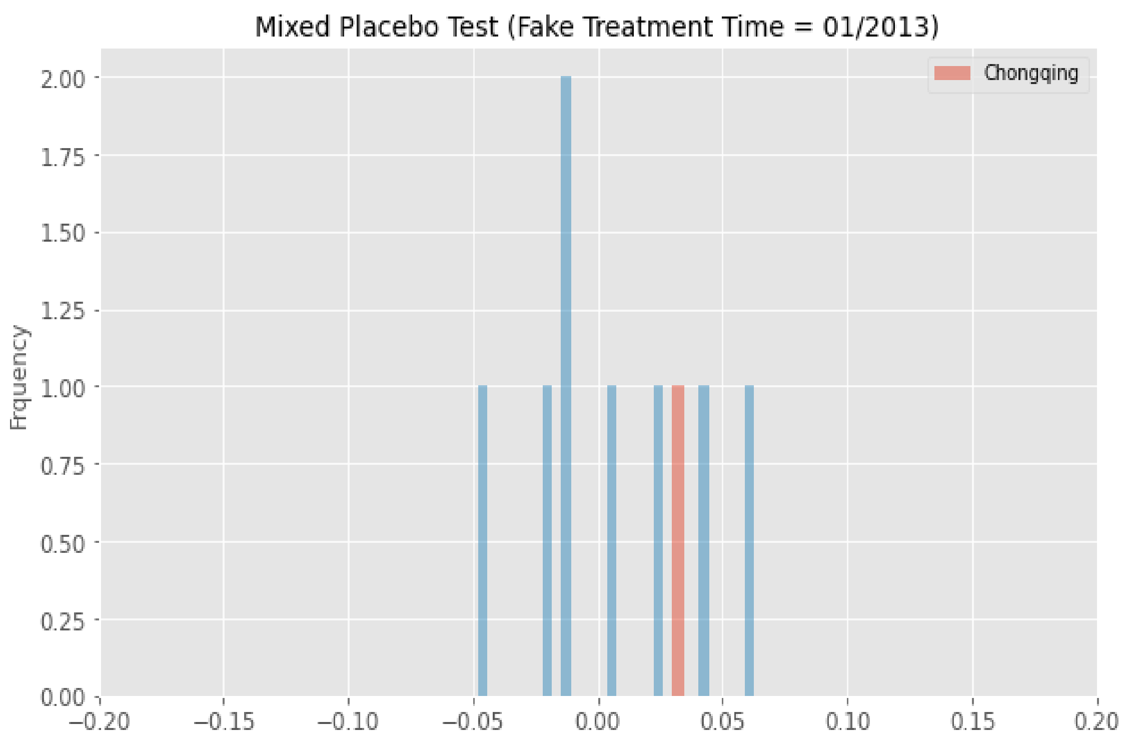


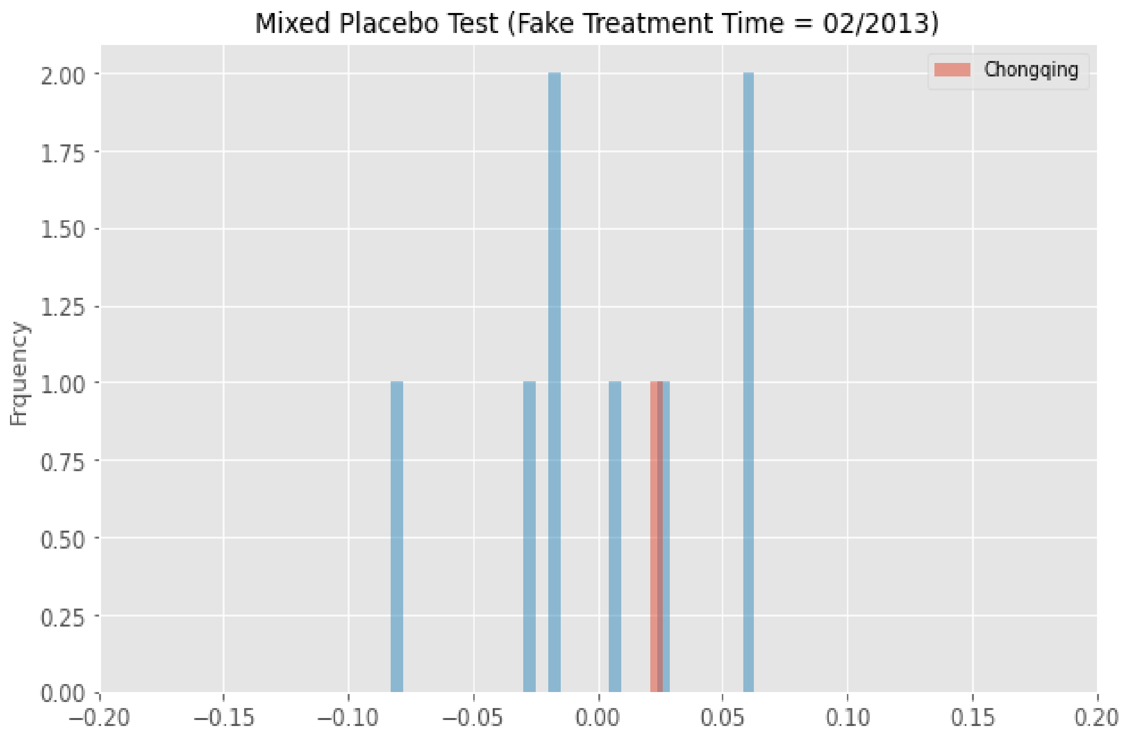
Source: Author's analysis.

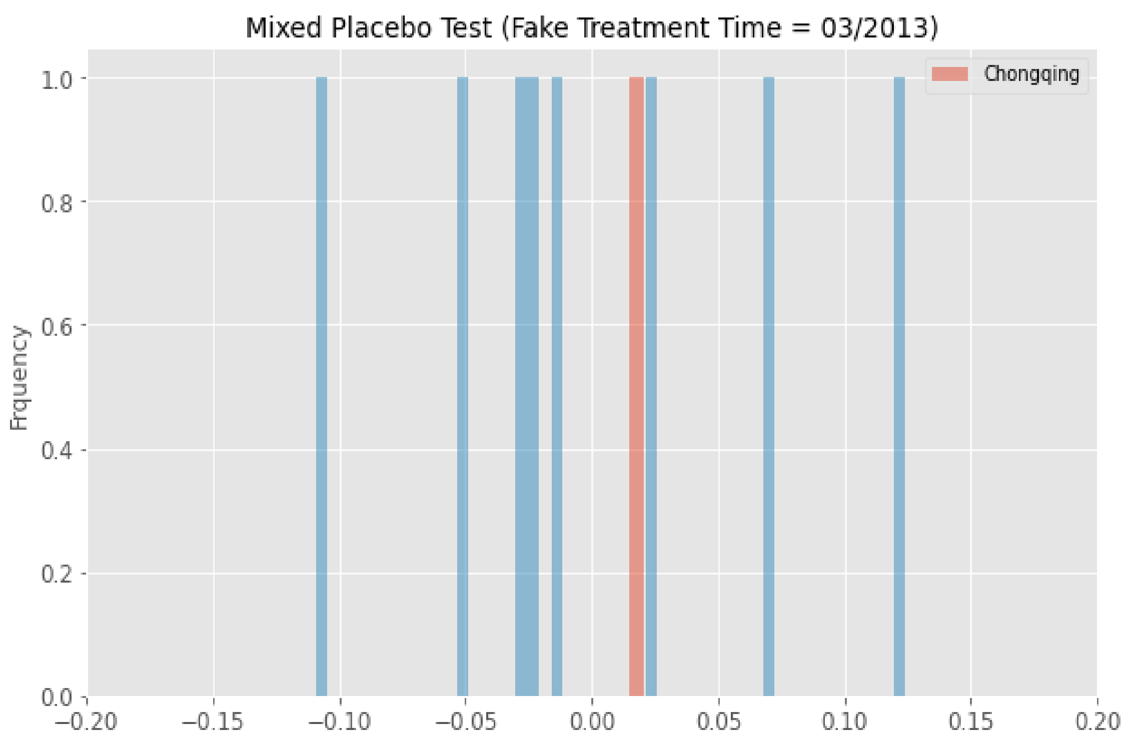
I also conduct a mixed placebo test which uses fake treatment times and fake treatment units. As Figures 2.12 – 2.15 show, for each of the fake treatment times (i.e., 12/2012, 01/2013, 02/2013, 03/2013), the mixed placebo test did not find significant placebo effects, which supports the robustness of the actual policy effect of Chongqing. This means that the positive impact of the land price control policy on total retail sales of consumer goods was likely a true effect, not confounded by pre-existing trends or placebo effects.

Figures 2.12-2.15: Distribution Effects in Mixed Placebo Tests









Source: Author's analysis.

Conformal Inference

In addition to the placebo tests mentioned above, I also employ conformal inference to compute the p-value, which focuses on the placebo effects of the treated unit, Chongqing, rather than the nontreated donor pool.

The empirical p-value is 0.18, indicating the probability of observing a treatment effect as extreme as or more extreme than 1.95 billion yuan under the null hypothesis. If we set the significance level at 0.05 or lower, the empirical p-value is higher than the significance level and therefore we do not reject the null hypothesis that the average treatment effect is 1.95 billion yuan. This conformal inference analysis lends support to the claim that Chongqing's land price control policy had a significant impact on the total retail sales of consumer goods.

Chongqing vs. Tianjin: Divergent Trajectories

I have demonstrated the strong causal effects of Chongqing's land price control policy on housing prices and total retail sales for consumer goods. This section supplements the empirical analysis with a comparative qualitative study between Chongqing and Tianjin. This case study illustrates the divergent trajectories of the two cities' land prices, housing prices, and total retail sales of consumer goods, showing the outcomes with and without the policy, thereby providing a more detailed and nuanced understanding.

Between 2013 and 2014, Tianjin's real estate sector experienced a remarkable period characterized by a lack of explicit policy restrictions on land prices, leading to multiple record-breaking land transactions.

On September 18, 2013, a significant transaction occurred when Tianjin Sunac Hongrun Real Estate Co., Ltd. acquired the Nankai Tiantuo plot for 10.32 billion yuan. This transaction set a new record for the highest total price of a single land transaction in Tianjin. It had a premium rate of 12.42% and a considerably high floor price of 10,109 yuan per square meter. [114]

On November 1, 2013, the same company successfully bid 1.52 billion yuan for the Nankai district watch factory plot, with a premium rate of 32%, equivalent to a floor price of 25,082 yuan per square meter. [115] This transaction set another record for the highest single price of land in Tianjin. Major real estate developers such as Luneng, Vanke, Rongqiao, China Resources, and the Sunac Tianfang consortium participated in the auction, underscoring the competitiveness of Tianjin's land market.

The year 2013 was not only about these two major land deals; Tianjin's land market performed remarkably well overall. The entry of Jinqiao into the Ximeljiang area and Dacheng Xingye's acquisition of land on Xiangjiang Road became hot topics among industry insiders and home buyers in Tianjin. For instance, on July 5, a plot in Hongqiao District was sold for 653 million yuan, with a floor price of about 6,530 yuan per square meter, and on September 26, Tianjin

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[114] Reallyinfo 2014.
[115] Ibid.

Jinqiao City Investment Co., Ltd. acquired another significant plot for 1.905 billion yuan, with a premium rate of 64.65% and a floor price of about 14,359 yuan per square meter. [116]

In 2014, the absence of land price control policies led to continued rises in starting prices for land auctions. For example, the auction of a 45,900 square meter plot in Huayuan Science and Technology Park on January 26, 2014, ended with a winning bid of 884 million yuan, a floor price of 9,633 yuan per square meter, and a staggering premium rate of 140.81%.[117] From January to June 2014, floor prices in residential areas such as Hexi District, Nankai District, Binhai High-Tech Zone, Hebei District, and the Development Zone soared to remarkably high levels, ranging from 7,200 yuan per square meter to an impressive 14,504 yuan per square meter.[118] This significant variation in floor prices reflected the unregulated auction system's impact on land prices.

The average residential land price in Tianjin also escalated significantly over these years. In 2012, it was 3,043 yuan per square meter. This figure jumped to 4,287 yuan per square meter in 2013 and further to 5,722 yuan per square meter in 2014, with year-over-year growth rates of approximately 34% to 41%. These statistics highlight the rapid growth in land prices and the profound impact of market dynamics in the absence of regulatory measures during this period.

In stark contrast to Tianjin's unfettered market dynamics, due to the implementation of stringent regulatory policies to cap land prices in 2013, Chongqing witnessed a substantially more temperate growth trajectory in its real estate sector. This regulatory approach effectively curtailed the rapid escalation of land prices, resulting in significantly lower floor and average prices for major land transactions. In 2013, a prominent consortium comprising Vanke and Poly, two of China's leading real estate developers, acquired a substantial plot in the Jiangbei Ilanxi area, encompassing 282,392 square meters. The initial total price for this acquisition was a modest 5.372 billion yuan, equating to roughly 12.7 million yuan per mu, and translating to a floor price of merely 4,323 yuan per square meter. [119] This figure starkly contrasts with the exorbitant rates observed in Tianjin, underscoring the effectiveness of Chongqing's regulatory framework.

Furthermore, the land prices in Chongqing exhibited remarkable stability in 2013 and 2014, with average prices per square meter being pegged at 2,366 yuan and 2,633 yuan, respectively. [120] These figures represent modest year-over-year increases of 9% and 11%, starkly juxtaposed against the rapid escalation in Tianjin. Notably, these rates amounted to just approximately 55% and 45.7% of Tianjin's average residential land price, respectively, in the corresponding years.

Over the same period, Tianjin's housing prices showed a clear upward trend, starting at 13,083 yuan per square meter in October 2011 and rising to 15,263 yuan per square meter by June 2014. Notably, between April 2013 and June 2014, housing prices in Tianjin witnessed an increase of approximately 14%, indicating robust market growth.

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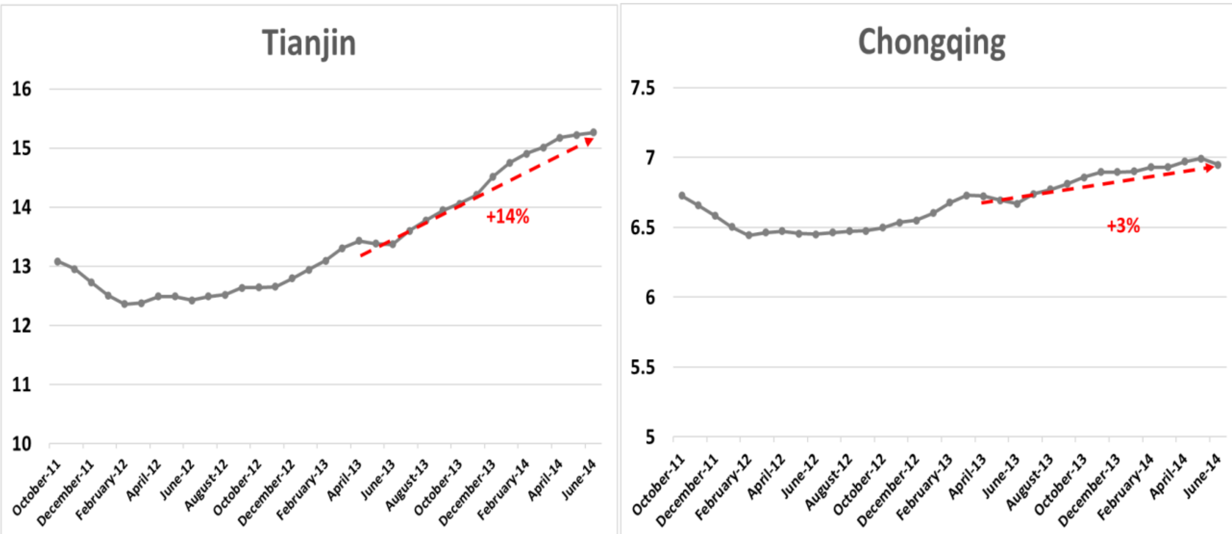
[116] fang.com 2013.
[117] Zhu 2014.
[118] fang.com 2014.
[119] China.com.cn 2013.
[120] JMedia 2020.

In contrast, Chongqing’s housing prices were relatively stable, beginning at 6,728 yuan per square meter in October 2011 and slightly increasing to 6,950 yuan per square meter by June 2014. In the post-policy treatment period, housing prices only saw a minor rise of approximately 3%.[121] The impact of the land price control policy in Chongqing appeared substantial on housing prices, reflecting a different market dynamic compared to Tianjin (Figure 2.16).

Figure 2.16: Housing Prices (in Thousand RMB/Sq. M): Tianjin vs. Chongqing



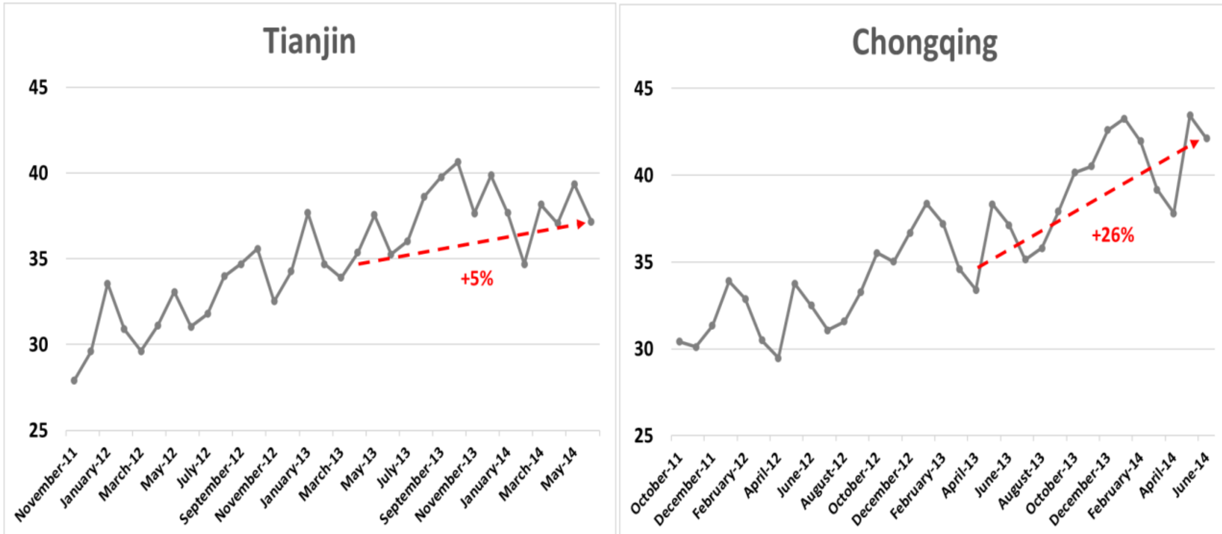
Source: Author’s analysis based on data from Anjuke.

Meanwhile, Chongqing’s total retail sales for consumer goods showed a consistent increase. Following the implementation of the land price control policy, retail sales in Chongqing demonstrated healthy growth with an approximately 26% increase, reflecting a strong consumer market.

By contrast, Tianjin’s retail sales figures, although on an overall upward trajectory between October 2011 and June 2014, displayed a more moderate growth. After the policy intervention, total retail sales for consumer goods in Tianjin increased by only about 5%, significantly less than Chongqing's (Figure 2.17). This suggests that while both cities experienced growth, Chongqing's retail market responded more positively post-policy implementation compared to Tianjin’s.

[121] Anjuke 2024.

Figure 2.17: Total Retail Sales for Consumer Goods (in Billion RMB): Tianjin vs. Chongqing



Source: Author's analysis based on data from CEIC and Wind.

Rationale Behind Chongqing's Stringent Land Price Control Policy

The formal land price control policy introduced in Chongqing in 2013 begs the question: what were the motivations of the municipal government? Although a causality test of why Chongqing pursued the stringent policy is beyond the scope of this study, this section provides possible political economy explanations.

The stringent regulation of land prices in Chongqing was mainly attributed to Huang Qifan, who was the mayor in charge of the city's economic activities at the time.
Firstly, the economic rationale for Chongqing's strict land price control policy in 2013, as an option to prevent housing price spikes, reflected Huang's strategic vision for urban economic management.

Distinguished from other local cadres in China, Huang Qifan has a deep-rooted understanding of land economics and the property market. As early as the early 1990s, when he was the deputy director of the Pudong New Area office, Huang oversaw the urban development of Pudong, providing him with practical insights into policies and the dynamics of the real estate sector in a rapidly modernizing China. [122]

Through in-depth studies of Hong Kong's land leasing and Western land auction systems, Huang Qifan identified inherent flaws in the existing land auction system, notably its propensity to escalate land prices due to the competitive nature of the "highest-bidder-wins" approach. While this system was effective in reducing corruption and gray market transactions, Huang recognized that it inadvertently led to inflated land costs, and therefore advocated for the use of

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[122] Huang 2020a.

administrative measures as a counterbalance to these market forces. In his book *Structural Reform*, he specifically wrote:

> Generally speaking, the floor price of land should not exceed 1/3 of the current housing price. If the current housing price in the surrounding area of the land is 10,000 yuan per square meter, then the land price should stop at 3,300 yuan per square meter; otherwise, it will be considered as driving up housing prices. When the supply of land is sufficient, reasonable, and effective, if the land price is high, the government should sell more of its reserve land to balance it out; when the cost of demolishing and rebuilding old cities is high, the government should not raise land prices just to avoid losses but should take a portion of the income from selling land in the suburban areas to balance it out, covering the costs of old city reconstruction... The government may seem to be at a small loss, but with a better investment environment, the development of commerce and industry, and a balance between the real economy and real estate, this will ultimately promote the long-term healthy development of the city. [123]

Huang's policy stance is particularly noteworthy given the context of China's economic landscape, where land sales constituted a significant revenue stream for local governments. In contrast to the prevalent trend of aggressive land sales by local authorities, often prioritizing immediate GDP growth over sustainable urban development, Huang's emphasis on making concessions for the city's long-term growth is exceptional.

In addition to his economic understanding that exorbitant land prices not only drive up housing prices but also adversely impact the broader real economy, the administrative regulation to limit land prices introduced in Chongqing during Huang's tenure had significant political considerations as well.

Contrary to many local cadres who engendered an "irresponsible state", [124] Huang Qifan made socio-economic decisions and allocated resources in a manner that catered to the public good. This professional and service-oriented approach subsequently facilitated the realization of his personal political ambitions. Huang Qifan's policies, which included keeping land and housing prices in Chongqing relatively low, garnered widespread acclaim from the citizens of Chongqing. Ensuring a high-level inclusion of popular demands was instrumental in enhancing his political stature and public approbation in the city. As reported by Chinese media in 2017, Chongqing experienced a marked increase in GDP and resident income in 2013 and 2014, whereas housing

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[123] Huang 2020b. See the original Chinese: "一般来说，楼面地价不要超过当期房价的 1/3. 如果地块周边当期房价为 1 万元/平方米，那么地价拍到 3300 元/平方米就要适可而止，否则就会认为推高房价。当土地供应比较充分、合理、有效的时候，如果地价高了，就把政府的储备地多卖几块来平衡一下；当旧城改造的拆迁成本很高时，政府不能为了不亏本而抬高地价，而应从城郊接合部的出让土地收入中拿出一部分来平衡，以此覆盖旧城改造的成本。政府看似吃了点小亏，但整个投资环境好了，工商经济发展了，实体经济和房地产之间平衡了，最终会推动城市的长期健康发展。"

[124] Cai 2004.

prices almost stabilized. [125] After Huang left Chongqing in 2016, “land kings” mushroomed in the city, and housing prices almost doubled within a year. Most of the populace attributed the stability of Chongqing's housing prices to Mayor Huang Qifan's adept management of urban land governance.

As a politician, Huang Qifan knows that an effective policy should also be in accordance with central-level guidelines. [126] Thus, he orchestrated the economic development model of Chongqing and adeptly managed the housing market, which earned him a reputation as a policy expert within China's political arena and significantly captured the attention of the top leadership in Beijing, aiding Huang in ascending further in his political career.

Since the 18th National Congress of the Chinese Communist Party in 2012, President Xi Jinping has repeatedly articulated significant expositions, elucidating his perspective on “people's livelihood” and underscoring the importance of safeguarding and enhancing the people's well-being. He delineated the focal points of livelihood work for the present and foreseeable future, aiming to unite the vast majority of the populace in the pursuit of a prosperous China. He emphasized, “Focusing on the people's livelihood, valuing it, safeguarding it, and improving it, constitute the sacred duty and ultimate goal of the Party and the government. Continuously improving people's livelihood is the essence and ultimate aspiration of realizing the 'Chinese Dream,' which primarily encompasses the nation's prosperity, national rejuvenation, and people's happiness”. [127] From the government's perspective, Chongqing, in the year following the 18th National Congress, namely 2013, introduced a stringent land price control policy aimed at addressing “people's basic needs”, in alignment with Xi's slogan.

In the subsequent years, it was reported that Huang Qifan “did an excellent job in Chongqing” and might be “tipped to replace Yang Jing as the secretary-general of the State Council, or cabinet”. [128] Although Huang did not secure this appointment, he successfully transitioned to Beijing in 2017, assuming the position of Deputy Director of the National People's Congress Financial and Economic Committee, and he remains active in the policy realm in China. [129]

Policy implications and lessons learned

Policy Intervention as a Tool for Stability and More Sustainable Growth

Policy treatments, when appropriately designed and implemented, have significant impacts on market trends and consumer behavior. During periods of rapid economic growth and booming real estate markets, the land price control policy in Chongqing has proven to be an effective measure for limiting housing prices and supporting consumer spending. By preventing speculative bubbles and boosting domestic consumption, such policies can ensure housing affordability and help economic transition, thereby promoting sustainable growth. This not only

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[125] Guancha.cn 2017.
[126] Huang 2020b; Huang 2020a.
[127] Yicai News 2014.
[128] Reuters 2016.
[129] Caixin News 2017.

addresses structural imbalances within the Chinese economy but also contributes to a more balanced global trade environment.

Policy Adjustments in Times of Economic Deflation

In the current context of economic deflation and a real estate downturn in China, policymakers face different challenges. To prop up (not excessively boost) the housing market, the government might consider removing any existing land price control policies introduced after 2017 to allow market mechanisms, such as competitive bidding, to play a larger role. This may help housing prices rebound. However, there are significant risks associated with this approach. Even with the recent drop in housing prices, housing in major cities remains very expensive and unaffordable for the working and middle classes. Removing land price controls could further constrain consumer spending, which would be detrimental to recent efforts to increase household consumption. Therefore, any policy adjustments must be carefully crafted to achieve balanced and sustainable development while preventing systemic risks.

Insights for Rapidly Growing Economies

The experience of Chongqing provides valuable lessons for other rapidly growing economies, particularly those with booming real estate markets. Countries that are experiencing high economic growth and rising land and housing prices can draw insights from the success of Chongqing's land price control policy. By analyzing and referencing Chongqing's approach, policymakers in these countries can explore and craft tailored land policies that promote balanced and inclusive economic growth, ensuring that the benefits of growth are widely shared and that the housing market remains accessible and affordable.

The Role of Policymakers Cannot be Ignored

Designing and implementing effective policies requires policymakers with a strategic vision for economic management. Policymakers need to have a deep understanding of economics and markets, adopting a service-oriented approach that considers both economic and social consequences in the short and long run. Whether in democratic or authoritarian countries, the focus on people's livelihood is paramount. Valuing, safeguarding, and improving the welfare of the population should be the sacred duty and ultimate goal of the state. This balanced approach ensures that policies are not only economically sound but also socially equitable, fostering long-term stability and prosperity.

Conclusion

This paper has analyzed the effects of Chongqing's land price control policy in 2013 on curbing the spike in housing prices and supporting domestic consumption. Utilizing the regularized synthetic control method, my findings show that without the land price control policy, housing prices in Chongqing would be 6% higher, and total retail sales for consumer goods (a proxy for household consumption) would be 5% lower. Meanwhile, the placebo tests and conformal inference analyses have confirmed that the findings are fairly robust. A comparative case study with Tianjin, which did not have the policy intervention, further illustrates divergent trajectories in land prices, housing prices, and consumption, where Tianjin experienced significantly higher land and housing prices coupled with lower consumption during the post-intervention period of Chongqing. Both the quantitative and qualitative analyses suggest that the impacts of the land price control policy were significant.

This study makes significant contributions to the academic literature and policy debates on China's development. This study contributes to a deeper understanding of how land price regulation policies influence housing prices and household consumption. The nuanced insights gained from the Chinese context not only fill a significant gap in the literature but also provide a grounded basis for evaluating the efficacy and consequences of land management strategies. By examining the motivations and actions of the former mayor of Chongqing, this study also finds that the strategic vision and deep economic understanding of Huang Qifan enabled a balanced approach that considered both short-term economic returns and long-term socio-economic development. This highlights the importance of capable and informed policymakers in crafting effective economic policies, which enriches the discourse on political economics by providing a concrete example of how political incentives and personal career objectives can intersect with broader economic and developmental goals.

While this study is focused on China, its findings have broader applicability to other economies experiencing rapid urbanization, housing market volatility, and policy challenges. This research provides policymakers with evidence-based guidance to balance growth objectives with housing affordability and robust household consumption. The study's recommendations aim to foster a more sustainable development framework, contributing to the discourse on real estate policy and economic growth.

There are two natural extensions of this research.

First, in Section 1 “Introduction”, I discuss two mechanisms—precautionary savings and the impact on capitalists and workers—underlying the relationship between changes in housing prices and consumption. This study focuses on understanding the effects of the land price control policy on housing prices and consumption. However, the specific causal mechanisms through which changes in housing prices influence consumption are beyond the scope of this study and have not been explored. While this research finds that the policy significantly impacted housing prices and consumer behavior, future studies are needed to fully understand the detailed pathways of these effects.

Second, a causality test may be necessary to further understand the motivations behind Chongqing’s policymaking. By delving deeper into the motivations and decision-making processes, researchers can uncover insights into how similar effective policymaking can be encouraged in other regions. Additionally, examining why other cities lacked policymakers like Huang Qifan in Chongqing could provide valuable lessons for cultivating informed and strategic decision-making.

While the first two articles focus on the internal weaknesses and challenges of China's development model—ranging from imbalanced industrial policies to real estate market instability—these domestic issues do not exist in isolation. They also have profound implications for China's external relationships, particularly with the United States. Article 3 expands the analysis to the global stage, examining the eye-catching U.S.-China trade war, a conflict deeply rooted in the structural features of China's development model and its rivalry with the U.S.

Article 3

Modeling the U.S.-China Trade War: A Utility Theory Approach [130]

Abstract

This article models the U.S.-China trade war initiated in 2018 and analyzes the (optimal) strategic choices of the United States and China. In contrast to existing literature on the topic, it employs the expected utility theory and examines the conflict mathematically. The study shows that under both perfect and incomplete information, the expected net gains for both countries diminish as the utility of winning increases because of the costs incurred during the trade war. The findings suggest that reducing protectionist, restrictive, and retaliatory measures would benefit both countries. China's optimal strategic response is to end the trade war and maintain the pre-trade war status quo. However, there is no easy or clear-cut optimal strategy for the U.S. due to China's entrenched development model and countermeasures. This article provides insights for policymakers navigating the complexities of the U.S.-China economic rivalry, and the theoretical framework can be applied to broader technological frictions between the two countries.

Introduction

Over the past six years, the U.S.-China trade war has captured significant global attention.

China's industrial policies are designed to bolster domestic producers and promote modernization. However, these policies have contributed to overproduction, massive exports, and substantial trade imbalances with the United States. The U.S. government perceives these policies as deliberate efforts by the Chinese government to undermine foreign competition and assert dominance in global markets for critical technologies.

In 2018, the Trump administration launched the trade war by imposing substantial tariffs on a range of Chinese products, attempting to reduce the U.S. trade deficit with China and shield American industries. In addition, the U.S. implemented high-tech export controls against China,

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seeking to prevent China from acquiring dual-use U.S. technologies and limit China's technological advancement. [131] Under the Biden administration, these tariffs on $350 billion worth of Chinese goods have remained in place, while the technological embargoes have been expanded to further restrict the export of critical components and advanced technologies vital to U.S. national security. [132]

In retaliation, the Chinese government has kept the tariff rate on U.S. exports at 21.1% over the past three years, higher than the 19.3% of U.S. tariffs on Chinese exports. [133] Moreover, China has sought to circumvent technological controls to access Western technology, while simultaneously strengthening its industrial policies to achieve greater high-tech self-reliance. It has also carried out antitrust measures and cybersecurity reviews aimed at U.S. companies operating in China. [134]

In assessing the U.S.-China trade conflict, the existing literature primarily focuses on the economic effects of tariffs and their broader consequences for the global trading system. [135] While an increasing number of scholars attribute the trade war to more than just economic imbalances, highlighting the deeper issue of technological competition, [136] there remains a lack of comprehensive analysis of strategic decision-making in the context of this bilateral rivalry.

Some researchers have applied qualitative models of game theory to understand the trade war's dynamics. For example, Jiang et al. (2020) suggest that the "Chicken Game" framework implies both countries would benefit from ending the trade war. [137] Similarly, Yin and Hamilton (2018) employ the "Prisoner's Dilemma" and "Chicken Game" models, agreeing with Jiang et al. They also add a nuance, arguing that "if a state must engage in protectionism, it should only do so if it can ensure that it can inflict greater asymmetric losses to the opposing state". [138] However, their analysis leaves unanswered whether continually imposing greater losses leads to higher or maximum payoffs and if stopping the trade war truly represents the best strategy for both countries.

In contrast to these qualitative approaches, Polat and Akan (2021) employ a formal model to study the U.S.-China trade war. They argue that imposing sanctions can be "more advantageous" during the conflict. [139] However, their model, which uses GDP as a proxy for payoffs, overlooks other critical dimensions. From a political-economy perspective, payoffs during the trade war should encompass both economic and political gains, given the broad context of U.S.-China strategic rivalry. Furthermore, their study does not clarify how different policy choices might influence the respective payoffs for the U.S. and China.

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[131] Eichengreen 2019a; Liu and Woo 2018; Sachs 2018; Zhang 2018.
[132] Bureau of Industry and Security 2023.
[133] Bown 2023.
[134] Allen 2023.
[135] Itakura 2020; Fajgelbaum and Khandelwal 2022; Chor and Li 2024; Lawrence 2018; Eichengreen 2020.
[136] Zhang 2018; Liu and Woo 2018; Chen, Chen, and Dondeti 2020.
[137] Jiang, Gong, and Cheng 2020.
[138] Yin and Hamilton 2018.
[139] Polat and Akan 2021.

This article seeks to fill these gaps. The research question is: can the United States and China maximize their overall benefits, and if so, through what strategies? Addressing this question can determine a better course of action for both countries and provide valuable insights for policymakers, helping them make rational decisions as they navigate this complex and evolving great power rivalry.

The article employs expected utility theory, formal models, and optimization techniques, under both complete and incomplete information settings, to explore how the expected net benefits of the U.S. and China are influenced by their political-economic preferences and constraints imposed by retaliatory actions in the trade war. Here, "benefits" encompass not only economic gains such as trade surplus but also strategic gains like achieving national technological objectives. “Net benefits” take into account costs incurred during the trade war.

The findings corroborate the core idea of liberalism and free trade. This study shows that reducing protectionist, restrictive, and retaliatory measures would benefit both countries. China’s optimal strategic response is to end the trade war and return to the pre-trade war status quo. However, there is no easy or clear-cut optimal strategy for the U.S. While both the Trump and Biden administrations seek to alter China’s policies and shield vulnerable sectors from the “China trade shock”, [140] China’s entrenched development model and countermeasures impose significant costs and make it unlikely for the U.S. to achieve maximum net benefits.

The remainder of this article will detail the models, identify rational policy options for both countries, and interpret the results through a political-economy lens. It will conclude with discussions and policy recommendations.

Models

In the trade war, each country faces the possibility of either winning or losing. For the U.S., winning means that China is forced to alter its trade practices and industrial policies in a manner that aligns with U.S. interests. Losing occurs if, despite U.S. pressures – such as imposing massive tariffs on Chinese goods or enforcing high-tech export controls – China maintains its existing policies (the status quo) or adopts even more aggressive strategies, which include depreciating its currency, slashing imports from the U.S., or intensifying its industrial policies. For China, the definitions of winning and losing are the exact opposite of those for the U.S.

In analyses of international conflicts, the probabilities of winning and losing are often measured in terms of the relative capabilities of the countries involved. [141] In this context, the overall national capacities of the U.S. and China are substantial, constant values, [142] denoted as C_i, $i \in$

[140] Autor, Dorn, and Hanson 2016.
[141] Mearsheimer 2001; Waltz 1979.
[142] As the world’s two superpowers, their overall economic and technological capabilities are relatively stable in the foreseeable future. Thus, we let their overall capacities be fixed.

{US, CN}. Given that the U.S. has greater national capability than China, [143] the probability that the U.S. wins the trade war can be written as:

$$\alpha = \frac{C_{US}}{C_{US}+C_{CN}}$$

Since $C_{US} > C_{CN}$, it follows that $\alpha > 0.5$. The probability that China wins can be expressed as:

$$\beta = \frac{C_{CN}}{C_{US}+C_{CN}}$$

Thus, $\beta < 0.5$. Note that the sum of these probabilities is equal to 1, i.e., $\alpha + \beta = 1$.

As rational actors, both the U.S. and China seek to maximize their expected net benefits. Drawing on Wu (1990), [144] the net benefits for each country i consist of three key components: the utility of fighting, the cost incurred during the trade war, and the utility of not fighting (maintaining the status quo).

In this context, "fighting" refers to engaging in the U.S.-China trade war, such as tariff impositions, export controls, and retaliatory measures such as imposing additional tariffs, reducing imports, or escalating industrial policies.

The cost of engaging in the trade war depends on two key factors: the adversary's incentive to retaliate and its capacity to do so. The incentive to retaliate is driven by the adversary's expected payoffs from fighting. For example, U.S. tariffs on Chinese imports are intended to protect domestic agriculture and manufacturing industries and reduce the trade imbalance, but they harm China's export market, thereby incentivizing retaliation and imposing costs on the U.S. in return. Similarly, China's industrial policies spark national security concerns in the U.S., prompting export restrictions on Chinese firms like Huawei and imposing significant costs on China's development. [145]

Perfect Information

The utilities associated with winning and losing for country i are denoted by U_W^i and U_L^i, respectively, where W represents winning and L represents losing. When country i wins, the cardinal utility is greater than that of losing, that is, $U_W^i > U_L^i$.

Under perfect information, both countries have full knowledge of the opponent's incentive. Let $I(U_k^{US})$ denote the incentive function for China to retaliate, where $k = \{W, L\}$. We assume I is an increasing, odd function and $I \in (-1,1)$. Additionally, I's first-order derivative, I', is bounded. The derivative tells us how sensitive the retaliation incentive is to changes in the opponent's

[143] The World Bank 2023; Chinese Academy of Social Sciences and Clarivate 2023; The U.S. News 2024.
[144] Wu 1990.
[145] Zhang 2023a.

utility. Given Chinese President Xi Jinping's national goals and that Chinese top leadership has expressed a strong commitment to maintaining its chosen path – illustrated by the statement, "[China] will not accept sanctimonious preaching...The Party and the Chinese people will keep moving confidently forward in broad strides along the path that we have chosen for ourselves"[146] – we assume that: $\frac{1}{C_{CN}} < I'$. Notice that $\frac{1}{C_{CN}}$ is a very small positive value, almost to 0, as C_{CN} is very large. A positive first-order derivative implies that as the U.S. winning utility increases, China's incentive to retaliate also grows due to the U.S.-China rivalry and the zero-sum nature of the trade war.[147] China's retaliation strategies during the trade war have included launching anti-dumping investigations into imports, reducing agriculture imports, brandishing export controls on critical minerals, and intensifying industrial policies to enhance self-reliance and innovation.[148] The cost to the U.S. from China's retaliation is scaled by China's capacity and is given by $C_{CN}I(U_k^{US})$.

Similarly, let $\psi(U_k^{CN})$ represent the U.S.'s incentive to retaliate against China. ψ is also an increasing, odd function, and $\psi \in (-1,1)$. Moreover, China is considered a perceived threat to the U.S., and the U.S. government aims to reduce trade deficits with China, protect domestic industries, and throw its resources to "outcompete" China. [149] During the trade war, the growth rate of U.S. tariff imposition has been positive and the scope of retaliations has become broader, affecting more industries. [150] Therefore, $\frac{1}{C_{US}} < \psi'$ and $\psi' \approx 0$ since C_{US} is substantial. Thus, the cost to China is $C_{US}\psi(U_k^{CN})$.

Lastly, the utility of the status quo is denoted U_S^i. The expected net gains are respectively:

$$E_{US} = \alpha[U_W^{US} - C_{CN}\, I(U_W^{US}) - U_S^{US}] + (1-\alpha)[U_L^{US} - C_{CN}\, I(U_L^{US}) - U_S^{US}] \quad (1)$$

$$E_{CN} = \beta[U_W^{CN} - C_{US}\psi(U_W^{CN}) - U_S^{CN}] + (1-\beta)[U_L^{CN} - C_{US}\psi(U_L^{CN}) - U_S^{CN}] \quad (2)$$

As mentioned earlier, if the U.S. cannot alter China's policies and behaviors, the state is defined as "lose". If the U.S. can change China's trade practices and industrial policies, the state is defined as a "win". Also, the U.S. utility of winning is China's payoff of losing, and the US payoff of losing is China's utility of winning, so we have $U_W^{CN} = U_S^{CN} = -U_L^{US} = -U_S^{US}$ and $U_W^{US} = -U_L^{CN}$.

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146 Xi 2021; Allison 2017.
147 The U.S.-China trade war is different from the U.S.-Japan trade war of the 1980s. Unlike Japan, which committed itself to military, diplomatic, and economic dependence on the United States, China is much less dependent on the U.S. It is determined to realize China's development and determined to resist U.S. pressure to adjust its trade and industrial policies. See, for example, Vogel 2002; O'Brien 2024; García-Herrero and Iwahara 2019.
148 Gertken 2024; Zhang 2023a.
149 For example, in a press conference, President Biden emphasized the importance of outcompeting China, stating "I see stiff competition with China. China has an overall goal…to become the leading country in the world, the wealthiest country in the world, and the most powerful country in the world. That's not going to happen on my watch because the United States is going to continue to grow and expand. See The White House 2021.
150 Bown 2023; Suzuki 2024; Feldgoise, Dohmen, and Love 2024.

Hence, Eq. (1) and Eq. (2) are simplified to

$$E_{\text{US}} = \alpha[U_W^{US} - C_{CN}\, I(U_W^{US}) - U_S^{US}] - (1-\alpha)\, C_{CN}\, I(U_S^{US}) \qquad (3)$$

$$E_{CN} = -\beta C_{US}\psi(U_W^{CN}) + (1-\beta)[U_L^{CN} - C_{US}\psi(U_L^{CN}) - U_W^{CN}] \qquad (4)$$

Incomplete Information

To make the analysis more realistic and comprehensive, let us consider uncertainty in the incentive functions. For instance, internal challenges (e.g. political or economic instability) triggered by external shocks might impact the commitment to the trade war effort. Each country only knows the probability distribution of these uncertain factors.

Let the incentive function for China to retaliate be denoted as $I(U_k^{US}, z)$, where $z \in [0,1]$ is a random variable representing, for example, the impact of a pandemic on domestic society. The variable z is independent of U_k^{US}, and $f(z)$ is the probability density function. Likewise, the incentive function for the U.S. is denoted as $\psi(U_k^{CN}, \varepsilon)$, where random variable $\varepsilon \in [0,1]$ and $g(\varepsilon)$ is the probability density function.

Adopting the same concept of expected net benefits, as defined earlier in Section 2.1 "Perfect Information", the expected net benefits for the U.S. and China are given by the following equations:

$$E_{US} = \alpha[U_W^{US} - C_{CN} \int I(U_W^{US}, z) f(z)dz \; - U_S^{US}] - (1-\alpha)\, C_{CN} \int I(U_S^{US}, z) f(z)dz \qquad (5)$$

$$E_{CN} = -\beta C_{US} \int \psi(U_W^{CN}, \varepsilon) g(\varepsilon)d\varepsilon \; + (1-\beta)[U_L^{CN} - C_{US} \int \psi(U_L^{CN}, \varepsilon) g(\varepsilon)d\varepsilon - U_W^{CN}] \qquad (6)$$

Notice that incentive functions under incomplete information are obtained from the original incentive functions by shifting, depending upon z and ε. Specifically, the adjusted incentive functions can be expressed as $I(U_k^{US}, z) = I(U_k^{US}) - M(z)$ and $\psi(U_k^{CN}, \varepsilon) = \psi(U_k^{CN}) - N(\varepsilon)$ where $M(z)$ and $N(\varepsilon)$ are non-negative, strictly increasing functions. These functions capture the additional uncertainty introduced by z and ε, effectively reducing the incentives as the magnitude of uncertainty increases.

Analytical Results

This section explores the key analytical results derived from the models constructed in Section 2 "Models". The following propositions present the key analytical results and include formal proofs to support the theoretical findings. In addition, each proposition is accompanied by a political economy explanation, linking the mathematical outcomes to real-world strategic interactions between the United States and China. This combination of formal proofs and contextual explanations helps to bridge the gap between abstract models and the broader dynamics of the U.S.-China trade war.

Proposition 1: Under conditions of perfect information, the United States does not have a maximum expected net benefit.

In the broad context of U.S.-China rivalry, Chinese policymakers interpret U.S. efforts to alter China's trade and technology policies as attempts to contain China's rise. China's substantial national capacity and its incentives to retaliate make it costly for the United States to pursue such strategies. As the U.S. increases its efforts to compel China to alter its trade practices and industrial policies, the resulting retaliation from China imposes escalating costs, leading to a reduction in the U.S.'s expected net benefits.

In the unlikely event that the U.S. successfully forces China to change all its policies, the associated costs would render the net benefit minimal. Alternatively, if the U.S. were to stop its pressure on China, it could maximize its expected net benefits. However, given the strategic focus of both the Trump and Biden administrations on reshaping China's policies and protecting domestic industries affected by the "China trade shock," the U.S. cannot achieve a maximum expected net benefit in this scenario.

More formally, let us consider E_{US} in Equation (3), subject to the following conditions:

$$0 < U_W^{US} \leq \underline{c}$$

$$-\overline{c} \leq U_S^{US} \leq -\underline{c}$$

where $\underline{c}$ and $\overline{c}$ are positive constants, with $\overline{c}$ much greater than $\underline{c}$. These bounds represent the upper and lower limits of the utility of winning and losing. If China's policies are not changed (the status quo remains), then $U_W^{CN} = -U_S^{US} = \underline{c}$. If China's behaviors become more undesirable to the U.S., then $U_W^{CN}\ and\ -U_S^{US}$ increases up to $\overline{c}$. In the unlikely event that the U.S. compels China to alter all its trade and industrial policies, U_W^{US} increases up to $\underline{c}$.

Under these conditions, the minimum value of E_{US} occurs when $U_W^{US} = -U_S^{US} = \underline{c}$, yielding $E_{US} = 2\alpha\underline{c} + (1-2\alpha)C_{CN}\, I(\underline{c}) < 0$.

However, a maximum for E_{US} does not exist, meaning that the U.S. cannot achieve a maximum expected net benefit under perfect information. It also indicates that no optimal strategy exists for the U.S. to maximize its gains in the trade war with China.

Proof

Notice that the set defined by the three conditions, denoted D, is a pre-compact set in R^2. Hence, the closure of *D*, say $\overline{D} \subseteq R^2$, is a compact subset.

Actually, $\overline{D} = \{0 \leq U_W^{US} \leq \underline{c}\} \cap \{-\overline{c} \leq U_S^{US} \leq -\underline{c}\}$. Since E_{US} is continuous in $\overline{D}$, so both maximum and minimum exist. We will first find the extreme values of E_{US} in $\overline{D}$, then show that the maximum occurs in $\overline{D} - D$ and the minimum occurs inside *D*.

We only consider E_{US} as a function of U_W^{US} as U_S^{US} is determined by China in the trade war. The partial derivative is $\frac{\partial E_{US}}{\partial U_W^{US}} = \alpha[1 - C_{CN}\, I'(U_W^{US})]$.

By the assumption of $\frac{1}{C_{CN}} < I'$, $\frac{\partial E_{US}}{\partial U_W^{US}} < 0$. Therefore, E_{US} achieves minimum in *D* when $U_W^{US} = -U_S^{US} = \underline{c}$. The minimum value is $2\alpha\underline{c} + (1 - 2\alpha)C_{CN}\, I(\underline{c})$. Because we consider C_{CN} is much larger than $\underline{c}$, so the minimum value is less than 0. On the other hand, E_{US} has a maximum in $\overline{D} - D$ when $U_W^{US} = 0$, so maximum for E_{US} does not exist in *D*.

Proposition 2: When China stops the trade war and maintains the status quo policies, a maximum expected net benefit exists for China.

From a political-economy perspective, China's pre-trade war status quo policies – such as promoting exports to the U.S. through industrial strategies and encouraging technology transfers from foreign firms – have granted it access to the U.S. market, enabled rapid technological growth, and bolstered its global economic influence. By maintaining these policies, China secures its maximum expected net benefit, as they align with its long-term strategic goals.

Some may argue that China could further boost its utility by adopting more aggressive policies, such as competitive currency devaluation to enhance exports. However, as China's policies become more aggressive, U.S. retaliation intensifies, reducing China's expected net gains in the trade war. If China's policies reach extreme levels—such as halting all imports from the U.S. or imposing prohibitive tariffs on American goods—China's expected net gain would diminish significantly.

More formally, let us analyze E_{CN} in Equation (4), subject to:

$$\underline{c} \le U_W^{CN} \le \overline{c}$$

$$-\underline{c} \le U_L^{CN} < 0$$

There exists a maximum for E_{CN} when $U_W^{CN} = \underline{c} = -U_L^{CN}$, which corresponds to China ending the trade war and maintaining the status quo, with no changes to its policies. At this point, China's strategy produces the most favorable outcome. The minimum exists when $U_W^{CN} = \overline{c}$, meaning China adopts a more aggressive stance at a certain level that worsens its position despite U.S. pressures. The maximum value of E_{CN} is

$(1 - 2\beta)C_{US}\psi(\underline{c}) - 2(1 - \beta)\underline{c} > 0$ and the minimum value of E_{CN} is $C_{US}[-\beta\psi(\overline{c}) - (1 - \beta)\psi(U_L^{CN})] + (1 - \beta)[U_L^{CN} - \overline{c}\,]$ which is likely less than zero, indicating a net loss for China in this more aggressive scenario.

Proof

Consider E_{CN} in the compact set: $\{\underline{c} \le U_W^{CN} \le \overline{c}\} \cap \{-\underline{c} \le U_L^{CN} \le 0\}$.

We only consider E_{CN} as function of U_W^{CN} as $U_L^{CN}$is determined by the U.S. The partial derivative is $\frac{\partial\, E_{CN}}{\partial\, U_W^{CN}} = -\beta C_{US}\psi'(U_W^{CN}) - (1-\beta)$.

Hence, $\frac{\partial\, E_{CN}}{\partial\, U_W^{CN}} < 0$. Given the constraints., the maximum occurs when $U_W^{CN} = \underline{c} = -U_L^{CN}$, the best response function exists, and the minimum occurs when $U_W^{CN} = \overline{c}$. Because we consider $\overline{c}$ is much larger than $\underline{c}$ and less than C_{US}, the maximum value is greater than 0, and the minimum value is likely less than 0.

Proposition 3: Under conditions of incomplete information, as the U.S. winning benefits increase, its expected net gains decrease; the U.S. has a larger minimum expected net benefit but no maximum.

Similar to the rationale in Proposition 1, when the U.S. intensifies its efforts to force changes in China's policies, China responds with greater retaliation, raising the costs for the U.S. and diminishing its expected net gains. Even if the U.S. were to achieve its objective and compel China to alter its policies, the high costs would still result in minimal expected net gains. While the U.S. could theoretically maximize its expected net gains by not pressuring China, the strategic objectives of both the Trump and Biden administrations—focused on altering China's policies and protecting vulnerable domestic sectors—prevent the realization of this maximum.

In the context of incomplete information, additional uncertainty is introduced, particularly concerning China's internal factors that might influence its willingness or capacity to retaliate. U.S. decision-makers do not fully know these factors, which means the U.S. cannot predict with certainty how aggressively China will respond. Therefore, while the U.S. still faces decreasing expected net gains as its pressure on China increases, the minimum expected net benefit is higher than in the perfect information scenario, as uncertainties may temper China's retaliation.

More formally, under incomplete information, assume E_{US} in Equation (5) is subject to the same constraints in Proposition 1:

$$0 < U_W^{US} \leq \underline{c}$$

$$-\overline{c} \leq U_S^{US} \leq -\underline{c}$$

As U_W^{US} increases, E_{US} decreases. The minimum of E_{US} is achieved when $U_W^{US} = -U_S^{US} = \underline{c}$. The minimum value is $2\alpha\underline{c} + C_{CN}[\int M(z)f(z)dz + (1-2\alpha)I(\underline{c})]$, which is larger than that under conditions of perfect information. The maximum does not exist, and therefore, no best response function can be identified for the U.S.

Proof

Based on Equation (5), we have the partial derivative: $\frac{\partial\, E_{US}}{\partial\, U_W^{US}} = \alpha[1 - C_{CN}\int \frac{\partial\, I(U_W^{US},z)}{\partial\, U_W^{US}}\, f(z)dz]$.

By the assumption that $I(U_W^{US}, z) = I(U_W^{US}) - M(z)$ and $\frac{1}{C_{CN}} < I'$,

$$\frac{\partial\, E_{US}}{\partial\, U_W^{US}} = \alpha[1 - C_{CN}\, I'(U_W^{US})] < 0$$

Thus, E_{US} has a minimum at $U_W^{US} = -U_S^{US} = \underline{c}$. The minimum value is $2\alpha\underline{c} + C_{CN}[\int M(z)f(z)dz + (1 - 2\alpha)I(\underline{c})]$. Notice that when $M(z)$ is a small number, the minimum value is likely less than 0. The maximum does not exist, as $U_W^{US} \to 0$ but $U_W^{US} \neq 0$.

Since $M(z)$ is a non-negative function that increases with uncertainty in China's responses, the additional term $C_{CN} \int M(z)f(z)dz$ in the incomplete information scenario increases the overall minimum expected net benefits for the U.S. Therefore, we have

$$E_{US}^{\text{Min,Incomplete}} > E_{US}^{\text{Min,Perfect}}$$

Proposition 4: For China, both the maximum and minimum expected net benefits exist under incomplete information, and their values are higher compared to the perfect information scenario.

As in Proposition 2, China achieves its maximum expected net gain by maintaining its pre-trade war policies. Its minimum expected net gain occurs when China adopts highly aggressive strategies, such as completely halting imports from the U.S., imposing prohibitive tariffs on all U.S. goods, or enforcing the forced transfer of sensitive U.S. technologies.

In a setting of incomplete information, China faces uncertainty about the U.S.'s internal factors, which may influence the level of U.S. retaliation. U.S. domestic conditions, such as economic challenges caused by external shocks, might reduce its capacity or willingness to retaliate as strongly as China expects. Therefore, both the maximum and minimum values of China's expected net gains are higher in the incomplete information scenario compared to the perfect information scenario, as these uncertainties limit the scale of potential U.S. countermeasures.

More formally, consider E_{CN} in Equation (6), subject to the same conditions in Proposition 2:

$$\underline{c} \leq U_W^{CN} \leq \overline{c}$$

$$-\underline{c} \leq U_L^{CN} < 0$$

There exists a maximum for E_{CN} when $U_W^{CN} = \underline{c} = -U_L^{CN}$, and a minimum when $U_W^{CN} = \overline{c}$. The maximum value is $C_{US}\big[(1 - 2\beta)\psi\big(\underline{c}\big) + \int N(\varepsilon)g(\varepsilon)d\varepsilon\big] - 2(1 - \beta)\underline{c}$, and the minimum value is $-\beta C_{US}\psi(\overline{c}) + C_{US} \int N(\varepsilon)g(\varepsilon)d\varepsilon + (1 - \beta)[U_L^{CN} - C_{US}\psi(U_L^{CN}) - \overline{c}]$. Both the maximum and minimum values are higher than under perfect information. In this scenario, the best response function exists for China.

Proof

Based on Equation (6), we have the partial derivative:

$$\frac{\partial\ E_{CN}}{\partial\ U_W^{CN}} = -\beta C_{US} \int \frac{\partial \psi(U_W^{CN}, \varepsilon)}{\partial\ U_W^{CN}} g(\varepsilon) d\varepsilon - (1-\beta)$$

Because $0 < \beta < 0.5$ and the expectation of $\frac{\partial \psi(U_W^{CN}, \varepsilon)}{\partial\ U_W^{CN}}$ is greater than 0, $\frac{\partial\ E_{CN}}{\partial\ U_W^{CN}} < 0$. Given the constraints, the best response function should exist. E_{CN} reaches the minimum when $U_W^{CN} = \overline{c}$. The minimum value is $-\beta C_{US}\psi(\overline{c}) + C_{US} \int N(\varepsilon)g(\varepsilon)d\varepsilon + (1-\beta)[U_L^{CN} - C_{US}\psi(U_L^{CN}) - \overline{c}]$. The maximum exists with the value of $C_{US}\left[(1-2\beta)\psi(\underline{c}) + \int N(\varepsilon)g(\varepsilon)d\varepsilon\right] - 2(1-\beta)\underline{c}$. Notice that when $N(\varepsilon)$ is a small number, the minimum value is likely less than 0.

Since $N(\varepsilon)$ is a non-negative function that increases with uncertainty in U.S. responses, the additional term $C_{US} \int N(\varepsilon)g(\varepsilon)d\varepsilon$ in the incomplete information scenario increases the overall maximum and minimum expected net benefits for China. Therefore, we have

$$E_{CN}^{\text{Max,Incomplete}} > E_{CN}^{\text{Max,Perfect}}$$

$$E_{CN}^{\text{Min,Incomplete}} > E_{CN}^{\text{Min,Perfect}}$$

Conclusion

China's intensive industrial policies have raised concerns among U.S. policymakers about China’s technological ascendency. They have also contributed to overproduction, massive exports, and significant trade imbalances with the United States. In response, both the Trump and Biden administrations have imposed substantial tariffs and strict high-tech export controls to pressure China into altering its trade practices and industrial policies, which in turn invited retaliatory measures from China. Over the past six years, the U.S.-China trade war has captured global attention and represents a pivotal chapter in global economic relations.

This study employs expected utility theory and formal modeling to analyze the strategic interactions between the U.S. and China during the trade war, discussing whether – and by choosing what strategies –can both countries enhance or maximize their net benefits.

Overall, the findings corroborate the core idea of liberalism and free trade. One of the major takeaways from this research is that neither the U.S. nor China truly benefits from the trade war. Reducing protectionist, restrictive, and retaliatory measures would benefit both countries during the conflict. China’s optimal strategic response is to end the trade war and maintain the pre-trade war status quo. However, there is no easy or clear-cut optimal strategy for the U.S. While both the Trump and Biden administrations seek to alter China’s policies and shield vulnerable sectors from the “China trade shock”, China’s entrenched development model and countermeasures impose significant costs, preventing the U.S. to from attaining a maximum expected net benefit.

This research makes several important contributions. First, it advances the existing literature on decision theory by applying it to the specific context of the ongoing U.S.-China trade disputes. By using formal models and expected utility theory, this study offers a structured approach to understanding the strategic decisions made by both countries, shedding new light on an ongoing global conflict. Second, it fills the gap in the political economy and political science literature on U.S.-China economic relations. The study provides a mathematically rigorous framework that can be used to analyze not only trade conflicts but also other forms of economic and technological competition between great powers. Third, the findings carry significant implications for policymakers, suggesting that protectionist trade policies and trade wars may not always lead to optimal outcomes, especially for powerful countries like the United States and China.

While this study offers valuable insights into the strategic decision-making dynamics of the U.S.-China trade war, several promising areas remain open for further exploration. In future studies, identifying and applying proxy variables to operationalize the theoretical constructs will enhance empirical relevance. Additionally, future research could extend these models to anatomize the U.S.-China rivalry in strategic high-tech sectors, such as artificial intelligence, quantum computing, and semiconductors.

Conclusion

Over the past three decades, China's development model has elevated the country into a position of significant global economic and technological influence. However, as this dissertation illustrates, the same model also presents profound challenges, both domestically and internationally. The key weaknesses identified within China's development paradigm not only jeopardize the sustainability of its growth but also strain U.S.-China relations.

One of the critical vulnerabilities lies in China's industrial policies, particularly in high-tech sectors, which have often emphasized infrastructure and equipment deployment over foundational research and development. This approach, while yielding short-term economic gains, has exposed strategic sectors to significant risks. The contrasting outcomes of China's supercomputing and 5G industries show that the success of industrial policy depends heavily on its design. In supercomputing, policies that focused on developing the entire industrial chain and promoted self-sufficiency in critical technologies enabled the sector to thrive and adapt to external pressures. Conversely, in the 5G industry, the lack of focus on upstream research contributed to distorted industrial growth and left the industry vulnerable to U.S. sanctions.

The real estate sector, another pillar of China's economic expansion, presents additional risks. While property development has driven urbanization and economic growth, unchecked speculative activity has inflated housing prices and placed significant financial burdens on households. This trend threatens the broader economic stability of the country. The dissertation's case study of Chongqing provides empirical evidence for understanding how targeted regulatory interventions can curb price spikes and support consumption.

Internationally, China's development model has significant implications, particularly in the context of U.S.-China relations. The prolonged U.S.-China trade war, rooted in tensions arising from China's industrial policies and trade surpluses, has imposed substantial costs on both countries. Formal models and analyses through a political-economy lens in the dissertation indicate that neither the U.S. nor China truly benefits from the trade war. Instead, protectionist and retaliatory measures diminish overall benefits for both countries.

Policy Prescriptions

Drawing from the dissertation's main findings, several policy recommendations emerge:

Balancing Industrial Policies

The research on China's 5G and supercomputing sectors highlights the dangers of unbalanced industrial policies that prioritize infrastructure and short-term gains over foundational research and technological development. To safeguard against technological dependence and ensure long-term resilience, Chinese policymakers need to allocate greater resources to fundamental research and foster technological sustainability. Such a supply-side shift will likely alleviate issues of overproduction and trade imbalances with foreign countries including the U.S.

Managing Real Estate Policies

The study of Chongqing's land price control policy provides clear evidence that well-designed regulatory policies can stabilize housing prices and promote consumption. Chinese leaders must align real estate policies with broader economic objectives, particularly housing affordability, to sustain household consumption. This, in turn, will promote long-term economic stability and growth.

Recalibrating Trade Strategy

The findings from the U.S.-China trade war analysis demonstrate that restrictive policies and retaliatory measures reduce net benefits for both sides. To improve trade relations and avoid further economic losses, Chinese policymakers should adopt a more measured trade approach. Reducing tariffs on U.S. goods and services can lower the cost burden on domestic consumers and create an environment conducive to bilateral negotiations. Additionally, boosting domestic consumption through recalibrated industrial policies and real estate strategies can improve China's relations with the U.S.

These policy prescriptions are directly drawn from the dissertation's research findings, which collectively offer a roadmap for China to address some of the vulnerabilities in its development model. The research underscores the importance of well-designed, forward-looking policies to ensure China's long-term economic stability and technological development.

Furthermore, the lessons and recommendations derived from China's experience have broader relevance for other countries navigating similar development challenges. Whether grappling with trade conflicts, high-tech industrial policy, or real estate volatility, policymakers around the world can glean valuable insights from this research to inform their strategies for fostering sustainable economic growth.

Directions for Future Research

While this dissertation provides substantial analysis regarding China's development model, its associated challenges, and global implications, several areas merit further exploration:

High-Tech Industrial Policies

Building upon the comparative study of 5G and supercomputing sectors, future research should run a causality inference to deepen our understanding of the underlying motivations and structural drivers behind these policy disparities, such as the role of political and institutional incentives in shaping China's industrial policies.

Additionally, as China's 5G policies have shifted upstream since 2021 but faced challenges due to the pandemic and intensifying U.S.-China competition, monitoring policy evolution will be crucial. Assessing whether China can achieve well-balanced high-tech industrial development with self-sufficiency in critical upstream components is also essential.

Real Estate Market Dynamics

While the real estate article has identified significant impacts of land policy intervention on housing prices and consumption, further research is needed to unpack the specific causal mechanisms through which changes in housing prices influence consumer behavior.

Moreover, conducting causality tests to better understand the motivations and decision-making processes behind real estate policies – particularly why cities like Chongqing have benefited from policy entrepreneurs such as Huang Qifan while many others have not – could offer critical insights for replicating effective governance models elsewhere.

Extended Trade Models

The formal model article on the U.S.-China trade war, grounded in expected utility theory, offers a foundational framework for analyzing key strategic decision-making dynamics. However, the current models rely on abstract variables. In future studies, Identifying and applying proxy variables to operationalize the theoretical constructs will enhance empirical relevance.

Besides, future research could extend these models to anatomize the U.S.-China rivalry in strategic high-tech sectors, such as artificial intelligence, quantum computing, and semiconductors.

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