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The Impact of Government Macro-Control on Commodity Housing Prices in China: An Analytical Study

Abstract:- The Chinese government has implemented macro-control measures to stabilize soaring housing prices, yet the effectiveness of these interventions remains largely unexamined. This study evaluates the impact of macroeconomic policies on commodity housing prices by considering both supply and demand factors and aims to construct a concise, robust simulation model. This model will serve as a reference for the government in establishing a systematic, strategic, and enduring macro-control mechanism for the real estate sector. Our model integrates four key variables: development/consumption stage tax rates, lending rates, and land prices, to simulate their collective influence on commercial housing prices. The findings indicate that: (1) the development stage tax rate and loan interest rates significantly enhance prices, demonstrating a strong positive feedback, whereas the consumption stage tax rate exerts a minimal negative impact; (2) land price exhibits the most substantial positive feedback effect on housing prices, primarily from the supply side; (3) adjusting land prices through land policy and modulating the development stage tax rate through tax policy are crucial for managing real estate development effectively; (4) a combined approach of adjusting land and development stage tax rates, supported by monetary policy, can significantly enhance the effectiveness of China's real estate macro-policy regulation.

Keywords: Macro-control; System Dynamics; Commodity Housing Prices

I. INTRODUCTION

Over the past decade, China's real estate investment relative to GDP has surged from 6% to 14%, with annual sales of commercial housing increasing nearly ninefold (citation needed). This rapid expansion has coincided with a sharp increase in commodity housing prices. To temper this growth and stabilize the market, the Chinese government frequently employs macro-control tools, such as monetary, tax, and land policies (Zhuo et al., 2022). Despite their widespread use, the effectiveness of these macro-regulation strategies remains ambiguous, with conflicting findings reported in the literature (Sommer and Sullivan, 2018). For instance, Knoll et al. (2017) constructed a VAR model and concluded that monetary policies have minimal impact on housing prices, suggesting that government interventions are largely ineffective. Conversely, Cajias et al. (2015) identified significant influences and disparities between short-term and long-term interest rates on the commercial housing market through regression analysis.

The inconsistent findings can be attributed to two main factors: the scarcity of studies examining the feedback relationship between housing prices and policies, and the lack of systematic analysis assessing the combined effects of various macro-control policies on housing prices. According to supply and demand theory, prices should decrease if supply remains constant while demand falls, or if supply increases while demand stays the same (Knittel et al., 2016). The influence of government macro-control policies on housing prices is therefore determined by the interplay of market demand and supply dynamics (Wen et al., 2017). For example, the real estate tax burden is often shifted between buyers and sellers, and the impact of tax policies on housing prices depends on the price sensitivity of the market's supply and demand (Zhang et al., 2016). Similarly, monetary policies can affect the investment and construction activities of developers and the borrowing capacity of home buyers, thereby influencing housing prices (Li et al., 2023; Barwell, 2017).

Given the pivotal role of supply and demand in macro-control, it is imperative to consider both when examining the reciprocal effects between policies and housing prices. The combination of these policies, their long-term efficacy, and their systemic interactions warrant comprehensive evaluation (Zhao & Rue, 2021; Li, 2021). To this end, system dynamics (SD) modeling is particularly suitable as it enables the integration of supply and demand considerations, facilitating the analysis of feedback loops and the variables involved (Edwards et al., 2021; Hwang et al., 2010). This study will employ SD modeling to develop a comprehensive simulation model based on causal

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loop diagrams, including flow and stock variables to capture dynamic changes over time. This model will simulate the trajectory of commercial housing prices, and after validating its accuracy, we will use it to analyze and predict policy outcomes. The study will specifically focus on Tianjin's commercial housing market, using extensive statistical data to conduct policy experiments and provide a systematic analysis of the outcomes from various policy interventions..

II. THEORETICAL BASIS

A. Tax policy and its transmission mechanism

Tax policy plays a crucial role in the distribution of national economic resources, providing the government with essential administrative funds while influencing the decision-making processes of various economic actors (Spiro, 2018). In the realm of real estate, tax policy significantly impacts commercial housing prices, making it a pivotal tool for macroeconomic control (Duca et al., 2017; Alesina, 2018). Particularly in China, tax policy is frequently utilized to manage economic fluctuations (Vegh & Vuletin, 2015). Grounded in the theories of tax regulation, tax non-neutrality, the user-pays principle, and tax capacity, real estate taxation encompasses four critical stages: acquisition of land use rights, development, circulation, and retention (Cao and Cao, 2017). This study focuses specifically on the tax rates applied during the development and consumption stages.

Incorporating the principles of supply and demand, the mechanism through which tax policy influences real estate supply primarily occurs at the development stage (Park and Lee, 2018). In China, real estate taxes are predominantly levied during this phase, and the burden falls primarily on developers. An increase in development-related taxes escalates the cost of construction, thereby straining developers' financial resources. This can significantly deter further investment in development, particularly for highly leveraged developers, resulting in a reduced overall supply of real estate. It is important to note that real estate companies, operating with profit motives, typically pass these increased costs onto homebuyers.

Conversely, the impact of tax policy on real estate demand is mediated through taxes imposed during the consumption stage, aiming to dampen speculative gains by elevating the costs associated with speculative transactions (Park and Lee, 2018). This regulatory focus is designed to curb speculative buying behaviors, thereby diminishing speculative demand in the housing market. This approach seeks to stabilize housing prices by moderating the extremes of market speculation..

B. Monetary policy and its transmission mechanism

Monetary policy is a key instrument of international government macro-control, and its impact on housing prices is often summarized by scholars as "housing prices are a monetary phenomenon" (Yan, 2019). The mechanisms through which monetary policy affects the housing market include the "money channel" and the "credit channel," primarily enacted through interest rates and money supply adjustments (Huang et al., 2019). This paper explores how monetary policy influences both the supply and demand sides of the real estate market, particularly through price-based instruments like interest rates (Barwell, 2017).

On the demand side, real estate demand can be categorized into consumer and investment demand (Jiang et al., 2019). Initially, consumer demand is relatively inelastic in the short term. However, an increase in interest rates directly raises the monthly mortgage payments for homebuyers, thereby increasing the overall cost of purchasing a home. This often leads potential buyers to adopt a wait-and-see approach, ultimately reducing their purchasing activities and leading to a decrease in demand. On the other hand, investment demand—which aims to buy low and sell high for profit—is highly sensitive to interest rate fluctuations. Rising interest rates decrease the price of monetary assets, increasing their yields, but also escalate the financing costs for real estate investments. Such shifts may prompt investors to divert their funds to bonds or other monetary assets, resulting in a decline in investment demand.

For the supply side, the real estate sector is inherently capital-intensive, and developers typically rely on indirect financing from banks (Deep et al., 2022). An increase in lending rates directly impacts the financing costs for developers, dampening their willingness to invest. Developers in the preliminary stages of market research and approval may reevaluate the viability of their projects considering higher investment costs and potentially decide against entering the market. This reduction in real estate project investments consequently leads to a decreased supply of real estate, which ultimately influences the price of commercial housing.

C. Land policy and its transmission mechanisms

Land policy has been a cornerstone of real estate macro-control in economically developed nations such as the United States, Japan, and South Korea, where it has demonstrated significant positive effects on the market (Rithmire, 2017; Han et al., 2022). In China, land policy holds a particularly strategic role due to the public ownership of land, offering a unique leverage point for macroeconomic regulation (Han et al., 2022; Fan et al., 2020). Given China's demographic and geographical challenges—marked by a large population and limited land resources—the country has adopted a long-standing national policy aimed at tightly controlling land development and enhancing land use efficiency.

Land is a crucial element for real estate market development, fundamentally influencing investment decisions and helping to balance supply and demand for commercial housing. Thus, land policy emerges as one of the most direct and effective tools for regulating the real estate market. The mechanisms of land policy can be broadly categorized into two aspects: land supply price and land supply quantity (Jung and Lee, 2019). This paper primarily explores the influence of land price on commercial housing prices.

The relationship between land price and commercial housing price is bidirectional; on one hand, rising housing prices drive up land prices, and on the other, escalating land prices exert upward pressure on housing prices, contributing to a continuous cycle of increases (Wang et al., 2018). Moreover, land prices can have a multiplier effect on housing prices.

Currently, the land market is characterized by a scenario where demand outstrips supply (Zhang et al., 2016), positioning land price as a key determinant of commercial housing prices, primarily through its influence on supply. The cost of land represents a major component of the overall development cost for commercial housing. Any fluctuation in land prices directly impacts the development and construction costs, which developers typically pass on to homebuyers, leading to higher housing prices. Additionally, rising land prices can deter real estate developers from undertaking new projects, reducing the amount of development and construction activity. This reduction in the supply of commercial housing further drives up prices, exacerbating the challenge of affordability in the housing market.

III. MODEL CONSTRUCTION

To comprehensively analyze the collective impact of various macro-policies on commercial housing prices and provide targeted recommendations, this study employs a system dynamics (SD) model rooted in supply and demand fundamentals and the transmission mechanisms of tax, monetary, and land policies. The model, developed using Vensim software, integrates considerations of supply and demand and assesses the systemic effects of these three macro-control policies on commercial housing prices.

A. Causal Loop Diagram and Feedback Loop Analysis

A causal loop diagram (CLD) serves as a qualitative SD tool, depicting variables and their interrelated feedback loops. This diagram is a crucial instrument for visualizing the feedback structure of a system, allowing for the succinct representation of the interconnections among various system variables, thus revealing the microstructure of the entire system (Newberry & Carhart, 2024; Wu et al., 2021). The CLD offers a graphical illustration of the system's internal dynamics. It distinguishes between positive feedback loops, which are self-reinforcing and amplify system behavior, and negative feedback loops, which act to stabilize the system and dampen fluctuations (Gaynor, 2012; Haerinck et al., 2023).

To ensure the model's comprehensiveness, this study incorporates highly correlated factors such as the supply-demand ratio, GDP, per capita residential area, and house price-to-income ratios, following the established transmission mechanisms of government macro-control policies impacting commercial housing prices. These factors are meticulously indexed and detailed, resulting in a refined set of variables used to construct the system. The causal relationships identified in this research are depicted in Figure 1, providing a foundational map for understanding and simulating the interactions and dynamics influencing commercial housing prices.

Figure 1 Systematic causal loop of the impact of macro-control policies on commodity housing prices

This study aims to dissect the causal relationships between macro-control policies and commodity housing prices by delving into the dynamics of supply and demand. Specifically, it centers on examining various feedback loops that are crucial to understanding the impact of these policies. The analysis highlights three feedback loops associated with tax policies, four connected to monetary policies, and two related to land policies, as detailed in Table 1. These loops provide a structured insight into how each policy influences the real estate market, affecting both the supply side and demand side, thereby shaping the pricing of commercial housing.

Table 1 Major feedback loops on the impact of macro-control policies on commodity housing prices

Policy	Loops	Explanation
Tax policy	Commercial property price →tax policy→development stage tax rate→+commercial property development cost →+commercial property price	positive feedback loop
	Commodity housing price →tax policy→development stage tax rate →+commodity housing development cost→-developers' willingness→+commodity housing supply →+supply-demand ratio →-commodity housing price	positive feedback loop
	Commodity housing price →tax policy→consumption stage tax rate→-willingness to buy→+demand for commodity housing→-supply-demand ratio→-commodity housing price	negative feedback loop
Monetary policy	Commodity housing prices → monetary policy →interest rates→+financing costs→+commodity housing development costs→+commodity housing prices	positive feedback loop
	Commodity housing prices → monetary policy →interest rates→+financing costs →+commodity housing development costs→-commodity housing developers' willingness→+commodity housing supply→+supply-demand ratio→-commodity housing prices	positive feedback loop
	Commodity housing prices → monetary policy → interest rates →+cost of homeownership →-willingness to buy →-autonomous demand for commodity housing→+supply-demand ratio →-commodity housing prices	negative feedback loop
	Commodity housing prices → monetary policy → interest rates →+cost of homeownership→-willingness to buy →-investment demand for commodity housing→+supply-demand ratio→-commodity housing prices	negative feedback loop
Land policy	Commodity housing price → land policy → land price +→+commodity housing development cost→+commodity housing price	positive feedback loop
	Commodity housing price → land policy → land price +→+commodity housing development cost→-developers' willingness →+commodity housing supply →+supply-demand ratio →-commodity housing price	positive feedback loop

B. System flow diagram creation and variable assignment

To ensure the model's operability, accuracy, and the feasibility of sourcing data, the causal loop diagram has been refined and optimized based on previous research by international scholars (Wang et al., 2021; Chen & Tan, 2020). This model specifically examines the commercial housing market in Tianjin, China, incorporating established

research findings into the development and simulation of the system dynamics model. The resulting system flow diagram is depicted in Figure 2.

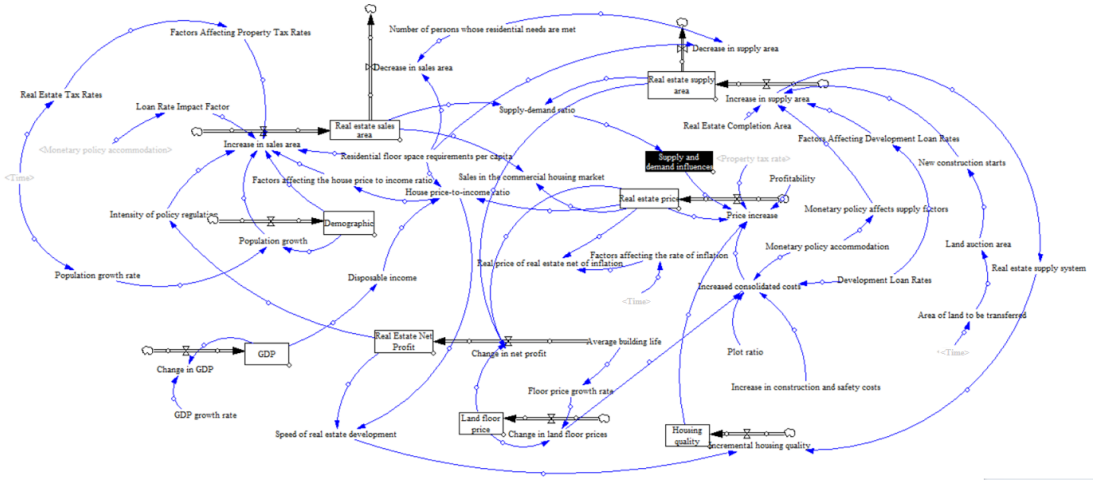

Figure 2 Systematic flow diagram model of the impact of macro-control policies on commodity housing prices

The simulation of the system dynamics model is grounded in accurately determining the relevant parameters within the stock-flow diagram and quantitatively defining their interrelationships. This approach enables the model to perform simulations that more precisely mirror the actual conditions (Wang et al., 2021; Qiao et al., 2024). To gather authentic and reliable data, most of the data inputs for the model are sourced from the National Statistical Yearbook of China and the Tianjin Municipal Statistical Yearbook. Additional data points are derived through regression prediction techniques applied to historically reviewed data. The system model operates over a span from 2012 to 2026, with simulation steps set at one-year intervals.

C. System dynamics model validity test

To determine if the established model accurately predicts real-world scenarios, conducting a validity test is essential. This test is among the simplest and most intuitive methods for assessing accuracy, and it operates on the principle of comparing actual data against model-simulated data, followed by calculating the relative error between them (Lan et al., 2021). As illustrated in Table 2, the probability that the relative error $|ei|\leqslant 5\%$ for the variable GDP of Tianjin, as simulated by the model, is at least 70%, and the relative error for each year remains below 10%. Based on these findings, the simulation effect of the model is considered satisfactory. Therefore, it is reasonable to utilize this system dynamics model to analyze the impact of Tianjin's municipal government's macro-control policies on commodity housing prices.

Table 2 Relative errors between real and simulated GDP values in Tianjin from 2016 to 2022

Particular year	2016	2017	2018	2019	2020	2021	2022
Actual data	13087	14660	15965	16795	17838	18549	18810
Simulation data	13382	15113	16450	16806	19104	19582	19712
Relative error	2.25%	3.09%	3.04%	0.07%	7.10%	5.57%	4.80%

D. Analysis and prediction of model simulation results

Using the system dynamics model developed, we can project the trends in commodity housing prices in Tianjin and examine the raw data from its single-scenario forecast. As illustrated in Figure 3, the growth rate of commercial housing prices in Tianjin moderated between 2016 and 2018, a period that aligns with the implementation of stringent macro-control policies initiated by China in 2010. These comprehensive policies, encompassing land, tax, and monetary measures, effectively curtailed the rapid escalation of housing prices.

Post-2018, as China’s economic landscape transitioned to a new normal, the acceleration in commodity housing prices resumed in 2019-2020, spurred by policies aimed at reducing housing inventories. In early 2020, Tianjin’s commodity housing market experienced a sharp increase in prices. However, following regulatory interventions in 2022, the rate of price growth decelerated, a trend that is also reflected in the simulation forecast results. According to the model, it is anticipated that commercial housing prices in Tianjin will continue to rise at a steady pace beyond 2023..

Figure 3 Simulation results of commodity housing prices in Tianjin city

IV. Moderation Simulation Of The Impact Of A Single Policy On Commodity Housing Prices

A. Tax policy regulation simulation

Building on the theoretical foundation and utilizing the constructed system dynamics model, this study focuses on two primary regulatory tools: the tax rate at the development stage and the tax rate at the consumption stage. Adjustments in these rates are simulated to observe their effects on the fluctuations and magnitudes of commodity housing prices.

In the context of Tianjin, the tax rate during the development stage encompasses more than ten different taxes, including stamp duty, urban construction tax, education surcharge, deed tax, land value-added tax, income tax, land use tax, property tax, among others. Collectively, these taxes account for approximately 20%-25% of the total costs in the real estate sector, with this study adopting an average rate of 23% (Yin et al., 2019). The taxes associated with real estate development, construction, and sales form a significant portion of the costs borne by developers. For this study, the development stage tax rate applied to developers is set at 20%. In the regulatory experiment, this rate is adjusted downward by 25% to 15%, under the assumption that all other factors remain constant. The simulation results from this adjustment are presented in Table 3 and more visually in Figure 4, where 'Before' indicates the original data and 'After' shows the data following regulation.

Table 3 Comparison of results of regulation of tax rate indicators at the development/consumption stage

Particular year		2022	2023	2024	2025	2026	2027	2028	2029	2030
Development stage tax rate	Raw data	19547	23175.16	25677.48	27569.09	28908.93	29550.24	29761.7	29832.92	29803.29
	Regulatory data	18967.87	22376.1	24668.18	26353.01	27495.58	27965.01	28024.29	27950.9	27783.53
	Magnitude of change	3.05%	3.57%	4.09%	4.61%	5.14%	5.67%	6.20%	6.73%	7.27%
	Average magnitude of change	5.15%								
Consumption stage tax rate	Raw data	19547	23175.16	25677.48	27569.09	28908.93	29550.24	29761.7	29832.92	29803.29
	Regulatory data	19313.61	22852.65	25269.51	27076.81	28335.94	28906.61	29055.24	29066.52	28979.58
	Magnitude of change	-1.19%	-1.39%	-1.59%	-1.79%	-1.98%	-2.18%	-2.37%	-2.57%	-2.76%
	Average magnitude of change	-1.98%								

The consumption stage tax rate includes various taxes and fees that consumers must pay when purchasing housing, such as deed tax, stamp duty, and registration fees. These taxes impact consumer purchasing behavior. Based on extensive literature reviews and data analysis, the initial consumption stage tax rate is set at 3%. In the regulatory experiment, this rate is increased by 78% to 5.3%, with all other factors held constant. The outcomes of this adjustment are also detailed in Table 3.

Figure 4 Comparison of the results of the regulation of tax rate indicators during the development phase

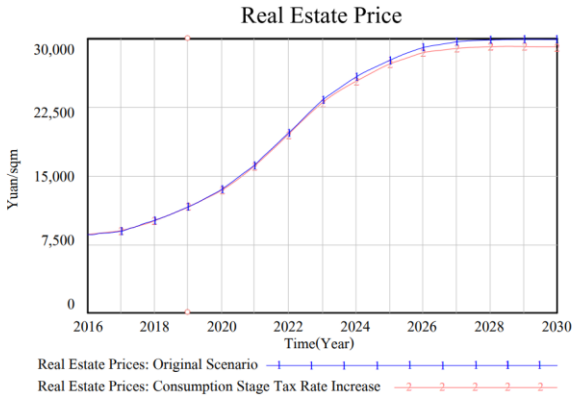

Figure 5 Comparison of the results of the regulation of tax rate indicators at the consumption stage

Comparative analysis of the results from adjusting these two tax policy variables (as shown in Table 3) reveals that reducing the development stage tax rate by 25% corresponds to an average decline of 5.15% in commercial housing prices. In contrast, increasing the consumption stage tax rate by 78% results in a negligible price decline, with average fluctuations not exceeding 2%. This minor effect is visually represented in Figure 5, where the price curves before and after the regulatory adjustments closely align, indicating a relatively weak impact of consumption stage tax adjustments on housing prices.

B. Monetary policy regulation simulation

Monetary policy in Tianjin, China, primarily impacts commercial housing prices through adjustments to the benchmark interest rate of bank loans and the reserve requirement ratio for RMB deposits at financial institutions. For this simulation, the study focuses on the bank loan benchmark interest rate as the regulatory parameter. Data on interest rates are sourced from the statistical releases of the People's Bank of China, with the annual lending rate set by commercial banks used for the simulation. In cases where interest rates change multiple times within a single year, a weighted average is calculated to represent the annual interest rate value (Vartiainen et al., 2020).

The baseline lending rate for 2016 is established at 6.25%. In our simulation experiment, without altering any other factors, we increase the lending rate by 20% to 7.5%. The comparison of data before and after this regulatory adjustment is presented in Table 4.

Table 4 Comparison table of lending rate regulation results

Particular year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Raw data	19547	23175.16	25677.48	27569.09	28908.93	29550.24	29761.7	29832.92	29803.29
Regulatory data	20140.79	23998.55	26722.73	28834.8	30387.33	31216.74	31597.33	31831.31	31958.69
magnitude of change	3.04%	3.55%	4.07%	4.59%	5.11%	5.64%	6.17%	6.70%	7.23%
Average magnitude of change	4.92%								

Figure 6 Comparison of the results of currency rate regulation

Figure 7 Land price regulation results against

The simulation results from this adjustment of the interest rate show that a 20% increase leads to a short-term decrease in commercial housing prices during the initial year. Subsequently, the higher lending rate contributes to an average increase in housing prices of about 4.92% from 2022 to 2030. Notably, the rise in housing prices, although consistent, is modest compared to the significant increase in the interest rate. This nuanced effect of the lending rate on housing prices is more clearly depicted in Figure 6, which illustrates the price change curve over the simulated period.

C. Land policy regulation simulation

Building on our previous analysis, this experiment will utilize adjustments to land prices as a regulatory tool to observe the impact on commodity housing prices and the extent of these fluctuations. With all other factors held constant, the growth rate of land prices will be increased by 10% for this simulation. The results, as generated through software simulation, are displayed in Table 5.

Table 5 Comparison of land rate regulation results

Particular year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Raw data	19547	23175.16	25677.48	27569.09	28908.93	29550.24	29761.7	29832.92	29803.29
Regulatory data	20749.53	24846.9	27805.02	30151.9	31933.44	32968.25	33536.21	33952.63	34258.1
magnitude of change	6.15%	7.21%	8.29%	9.37%	10.46%	11.57%	12.68%	13.81%	14.95%
Average magnitude of change	10.50%								

The data comparison clearly indicates a significant fluctuation in commercial property prices following the adjustment in land prices. By increasing the growth rate of land prices by 10%, the average rise in commercial housing prices is recorded at 10.50%, which is approximately double the adjustment rate of land prices. Moreover, there appears to be an ongoing trend of expanding growth rates. This change and its dynamics are more vividly

depicted in Figure 7, illustrating the significant leverage that land price adjustments hold over housing market dynamics.

V. Moderation Simulation Of The Impact Of Integrated Policies On Commodity Housing prices

Following the simulations and predictions based on individual policies, this study integrates three regulatory tools—development stage tax rate, loan interest rate, and land price—derived from tax, monetary, and land policies. The aim is to simulate the collective impact of these tools on commodity housing prices under an integrated policy environment. The original housing prices are represented by "Original" in the data, with the following four types of integrated policy simulations conducted:

Policy Simulation I (Simulation I): With all other indicators held constant, the development tax rate and loan interest rate are each reduced by 10%.

Policy Simulation II (Simulation II): All other indicators remain unchanged while the development tax rate, loan interest rates, and land prices are all decreased by 10%.

Policy Simulation III (Simulation III): Maintaining all other indicators, both the loan interest rate and land price are decreased by 10%.

Policy Simulation IV (Simulation IV): With no changes to other indicators, both the development tax rate and land price are reduced by 10%. ·

Table 6 Comparison table of integrated regulation results

Particular year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Raw data	19547	23175.16	25677.48	27569.09	28908.93	29550.24	29761.7	29832.92	29803.29
Policy Simulation 1	19313.61	22852.65	25269.51	27076.81	28335.94	28906.61	29055.24	29066.52	28979.58
Policy Simulation 2	18403.12	21600.76	23693.76	25184.85	26144.72	26457.46	26380.32	26179.02	25891.49
Policy Simulation 3	19082.54	22533.99	24867.21	26592.33	27773.16	28275.72	28364.14	28318.29	28177
Policy Simulation 4	18967.87	22376.1	24668.18	26353.01	27495.58	27965.01	28024.29	27950.9	27783.53

The simulations are performed using Vensim software, and the outcomes are documented in Table 6. An accompanying figure 8 provides a more intuitive visualization of the results of these integrated regulatory experiments. Curve 5 displays the original data, while Curves 1 to 4 correspond to the results from Policy Simulations I through IV, respectively. This visual representation helps elucidate the differential impacts of these combined regulatory approaches on the dynamics of commodity housing prices.

Figure 8 Comparison of the results of integrated regulation

VI. Discussion and Recommendations

A. The Impact of Tax Policy Regulation on Commercial Housing Prices

From both supply and demand perspectives, in conjunction with the monetary policy regulation findings from Section 4.1, the development stage tax rate exerts a positive feedback effect on commodity housing prices. A reduction in the development stage tax rate leads to a noticeable decrease in housing prices. Conversely, the

consumption-phase tax rate shows a negative feedback effect; an increase in this rate results in only a marginal decline in housing prices. Comparative analysis within the tax policy realm reveals that the development-stage tax rate is more effective than the consumption-stage tax rate in controlling housing prices. While some scholars assert that taxation dampens the rise in commodity housing prices (Guo et al., 2021), this study observes the opposite for the consumption stage tax rate. Despite significant increases, the consumption stage tax rate does not lead to a corresponding decrease in housing prices. This could be attributed to China's real estate demand structure, which is dominated by inelastic, necessity-driven demand that is largely unresponsive to tax rate changes, coupled with the relatively low base tax rate at the consumption phase.

B. Effectiveness of Monetary Policy in Housing Price Regulation

Both supply and demand factors, together with results from monetary policy regulation in section 4.2, show that the lending rate ultimately has a positive feedback effect on commodity housing prices, though the response is not fully proportionate. The increase in lending rates heightens financing difficulties for developers, reducing their willingness to invest and thereby slightly increasing residential housing prices due to reduced supply. Simultaneously, higher lending rates also dampen homebuyer enthusiasm, reducing demand for commercial real estate, which in turn could lower housing prices. Considering the overall dynamics of the real estate market, rising interest rates primarily depress market demand, while supply adjustments have a longer-term effect (Bauer, 2017; Antweiler & Muesgens, 2021). Thus, while the immediate impact of dampened demand is more pronounced, the long-term regulatory role of loan interest rates significantly affects the supply side.

C. Influence of Land Policy on Commodity Housing Prices

Data from regulation experiments in section 4.3 indicate a strong positive feedback effect from land price adjustments, primarily impacting the supply side. Land price is a critical determinant of commodity housing prices, showing the most substantial effect among the studied factors. An increase in land prices directly leads to higher housing prices, and this effect intensifies over time. The strong correlation between land and commercial housing prices means that as housing prices rise, more developers are attracted, leading to fierce competition and higher land prices, which in turn drive housing prices even higher. Given that land finance is a major revenue source for local governments in China, maintaining a rapid pace of real estate development is often in the local government's interest to ensure further land price increases.

Fourth, comparing the results of the four comprehensive policy simulations in Section 5, except for Policy Simulation 2, Policy Simulation 4 has the strongest impact on commodity housing prices, i.e., adjusting the tax rate of the development segment and the land price, which are the two regulatory tools. The less influential role on commodity housing prices is played by Policy Simulation I, i.e., the two regulatory tools of adjusting the development segment tax rate and the loan interest rate. Thus, the combination of tax policy and land policy has the largest impact on the price of housing, and the combination of tax policy and financial policy has the smallest impact on the price of housing.

D. Comparison of Comprehensive Policy Simulation Results

From the results of the four comprehensive policy simulations in Section 5, except for Policy Simulation II, Policy Simulation IV, which adjusts both the development tax rate and land price, has the strongest impact on commodity housing prices. The least impactful is Policy Simulation I, adjusting the development stage tax rate and loan interest rate. Therefore, a combination of tax and land policies has the most significant effect on housing prices, while the combination of tax and monetary policies has the least impact.

E. Recommendations for Policy Improvements

Tax Policy: Adjust the tax structure by optimizing tax types and rates, such as reducing the development tax rate to decrease the tax burden on developers, which may prevent undue price increases in commercial real estate.

Monetary Policy: Implement differentiated interest rates and adjust the intensity of regulation to enhance the effectiveness of monetary policy, ensuring consistency and transparency in its application.

Land Policy: To curb rapid housing price increases, the government should scientifically devise land supply plans, improve land transfer methods, and optimize land supply structures.

Integrated Policy Strategy: Develop land policies that effectively adjust land prices and tax policies that modify the development stage tax rate as primary tools, with monetary policy serving as a supportive measure to boost the efficacy of China's real estate macroeconomic regulation.

VII. CONCLUSION

This study sets out to systematically examine the feedback relationship, specific impacts, and the extent of influence of the government's three principal macro-control policies—taxation, monetary, and land—on commercial housing prices. Through establishing a dynamic system dynamics (SD) integrated model, we first analyze the transmission mechanisms of these macro-control policies from the perspectives of supply and demand. We then construct causal loop diagrams and system stock flow diagrams. After determining the relevant parameters and establishing the relationships between the functions of each variable and completing a validity test, we conduct simulation tests of the system model and control simulations to evaluate the systematic effectiveness of these macro-policies on commodity housing prices.

The results of our study affirm that supply and demand critically determine the interrelationships between government macro-control policies and commodity housing prices. Utilizing the model, we systematically explore the medium- and long-term comprehensive effectiveness of both single and integrated macro-control policies on commodity housing prices, offering recommendations for improving China's existing real estate policies. Thus, our research contributes to three main areas: elucidating the mutual feedback relationship between commodity housing prices and macro policies based on supply and demand theory, assessing the systematic impact of macro-control policies on commodity housing prices, and applying system dynamics to analyze commodity housing prices.

While legal and administrative regulatory policies primarily regulate the behavior of market participants rather than directly impacting commodity housing prices themselves, this study specifically focuses on the macro-regulatory policies of tax, currency, and land. Multiple regression analysis is employed to identify the influencing factors among variables in the system dynamics model, and some hard-to-obtain data are estimated, which may affect the accuracy of the model's predictions. Future research could include the influence of legal and administrative macro-control policies on commercial housing prices for a more comprehensive and precise reflection of reality. Additionally, finding a more scientific and rational method to determine the relationships between variables in the model could further enhance the overall accuracy of the system dynamics model.

Building on previous studies and incorporating insights from information economics, this study develops a mediation model with initial trust as the intermediary variable and "GuanXi" as the regulating variable. The model elucidates how information disclosure influences cooperative behavior between owners and contractors, initially mediated by trust, and identifies conditions under which these interactions may be significantly influenced through adjustments in "GuanXi." This aspect of the study holds both theoretical and practical significance, guiding owners in selecting suitable contractors, fostering effective collaboration, and thereby enhancing project management performance.

A. Theoretical significance

1) Effectiveness of Information Disclosure in Enhancing Cooperation

This study underscores the pivotal role of information disclosure in fostering cooperation, particularly through third-party platforms like the National Construction Market Supervision Public Service Platform. By examining the influence of such platforms on the cooperative behavior between owners and contractors, the research not only aligns with prior studies (Huang 2014; DIAMOND 2012; Argyres and Liebeskind 1999) that highlighted the benefits of prior information disclosure in improving mutual understanding and cooperation but also emphasizes the significant contribution of third-party information disclosure. The study indicates that platforms dedicated to the engineering construction industry facilitate excellent cooperation by providing information that is rich, accurate, and efficiently delivered.

2) Mediating Role of Initial Trust

The findings from this study reveal that initial trust significantly mediates the relationship between information disclosure and cooperation. Specifically, the direct effect of information disclosure on cooperation was quantified at 0.192, constituting 37.45% of the total effect (0.514). When initial trust is factored in as a mediating variable, it accounts for 62.55% of the total effect. This suggests that information disclosure not only directly influences cooperation but also exerts a stronger indirect impact through enhancing initial trust, corroborating earlier research that links effective information disclosure to deepened trust and improved collaborative outcomes (Huang 2014).

3) Moderating Effect of Chinese "GuanXi"

This study also highlights the moderating role of Chinese "GuanXi" in the dynamics of information disclosure, initial trust, and cooperation. The data suggests that at low levels of "GuanXi," information disclosure significantly

boosts initial trust and cooperation. However, as "GuanXi" intensifies, the impact of information disclosure gradually diminishes, supporting the unique governance characteristics associated with Chinese "GuanXi".

B. Practical significance

The practical implications of this research are profound, affirming the importance of third-party information disclosure platforms like the national public service platform for construction market supervision. Such platforms not only aid in enhancing the engineering construction industry's development and integrity but also facilitate a more transparent, honest, and cooperative market environment. Industry stakeholders recognize the value of sharing credible information on these platforms, which fosters a culture of good faith and collaborative ethics across the industry. This realization paves the way for the expansion and enhancement of similar third-party information platforms.

C. Conclusions and prospects

The study concludes that effective information disclosure directly promotes cooperation between project owners and contractors, with initial trust serving as a crucial intermediary in this process. Additionally, the study identifies "GuanXi" as having a potentially diminishing effect on the impact of information disclosure on trust and cooperation. While these findings reinforce and expand upon previous research, the study also acknowledges certain limitations which future research could address:

Differentiation of Stakeholder Attributes: Future studies could explore the distinct cognitive perspectives of owners and contractors to better understand their interactions.

Roles of Trust: Further research might examine how different types of trust (e.g., ex ante vs. ex post) influence the relationship between information disclosure and cooperation.

Methodological Enhancements: Adopting longitudinal study methods could provide a more dynamic understanding of how these relationships evolve over time, overcoming the limitations of the cross-sectional research approach used in this study.

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REFERENCES

[1] AHMAD, S. & SIMONOVIC, S. P. 2000. System Dynamics Modeling of Reservoir Operations for Flood Management. Journal of Computing in Civil Engineering, 14, 190-198.

[2] ALESINA, A. 2018. Political models of macroeconomic policy and fiscal reforms. In Modern Political Economy and Latin America (pp. 44-58). Routledge.

[3] ANTWEILER, W., & MUESGENS, F. 2021. On the long-term merit order effect of renewable energies. Energy Economics, 99, 105275.

[4] BARWELL, R. 2017. Macroprudential Policy and the UK Housing Market, Springer International Publishing.

[5] BAUER, G. H. 2017. International house price cycles, monetary policy and credit. Journal of International Money & Finance, 74, 88-114.

[6] BAUMEISTER, C., LIU, P. & MUMTAZ, H. 2010. Changes in the Transmission of Monetary Policy: Evidence from a Time-Varying Factor-Augmented VAR. Bank of England Working Papers, 346.

[7] CAJIAS, M., ERTL, S. & THANOS, S. 2015. The Sensitivity of House Prices Under Varying Monetary Regimes: The Nordic Case. International Journal of Housing Markets & Analysis, 10.

[8] CAO, C. Y. & CAO, Z. P. 2017. Research on the Impact of Real Estate Tax on Price of Commercial Residential Houses--based on Ref orm Pilot Situation in Chongqing and Shanghai. Prices Monthly.

[9] CAO, J. A. & KEIVANI, R. 2014. The Limits and Potentials of the Housing Market Enabling Paradigm: An Evaluation of China's Housing Policies from 1998 to 2011. Housing Studies, 29, 44-68.

[10] CHEN, H., ZHANG, Y., ZHANG, N., ZHOU, M., & DING, H. 2022. Analysis on the spatial effect of infrastructure development on the real estate price in the Yangtze River Delta. Sustainability, 14,13, 7569.

[11] CHEN, T., & TAN, B. 2020. Research on Project Resource Allocation and Lean Procurement Strategy Based on System Dynamics'. Academic Journal of Business & Management, 2,5, 25-36.

[12] DEEP, S., BHOOLA, V., VERMA, S., & RANASINGHE, U. 2022. Identifying the risk factors in real estate construction projects: An analytical study to propose a control structure for decision-making. Journal of financial management of property and construction, 27,2, 220-238.

[13] DU, Z. & ZHANG, L. 2015. Home-purchase restriction, property tax and housing price in China: A counterfactual analysis. Journal of Econometrics, 188, S0304407615000871.

[14] DUCA, J. V., HENDERSHOTT, P. H., & LING, D. C. 2017. How taxes and required returns drove commercial real estate valuations over the past four decades. National Tax Journal, 70,3, 549-584.
[15] Edwards, T. L., Nowicki, S., Marzeion, B., Hock, R., Goelzer, H., Seroussi, H., ... & Zwinger, T. (2021). Projected land ice contributions to twenty-first-century sea level rise. Nature, 593(7857), 74-82.
[16] FAN, X., QIU, S., & SUN, Y. 2020. Land finance dependence and urban land marketization in China: The perspective of strategic choice of local governments on land transfer. Land Use Policy, 99, 105023.
[17] GAYNOR, A. K. 2012. Systems Thinking: Modeling Problem Systems. In Analyzing Problems in Schools and School Systems (pp. 108-130). Routledge.
[18] GUO, J., WANG, J., LIU, D., QIAO, S., & WU, H. 2021. Study of a System Dynamics Model of Wuhan Commodity Housing Price. Advances in Civil Engineering, 2021, 1-21.
[19] GREEN, R. K. 1999. Land Use Regulation and the Price of Housing in a Suburban Wisconsin County. Journal of Housing Economics, 8, 144-159.
[20] HAMILTON & BRUCE 1975. Zoning and Property Taxation in a System of Local Governments. Urban Studies, 12, 205-211.
[21] HANSEN & WALTER, G. 1959. How Accessibility Shapes Land Use. Journal of the American Institute of Planners, 25, 73-76.
[22] HAN, W., ZHANG, X., & ZHENG, X. 2020. Land use regulation and urban land value: Evidence from China. Land Use Policy, 92, 104432.
[23] HAERINCK, J., GOOSSENS, S., & BERX, G. 2023. The epithelial‐mesenchymal plasticity landscape: Principles of design and mechanisms of regulation. Nature Reviews Genetics, 24,9, 590-609.
[24] HOWICK, S. 2005. Using system dynamics models with litigation audiences. European Journal of Operational Research, 162, 239-250.
[25] HUANG, X., JIN, T. & ZHANG, J. 2016. Monetary Policy, Hot Money and Housing Price Growth Across Chinese Cities. SSRN Electronic Journal.
[26] HUBBARD, R. G. Capital-Market Imperfections, Investment, and the Monetary Transmission Mechanism.
[27] HUANG, Y., GE, T., & WANG, C. 2019. Monetary policy framework and transmission mechanism. Handbook of China ’ s financial system.
[28] HWANG, S., LEE, J., YI, J.-S. & KIM, M. Korean public rental housing for residential stability of the younger population: analysis of policy impacts using system dynamics.
[29] HWANG, S. & LIU, L. Y. 2015. Contemporaneous Time Series and Forecasting Methodologies for Predicting Short-Term Productivity. Journal of Construction Engineering & Management, 136, 1047-1055.
[30] HWANG, S., PARK, M., LEE, H.-S. & KIM, W. 2010. [American Society of Civil Engineers Construction Research Congress 2010 - Banff, Alberta, Canada (May 8-10, 2010)] Construction Research Congress 2010 - Korean Real Estate Market and Mortgage Lending Policies: A Quantitative Approach.
[31] Islam, M., Uddin, M. N., & Rahman, M. M. (2022). A GIS-based approach to explore the factors contributing towards Urban residential land development and re-development (LDR): a case of Rajshahi City Corporation area. Geology, Ecology, and Landscapes, 6(2), 113-124.
[32] IHLANFELDT, K. R. 2007. The effect of land use regulation on housing and land prices. Journal of Urban Economics, 61, 420-435.
[33] JIANG, Y., LI, C., ZHANG, J. & ZHOU, X. 2019. Financial Stability and Sustainability under the Coordination of Monetary Policy and Macroprudential Policy: New Evidence from China. Sustainability, 11.
[34] JOHN, D. & STERMAN 2000. Learning In and About Complex Systems. Reflections the Sol Journal.
[35] JUNG, J. & LEE, Y. 2019. Impacts of Open Space and Land Use Regulation on Housing Price. Journal of The Korean Urban Management Association, 32, 17-31.
[36] KIM, H. J., PARK, J., KIM, J., JI, K. & SON, J. W. 2009. A Comparative Study on the Real Estate Market and Policy Responsesin England, Australia, the USA, Japan, China, and Korea. Seoul Studies, 10.
[37] Knittel, C. R., & Pindyck, R. S. 2016. The simple economics of commodity price speculation. American Economic Journal: Macroeconomics, 8,2, 85-110.
[38] KNOLL, K., SCHULARICK, M. & STEGER, T. No Price Like Home: Global House Prices, 1870‐2012*. Social Science Electronic Publishing.
[39] LAN, H., GOU, Z., & XIE, X. 2021. A simplified evaluation method of rooftop solar energy potential based on image semantic segmentation of urban streetscapes. Solar Energy, 230, 912-924.
[40] LEE, M. H., CHOI, N. H. & PARK, M. 2005. A systems thinking approach to the new administrative capital in Korea: balanced development or not? System Dynamics Review, 21, 69-85.
[41] LI, Y. 2021. Essays on the Housing Market in China and Some Evidence on Inflation Targeting.
[42] LI, S., ZHENG, X., & ZENG, Q. 2023. Can Green Finance Drive the Development of the Green Building Industry?−Based on the Evolutionary Game Theory. Sustainability, 15,17, 13134.

[43] MADRID, U. S. P. C. D. DSpace CEU: The monetary transmission mechanism [Recurso electrónico] : an empirical framework / John B. Taylor.
[44] NEWBERRY, P., & CARHART, N. 2024. Constructing causal loop diagrams from large interview data sets. System Dynamics Review, 40(1), e1745.
[45] PARK, J. B. & LEE, Y. 2018. The Real Estate Tax Policy and the Housing Market Stabilization - Focused on the Property Possession Tax and the Transaction Tax.
[46] PEA-MORA, F. & LI, M. 2001. Dynamic Planning and Control Methodology for Design/Build Fast-Track Construction Projects. Journal of Construction Engineering & Management, 127, 1-17.
[47] QIAO, W., JU, Y., DONG, P., & TIONG, R. L. 2024. How to realize value creation of digital transformation? A system dynamics model. Expert Systems with Applications, 244, 122667.
[48] RITHMIRE, M. E. 2017. Land institutions and Chinese political economy: Institutional complementarities and macroeconomic management. Politics & Society, 45,1, 123-153.
[49] SCHOENMAKER, D. A., & Van der Vlist, A. J. 2015. On real estate development activity: the relationship between commercial and residential real estate markets. Letters in Spatial and Resource Sciences, 8, 219-232.
[50] SGHERRI, S. 2000. Monetary Transmission Channels, Monetary Regimes and ConsumptionBehaviour. DNB Staff Reports (discontinued).
[51] SOMMER, K. A. & SULLIVAN, P. 2018. Implications of US Tax Policy for House Prices, Rents, and Homeownership. American Economic Review, 108, 241-274.
[52] SONG, S., JOU, J. B. & TRIPE, D. 2014. Can interest rates really control house prices? Effectiveness and implications for macroprudential policy. Journal of Banking & Finance, 47, 15-28.
[53] SPIRO, P. S. 2018. Tax policy and the underground economy. In Size, causes and consequences of the underground economy (pp. 179-201). Routledge.
[54] TAYLOR, T. R. B. & FORD, D. N. 2008. Managing Tipping Point Dynamics in Complex Construction Projects. Journal of Construction Engineering & Management, 134, 421-431.
[55] VARTIAINEN, E., MASSON, G., BREYER, C., MOSER, D., & ROMAN MEDINA, E. 2020. Impact of weighted average cost of capital, capital expenditure, and other parameters on future utility‐scale PV levelised cost of electricity. Progress in photovoltaics: research and applications, 28(6), 439-453.
[56] VEGH, C. A., & VULETIN, G. 2015. How is tax policy conducted over the business cycle?. American Economic Journal: Economic Policy, 7,3, 327-370.
[57] WANG, S. J., WANG, J. Y. & WANG, Y. 2018. Effect of land prices on the spatial differentiation of housing prices: Evidence from cross-county analyses in China. Journal of Geographical Sciences, 28, 725-740.
[58] WANG, L., ZHAO, Z., WANG, X., & XUE, X. 2021. Transportation de-carbonization pathways and effect in China: A systematic analysis using STIRPAT-SD model. Journal of cleaner production, 288, 125574.
[59] WEI, Y., CUI, H., PATRICK, L., YONG, S. & YONG, F. 2015. Using Urban-Carrying Capacity as a Benchmark for Sustainable Urban Development: An Empirical Study of Beijing.
[60] WEN, XING-CHUN, HE & LING-YUN 2017. Population growth, interest rate, and housing tax in the transitional China. Physica A Statistical Mechanics & Its Applications.
[61] WOOD, G., WATSON, R. & FLATAU, P. 2006. Microsimulation Modelling of Tenure Choice and Grants to Promote Home Ownership. Australian Economic Review, 39, 14-34.
[62] WU, J., GYOURKO, J. & DENG, Y. 2012. Evaluating conditions in major Chinese housing markets. Regional Science and Urban Economics, 42, 531-543.
[63] WU, W., SHENG, L., TANG, F., ZHANG, A., & LIU, J. 2021. A system dynamics model of green innovation and policy simulation with an application in Chinese manufacturing industry. Sustainable Production and Consumption, 28, 987-1005.
[64] XIAO, L., QIU, Q. & GAO, L. 2016. Chinese Housing Reform and Social Sustainability: Evidence from Post-Reform Home Ownership. Sustainability, 8, 1053-.
[65] YIN, S., MA, Z., SONG, W. & LIU, C. 2019. Spatial Justice of a Chinese Metropolis: A Perspective on Housing Price-to-Income Ratios in Nanjing, China. Sustainability, 11.
[66] YAN, N. 2019. Study on the influence of monetary policy on real estate price in China. Journal of Service Science and Management, 12,02, 152.
[67] ZHANG, X., LIU, X., HANG, J., YAO, D. & SHI, G. 2016. Do Urban Rail Transit Facilities Affect Housing Prices? Evidence from China. Sustainability, 8, 380.
[68] ZHAO, W., & RUET, J. 2021. Managing the “post miracle” economy in China: Crisis of growth model and policy responses. Post-Communist Economies, 33(7), 820-841.
[69] ZHUO, H., YU, C., & ZHANG, W. 2022. Response or avoidance: The reaction of local governments to the central government's housing market control policies. Cities, 129, 103895.