Macroeconomic drivers effect on housing sale prices in China

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Abstract

Purpose – The purpose of this study is to conduct a thorough empirical investigation of the intricate relationship between urban housing sales prices and land supply prices in China, with the aim of elucidating the underlying economic principles governing this dynamic interplay.

Design/methodology/approach – Using monthly data of China, the authors use the asymmetry nonlinear autoregressive distributed lag (NARDL) model to test for nonlinearity in the relationship between land supply price and urban housing prices.

Findings – The empirical results confirm the existence of an asymmetric relationship between land supply price and urban housing prices. The authors find that land supply price has a positive and statistically significant impact on urban housing prices when land supply is increasing. Policymakers should strive to strike a balance between safeguarding residents’ housing rights and maintaining market stability.

Research limitations/implications – Although the asymmetric effect of land supply price has been identified as a significant contributor in this study, it is important to note that the research primarily relies on time series data and focuses on analysis at the national level. Although time series data offer a macroscopic perspective of overall trends within a country, they fail to adequately showcase the structural variations among different cities.

Practical implications – To ensure a stable housing market and meet residents’ housing needs, policymakers must reexamine current land policies. Solely relying on restricting land supply to control housing prices may yield counterproductive results. Instead, increasing land supply could be a more viable option. By rationally adjusting land supply prices, the government can not only mitigate excessive growth in housing prices but also foster the healthy development of the housing market.

Originality/value – First, the authors have comprehensively evaluated the impact of land supply prices in China on urban housing sales prices, examining whether they play a facilitating or mitigating role in the fluctuation of these prices. Second, departing from traditional linear analytical frameworks, the authors have explored the possibility of a nonlinear relationship existing between land supply prices and urban housing

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sales prices in China. Finally, using an advanced NARDL model, the authors have delved deeper into the asymmetric effects of land supply prices on urban housing sales prices in China.

**Keywords** China, Housing market, NARDL, Asymmetric effect, Land supply price, Urban housing prices

**Paper type** Research paper

1. **Introduction**

In recent decades, housing price volatility risk has drawn much attention from economists, investors, policymakers and regulators across the globe. The development of the housing sector has a direct and considerable impact on various macroeconomic factors, including employment, construction-related industries and financial development, as well as individual wealth consumption and distribution. Sustained robustness within the housing market serves as a vital pillar for long-term economic expansion. Moreover, Ahmed et al. (2022) have extended our understanding by documenting that the evolution of the housing market is directly tied to the financial stability of an economy. The swift escalation of house prices is a catalyst for an economic downturn, ultimately resulting in precarious circumstances (Ahmed et al., 2021a). Financial crises, such as the Asian financial crisis in 1998, which led to currency devaluations and economic slowdowns, and the dot-com bubble burst in the early 2000s, which impacted investor confidence and mortgage availability, have historically disrupted the housing market globally (Li et al., 2022). Given the potential for significant economic repercussions, academics and policymakers are intensively monitoring the housing sector.

To address the growing interest in real estate market dynamics, DiPasquale and Wheaton (1992) proposed a groundbreaking framework for investigating the housing sector that has attracted considerable interest from theoretical and empirical researchers. Existing research on the factors influencing housing prices has encompassed a wide range of topics, including foreign capital inflow (Ahmed and Jawaid, 2023; Ahmed et al., 2021b), air quality (Choi et al., 2023; Zou et al., 2022), housing supply (Egan and McQuinn, 2023), tourism (Song et al., 2023), the impact of metro lines (López-Morales et al., 2023), oil prices (Ahmed et al., 2022) and land supply (Mohamadzadeh et al., 2016; Zeng et al., 2022). Taken together, these studies highlight the complex interplay of economic, environmental and social factors that jointly determine property values in the housing market. One of the most important drivers of housing prices is the land supply price (Ahmed et al., 2021b). It is considered a key factor in other housing sectors’ determinants, such as housing construction costs and market interest rates (Xu and Zhang, 2023). In the case of China, the real estate market has seen significant transformation in recent decades. The Chinese Government has encouraged the commercialization of urban housing since 1978 (Li et al., 2018). As a result, real estate development has emerged as a major business, and the housing market has expanded rapidly. In this context, recent literature has explored the linear relationship between housing land supply prices and urban housing sale prices (Murray and Limb, 2023). However, these studies have overlooked the potential for an asymmetric impact, particularly in the Chinese housing market. Our study aims to fill this gap.

For Chinese citizens, housing is not just mere physical shelter; it constitutes the foundation of social welfare. Embodying the profound concept of home, it represents their aspirations for a secure and flourishing life with their families. However, rapid urbanization, particularly in major cities, has propelled housing prices to alarming heights, capturing the attention of the public (Chen and Wen, 2017; Zhu et al., 2020; Qian, 2023). The pursuit of homeownership often demands significant sacrifices, with individuals and families...
tightening their belts and bearing the weight of substantial financial commitments (Ahmed and Jawaid, 2023; Osmadi et al., 2015; Berisha et al., 2023). Urban housing prices not only directly influence residents’ economic well-being but also exert a profound impact on their consumption, savings and investment decisions (Lee, 2023). Consequently, any fluctuations in urban housing sales prices arouse intense scrutiny and concern among the general populace. This makes urban housing prices a critical issue closely tied to social stability and the well-being of citizens. To comprehensively grasp this issue, a thorough investigation into the various influencing factors behind housing prices is imperative.

Furthermore, the acceleration of urbanization strengthens the correlation between land supply prices and urban housing sales prices. With the continuous advancement of urbanization, the urban population expands, leading to an increase in housing demand (Pan and Wang, 2013; Zhong et al., 2023). However, urban land resources are limited, causing land supply prices to rise incessantly, further inflating housing prices. Simultaneously, the development of urban economies and enhanced attractiveness attract large populations to cities, augmenting housing demand and further complicating the intricate relationship between land supply prices and urban housing sales prices (Liu and Xiong, 2018; An et al., 2021). Therefore, in China, under the combined influence of limited urban land resources and government regulations on the land market, land supply prices have emerged as one of the critical factors affecting urban housing sales prices (Shin et al., 2023; Li et al., 2020). This impact is amplified in the context of accelerated urbanization, making the relationship between urban housing sales prices and land supply prices even more intricate and challenging. This also imposes higher demands and challenges on urban planning and economic development.

The primary objective of this study is to conduct a thorough empirical investigation of the intricate relationship between urban housing sales prices and land supply prices in China, with the aim of elucidating the underlying economic principles governing this dynamic interplay. Through rigorous data analysis and econometric modeling, we endeavor to unveil the intricate mechanisms that drive the coevolution of these two crucial economic indicators. By conducting such research, we aspire to provide policymakers with more precise and actionable insights to inform evidence-based decision-making. Understanding the dynamic interplay between urban housing sales prices and land supply prices empowers policymakers with the ability to anticipate and evaluate the potential impacts of policies with greater precision when designing and implementing relevant measures, thus fostering the development of more scientifically sound land supply and housing policies. Furthermore, the findings of this study hold significant reference value, providing real estate investors and developers with valuable insights into the trends of urban housing prices in China. Gaining a comprehensive understanding of pricing indicators and market dynamics empowers investors to make more informed decisions, thereby mitigating investment risks while optimizing returns. In addition, financial analysts can also benefit from this research by using our findings to provide their clients with more precise and comprehensive housing investment counsel, facilitating the achievement of their financial goals. In essence, by offering an in-depth exploration of the interplay between land supply prices and urban housing sales prices in China, this study answering the following research questions:

*RQ1.* What are the broader macroeconomic spillover effects of land supply price adjustments on urban housing prices?

*RQ2.* Whether economic performance influence urban housing sale price in China?
The contributions of this research can be summarized into three key aspects. First, we have comprehensively evaluated the impact of land supply prices in China on urban housing sales prices, examining whether they play a facilitating or mitigating role in the fluctuation of these prices. Through rigorous empirical analysis, we offer valuable insights into the dynamic interplay between the land market and the urban housing sales market, enhancing our understanding of their intricate mechanisms. Second, departing from traditional linear analytical frameworks, we have explored the possibility of a nonlinear relationship existing between land supply prices and urban housing sales prices in China. This revelation underscores the complexity and diversity of their relationship, presenting policymakers and market participants with a more holistic perspective that acknowledges the nuances and dynamics of this interplay. Finally, by using an advanced nonlinear autoregressive distributed lag (NARDL) model, we have delved deeper into the asymmetric effects of land supply prices on urban housing sales prices in China. The incorporation of monthly data not only enhances the research’s timeliness but also spotlights the influence of seasonal structures on housing prices, thereby bolstering the practical relevance and guiding significance of our findings. This sophisticated approach allows us to offer more targeted and context-specific recommendations, fostering informed decision-making in the realm of real estate policy and investment.

This paper has the following structure: Section 2 provides the theoretical framework; Section 3 provides previous literature review; Section 4 presents data and methodology for NARDL, respectively; Section 5 shows result of NARDL model; and Section 6 shows conclusion and policy recommendation.

2. Theoretical framework: the relationship between housing sale prices and macroeconomic drivers

To achieve these research objectives, this article constructs an analytical framework grounded in relevant economic literature. This framework aims to provide a more comprehensive and in-depth understanding of the relationship between land prices and housing sales prices. Within this framework, rent theory emerges as a critical tool for unpacking the linkage mechanism between the land market and the housing market (Alonso, 1964; Muth, 1969). At its core, rent theory illuminates how rent— as compensation for land use rights—reflects the economic value and scarcity of land (Smith, 1979), thereby influencing housing sales prices.

In the current era of rapid urbanization, the steady influx of population into cities has become a pronounced trend (Chen et al., 2023; Ma and Shi, 2023). This shift has exacerbated the scarcity of urban land resources (Qu et al., 2024), a scarcity that stems not only from land’s nonrenewability but also from its fundamental and irreplaceable role in urban development (He et al., 2022; Gao et al., 2023). Consequently, the preciousness of urban land resources is unmistakable, often manifesting in higher rents paid by land users as the price for accessing these limited resources. This phenomenon reflects both the high market demand for land resources and the pivotal position of land in the urbanization process.

The escalation of land rent is a direct consequence of both the appreciation of land value and the intensifying market competition (Zheng et al., 2023; Yuan et al., 2019). In central urban areas, with their robust infrastructure, convenient transportation networks and abundant public services, land often emerges as a sought-after commodity for various development projects. This competition drives up land rent significantly, underscoring land’s value as a crucial economic resource and highlighting the scarcity of urban land (Bell et al., 2022). As urbanization progresses and the population continues to grow, this scarcity is poised to deepen further, perpetuating the upward trend in land rent (Lu and Wang, 2020).
Furthermore, the rent increase exposes the fierce competition within the land market. Amid tight land supply conditions, numerous land users engage in cutthroat competition for the same parcel of land (Deng, 2022). This competitive dynamic inevitably pushes up land rent levels, resulting in only those willing to pay premium prices securing land use rights (Zheng et al., 2023; Anderson, 2019). This phenomenon is particularly pronounced in the real estate market, where developers often shell out high rents to acquire scarce land resources for project development. This not only intensifies competition in the land market but also reinforces the upward spiral of rent.

Land price can be conceptualized as the capitalization of rent—i.e., the summation of expected future rent income streams (Cheng et al., 2021). Hence, any fluctuations in land rent directly impact land prices (Valenti et al., 2021). Specifically, an uptick in rent levels translates into higher land prices. This relationship is succinctly expressed in the formula: land price equals rent divided by the discount rate. In this context, the discount rate is typically viewed as a relatively stable variable, making the rent increase the primary force driving up land prices (Zou et al., 2015). This explanation sheds light on the dynamic pricing mechanisms within the land market.

The cost of land is a crucial determinant in real estate development, significantly impacting the overall structure of housing costs (Acquaye et al., 2007). As land prices continue to rise, developers must implement proactive and effective strategies to protect the economic viability and long-term profitability of their projects. One common strategy is to increase housing sales prices, which allows developers to pass along the added expenses associated with higher land costs to homebuyers (Huffman et al., 2007; Grimes and Aitken, 2010). Although this approach helps maintain expected profit margins, it inevitably results in higher housing prices, which can affect homebuyers’ purchasing decisions and financial capabilities.

The surge in housing sales prices can trigger a cascade of consequences. On the one hand, certain homebuyers, apprehensive about the relentless rise in housing prices, may opt to expedite their home purchases—a phenomenon known as “price chasing” (Shui and Murthy, 2019). This behavior, to some extent, intensifies the already tense atmosphere in the market. On the other hand, elevated housing prices may lure speculators into the real estate market, enticed by the prospect of profits through short-term property transactions (Yang and Zhou, 2023). Such speculative activities can disrupt the market’s normal order, further inflate housing prices and exacerbate market volatility.

Moreover, excessively high housing prices can impose a substantial economic burden on homebuyers (Murphy, 2007). This may compel some individuals to postpone their purchase plans, settle for smaller living spaces or explore alternative housing options. This adjustment in market demand can, to some extent, exert a moderating influence on housing prices, establishing a self-regulatory mechanism within the market. However, the precise magnitude and efficacy of this inhibitory effect are contingent upon a multitude of factors, including supply–demand dynamics and policy interventions (Zou, 2020; Head and Ellis, 2016).

The rent theory offers a valuable theoretical lens through which we can gain deeper insights into the intricate relationship between land prices and housing sales prices. This paper extends theoretical knowledge by examining whether asymmetry exists in the nexus between land supply price and urban housing price. The existing literature on the Chinese economy primarily explores the linear relationship between these two variables. This paper aims to fill this gap by elucidating the inherent asymmetry connections between rent, land prices and housing sales prices. By doing so, the rent theory provides a valuable framework for understanding the dynamics of the real estate market.
3. Literature review
In recent years, China’s rapid economic development and urbanization have thrust the urban housing market into the spotlight, attracting the attention of various sectors of society. Within this intricate and ever-evolving market, urban housing sales prices and land supply prices have emerged as two particularly significant economic indicators. The interplay and dynamic evolution between these two prices not only reflect the supply–demand dynamics of the market but also provide invaluable reference points for policymakers. Gaining a comprehensive understanding of their interactive relationship is of paramount importance in comprehending market trends, anticipating market trajectories and formulating and implementing effective policies.

Some research studies endeavor to elucidate the linear relationship between urban housing sales prices and land supply prices, seeking a concise yet insightful comprehension of urban housing market price trends. Heathcote and Davis (2005) discovered that between 1975 and 2005, the real price index of residential land in the USA experienced a nearly threefold increase. Conversely, urban housing prices increased by a mere 24%. This suggests that fluctuations in housing prices, influenced by business cycles, are primarily driven by shifts in land prices. Eicher (2024) drew upon an unusually extensive data set from 250 major US cities to investigate the impact of land-use regulations on urban housing prices between 1989 and 2006. The findings aligned with similar sentiments expressed in previous research. Chen and Wu (2021) focused on three diverse Chinese cities—Shanghai, Xi’an and Xining—and analyzed the interplay between housing land supply and housing prices using data encompassing 2008 to 2014. Their research underscored that cities with higher levels of economic development exhibit a more pronounced influence of housing land supply on housing prices. Mohamadzadeh et al. (2016) delved into the dynamics between land prices and urban housing prices in Iran. Empirical evidence suggests a bidirectional relationship: escalating land prices fueled urban housing prices upward, whereas surging urban housing prices, in turn, drove up land prices. This highlights the interconnected nature of these two variables within the broader housing market landscape. Overall, these studies offer valuable insights into the intricate interplay between urban housing sales prices and land supply prices.

In contrast to the previously mentioned studies, Oikarinen (2009) used data specific to the Helsinki Metropolitan Area in Finland, encompassing the period from the first quarter of 1988 to the second quarter of 2008. Using a vector error correction model, the research revealed that while an increase in urban housing prices stimulated land prices, the influence of land prices on urban housing prices appeared relatively subdued. Buljan and Zhang (2020), examining data from Croatia between 2002 and 2017, observed that while property prices persisted in their upward trajectory, the land price index did not mirror this growth pattern. Instead, factors such as construction costs appeared to exert a more significant influence on property prices. Tse (1998) conducted an empirical analysis centered on annual public land sales data from Hong Kong. The findings suggested that no causal relationship exists between land supply and urban housing prices, offering a contrasting perspective to other research in the field. These insights underscore the importance of considering contextual factors and regional variations when examining the relationship between urban housing prices and land prices.

In addition, a growing body of research literature incorporates spatial factors when examining the relationship between urban housing sales prices and land supply prices, integrating them into the analytical framework. Lee and Stefanie (2021) focused on county-level residential land prices in Germany, spanning from 2014 to 2018, to assess the spatial impacts of land prices. Their findings revealed that the spillover effect of land prices is a
primary determinant in shaping regional housing prices. Zeng et al. (2022) developed a spatial panel simultaneous equation model, comprehensively considering both housing and land prices. By analyzing data covering 286 cities in China between 2009 and 2016, they examined the spatial autocorrelation and spillover effects between housing and land prices. The empirical results underscored the existence of a notable spatial interaction between housing prices and land prices. Specifically, housing prices are not only influenced by local land prices but also by housing prices in neighboring cities. Moreover, urban land prices are impacted not only by local housing price demands but also by the land prices of surrounding cities. This underscores the importance of considering spatial dynamics when analyzing the complex interplay between housing and land prices.

Wang et al. (2018a, 2018b) examined the spatial patterns and driving forces of housing prices in China, using a comprehensive 2014 data set encompassing 2,872 counties. By integrating multiple theoretical perspectives on housing demand, supply and the market, they established a housing price model to investigate the influence of land prices on housing prices. Their findings affirmed that land prices are the primary driving force behind housing prices, with their impact varying according to administrative hierarchy. Notably, the influence of land prices is most pronounced in urban areas of provincial capital cities. The underlying mechanisms driving this relationship between land prices and housing prices encompass terrain factors, urban construction levels, the concentration of high-quality public service resources and the development of the tertiary industry. The urban land supply plan, or supply policy, serves as the internal driving force determining the price of urban land. Land prices can influence housing prices through various channels, including supply and demand dynamics, cost implications and market mechanisms. Wu et al. (2022) constructed a vector autoregressive (VAR) model using pertinent data on land supply and housing prices in Nanchang, China, covering the period from 2010 to 2018. This model incorporated one external factor related to land supply and four internal factors. Through regression analysis, they thoroughly investigated the dynamic effects and spatial heterogeneity of land supply on housing prices. Their study unveiled the intricate nature of the interplay between land supply and housing prices, arising from substantial regional disparities in research areas. The variable of land supply exhibits both positive and negative influences on housing prices, with the actual outcomes varying across different regions. This highlights the significance of considering contextual factors and regional nuances when examining the relationship between land supply and housing prices.

In the unique economic context of China, the government’s land regulation policy emerges as a pivotal factor influencing the correlation between urban housing sales prices and land supply prices. Consequently, several research studies have conducted comprehensive explorations and analyses of this scenario. Zhang et al. (2017) used data from prefecture-level cities in China spanning from 2000 to 2010 to investigate how government intervention in the land market impacts urban development and the escalation of housing sales prices. Their findings revealed that government intervention primarily amplifies the influence of positive productivity shocks on housing price appreciation through the government’s control over residential land supply. Wang et al. (2018a, 2018b) examined the impact of the “Tender, Auction, and Listing (TAL)” system, implemented on August 31, 2004, on land prices using monthly housing price data in China from July 1998 to June 2015. Their research indicated that while the implementation of the TAL system resulted in a 10% increase in the national average housing prices, accounting for 11% of the total housing price increase in the previous year, it does not constitute the primary driving force behind housing price escalation. Moreover, the TAL system has had a more profound influence on commercial and residential real estate, particularly in the central and western regions of China. By delving into the transmission
mechanism, they discovered that the impact of the TAL system is primarily mediated through the government’s land supply constraint effect and market restructuring effect. These insights offer valuable implications for understanding the complex interplay between government policies, land supply, and housing prices in China’s dynamic real estate market.

Cai et al. (2023) examined three primary factors within China’s housing system: supply, demand, and government policy intervention. Their findings revealed that, in terms of supply factors, an increase in real estate investment generally exerts an inhibitory effect on real estate prices. Notably, as a significant component of real estate development costs, escalating land prices have contributed to driving up the sales prices of properties. Gao and Feng (2023) developed a framework that accounts for the degree and primary types of mixed land use, integrating them into traditional geographically weighted feature price models. Conducting empirical analysis in Qingdao, China, they discovered that, on a global scale, the degree of mixed land use exerts a noteworthy positive influence on housing prices. Fan et al. (2021) delved into how China’s land quota system and land supply structure impact housing prices within the country. Precisely, the Chinese Government determines urban land supply, using land quotas to augment land supply in the central and western regions while scaling back in the eastern regions. In addition, the government exerts control over the land supply structure, with industrial land accounting for a larger proportion compared with commercial and residential land. Their study unveiled that during the examined period, housing price growth in cities with lower land quotas was approximately 10% higher than that in cities with higher land quotas, predominantly observed in large and coastal cities. Further exploration uncovered that the land supply structure has ramifications on housing prices, with a lower proportion of commercial and residential land supply leading to elevated housing prices. Both land quotas and land supply structure mediate their impact on housing prices through land prices. Consequently, China’s housing prices escalated by 295% from 2003 to 2019, primarily attributed to spatial and structural mismatches in land supply.

Further analysis of existing literature indicates that the economic environment—especially core indicators like GDP, unemployment rate, and household income—is considered the main driver of housing price fluctuations (Vaidynathan et al., 2023). Economic prosperity is often accompanied by an increase in housing prices, whereas economic recession may lead to their decline. The role of government policies in shaping housing prices is equally important and complex (Hu, 2022). Adjustments to fiscal, monetary, land and housing policies all have a direct or indirect impact on housing prices (Miles and Zhu, 2023; Fan et al., 2021; Wang and Hou, 2021). Specifically, a tight monetary policy usually leads to an increase in mortgage interest rates, which in turn raises the cost of funds for homebuyers and exerts downward pressure on housing prices. Conversely, loose monetary policy often lowers mortgage interest rates, enhances homebuyers’ purchasing power and thus fuels the rise of housing prices. The supply-and-demand relationship is also a key factor determining the trend of housing prices (Egan and McQuinn, 2023). When the supply of housing cannot meet market demand, housing prices often rise due to scarcity; conversely, when supply exceeds demand, prices may fall due to oversupply. In addition, factors such as the desirability of geographical location, housing quality, population growth or decline, the availability of educational resources and the adequacy of infrastructure all have varying degrees of impact on housing prices (Liang et al., 2018; Wang et al., 2017; López-Morales et al., 2023; Chen et al., 2023). The combined effect of these factors makes housing prices a multidimensional and dynamic economic phenomenon.

In addition, scholars have used diverse methodologies to anticipate property price trends. For instance, Ahmed et al. (2021c) conducted a groundbreaking study to predict house prices (HP), foreign direct investment (FDI), and workers’ remittances (WR) using time series data spanning from 1973 to 2018, focusing on Pakistan’s economy. Xu and Zhang (2022), on the
contrary, examined neural networks for forecasting the residential housing price index in ten major Chinese cities between July 2005 and April 2021. These studies serve as the foundation for the present investigation.

There is a lack of consensus regarding empirical results and findings regarding the correlation between urban housing sale price, land supply price and economic performance, despite the increasing interest in this topic. Despite the advancements made in our comprehension of these connections through prior research, the results continue to be varied and inconclusive. There appear to be two primary concerns: first, research predominantly concentrates on the relationship between housing sale price and economic growth, or housing sale price and land supply price; and second, there is a scarcity of studies that have investigated the interplay among urban housing sale price, land supply price, economic performance, money supply and new construction, with a specific emphasis on commercial housing. Moreover, there is a paucity of research that is specifically dedicated to the Chinese economy. In two significant ways, this research endeavors to address these deficiencies in understanding and make a scholarly contribution:

1. scrutinizing the asymmetric relationship between the price of urban land for sale and the price of land supply; and
2. assessing the influence of economic performance on the price of urban land for sale.

With these goals in mind, we can better assess whether and how land supply price and economic performance affect urban housing sale prices in China.

4. Methodology
This study aims to examine the dynamic relationship between real estate sales prices and land supply prices in China. The analysis uses the sales price of existing residential properties, calculated by dividing sales revenue by the actual sales area, as the dependent variable. Meanwhile, the core independent variable is the land supply price, which is calculated by dividing the total expenditure incurred by real estate development enterprises on land transactions by the area of land they have purchased. To mitigate the influence of potential confounding factors, the analysis incorporates Gross Domestic Product (GDP), Money Supply (M2) and New Construction Area of Commercial Housing as control variables.

To ensure a sufficient sample size and enhance the credibility of our empirical analysis, we used a monthly data set spanning from August 2005 to December 2022, with all data points expressed in natural logarithmic form. The data used in this research was sourced from the China Research Data Service Platform (CNRDS) (see Table 1).

In this research, we develop an analytical framework based on established economic theories, particularly rent theory as explained by Alonso (1964), Muth (1969) and Smith (1979). These foundational works explore how rent, as a measure of both land value and location-based scarcity, influences housing sales prices. Our approach also incorporates contemporary studies by Chen et al. (2023), Ma and Shi (2023) and Qu et al. (2024), highlighting the dynamics of urban land scarcity in rapidly urbanizing contexts: This provides insights into how such dynamics impact housing sales prices. The framework is further strengthened by Zheng et al. (2023) and Yuan et al. (2019) on the relationship between land value, rent and, specifically, developer competition in the housing market. By leveraging both historical and contemporary perspectives, we explore how rising land prices, fueled by increasing rents, shape housing market trends and developer strategies, as examined by Cheng et al. (2021) and Acquaye et al. (2007). This multifaceted approach
enables a nuanced analysis of the intricate interplay between land prices and housing sales prices.

The model presented here delves into the intricate causal connections among the variables under scrutiny. To ensure the robustness of the findings, the variables are expressed in logarithmic form. This transformation not only diminishes the disparities among the instruments but also enhances their distributional normality, thus leading to more reliable and consistent results:

$$LFJ_t = \alpha_0 + \alpha_1 LDJ_t + \alpha_2 LGDP_t + \alpha_3 LM2_t + \alpha_4 LMJ_t + \varepsilon_t$$  \hspace{1cm} (1)

In the aforementioned equation, $LFJ_t$ denotes the sales price of existing residential properties, $LDJ_t$ represents the land supply price, $LGDP_t$ signifies the gross domestic product, $LM2_t$ indicates the money supply and $LMJ_t$ represents the new construction area of residential properties, all measured during the $t$th period. $\alpha_0$ signifies the intercept term, which encompasses baseline factors that might influence the dependent variable. Moreover, $\alpha_1 - \alpha_4$ denote the elasticities associated with the land supply price, GDP and money supply, respectively, illuminating the degree of responsiveness exhibited by the dependent variable to fluctuations in the explanatory variables. Finally, $\varepsilon_t$ embodies the error term inherent in the model, which takes into account any unexplained variability or randomness intrinsic to the relationship between the variables under examination.

Based on the author’s understanding, previous studies have primarily focused on examining the linear relationship between the sales price of existing residential properties and the land supply price. However, this research delves into a more sophisticated analysis within a nonlinear framework, allowing for an investigation into whether time series components, encompassing both positive and negative aspects, are cointegrated. To achieve this, the study uses the NARDL model as its analytical tool, with a primary aim to scrutinize the asymmetric effects of land supply prices on the sales prices of commercial housing, both from short- and long-term perspectives. The specified nonlinear model adopts a particular functional form, which is outlined as follows:

$$LFJ = f(LDJ^+, LDJ^-, LGDP^+, LGDP^-, LM2^+, LM2^-, LMJ^+, LMJ^-)$$  \hspace{1cm} (2)

Within the confines of this analytical framework, the utilization of positive (+) and negative (−) indicators serves to delineate the favorable and adverse impacts, respectively, of the independent variable shocks — encompassing both positive and

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<td>LMJ</td>
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Table 1. Variable description

Source: Authors’ compilation
negative fluctuations – on the dependent variable. Shin et al. (2014) have introduced an estimation technique known as the NARDL. This methodology involves the utilization of partial sums of positive and negative alterations, enabling a precise delineation of both short-term and long-term asymmetrical effects.

The NARDL methodology offers several advantages over other traditional cointegration models. First, it does not require a stationarity test, providing greater flexibility in its application. Second, the NARDL model demonstrates robust performance even in scenarios with limited sample sizes, ensuring its reliability in diverse contexts. Third, the NARDL approach is versatile and can be effectively used regardless of whether the incorporated variables exhibit stability at level I(0), first difference I(1) or fractional integration (Ibrahim, 2015; Lee et al., 1997). However, it is important to note that this technique may not yield optimal results when dealing with variables that exhibit I(2) characteristics. Based on empirical studies conducted by various researchers (Dhaoui and Bacha, 2017; Katrakilidis and Trachanas, 2012; Koutroulis et al., 2016; Meo et al., 2018; Raza et al., 2016), we have formulated the following model for our analysis:

$$LF_t = \theta_0 + \theta_1(LDJ^+_t) + \theta_2(LDJ^-_t) + \theta_3(LGDP^+_t) + \theta_4(LGDP^-_t) + \theta_5(LM2^+_t)$$

$$+ \theta_6(LM2^-_t) + \theta_7(LMJ^+_t) + \theta_8(LMJ^-_t) + \epsilon_t$$

(3)

The + and − symbols represent the cumulative sum of positive and negative changes, respectively, whereas the $\theta_1 - \theta_8$ are the unknown long-run coefficients associated with the regressors. The partial sum of these variables can be expressed as follows:

$$LDJ^+_t = \sum_{s=1}^{t} \Delta LDJ^+_s = \sum_{s=1}^{t} \max(\Delta LDJ_s, 0)$$

$$LGDP^+_t = \sum_{s=1}^{t} \Delta LGDP^+_s = \sum_{s=1}^{t} \max(\Delta LGDP_s, 0)$$

$$LGDP^-_t = \sum_{s=1}^{t} \Delta LGDP^-_s = \sum_{s=1}^{t} \min(\Delta LGDP_s, 0)$$

$$LM2^+_t = \sum_{s=1}^{t} \Delta LM2^+_s = \sum_{s=1}^{t} \max(\Delta LM2_s, 0)$$

$$LM2^-_t = \sum_{s=1}^{t} \Delta LM2^-_s = \sum_{s=1}^{t} \min(\Delta LM2_s, 0)$$

$$LMJ^+_t = \sum_{s=1}^{t} \Delta LMJ^+_s = \sum_{s=1}^{t} \max(\Delta LMJ_s, 0)$$

$$LMJ^-_t = \sum_{s=1}^{t} \Delta LMJ^-_s = \sum_{s=1}^{t} \min(\Delta LMJ_s, 0)$$

(4)

In addition, the NARDL model’s formulation encompasses distinct short- and long-run aspects, which are presented in detail below:
The aforementioned equations are estimated to scrutinize the presence of cointegrating relationships. Herein, $\Delta$ signifies variables in their first differences, which serve as proxies for short-run estimates. The coefficients associated with these first differenced variables offer profound insights into the short-term influences of the independent variables on the sales price of preexisting commercial residential properties. The symbol $q_1 - q_5$ denotes the lag order for both the explained and explanatory variables, determined based on the optimal lag selection criterion, specifically Akaike's information criterion (AIC) in our context. $\delta_1 - \delta_5$ are coefficients of long-run, and coefficients of the short-run, along with summation signs, are $\eta_i - \eta_5$. Finally, the white noise error term is denoted by $\varepsilon_t$, accounting for any random fluctuations or variations in the model.

5. Results and discussion
A descriptive statistical overview of the selected variables is presented in Table 2.

To initiate our analysis, we undertook a thorough examination of the integration properties of the variables by implementing both the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests. The meticulous execution of these rigorous unit root tests yielded results that are systematically presented in Table 3. The exhaustive findings, thoroughly extracted from both the ADF and PP unit root tests, unequivocally demonstrate that the variables, while exhibiting nonstationarity at their initial level, achieve stationarity upon first differencing.

Having verified the stationarity of the variables, we delve into a meticulous examination to ascertain whether a long-run equilibrium relationship exists within the intricate framework of a NARDL model. To ensure rigorous assessment, we use the sophisticated

<table>
<thead>
<tr>
<th>Variables</th>
<th>LFJ</th>
<th>LDJ</th>
<th>LGDP</th>
<th>LM2</th>
<th>LMJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>8.533445</td>
<td>7.925981</td>
<td>11.88072</td>
<td>13.83660</td>
<td>9.001675</td>
</tr>
<tr>
<td>Minimum</td>
<td>7.710000</td>
<td>6.490000</td>
<td>10.75000</td>
<td>12.55000</td>
<td>7.740000</td>
</tr>
<tr>
<td>Std. dev.</td>
<td>0.410477</td>
<td>0.711740</td>
<td>0.535222</td>
<td>0.657273</td>
<td>0.531416</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.099782</td>
<td>0.030242</td>
<td>0.390343</td>
<td>0.401991</td>
<td>0.473625</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.010783</td>
<td>2.215982</td>
<td>2.091455</td>
<td>1.936346</td>
<td>2.493153</td>
</tr>
<tr>
<td>Jarque–Bera</td>
<td>8.868363</td>
<td>5.384733</td>
<td>12.49580</td>
<td>15.48121</td>
<td>10.0594</td>
</tr>
<tr>
<td>Probability</td>
<td>0.01865</td>
<td>0.067721</td>
<td>0.001935</td>
<td>0.000435</td>
<td>0.006569</td>
</tr>
<tr>
<td>Sum</td>
<td>1783.490</td>
<td>1656.530</td>
<td>2483.070</td>
<td>2891.850</td>
<td>1881.350</td>
</tr>
<tr>
<td>Sum sq. dev.</td>
<td>35.04612</td>
<td>105.3672</td>
<td>59.58419</td>
<td>89.85769</td>
<td>58.73971</td>
</tr>
</tbody>
</table>

Table 2. Descriptive statistics  **Source:** Authors' compilation
Bounds test methodology, carefully crafted by Pesaran et al. (2001). The compelling results of our carefully conducted examination, as exemplified by the NARDL bound tests thoughtfully presented in Table 4, shed profound light on the intricate relationships that emerge under nonlinear specifications. Subsequently, we embarked on a rigorous investigation of asymmetric cointegration among the variables. Remarkably, our nonlinear analysis revealed a discernible comovement relationship between the variables, prompting us to reject the null hypothesis of no cointegration. This rejection is significant not only because it confirms the existence of a robust and dependable relationship between the variables but also because it provides compelling evidence for the potential sustainability of sales prices for existing residential properties and land supply prices. Consequently, our findings offer a refined perspective on the ongoing discourse in this field.

Following the established methodology, we estimated the NARDL model as outlined in equation (5). To determine the optimal lag specification, we used AIC, setting a maximum limit of six lags for all variables. This approach aligns with prevailing practices in the literature (Batabyal and Killins, 2021), which favor unrestricted constants and the exclusion of trend specifications. The meticulously derived NARDL estimation results are comprehensively presented in Table 5.

According to the asymmetric ARDL model estimated result (Table 5), land supply price (DJ) has a significantly positive impact on urban housing sales prices in the short and long run. Furthermore, a 1% increase in the land supply price will increase urban use prices by 0.052% in the short run and 0.617% in the long run. The empirical results of the asymmetric ARDL approach demonstrate that land supply price has a significant positive impact on urban housing prices, whereas our study results are limited and align with those of Staikos and Xue (2019) and Knoll et al. (2017). Moreover, economic growth (GDP) and money supply (M2) have a positive impact on urban land supply in China. Our empirical result aligns with

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF</th>
<th>PP</th>
<th>ADF</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFJ</td>
<td>2.236688</td>
<td>3.543239</td>
<td>-10.57701***</td>
<td>-24.63446***</td>
</tr>
<tr>
<td>LDJ</td>
<td>4.135997</td>
<td>2.203077</td>
<td>-9.720946***</td>
<td>-26.02909***</td>
</tr>
<tr>
<td>LGDP</td>
<td>5.169258</td>
<td>5.366111</td>
<td>-1.957413***</td>
<td>-9.397223***</td>
</tr>
<tr>
<td>LM2</td>
<td>2.662797</td>
<td>12.31711</td>
<td>-5.090273***</td>
<td>-11.27954***</td>
</tr>
<tr>
<td>LMJ</td>
<td>1.458995</td>
<td>-0.217414</td>
<td>-3.741673***</td>
<td>-67.53447***</td>
</tr>
</tbody>
</table>

Notes: ** and *** denote the significance level at 5 and 1%. The unit root is rejected at the 1, 5 and 10% significance levels, according to the results of the unit root test, suggesting that the data are probably stationary at first difference [1].

Source: Authors’ construction by using EViews 13

Table 3. Unite root test
the studies conducted by Leung (2003), Wen and He (2015), Yin et al. (2020) and Su et al. (2019). New construction areas of commercial housing have negative impact on urban housing price according to asymmetric ARDL model estimations in short and long run. Our empirical result aligns with the studies conducted by Chen and Nong (2016) and Li (2021).

Through a comprehensive suite of diagnostic tests, we have rigorously validated the robustness and coherence of the estimated models. These diagnostic tests encompass a range of methodologies, including the Breusch–Godfrey LM test, ARCH test and Ramsey RESET test, as well as the CUSUM and CUSUMSQ tests. The results of these meticulous examinations are systematically presented in Table 6. In particular, the Breusch–Godfrey LM test has been employed to scrutinize the presence of autocorrelation in the residuals. Given that the obtained $p$-value exceeds 0.05, we confidently conclude that there is no evidence of serial correlation. Furthermore, we have used the ARCH test to detect any potential heteroscedasticity issues in the residuals. This test operates under the null of no heteroscedasticity.

<table>
<thead>
<tr>
<th>Diagnostic tests</th>
<th>F-statistic (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breusch–Godfrey LM Test</td>
<td>0.647921 (0.5248)</td>
</tr>
<tr>
<td>ARCH test</td>
<td>0.022153 (0.8818)</td>
</tr>
<tr>
<td>Ramsey RESET test</td>
<td>1.975309 (0.1623)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.915687</td>
</tr>
<tr>
<td>CUSUM</td>
<td>Stable</td>
</tr>
<tr>
<td>CUSUMSQ</td>
<td>Stable</td>
</tr>
</tbody>
</table>

Table 6. Diagnostic tests of NARDL

**Note:** $p$-Values are reported in parenthesis

**Source:** Authors’ construction by using EViews 13
hypothesis of no ARCH effect in the residuals. Our findings, which reveal a p-value greater than 0.05, indicate the absence of heteroscedasticity in the residuals. The functional specification of our model has been examined using the Ramsey RESET test, which operates under the null hypothesis of correct specification. Notably, we were unable to reject this null hypothesis in both sample periods, thereby providing compelling evidence that our model is correctly specified. In addition, Figure 1 offers a visual representation of the results from our stability test. Here, we have applied the CUSUM test to ascertain whether the model’s parameters remain stable over time. The CUSUM plot consistently remains within the 5% significance levels of both the upper and lower bounds throughout both sample periods, offering assurance of the model’s stability.

6. Conclusion
This paper thoroughly examines the impact of China’s land supply prices on urban housing sales prices. The findings uncover an asymmetric relationship between the two. Specifically, when land supply prices exhibit a positive change (i.e. a price increase), their influence on urban housing sales prices is more pronounced compared with periods of negative changes in land supply prices (i.e. a price decrease). The observed asymmetry in the impact emphasizes the intricate interaction between the land and housing markets. According to the asymmetric ARDL model estimated result, land supply price (DJ) has a significantly positive impact on urban housing sales prices in the short and long run. Furthermore, 1% increase in the land supply price will increase urban use prices by 0.052% in the short run and 0.617% in the long run. The empirical results of the asymmetric ARDL approach demonstrate that land supply prices have a significant positive impact on urban housing prices. Moreover, economic growth (GDP) and money supply (M2) have a positive impact on urban land supply in China. New construction areas of commercial housing have a negative impact on urban housing price according to asymmetric ARDL model estimations in the short and long run. Our estimation results emphasize the significance of policymakers adopting a more prudent approach to their regulatory decisions.

To ensure a stable housing market and meet residents’ housing needs, policymakers must reexamine current land policies. Relying solely on restricting land supply to control housing prices may yield counterproductive results. Instead, increasing land supply could be a more viable option. By rationally adjusting land supply prices, the government can not only mitigate excessive growth in housing prices but also foster the healthy development of the housing market. In addition, the research outcomes imply that the formulation and implementation of land policies require greater consideration of actual market conditions and the interests of various stakeholders. Overly stringent restrictions on land supply might lead
to imbalances between market demand and supply, thereby pushing up housing prices, whereas overly lenient land policies could induce overdevelopment and resource waste. Consequently, the government must strike a balance between safeguarding residents’ housing rights and stabilizing the market. Finally, the findings of this study hold significant international implications. For other countries and regions grappling with similar housing challenges, ascertaining an appropriate balance between land policies and the housing market is equally crucial to investigate. Through the examination of the experiences and practices that are prevalent within the Chinese context concerning the regulation of the housing market and the supply of land, we can develop solutions that are completer and more insightful to address the urban housing difficulties that are prevalent within the Chinese economy.

Although the asymmetric effect of land supply price has been identified as a significant contributor in this study, it is important to note that the research primarily relies on time series data and focuses on analysis at the national level. However, to gain a deeper understanding of the impact of land supply prices on urban housing sales prices, future studies could consider using panel data for broader comparisons. By using panel data, we can extend the scope of investigation to various provincial cities within China, unveiling potential disparities and characteristics among them. Although time series data offer a macroscopic perspective of overall trends within a country, they fail to adequately showcase the structural variations among different cities. In contrast, panel data encompass multiple dimensions, enabling examination of changes over time as well as comparisons of various cities at a specific point in time. This multidimensional research approach will facilitate a more comprehensive comprehension of the relationship between land supply prices and urban housing sales prices.

Note

1. Critical values at 1%, 5% and 10% significance levels for the ADF test are LFJ (−2.576814, −1.942456, −1.615622), LDJ (−2.576936, −1.942473, −1.615611), LGDP (−2.576693, −1.942439, −1.615633), LM2 (−2.576403, −1.942399, −1.615659) and LMJ (−2.576814, −1.942456, −1.615622), respectively. For the PP test, the critical values at the same significance levels are LFJ (−2.576181, −1.942368, −1.615679), LDJ (−2.576181, −1.942368, −1.615679), LGDP (−2.576181, −1.942368, −1.615679), LM2 (−2.576181, −1.942368, −1.615679) and LMJ (−2.576181, −1.942368, −1.615679), respectively.

References


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