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Research Progress on Evaluating the Effectiveness of China's Urban Tiered Water Pricing Policy

Mengyu Xu*

School of Economics and Management , Northeast Normal University, Changchun, Jilin 130000, China

Corresponding author: Mengyu Xu

Abstract

China is a water-scarce country. The long-term free utilization of water resources in China has led to immense national water resource waste. As an effective economic instrument, tiered water pricing plays a valuable role in promoting the establishment of a water-saving society and adjusting water resource supply and demand in China. This paper focuses on the urban tiered water pricing policy. It analyzes the policy's theoretical foundation, implementation effects, and the factors influencing policy effectiveness. Using a literature review method, this study synthesizes domestic and international research on China's tiered water pricing policy and assesses the social equity of the policy's effectiveness. The research finds that the tiered water pricing policy has shown good effectiveness in curbing residential, industrial, and agricultural water consumption. However, the implementation effect of the tiered water pricing policy is characterized by social unfairness. The effectiveness is influenced by natural factors, economic factors, policy formulation factors, and humanistic factors. The existing policy also suffers from an incomplete dynamic mechanism, and the tiered pricing structure struggles to differentiate between households with a large number of residents. Future tiered water pricing design should be formulated more meticulously, taking the aforementioned influencing factors into account. This includes factoring in elements such as urban population distribution, household income, and household size differences, establishing clear policy safeguards, regularly updating the water price policy, and creating a long-term dynamic mechanism.

Keywords

tiered water pricing, urban water resources, social equity

1. Introduction

Freshwater is a fundamental element for sustaining life and remains a globally scarce commodity of increasing scarcity. Although China ranks sixth worldwide in total renewable freshwater resources, surpassed only by Brazil, Russia, Canada, the United States, and Indonesia, its per capita water availability is merely one-third of the global average due to its vast territory and large population. Given China's natural geographical characteristics and the patterns of socio-economic development, urban water resources continue to face severe shortages. These shortages are compounded by spatial mismatches in water resource productivity, localized water deficits, and structural imbalances that are unlikely to be resolved in the short term (Wang et al., 2021). Against this backdrop, scientifically raising water prices and effectively managing urban water-use efficiency are of critical importance for promoting water conservation and alleviating imbalances in water resource availability.

The rational utilization of freshwater resources constitutes a cornerstone of China's sustained and stable economic development. Water pricing, as the primary economic instrument influencing water resource utilization, not only ensures the sustainable operation of the national water supply system but also shoulders the critical function of promoting the construction of a water-saving society and advancing the sustainable use of water resources. Research finds that the tiered water pricing policy has a net positive effect on crop irrigation technical efficiency, and that it can significantly enhance the average irrigation efficiency of maize crops in plain irrigation areas(Li and Ma, 2025). Other scholars, examining the shift from non-conservation-oriented to conservation-oriented water pricing structures, have found a notable decline in residential per capita water consumption (Lee et al., 2024). In January 2014, the Guidance on Accelerating the Establishment and Improvement of the Tiered Pricing System for Urban Residential Water Use, issued by the National Development and Reform Commission, explicitly stipulated that—while safeguarding residents' basic domestic water needs and taking the reform of residential water billing methods as the key lever—the tiered water pricing system for residents should be established and refined. The aim is to fully leverage the regulatory role of the tiered pricing mechanism and enhance overall water resource utilization efficiency.

Water resource management is inherently complex and fraught with challenges. Public attention is frequently drawn to the equity of policy design as well as to the heterogeneity arising from differences in water-use habits and economic conditions. An article published by the Chinese Academy of Governance and Public Policy noted that the current criteria for tier division in China's tiered water pricing system remain to be optimized and that precise metering and billing are difficult to implement in practice.

By systematically reviewing and synthesizing the domestic literature on the implementation effects of China's tiered water pricing policy, this paper identifies the key factors influencing policy outcomes and offers targeted recommendations for future policy design. These efforts not only help demonstrate the effectiveness of the tiered water pricing policy but also provide a theoretical foundation for policymakers to fully harness the price lever in optimizing water resource allocation and regulating water demand.

2. Theoretical Foundation and Policy Evolution of Tiered Water Pricing

2.1 Theoretical Foundation

Water pricing serves as the core instrument for water resource allocation. Its theoretical basis lies in the scarcity of resources and the pricing strategies applied to public goods. The shortage of essential resources such as water and arable land directly threatens human survival and the sustainable development of urban economies. To mitigate the resource pressure in this area, conservation measures such as reducing water consumption and increasing soil fertility must be adopted (Freedman, 2018). Early research on the price elasticity of residential water demand offers important evidence. Ma et al. (2011) reviewed overseas studies and assessed price and income elasticities of water demand across different regions of the United States. Their results showed a price elasticity of –1.278 and an income elasticity of 0.462, findings that align closely with standard consumer demand theory. In the agricultural sector, Sun and Wang (2024) observed that irrigation water price elasticity tends to be larger in higher price ranges. This pattern indicates that raising water prices can effectively suppress irrigation demand and generate substantial water-saving effects. These studies on elasticity reflect the extent to which people's water consumption responds to changes in water resource prices. Overall, the "price signal" emitted by water pricing policies can influence the efficiency of water resource allocation through both direct behavioral adjustments and indirect structural optimization, thereby laying the foundation for the policy design of tiered water pricing.

As a tap water pricing system, tiered water pricing aims to promote the rational utilization of water resources through classified metering and progressive surcharges for consumption exceeding the set quota. Its main objectives are to guarantee basic domestic water supply, foster residents' water conservation awareness, and improve the efficiency of water resource utilization. Existing theories contain numerous studies on methods for formulating tiered water pricing, such as the two-part tariff pricing method which relies on a capacity charge and a volumetric charge, and pricing based on the cost recovery logic by calculating fixed costs and variable costs (Liu, 2021). To achieve water conservation without reducing aggregate social welfare, water prices must strike a balance with residents' ability to pay. Pan and Zhu (2015) conducted a comprehensive evaluation of household affordability and advocated setting tier thresholds and rates

accordingly. The three-tier pricing structure adopted in Tangshan City, for instance, simultaneously covers the needs of low-income households, ensures reasonable profits for water-supply enterprises and imposes higher charges on users with excessive consumption, thereby contributing significantly to the rational utilization of water resources in the city.

In common tiered water pricing structures, the first tier is designed to meet the basic domestic needs of residents, while the second tier is intended to generate profit for the water supply enterprise. As water consumption increases, the prices of subsequent tiers progressively rise, approaching or exceeding the average cost, which ensures that high consumers bear a more accurate social cost, thereby correcting overconsumption behavior. In addition to academic literature, the "Guiding Opinions on Accelerating the Establishment and Improvement of the Tiered Water Pricing System for Urban Residents" mentions that the state has put the comprehensive implementation of the tiered water pricing system for urban residents on its agenda. Tiered pricing is essentially seeking the optimal solution between market failure and public interest. It requires various cost-based pricing theories while achieving practical feasibility through phased differential pricing; it needs to pursue resource allocation efficiency while also considering social welfare. In essence, tiered pricing seeks an optimal balance between market failure and the public interest. It draws on multiple cost-based pricing theories while achieving practical implementation through differentiated rates across consumption blocks. At the same time, it pursues both allocative efficiency in resource use and equity in social welfare outcomes.

2.2 Policy Evolution

China's water pricing policy has undergone a progressive evolution from public-welfare-oriented free supply, to politically determined low-cost supply, to cost-based pricing, to commodified water pricing management, and finally to the establishment of tiered pricing. Documents such as the National Agricultural Water-Saving Program (2012–2020) issued by the General Office of the State Council and the discussions at the fifth meeting of the Central Leading Group for Financial and Economic Affairs all underscore that China's freshwater resource utilization must follow the sixteen-character principle of "prioritizing water conservation, achieving spatial balance, pursuing systematic governance, and leveraging both hands." Consequently, China's water policy orientation has shifted from "ensuring water supply" to "incentivizing water conservation."

In northern China, arable land accounts for 64% of the national total and agricultural development is more intensive, resulting in higher agricultural water demand. Yet the region possesses only 19% of the country's water resources. To address this imbalance, China is currently advancing agricultural water pricing reform by combining a mechanism of "rational pricing, targeted subsidies, and water-saving incentives with quota-based management, thereby improving agricultural water-use efficiency. Industry represents another critical domain for water conservation. The National Development and Reform Commission has emphasized that rationally planning industrial layouts, optimizing and adjusting industrial structure, and lawfully reducing the scale of high-water-consumption industries constitute essential measures for achieving industrial water savings. Xie et al. (2018) found that the proportion of groundwater resource fees within end-user water prices is a key factor influencing industrial water demand. Structural reform through increasing or decreasing this proportion can effectively regulate industrial water consumption. For urban water use, documents such as the Administrative Measures for Urban Water Supply Pricing and the Supervision and Review Measures for Urban Water Supply Pricing Costs clearly indicate that China will accelerate the establishment of a pricing mechanism grounded in "permitted costs plus reasonable returns." This mechanism is designed to encourage improvements in water supply quality and promote water conservation.

3. Multi-dimensional Evaluation of the Effects of Tiered Water Pricing Policy

3.1 Direct Effects of the Policy

Improved water-use efficiency can be understood as generating greater value with less water. As a country with a large population, China regards food security as a top priority, and water resources are inextricably linked to the agricultural sector. Excessively high agricultural water prices increase farmers' production costs and disrupt normal farming activities, whereas excessively low prices lead to waste of water resources. Consequently, the design of tiered water pricing plays a crucial role in promoting water conservation and efficiency gains in agriculture. The implementation of tiered water pricing helps improve agricultural water-

use efficiency in China's arid and semi-arid regions. Li and Ma (2025) examined the impact of agricultural water pricing reform in the Heihe River Basin in northwest China and found that tiered pricing raised irrigation technical efficiency for seed corn and field corn in pilot villages by 16.24% and 19.7%, respectively. This improvement in technical efficiency effectively reduced water consumption for irrigated crops. Although tiered pricing contributes to agricultural water conservation, the pursuit of conservation must not be unconditional. Policymakers must also consider farmers' welfare and ensure that the first-tier price remains within an acceptable range for farmers.

With respect to curbing unreasonable water use by urban residents, numerous scholars have analyzed the leverage effect of tiered pricing. Hao et al. (2023) took Xi'an as a case study and found that raising the price in the first tier effectively encouraged water conservation. A survey on the impact of tiered water pricing on water-saving behavior of urban residents in Beijing revealed that the implementation of tiered pricing in 2022 reduced household water consumption to varying degrees, producing a clear conservation effect that became more pronounced as annual water expenditure increased (Guo et al., 2025). Similarly, Qin et al. (2024) used Hangzhou as an empirical case and demonstrated that the first-tier price is a key channel for achieving water-saving effects. Existing studies on the influence of tiered pricing on residential water-use behavior consistently show that the first tier exerts the strongest impact on behavioral change. The likely reason is that the first tier targets basic domestic needs. When residents perceive that even basic water use has become costly and the marginal benefit of an additional cubic meter no longer justifies its cost, they unconsciously restrain consumption to avoid entering the second tier. This mechanism also motivates households to install water-saving appliances and reduce the frequency of water use.

The rise of industry ended China's millennia-long agricultural society, and industry replaced agriculture to become China's new pillar industry. The National Development and Reform Commission (NDRC) vigorously advocates for improving water resource utilization efficiency. The proportion of industrial water consumption in Shanghai and Chongqing reaches as high as 62.9% and 47.6%, respectively, and 12 out of 31 provinces nationwide have an industrial water share higher than the national average. Unlike agricultural water use, which is influenced by factors such as climate, the main impact on industrial water use lies in industrial water efficiency. For instance, Shi and Shen (2016), in his analysis of the impact of rising water prices for high water-consuming industries on the economy, society, and water resource utilization, concluded that the increase had a relatively small impact on the macro economy but was highly significant in boosting industrial water use efficiency. Concurrently, the research by Xie et al. (2018), through analyzing the structural issues of China's industrial water prices, found that reforming the water resource fee system had a significant negative impact on industrial water demand; that is, raising industrial water prices can effectively reduce industrial water demand. The implementation of the tiered water pricing policy is thus conducive to improving industrial water use efficiency, reducing the waste of industrial water resources, and has a positive effect on water conservation in the urban industrial sector.

3.2 Social Equity in Policy Implementation

This paper analyzes the implementation effect of the tiered water pricing policy by dividing the assessment of social equity into two parts. The first part is vertical equity, which refers to the differing performance of the tiered water pricing policy's implementation effects across regions with varying income levels, different resource endowments, and diverse development statuses. The second part is horizontal equity, which posits that the tiered water pricing policy's implementation effects should be identical in regions where conditions are the same.

The implementation effect of the tiered water pricing policy varies across regions with different income levels, a finding reflected in the research of several scholars. For example, (Jiang and Hong, 2025) analyzed tiered water pricing in various regions of Guangdong Province and discovered that residents in regions with relatively lower incomes are more sensitive to water price changes. Fan et al. (2017) not only studied the effect of tiered water pricing but also implemented a targeted subsidy policy for low-income users. However, the article also mentioned that the first tier of water prices in Guangdong Province covers the vast majority of households, and the tiered water pricing policy did not achieve desirable water-saving results. The potential reason is that if the first tier can cover most households, the tier setting will only affect a very small percentage of the population, rendering the implementation of the tiered water pricing policy largely meaningless.

Providing policy subsidies to low-income families would ensure the basic water needs of low-income users while simultaneously promoting water conservation among high-income users.

The implementation effect of the tiered water pricing policy varies across regions with different resource endowments. For instance, Jia et al. (2024) analyzed the price elasticity of residents' water demand in water-abundant cities and water-scarce cities through the residential block water pricing policy. Data shows that the average upper limit of annual water consumption for the first tier is 176 cubic meters in water-scarce cities, but this figure is only 74% for water-rich cities. Water resources are more precious in water-scarce cities, the policy implementation of tiered water pricing is stricter, and residents are more sensitive to water prices. Consequently, the policy's implementation effect will be better in water-scarce cities. Concurrently, residents with high daily water consumption will be more price-sensitive, as their water usage often reaches the second-tier or even third-tier prices more easily.

Cities with highly developed water supply systems benefit from sound pricing mechanisms and longer water supply pipeline networks compared to less developed regions, resulting in lower water transportation costs. Simultaneously, highly developed regions place greater emphasis on equipment maintenance, leading to a lower leakage rate in supply pipelines. Under conditions of low cost and high efficiency, implementing tiered pricing for residents in developed cities generally yields better results. This is because residents in developed cities receive a greater amount of water resources for the same price, and when water prices rise, they are more likely to replace equipment with water-saving alternatives.

Furthermore, according to the results of the Seventh National Population Census in 2020, developed cities such as Beijing, Shanghai, Hong Kong, and Macao rank high in terms of educational attainment, with a larger proportion of the population having received higher education. This suggests that residents in these regions have a deeper understanding of national water conservation policies and possess stronger execution capabilities, meaning the tiered water pricing policy will be implemented more effectively than in less developed regions. When all differences are eliminated, and two cities are fundamentally identical in their basic conditions, the factors interfering with the implementation effect of tiered water pricing cease to exist. Theoretically, the policy implementation effect of tiered water pricing in such cities should be approximately the same.

4. Analysis of Key Factors Influencing Policy Effectiveness

4.1 Natural Factors

A city's geographical location is fixed, making natural factors one of the important determinants of tiered water pricing effectiveness. In terms of water resource availability, residents in water-scarce areas are more aware of the preciousness of water, so price adjustments produce a stronger behavioral response in these regions. In contrast, residents in water-abundant areas perceive scarcity less acutely, and the conservation effect of tiered pricing is often diluted. Xu et al. (2023)explicitly incorporated water availability into the analysis and found that regions with greater access to water resources tend to have lower water prices. Within the same province, therefore, cities closer to rivers or lakes typically adopt lower tiered pricing schedules than cities farther away. This reduces the marginal cost of additional consumption for residents and weakens the constraining effect of tiered pricing. Similarly, in areas with better raw water quality, residents are willing to pay higher prices to secure supply, which also attenuates the policy's conservation impact.

4.2 Economic Factors

The impact of implementing tiered water pricing on water consumption is embodied by the law of demand, where the "price signal" drives behavioral adjustments. Water, as a necessity of life, is categorized into essential consumption for basic living and discretionary excess consumption. Existing research often finds that adjusting the price of the first tier (which satisfies essential consumption) has a significant impact on residents' water conservation effects. This also incentivizes behaviors such as replacing water-saving facilities and reducing water usage frequency. Liao Xianchun's (2015) study found that the implementation of tiered water pricing had a smaller impact on high-income households than on low-income households, which may be related to the difference in the proportion of water expenditure relative to household expenditure. The proportion of water-intensive industries in a city, the local government's capacity for water environment

supervision, and the level of completeness of water supply infrastructure also influence the policy implementation outcome in that region. Concurrently, developed cities that receive greater national attention tend to have more comprehensive policy support for the implementation of tiered water pricing. Due to their economic and technological advantages, developed cities also possess superiority in areas such as water treatment and water recycling.

4.3 Policy Factors

In tiered water pricing policy, the consumption threshold for the first tier should not cover the vast majority of households. If 90% of users fall within the first tier, the second and third tiers become effectively idle. No matter how high the prices are set for higher tiers, household consumption will show little change, and the overall effectiveness of tiered pricing is substantially weakened. Widening the price gap between the first and second tiers, however, markedly strengthens the conservation incentive. When residents realize that every additional liter in the second tier is extremely costly, they become far more conscious of saving water.

Raising the first-tier price while simultaneously introducing subsidies for low-income households can achieve dual objectives. This combination safeguards the welfare of low-income families and imposes meaningful restraint on high-income households, thereby promoting water conservation and improving urban water-use efficiency.

The “one meter per household” system is a fundamental prerequisite for water pricing reform. At present, no prefecture-level city in China has achieved 100% household metering, which seriously impedes the full implementation of tiered pricing. Additionally, the current tier structure remains immature and struggles to accommodate large households. This shortcoming can generate inequity in the first-tier allowance, foster resentment among residents, and reduce public acceptance of the policy.

Implementation of tiered pricing in neighboring cities can produce a demonstration effect. When water consumption falls in adjacent jurisdictions following policy introduction, surrounding cities are often prompted to learn from and emulate the reform. This dynamic encourages local governments to refine their own tiered pricing frameworks and ultimately yields stronger policy outcomes.

4.4 Socio-cultural Factors

The average years of education among a city’s residents influence water-conservation behavior. Cities with a higher proportion of well-educated individuals tend to exhibit stronger responses to tiered water pricing policy. Residents’ general awareness of water conservation also affects policy effectiveness, as does the age structure of the population. According to the Fifth Sampling Survey on the Living Conditions of the Elderly in Urban and Rural China, elderly residents (aged 60 and above) account for 39.1%, 26.0%, 25.9%, and 9.0% of the national elderly population in the eastern, central, western, and northeastern regions, respectively. In the same survey period, per capita annual living expenditure of the elderly was 11,151 yuan, compared with the national per capita consumption expenditure of 28,227 yuan. The markedly lower consumption level among older adults likely reflects both lower expectations regarding living standards and a stronger propensity to economize.

In cities with a higher proportion of elderly residents, average per capita water use is therefore typically lower than in other cities. The effect of introducing tiered pricing in such cities can take two distinct forms. First, if most elderly households already consume below the first-tier threshold, the addition of second and third tiers produces limited marginal impact compared with cities having younger populations. Second, because older adults tend to be highly cost-conscious, the introduction of tiered pricing can reinforce their existing inclination to save, prompting them to pay even closer attention to daily water use and yielding a stronger overall conservation outcome.

5. Research Review and Directions for Future Studies

This paper systematically reviews the literature on the effects of tiered water pricing policy on urban residential, industrial, and agricultural water use in China. It examines differences in policy outcomes arising from social equity concerns and categorizes the factors influencing effectiveness into four dimensions: natural,

economic, policy-related, and socio-cultural. Existing studies collectively demonstrate that tiered water pricing exerts a clear restraining effect on urban residential, industrial, and agricultural water consumption and confirm the regulatory role of price mechanisms in shaping user demand. At the same time, numerous studies emphasize that implementation of tiered pricing must not focus solely on conservation outcomes but must also give due consideration to residents' social welfare.

Nevertheless, most current research on urban tiered water pricing evaluates factors within a single city and rarely examines inter-city policy spillover effects or demonstration effects. Moreover, empirical models typically include few control variables for climatic or socio-cultural influences on policy outcomes. The trade-off between water-conservation benefits and social equity remains insufficiently clarified in some studies, and broader nationwide implementation of tiered pricing will require further rigorous validation.

Future research should extend beyond city-specific factors to investigate the influence of policy implementation in neighboring jurisdictions. When proposing revisions to tiered pricing, scholars and policymakers should pay close attention to regional heterogeneity and develop locally tailored schemes that account for differences in climate, water intensity of industries, and agricultural development levels. Theoretical work would also benefit from greater interdisciplinary integration. For instance, resident resistance triggered by poorly designed policies could be explored through political science, sociology, and psychology perspectives, leading to the construction of coupled "policy–behavior–household" models. In empirical analyzes of policy effectiveness, incorporating socio-cultural variables such as aging rates and educational attainment would help mitigate omitted-variable bias. Additionally, introducing interaction terms between household structure and tiered pricing would enable researchers to assess how differences in household size moderate policy outcomes.

6. Conclusion

The implementation of China's tiered water pricing policy has, to a certain extent, reduced urban residential water consumption and improved efficiency in industrial and agricultural water use. As a significant economic instrument influencing water resource utilization, it holds crucial importance in promoting the establishment of a water-saving society and advancing the sustainable development of water supply enterprises.

Given China's specific water resource distribution and distinct regional differences, the formulation of tiered water pricing in China must emphasize being "tailored to local conditions" and conducting "thorough and detailed investigation".

Prior to policy formulation, it is best to thoroughly investigate the local residents' demographic structure, analyze the city's natural conditions, identify the existence of potential hidden affluent and impoverished areas, and conduct detailed surveys of household sizes. When formulating the policy, the water price tiers should either be segmented according to the surveyed areas, or subsidies should be provided to low-income households and large households to ensure social equity. Following policy finalization, implementation must be accelerated to prevent the emergence of "zombie policies" (i.e., policies that are officially active but lack practical enforcement or impact)".

Although existing research has pointed out the need for policy optimization, the pricing structure requires further refinement. Future efforts should focus on the long-term effects of the policy, clearly setting out social security policies for low-income groups, accelerating the establishment and improvement of reforms like the "one meter per household" system, conducting unscheduled monitoring of the tiered water pricing policy's effectiveness, and ensuring the regular updating of the tiered water price setting.

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Conflicts of Interest

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