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Influence of Cross Subsidization in Electricity Pricing in Tangshan on Environment

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Abstract:

The paper conducts an in-depth study on the cross-subsidy policy for residential electricity consumption in Tangshan City from 2015 to 2024, focusing on its broader implications. The research evaluates how this policy has affected energy conservation and emission reduction efforts. The findings suggest that while the policy, designed to subsidize low-cost residential electricity, has been successful in encouraging greater electricity consumption among households, it has also led to price distortions. These distortions result in an imbalance in electricity pricing, which could undermine long-term sustainability goals by disincentivizing energy efficiency and conservation measures. The study concludes with a prediction of the policy's future impact on energy and environmental strategies.

Keywords: Cross-Subsidization, Economics, Statistics, Electricity

1. Introduction

Given that residential users usually consume electricity during peak hours and are located at the end of the grid, which makes their power supply costs relatively high; while industrial users usually consume electricity during off-peak hours, with lower power supply pressure, resulting in lower power supply costs. China's State Grid implements cross-subsidy policy, using industrial electricity prices to subsidize residential electricity prices, so that the actual electricity price cannot reflect the actual supply and demand relationship. Due to government control, the subsidized electricity price often conveys the wrong hint to consumers. This can lead to overconsumption and waste of resources. Therefore, this paper analyzes the specific electricity prices and residential electricity consumption in Tangshan City from 2015 to 2024, in an attempt to find out the impact of the total cross-subsidy on individual energy consumption.

2. Methodology

2.1 Formula

Let's consider a cross-subsidy-free price P0, and designate the industrial electricity price as Pi and the residential electricity price as Ph. Then, let Xli represent the total industrial electricity consumption, and Xh denote the residential electricity consumption. Given that the total national cross-subsidy remains constant, we can derive in the equation (1) to (4):

$$Xli(Pi - P0) = Xlh(P0 - Ph) \quad (1)$$

Expanding this formula yields

$$Xli * Pi - Xli * P0 = Xlh * P0 - Xlh * Ph \quad (2)$$

After that derives

$$Xlh * P0 + Xli * P0 = Xlh * P0 + Xli * Ph \quad (3)$$

The average electricity price can now be calculated prior to the implementation of cross-subsidies

$$P0 = \frac{Xlh * P0 + Xli * Ph}{Xli + Xlh} \quad (4)$$

After calculating the pre-subsidy price, we can determine the total cross-subsidy according to step.

2.2 Hypothesis

After the numerical values were calculated, the initial hypothesis could be proposed. Based on the most basic market supply and demand relationship, demand would decrease as the price of electricity increased. Therefore, the basic assumption could be set: the lower the residential electricity price, the greater the total residential electricity consumption. The trend in the graph can clearly show the specific trend (Figure 1).

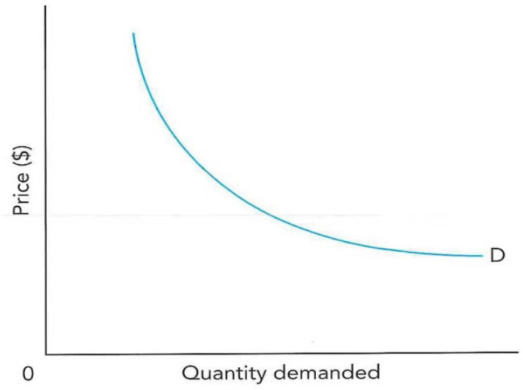

Figure 8.5: Unit elastic demand curve

Fig. 1 Relationship Between quantity demanded and price

2.3 Data Analysis

Through taking a look at the data from the Tangshan Development and Reform Commission, we can calculate average industrial and residential electricity prices, as well as individual consumption. Utilizing the formula computed in section 4.1, we can determine the total cross-subsidy for each year spanning from 2015 to 2023. Through a comparative analysis of electricity prices and consumption figures, along with an examination of consumption figures and the total cross-subsidy, we can conclude the interrelationships within the data.

2.5 Reference

This study primarily focuses on an analysis of cross-subsidy policies' influence on the total amount of energy consumption through data that Chinese government shows. Due to limited time, this analysis primarily concentrates on both sides of cross subsidization policies that are presented in other articles rather than conducting a survey. The study produces its own understanding and recommendations on cross subsidization policies by both analyzing my data and by reading essays.

3. Literature References

China has consistently considered the cross-subsidy policy for electricity as a focal point of its national energy policy. In 2015, the Central Government issued the "Opinions on Further Deepening Reform of the Power Sector," which emphasized that "appropriate resolution of cross-subsidy issues and reforming cross-subsidies between different types of electricity prices should be integrated into the process of electricity price reform." Furthermore, in 2015, the Central Government issued the "Opinions on Further Deepening Price Mechanism Reform," reiterating China's need to "properly manage and gradually diminish cross-subsidies while restoring energy's commodity attributes" [1].

In Chinese academic circles, the issue of cross-subsidization in the electricity sector has been a subject of extensive debate and controversy. Zhang Ning conducted an assessment of the potential impact of eliminating cross-subsidies on GDP and energy structure [2]; Ruan Di, Ye Nan, and six others analyzed the accounting methods and equilibrium mechanisms for precise and transparent subsidies [3]; Yangjiacheng, Zhangxiao, and Wangtao calculated and applied a transfer cross-subsidy model based on cost audits of transmission and distribution [4]; Houyu examined the effects of cross-subsidization on marginal electricity production costs and social welfare levels [4]. While recent research in China has predominantly focused on analysis, calculation, and application models, it has not sufficiently integrated with international trends in energy conservation and emission reduction. This paper not only emphasizes the significance of equity but also expands upon the theme of energy consumption.

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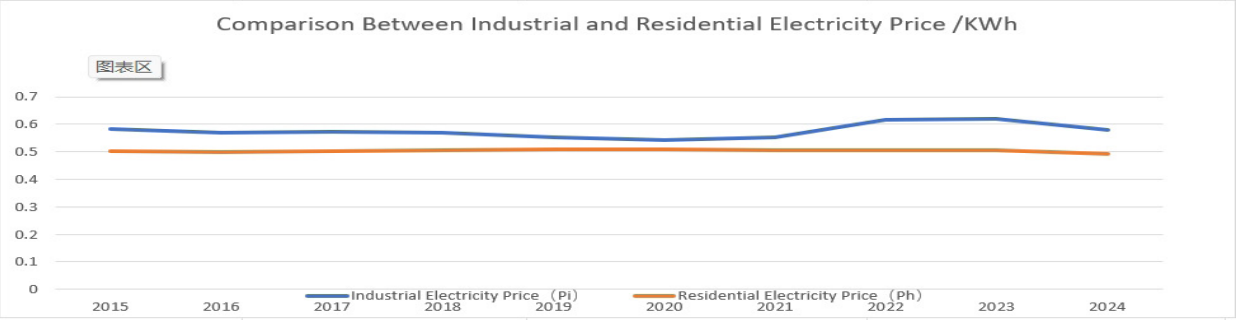
4. Results

Fig. 2 Comparison Between Industrial and Residential Electricity Price [5]

4.1 Basic Price Relationships



The cross-subsidy policy in Tangshan maintains residential electricity prices below industrial rates, with the difference mostly staying within 0.1 yuan. Moreover, both industrial and residential electricity prices are generally kept within a range of 0.5 to 0.6 yuan, ensuring relative price stability even when accounting for inflation [5] (Figure 2).

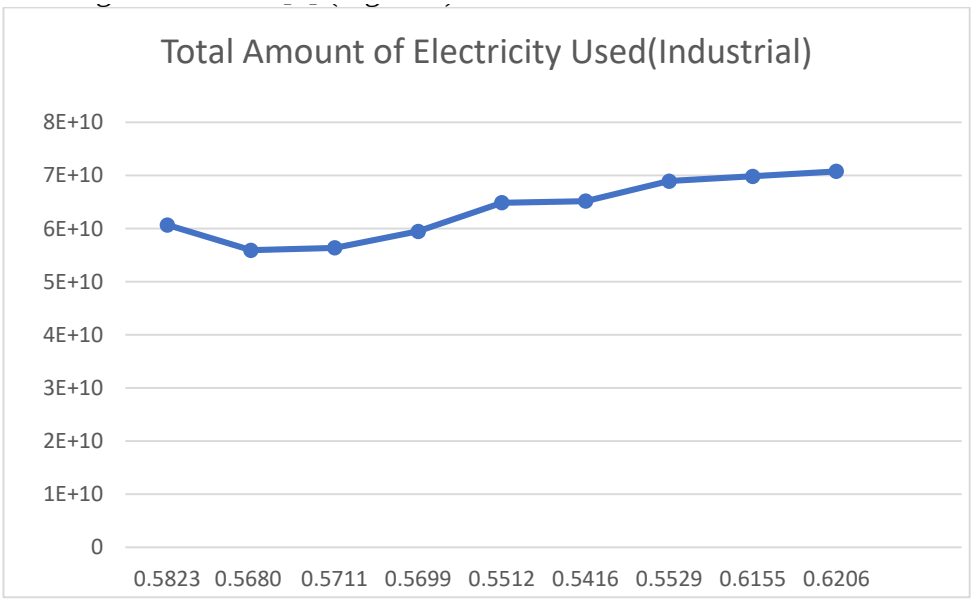


Fig.3 Total Amount of Electricity Used (Industrial) [2]

4.2 Industrial Pricing Statistics

It is obvious that the overall industrial electricity consumption has exhibited minimal fluctuations in response to variations in electricity prices and subsidy levels, fluctuating between 550 billion and 570 billion yuan (Figure 3 and Figure 4). Despite there's an upward trend, the expanding population of Tangshan by 140,694 individuals from 2016 to 2020 implies an inevitable surge in energy demand [6]. Thus, it can be affirmed that the cross-subsidy policy within the industrial sector has effectively accomplished its goal of promoting energy conservation and emission reduction [7-10].

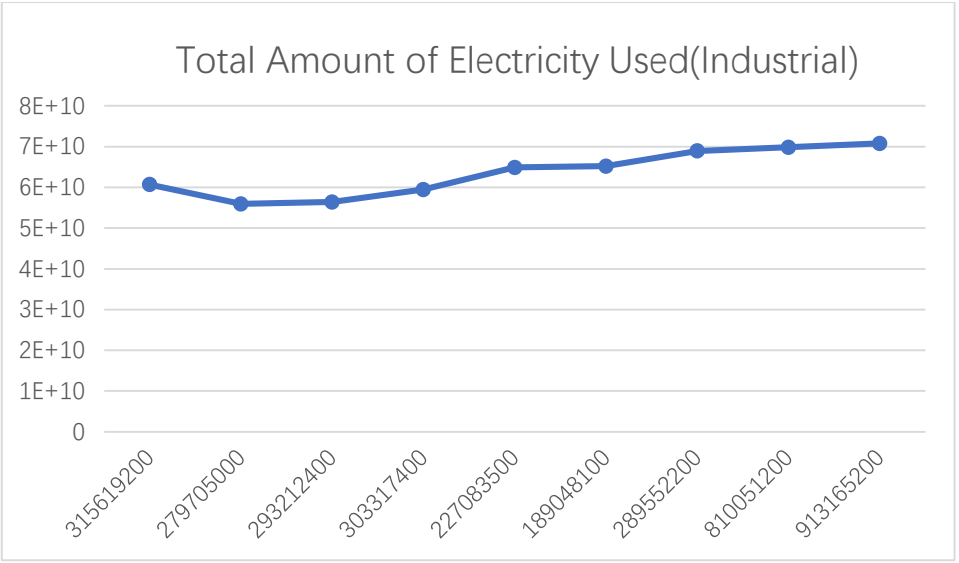


Fig.4 Total Amount of Electricity Used (Industrial) [3]

4.3 Residential Pricing Statistics

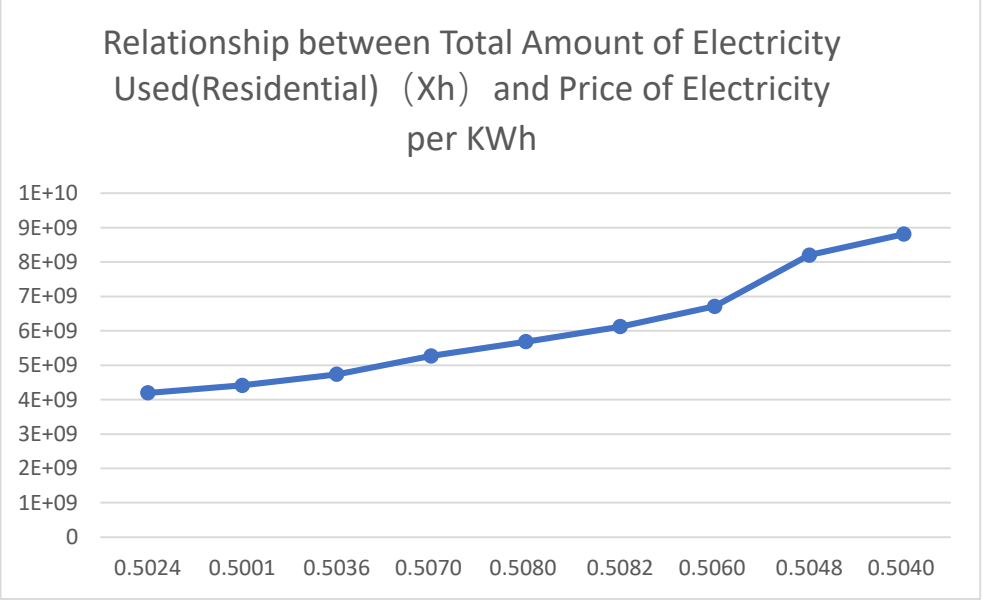


Fig.5 Relationship between Total Amount of Electricity Used (Residential) and Price of Electricity per KWh [3]

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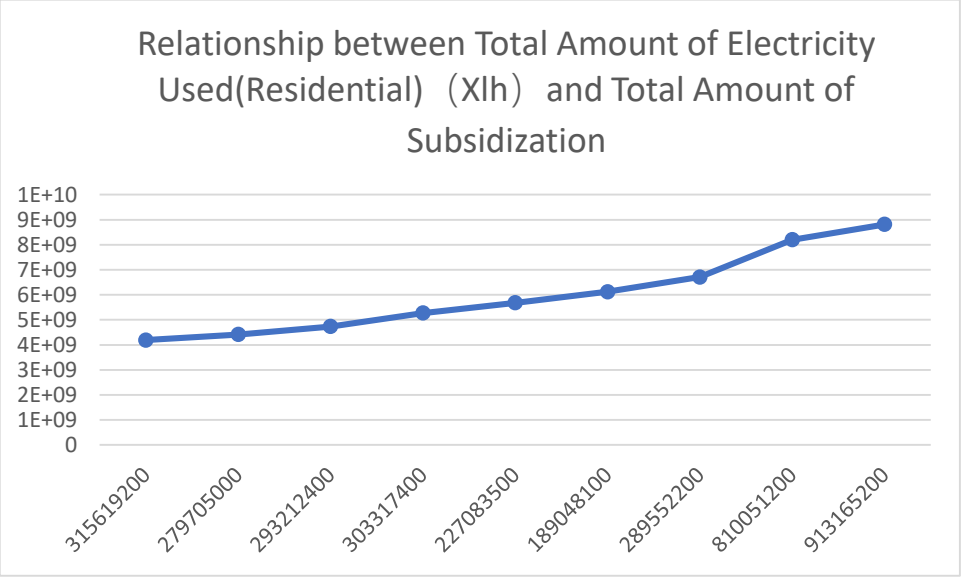

Fig.6 Relationship between Total Amount of Electricity Used (Residential Xlh) and Total Amount of Subsidization [5]

The figure 5 and figure 6 above illustrates a sustained and relatively rapid upward trend. The vertical axis indicates that residential electricity consumption has doubled from 2015 to 2023, while the residential electricity price has remained stable between 0.5 and 0.6 yuan per unit during the same period, indicating an absence of correlation between electricity price and total consumption. However, a different scenario is depicted in the chart showing total electricity consumption and cross-subsidy. The cross-subsidy total on the vertical axis remains relatively stable between 2015 and 2021 but increases by more than four times between 2022 and 2023, with the increase from 2021 to 2022 surpassing that of any other year. Consequently, it can be inferred that residential electricity consumption continues to grow and is roughly positively correlated with the cross-subsidy total. From another perspective, excessive cross-subsidization may incentivize residential electricity consumption, convey misleading pricing signals to consumers, and promote greater use of electricity. Despite the initial intention of subsidizing residential electricity being to foster social harmony, this practice runs counter to national goals for energy conservation and emission reduction.

5. Conclusion

5.1 Summary

This article primarily investigates the impact of this policy on energy conservation and emission reduction by conducting numerical studies on specific electricity prices and electricity consumption. The analysis of charts is used to examine the influence of industrial and residential electricity consumption as well as the overall cross-subsidy on the cross-subsidy policy. The State Grid subsidy policy, which cross-subsidizes residential electricity prices with industrial electricity prices, exerts a significant dampening effect on total industrial electricity consumption. Consequently, from an industrial standpoint, this policy yields positive environmental impacts. Simultaneously, the cross-subsidy policy serves to enhance social equity by enabling certain households to afford their electricity bills. However, viewed from another angle, the cross-subsidy policy imparts inaccurate pricing signals to residents and contributes to a rapid upsurge in residential electricity usage. Furthermore, the beneficiaries of subsidized residential electricity consumption are predominantly from the affluent class, leading to excessive energy utilization. Given China's heavy reliance on coal-fired power generation, this policy runs counter to national objectives for reducing energy emissions.

5.2 Suggestions

Subsidy policies for residential electricity rates can be more effectively targeted to create welfare for low-income families, rather than providing convenience for the wealthy. For instance, specific subsidies could be allocated to families with an annual income below a designated threshold, and a tiered policy could be implemented where the subsidy decreases as income increases until it is phased out entirely. This approach not only modestly reduces industrial electricity costs but also contributes to

greater social equity. Furthermore, it incentivizes reduced energy consumption among the affluent, thereby advancing the goals of energy conservation and emission reduction in contemporary society.

References

[1] Ruandi, Yenan, Yeyingjing, Linhongyang, Hanyaru, Zhuyafang. Study on the Calculation Method of Precise Cross-Subsidy and Analysis of Balancing Mechanism in Electricity Market Reform. State Grid Fujian Electric Power Co., LTD. Economic and Technical Research Institute, 2023, DOI: 10.19851/j.cnki.CN11-1010/F.2023.12.466.

[2] Zhang Ning, Pang Jun, Wen Jing, Wang Junxia. An Analysis of the Economic Implications of Electricity Price Subsidy Elimination in China: A Study Based on Electricity Price Regulation and a Perfectly Competitive Market. Environmental Science in China, 2022, 42(05): 2442-2452.

[3] Ruandi, Yenan, Yeyingjing, Linhongyang, Hanyaru, Zhuyafang. Study on the Calculation Method of Precise Cross-Subsidy and Analysis of Balancing Mechanism in Electricity Market Reform. State Grid Fujian Electric Power Co., LTD. Economic and Technical Research Institute, 2023, DOI: 10.19851/j.cnki.CN11-1010/F.2023.12.466.

[4] Yang Jiacheng, Zhang Xiao, Wang Tao, Wan Xiangxin, Cai Jiwei, Li Nan, Tan Zhongfu. North China Electric Power University, Beijing 102206, China State Grid Tangshan Power Supply Company, Tangshan 063000, China Yan'an University, Yan'an 716000, China. 2021.

[5] Hou Yu. Impact Analysis of Marginal Cost and Social Welfare Level of Electricity Price Reform Based on Cross-Subsidy Problem. Dongbei University of Finance and Economics, 2020.

[6] Tangshan Statistics Bureau. The 7th Census Report on the Population of Tangshan City. Tangshan Labor Daily, 2021-02-06, 002 layout.

[7] Kim, J., Baek, K., Lee, E., & Kim, J. (2023). Analysis of Net-Metering and Cross-Subsidy Effects in South Korea: Economic Impact across Residential Customer Groups by Electricity Consumption Level. Energies, 16(2), 717.

[8] Harring, N., Jönsson, E., Matti, S., Mundaca, G., & Jagers, S. C. (2023). Cross-national analysis of attitudes towards fossil fuel subsidy removal. Nature Climate Change, 13(3), 244-249.

[9] Qi, Y. (2024). Big broad banks: how does cross-selling affect lending?. Review of Finance, 28(2), 551-592.

[10] Na, M., & Yoon, C. (2023). Evaluating the Impact of Affordable Housing Policy: The New York City 421-A Program. Available at SSRN 4331230.