



Reforming residential electricity tariff in China: Block tariffs pricing approach

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HIGHLIGHTS

- We design a rising block tariff structure of residential electricity in China.
- We set up a translog demand model to find the non-linear effects on elasticities.
- The higher income groups are less sensitive to price changes.
- Block tariff structure generates more efficient allocation of cross-subsidies.
- Block tariff structure supports the living standards of low income households.

ARTICLE INFO

Article history:

Received 12 June 2011

Accepted 8 May 2013

Available online 14 June 2013

Keywords:

Block tariffs

Residential electricity

Price elasticity of power demand

ABSTRACT

The Chinese households that make up approximately a quarter of world households are facing a residential power tariff reform in which a rising block tariff structure will be implemented, and this tariff mechanism is widely used around the world. The basic principle of the structure is to assign a higher price for higher income consumers with low price elasticity of power demand. To capture the non-linear effects of price and income on elasticities, we set up a translog demand model. The empirical findings indicate that the higher income consumers are less sensitive than those with lower income to price changes. We further put forward three proposals of Chinese residential electricity tariffs. Compared to a flat tariff, the reasonable block tariff structure generates more efficient allocation of cross-subsidies, better incentives for raising the efficiency of electricity usage and reducing emissions from power generation, which also supports the living standards of low income households.

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1. Introduction

Different from the United States (Sueyoshi, 2010), China does not have a perfect market for wholesale or retail power trade. The Chinese state-owned power grid companies (State Power Grid Company and China Southern Power Grid Company) are in charge of the power transmission, distribution and retailing of the whole country. The transactions are under the government-regulated tariffs which are controlled by National Development and Reform Commission (NDRC) rather than by the market.

In China, the electricity tariffs often play an important role as government policy tools, for example, the substantial cross-subsidies¹ in retail power tariffs. Government charges differential retail tariffs for industrial and residential end-users. For the industrial sector, the power tariff is higher than its long-term

¹ In China, industrial and commercial power tariff is higher than residential power tariff, from which residents obtain subsidies. That is the cross-subsidies we discuss in the paper. On one hand, cross-subsidies make residents enjoy the lower tariffs. On the other hand, it also makes sure the power companies profitable. Besides cross-subsidies, there are also different forms of subsidy in power sector in China, for example subsidies for wind or solar power generation and direct-allowance for lowest income families. Since cross-subsidies are not able to differentiate the targeted groups, it is lack of efficiency. The high income people who consume more power enjoy larger subsidies than the low income ones who consume less power. Therefore, to design targeted power tariffs is the key to power tariffs reform in China.

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marginal cost (LTMC). The residential end-user sector, however, usually pays a power tariff that is lower than its LTMC. The state-owned power companies ensure their budget balance by taking the gains from industrial sectors to compensate the loss from residential sector. In other words, the residential end-users enjoy subsidies from the industrial sector (Lin and Jiang, 2012). Lin et al. (2009a) found that in 2007 the amount of retail power cross-subsidies was about US\$32.5 billion.

The Chinese government adopts a flat pricing mechanism in residential sector. It indicates that paying the same tariff as the lower income ones, the higher income households usually consume more electricity and enjoy more subsidies. Lin et al. (2009a) found that 45% of the subsidies were given to the higher income groups (accounting for 27% of population) while the lower income persons (accounting for 22% of population) only received the 10.1% subsidies. Therefore, the flat tariff for residential power consumption is not consistent with social equity, and leads to a lack of allocation efficiency in cross-subsidies.

Under the background of energy conservation and emission control, China is promoting the reform of residential tariff for making it more sensitive to price signals. It is now clear for the government that a more active tariff reform is required to reflect the power supply cost better and to improve efficiency². In November 2009, the government puts forward a plan for reforming residential tariff with an intention to apply a rising block tariff mechanism, in which the residential tariff will vary according to the consumption levels. The reform plans a three-step tariff system assigned to three consumption thresholds: basic power consumption (BPC), normal power consumption (NPC), and luxury power consumption (LPC). Under the plan for block tariffs, the BPC will be charged at a subsidized price; the price will be higher for any NPC exceeding the BPC limit; there will be a further price increase at LPC thresholds.

The residential electricity block tariffs have been extensively adopted in other countries, such as the United States and Japan³. So the residential power tariff reform would update Chinese tariff policy by meeting the global standards. The power tariffs are seen as an important tool to achieve the objectives of social equity and efficiency. First, the rising block tariffs of residential electricity can increase the economic efficiency by charging a price that follows the marginal cost pricing. Basically, residential electricity consumption tends to happen more around the peak time which adds to the peak network capacity. Higher peak capacity leads to higher marginal supply cost. The cost information cannot be reflected in the flat tariff, while the rising block tariff can reflect the increased marginal cost. Second, the rising block tariff of residential electricity follows the inverse elasticity pricing, which means that different prices are set for consumers with various price elasticities of demand. The consumers with a lower price elasticity of demand have to purchase the electricity at a higher price than those with a higher price elasticity under the rising block tariff mechanism. The flat tariff charges uniform price for each unit of electricity consumption. In contrast, the rising block tariffs will be able to identify the different responsiveness of demand for electricity facing price changes. We can use Ramsey pricing to analyze the above features of block tariffs.

Accordingly, estimating the price elasticity of electricity demand for consumers of different incomes should be crucial for the research on the rising block tariffs. We present a dataset for

the residential electricity consumption of China's 30 provinces over the years 2000–2007, and employ a translog model of residential power demand to estimate the price and income elasticity.

The remainder of this study is organized as follows. Section 2 reviews the previous research. Section 3 describes China's fundamental conditions on residential electricity consumption, residential electricity tariff and income per capita. Section 4 analyzes the inverse elasticity pricing model and residential utility curve. Section 5 empirically studies the income and price elasticity of residential electricity demand by a panel-data translog model. Section 6 puts forward three proposals of the block tariffs for residential electricity. Section 7 summarizes this study along with future extensions.

2. Literature review

In this section, we include two parts. We first summarize the existing empirical researches on price elasticity of residential electricity demand. In the second part, we summarize and compare the applications of inverse elasticity pricing approach in public utility.

There are a lot of studies on demand functions of residential electricity aiming at not only the developed countries, but also some developing countries. Taylor (1975), Halvorsen (1975) and Bohi (1981) conducted early research on the price elasticity of residential electricity demand and finished the related work of data classification. Bohi and Zimmerman (1984) found that the short-term and long-term price elasticity of residential power demand was -0.2 and -0.7 , respectively. Narayana et al. (2007) highlighted that the residential power demand is price elastic and income inelastic in G7 countries. Garcia-Cerrutti (2000) pointed out the minute impact of American household income on residential power demand based on the estimation of elasticity from panel data. Silk and Joutz (1997) analyzed the impact of economic variables, such as actual disposable income, power tariffs, temperature and real rate of interest, on residential power consumption. Filippini (1999) estimated a log-linear model employing aggregated data referring to 40 cities in Switzerland between 1987 and 1990, and found that the price elasticity of residential power demand was -0.3 . The Australian National Institute of Economic and Industry Research (2007) found that the price elasticity of residential power demand was -0.25 . Dilaver (2008) investigated the interrelationship between the residential power tariff, the household power consumption and the total household expenditure in Turkey using the structural time series model. Wasantha and Wilson (2009) found the value of income elasticity of power demand was between 0.32 and 0.78 and the value of price elasticity of demand was between -0.62 and -0.16 in Sri Lanka. Bose and Shukla (1999) made a panel regression of the parallel data of 19 states in India over 9 years to find the estimated result of the price elasticity of Indian residential electricity consumption. Dividing the samples by seasons, Filippini and Pachauri (2004) took the income, power tariff and dummy variables that reflect household conditions as the independent variables into the research. Holtedahl and Joutz (2004) studied the impact of household disposable income, population growth rate, residential power tariff, urbanization rate and temperature condition on the power demand of Taiwan residents.

However, there are few empirical analyses focusing on the electricity demand of Chinese households who make up about a quarter of all households in the world. We conduct a research on estimating price and income elasticity of residential power demand in China. Instead of adopting a log-linear model as most

² The efficiency here means a broad term containing economic, social, and environmental objectives.

³ Source: <http://www.tepco.co.jp/e-rates/individual/menu/home/home02-j.html>. Although the United States and Japan have power trading markets like PJM, their tariffs of residential electricity are nearly in accordance with the forms of increasing block tariffs.

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