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Distributional incidence of green electricity price subsidies in China

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HIGHLIGHTS

- We quantified the distributional effects of the green electricity price subsidy.
- The distributional effects of different income groups were compared.
- The poorest two groups accounted for less than 10.2% of the total subsidies.
- The green electricity price subsidy policy benefited the rich at household level.

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ABSTRACT

Distributional incidences are fundamental to environmental and energy policies, a condition that has led to controversies on the equity of environmental and energy policy. Using data from China's Urban Household Income and Expenditure Survey data from 2007, this study quantified the distributional effects of the green electricity price subsidy policy among Chinese urban household and compared its effects by using lifetime income and annual income to classify households, respectively. The results show that total electricity subsidies are mainly driven by indirect electricity subsidies. By using lifetime income to classify households, subsidies to households in the poorest two groups accounted for less than 10.2% of the total subsidies, whereas money distributed to households in the top two deciles reached 35.4%. The comparison using annual income to group households also demonstrated the similar impact of the green electricity price subsidy policy. China's future market reforms should allow electricity prices to reflect pollution abatement costs. Additionally, a multi-step block electricity price schedule can reduce the regressivity of the policy.

1. Introduction

Environmental and energy policies, which aimed to accelerate the shift toward sustainable consumption and production patterns, may inevitably have distributional effects (Kriström, 2006). Households in the bottom income bracket may incur higher costs, and higher-income households may gain from these policies (Fullerton, 2009, 2011). This condition has ignited controversies on the equity of environmental and energy policies (Gianessi et al., 1979; Gonzalez, 2012; Komives, 2005, 2009; Perlin et al., 1995; Rausch et al., 2011; West and Williams Iii, 2004). Moreover, encouraged by lower burdens or higher benefits from such policies, households in the top income decile inevitably tend to consume much more, which leads to greatly increased pollution. The potentially regressive incidence of environmental and energy policies will render them both inefficient and inequitable, particularly in developing countries such as China, where a huge wealth gap exists and there are extraordinary disparities in household living conditions (Xie and Zhou, 2014). Integrating the distributional incidences into policy design and assessment is therefore indispensable to ensure both equity and efficiency.

To address the increasingly severe challenge of environmental pollution, since 2005, the Chinese government has set ambitious and pragmatic targets to address the major sources of water and air pollution and climate change. In the Eleventh Five-Year Plan (11th FYP) period, a binding emission ceiling has been set to control national sulfur dioxide emissions; specifically, at the end of the 11th FYP period, national sulfur dioxide emissions should be 10% less than that of 2005 (NPC, 2006). As the largest source of SO_2 emissions, coal-fired power plants, which account for some 50% of national SO_2 emissions, have been required to gradually accelerate

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the installation of desulfurization facilities (NDRC and SEPA, 2007a). The ambitious mitigation target will undoubtedly increase the production cost of coal-fired power plants. To mitigate the construction and operation burden faced by coal-fired power enterprises and guarantee the electricity supply, a green electricity price subsidy has been issued by the National Development and Reform Commission (NDRC), State Environmental Protection Administration (SEPA). Specifically, once the existing and new-built coal-fired units with desulfurization equipment installed have passed the acceptance inspection by the provincial price competent department and put into operation, a 15 CNY/MWh (i.e. $1.97 per MWh) premium can be subsidized for the feed-in tariff, effective July 1st, 2007 (NDRC and SEPA, 2007b). Currently, the green electricity price subsidy has been implemented for several years, and has effectively promoted the portion of coal-fired units with desulfurization equipment installed soaring from 13.5% in 2005 to 92.1% in 2014 of the total installed thermal capacity (CEC, 2015). In face of the unprecedented environmental and health challenge across the country, the green electricity price subsidy will continue to play a key role in the emission reduction of coal-fired power plants in the near term. Therefore, it's vital to analyze the distributional incidence of the green electricity price subsidy.

In China, power grids have been tasked with purchasing electricity from power plants and distributing electricity to end consumers. In general, due to the feed-in tariff subsidy for desulfurization equipment installation in coal-fired power plants, the power grids would have to raise the sale price to offset the higher purchasing cost. Consequently, SO_2 abatement costs will ultimately be borne by household consumers and firms. For firms consuming electricity, higher costs may also be passed on to their final consumers, namely, households at different levels. In other words, the sulfur abatement cost would be paid for by households to a certain extent.

However, electricity sale prices have not changed accordingly. In China, the sale prices of electricity have been under strict government control for a long time. Since 2006, NDRC has adjusted electricity prices only three times. It is clear that the sale price for residential electricity in each region has been kept constant (Fig. A1), whereas the sale price for industrial (Fig. A2) and commercial use (Fig. A3) has been adjusted to different extents in the range of -5.1% to 43.7% and -13.5% to 43.7%, respectively[1]. According to the Circular on Electricity Price Adjustment (NDRC, 2008a, 2008b, 2008c, 2008d, 2008e, 2008f) since 2008, there are two main reasons for the fluctuations in sale prices for industrial and commercial electricity. One reason is that the fluctuating price of coal for power generation has changed the production cost of coal-fired power plants, and the government has to regulate the sale price as a response. The other reason is the sale price structure integration, namely, applying one single price standard to electricity for non-resident lighting, industrial use and commercial use. In other words, fluctuations in electricity sale prices have not taken into account the increased feed-in tariff resulting from the green electricity price subsidy. Therefore, under the current electricity pricing mechanism in China, the green electricity price subsidy had prevented the sale price of electricity to increase and represented an implicit subsidy for different households.

The green electricity price subsidies can vary substantially among income brackets. Household electricity consumption can be decomposed into direct residential electricity usage and indirect electricity consumption, which is the electricity used in the production of commodities and services purchased by households (Dai et al., 2012). Due to diverse consumption patterns and family compositions, there are obvious discrepancies in the direct residential electricity usage for various income brackets (Shigetomi et al., 2014). Moreover, indirect household consumption can lead to much higher energy consumption (Liu, 2010; Liu et al., 2011). Due to lifestyle differences, both in terms of the composition and volume of goods and services, indirect electricity consumption can also cause huge disparities among different income brackets (Jones and Kammen, 2011). As a consequence, on the combination of the striking difference in direct residential electricity usage and the indirect electricity consumption by different income levels, there is a substantial gap among green electricity subsidies for different income brackets.

With the above-mentioned considerations in mind, the objective of this study was to answer the following question: How is the green electricity subsidy ultimately distributed across different income deciles? The remainder of the paper is structured as follows: Section 2 details the methodology and data used to gauge the total electricity subsidies for each household, and Section 3 describes the key results. Finally, policy implications are thoroughly explored.

2. Methodology

To assess the consequences caused by the green electricity subsidy in China, we need to understand how the electricity price subsidies would pass on to households in the national context. In reality, the electricity subsidies can be transferred to household consumers in two ways, namely, by the direct household electricity consumption to consumers, and by the indirect electricity consumption embodied in the life cycle of commodities and services for household consumption (Yang and Chen, 2014). In addition, households may consume even more indirect energy than direct energy (Liu et al., 2009). Therefore, it should also be vital to consider the incidence of the indirect electricity consumption for different households. Currently, the input–output (IO) analysis combined with household survey data has been considered as a very convenient and effective method to portray the energy requirement of different household types and been widely used to numerate the indirect energy embodied in the household consumption (Kok et al., 2006; Feng et al., 2010).

In this paper, to analyze the distributional incidence of green electricity subsidies, we first need to estimate the direct and indirect electricity consumption for different household types. This is achieved by an input–output model combined with household-level survey data. Then we convert the household electricity consumption into household electricity subsidies, by determining the transferring subsidy rate for households in different income brackets. Finally, we compare the household-level electricity subsidies on the basis of household economic status to reveal the distributional impact.

2.1. Household electricity consumption

In this study, the total household electricity consumption, which can be expressed as the sum of the direct electricity usage and the indirect electricity consumption, is given by the following:

$$E_t = E_d + E_{id} \tag{1}$$

[1] In China, the sale prices of electricity have been set for five major use at different voltage levels, including the residential use, non-resident lighting use, the industrial use, the commercial use and the agricultural use. In this study, a full comparison of the electricity prices for a variety of purposes at different voltage levels have been made and it has been revealed that the fluctuations in electricity sale prices have not taken into account the increased feed-in tariff resulting from the green electricity price subsidy. In Figs. A1 and A3, the average electricity prices for residential, and commercial use of different voltage levels have been illustrated. In Fig. A2, the average electricity prices for industrial users, who having a regular power demand less than 315 kV. A, has been displayed.