Shedding light on the impacts of electricity subsidies in Brazil

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1 Introduction

While energy tariff subsidies exist in various countries around the world, their real impacts are not yet fully understood. This study assesses the effects and efficiency of the brazilian Social Electricity Tariff Program (TSEE), which provides discounts on electricity bills to low-income costumers. Using a difference-in-differences methodology, we estimate the program's effect on energy consumption of the directly benefited population, using a regulatory change as an instrument of exogenous variation in electricity prices. We also discuss how this policy affects social wellrafe, considering the tariff pass-through of the subsidy to other consumers. With this work, we aim to contribute to the literature on energy subsidies, providing evidence from a developing country, and enrich the discussion on the intersection between efficiency and equity in energy policies.

The refrigerator preserving food, the computer connecting to news and opportunities, the light extending the useful period of the day - modernity has brought with it an undeniable dependence on electricity, now indispensable for maintaining a good quality of life. Globally, the universalization and assurance of access to electricity are among the objectives of the UN's 2030 Sustainable Development Agenda. In Brazil, nearly the entire population already has access to electricity, which is considered universal in the country. However, the discussion becomes more complex when considering the socio-economic reality of the population. Income inequality raises questions about families' ability to pay for the costs of electricity.

The TSEE was established in 2010, offering energy bill discounts to families who applied for the benefit through the distributor living on less than half a minimum wage (US$143.75). Discounts are cumulative, ranging from 65% (consumption up to 30 kWh/month) to 10% (up to 220 kWh/month). With the approval of Law No. 14,203, as of January 2022, all clients enrolled in CadÚnico, a platform aggregating low-income families in the country, automatically receive the subsidy. This change aimed to eliminate the program's enrollment cost for consumers.

The TSEE, alongside other policies, constitutes part of the Brazilian government's efforts to ensure the population's access to electricity. The 'Light for

All' program (LpT) from 2003 aimed to universalize access in the country. The electrification resulting from the program had a positive effect on various aspects of the Human Development Index of the affected municipalities, especially the education component (Bezerra et al., 2017). In 2020, the program 'More Light for the Amazon' was launched, aiming to complement LpT by bringing renewable energy to isolated indigenous communities in the Legal Amazon. The creation of the TSEE inaugurates a new phase in the country's electricity access policies, where access is understood not only as the capacity to consume but also to bear the costs of electricity demand. In the past year, the program covered 19.5 million families, granting a total subsidy of R$5.29 billion.

The funds financing the benefit come from the Energy Development Account (CDE), which receives contributions from all energy distributors in the country. In addition to discounts for low-income consumers, the CDE funds programs for universalizing electricity in the country, among other initiatives. The pass-through of CDE financing to consumer tariffs is defined annually by the National Electric Energy Agency (ANEEL). Regarding the TSEE, the distributor is reimbursed in the same amount as the subsidy granted. In this sense, the inclusion of eligible customers in the program is also advantageous for the provider. By being included in the social tariff, part of the family's electricity bill is paid directly by the government, free from the risk of default.

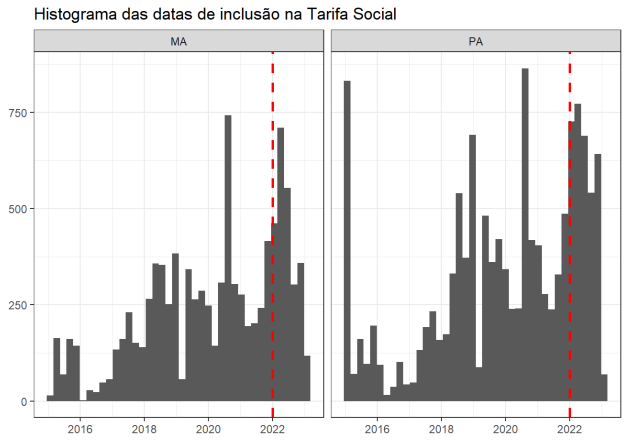
Using the automatic inclusion of consumers in the subsidy from 2022 as an instrument of exogenous variation in electricity prices, this research seeks to answer the following questions about the TSEE. What is the effect of the discount for the low-income population? Given the tariff pass-through of the program's costs to other consumers, is it efficient in terms of wellfare variation? How do these results relate to issues regarding the balance between the efficiency and equity of public policies?

2 Methodology

The primary database for this research is a consumer panel from the Equatorial Energia Group in the states of Pará and Maranhão. The panel covers the period from January 2016 to September 2022 and includes information such as the customer's registration date, monthly energy consumption (kWh), electricity bill amount (R$), whether the consumer receives the TSEE or not, and the inclusion date in the benefit. To assess the program's efficiency, we use data on the tariff pass-through of Social Tariff costs, made available by ANEEL. We isolate the portion of the tariff pass-through from the Equatorial Group distributors allocated to funding the TSEE in the years pre- and post-regulatory change.

The treatment group consists of families who were already customers of Equatorial Energia before January 2022, were already registered in CadÚnico (meaning they were already eligible for TSEE), but only joined the program with the regulatory change. The control group is composed of consumers who are not eligible to receive the subsidy. Figure 1 shows a histogram with the

inclusion dates of customers in the TSEE. A peak can be observed after the enactment of Law No. 14,203, indicated by the dashed line.



With the treatment and control groups well identified from the regulatory change, we estimate the model presented in Equation 1. In this approach, the parameter of interest β gives us the impact on electricity consumption associated with the discount from the TSEE. The exogenous nature of the price variation ensures that the treatment does not depend on potential outcomes.

$$E_{imt} = \beta TS_{imt} + \theta_m E^b_{im} + \pi_m + \gamma_i + \phi X_{imt} + \epsilon_{imt} \quad (1)$$

[1]

The wellfare gain of the included consumers has two components. The first is the savings on the energy bill for the consumption they already had. The second component is the surplus associated with additional consumption due to the tariff reduction. An assumption we make for this analysis is that all consumers benefiting from the TSEE are equal, meaning they have the same price elasticity of demand estimated in the previous stage. The consumer surplus variation of consumers not covered by the TSEE can also be decomposed into two parts. The first part comes from additional expenses associated with energy consumed at a higher price. The second portion corresponds to the loss of surplus associated with the decrease in consumption resulting from the tariff increase.

[1] Where E_{imt} is the electricity consumption of family i in month m and year t; TS_{imt} indicates whether the family participated in the Social Tariff in the month under analysis (= 1 for the treatment population from January 2022 onwards, = 0 otherwise); $E^b im$ is the family's average monthly consumption in periods before the treatment; π_m controls for seasonal effects influencing electricity consumption (mainly related to weather patterns); $Ximt$ is a vector of controls; and γ_i controls for fixed effects of families

3 Results

Our preliminary results indicate that inclusion in the TSEE and the subsequent discount on the electricity tariff had no significant effect on the consumption of the treatment population at any analysis horizon, which extended up to eight months post-treatment. In our analysis of the subsidy pass-through to other consumers, we found that 0.65% of the electricity tariff in the states of Maranhão and Pará was allocated to funding the social tariff in 2021, while this number increased to 1.01% in the post-treatment period. For the population of the states of Maranhão and Pará, this translated to an increase of US$20.36 million in the total subsidies paid for TSEE funding.

The low responsiveness of electricity consumption to price variations was expected and aligns with the results of similar studies. Hahn and Metcalfe (2021), in their paper "Efficiency and Equity Impacts of Energy Subsidies," analyze the impact of the CARE subsidy (California Alternate Rates for Energy) on the natural gas tariff in the state of California. They use a natural experiment to estimate the price elasticity of gas demand for consumers affected by the program and assess its environmental and social wellfare impacts. The main results indicate that the subsidy reduced aggregate social wellfare, and the benefit to recipients should increase by 6% to offset program costs. Liddle and Huntington (2020) found that residential demand for electricity was not responsive to price shocks. On the other hand, the authors found a high income elasticity of demand, especially in middle-income countries.

4 Conclusions

In summary, the preliminary results of this research reveal that inclusion in the Social Electricity Tariff Program and the subsequent discounts on the electricity bill had no significant effects on the electricity consumption of the low-income population, even within an analysis horizon of up to eight months after the implementation of the treatment. Notably, the low elasticity of consumption to price variations aligns with similar findings in comparable studies, emphasizing the inelastic nature of this demand, even in a low-middle-income country.

When examining the subsidy pass-through to other consumers, we identified a considerable increase in the portion of the tariff allocated to fund the TSEE in the states of Maranhão and Pará, resulting in a total increase of US$20.36 million in subsidies paid. This finding underscores the importance of understanding the impacts not only on direct beneficiaries but also on society as a whole.

In light of these results, the next step in this research will be to deepen the analysis of consumer surplus, aiming for a more precise estimate of the subsidy's impact on aggregate wellfare. However, as observed in many studies analyzing energy subsidies, it is evident that an energy policy planner needs to substantially consider equity issues to ensure that the subsidy is truly efficient in terms of consumer surplus variation. This study, therefore, contributes to a broader understanding of the intersection between efficiency and equity in

energy policies in a diverse socioeconomic context.