# *IMPACT OF TARIFF ON THE HOUSEHOLD CONSUMPTION OF ELECTRICITY IN BRAZIL*

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## Overview

This article analyzes the impact of tariffs on the household consumption of electricy in Brazil between 1985 and 2013 through linear regressions. The explanatory variables considered in the linear regression were the number of households, effective consumption of families as a proxy for family income, and electricity tariff for households. The regression presented coefficient of determination of 0.9892, and the several statistic tests conducted assured the existence of long-term relation between the electricity consumption in residences and the explanatory variables. The obtained elasticities for the household consumption of electricity with respect to the residential tariff of electricity was -0.230±0.060. These results allowed understanding the evolution over time of the household consumption of electricity in Brazil and the importance role played by tariffs. They suggest that the electric sector in Brazil should pursue an active policy to manage demand of residential electricity using tariffs as a means to control it.

## Methods

The residence electricity consumption behavior in Brazil is described through explanatory variables, expressed in time series, using linear regression based on the ordinary least squares approach. The approach furnishes elasticities relating the electricity consumption in residences to the explanatory variables. We start choosing a set of explanatory variables over the period starting in 1985 and finishing in 2013. To perform the regressions and statistical tests we employed the EViews 8 software. Econometric theory is used to evaluate the stationarity of the time series, their order of integration and possible cointegration to verify if there are meaningful causal relations between the explanatory variables and the electricity consumption in residences.

The chosen explanatory variables were the electricity consumption in residences ($E_t$), the number of households in the country ($H_t$), the effective consumption by families as a proxy for the available family income for consumption ($I_t$), and the electricity tariff for residences ($T_t$). All series were normalized to 1 in 1985 which is taken as a reference year. In 1994 Brazil achieved monetary stability with the new currency (Real). The tariff and family income variables were corrected by the annual inflation rates in order to produce consistent evaluations over time.

The electricity consumption has been increasing during the period of study except by the important drop during the power generation crisis of 2001. The number of households has increased continuously with a slight decline in the growth rate after 2005. This continuous increase in the number of residences in Brazil is thought to be an important contributor to the total consumption of residential electricity as each new home requires a minimum load to meet the various uses of typical family.

## Results

Figure 1 compares the regression obtained for models A and B and the actual data for electricity consumption. The discontinuity due to the 2001 power generation crisis is accounted for by the dummy variable in model B. Due to the better coefficient of determination, $R^2$, and its ability to describe the 2001 events, we choose model B as the best regression to represent the behavior of the electricity consumption in residences in Brazil during 1985 and 2013. From the data we describe model B as

$$log(E_t) = -15.62 + 1.534\ log(H_t) + 0.188\ log(I_t) - 0.230\ log(T_t) - 0.233\ \log(D_t).$$

The elasticities for models A and B show differences. Model B regression, which includes the dummy variable to represent the event of 2001, presents higher elasticity of electricity consumption with respect to the number of households and lower elasticities with respect to tariff and family income. Thus the effect of introducing the dummy variable in model B was to increase the explanatory importance of the variable number of households and to decrease the explanatory importance of the variables family income and residential tariff.

Figure 2 shows the behavior of the electricity consumption for the seven scenarios. The actual evolution trend is represented by the curve named "Data" in the figure. For scenarios S1 and S2, with reduction in electricity tariffs, the electricity consumption in residences increases as much as 10 % in two years and follows the trend of the previous years. For scenarios S3 and S4, with high electricity tariff rise, the electricity consumption in residences increases about 3 %. For scenarios S5 and S6, with very high tariff rise, the residential consumption falls about 5 % in two years. For the S7 scenario, with very high tariff rise and strong reduction in family income, the residential consumption falls about 15 % in two years. Scenarios S5 and S7 may represent limiting scenarios of the Brazilian situation in 2015. They show important reduction in electricity consumption in residences and evidence the impact of tariffs on its evolution.

These results indicate that tariffs may be considered an effective means to manage residential consumption of electricity in the country. Although the elasticity of residential electricity consumption with respect to tariff is not high in Brazil, it is sufficient to control the electricity demand in residences or even reduce it, as shown in scenarios S3 to S7. If the Brazilian agencies had pursued an active behavior to avoid the tariff reduction over time, the electricity consumption in the residential sector would not have increased as it did and the stress in the power generation sector would have been lower.

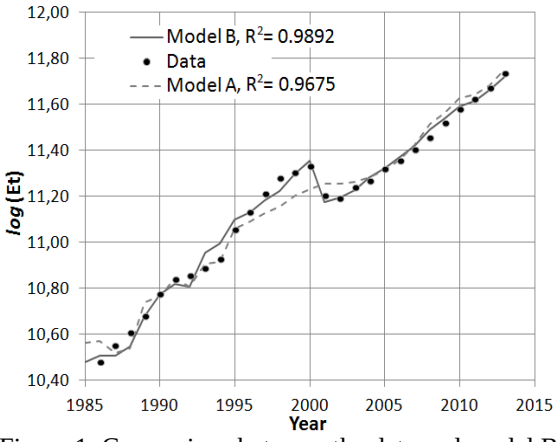


Figure 1. Comparison between the data and model B regression representing the electricity consumption in residences during 1985 and 2013.

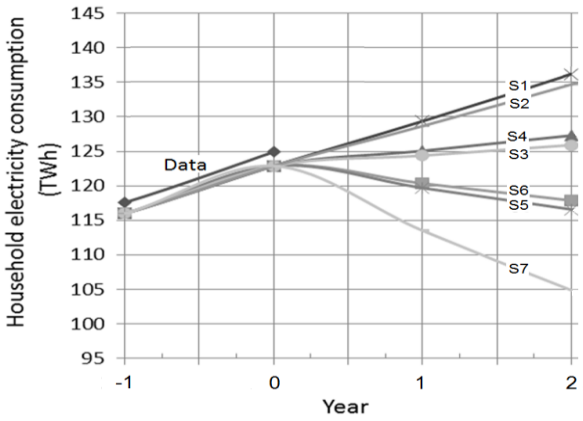


Figure 2. Projections of electricity consumption in residences for different scenarios for the evolution of the explanatory variables.

## Conclusions

According to these results, the evolution of the household electricity consumption over time is more sensitive to evolution of the number of households in the country, followed by those of tariffs and family income which have similar elasticities but with opposite signs. These results allow some policy recommendations regarding managing the demand of electricity in Brazilian residences. The first is that the Brazilian agencies responsible to manage the electric sector in the country should consider pursuing an active policy to manage demand of residential electricity. The second is that tariffs may be considered an effective means to control residential consumption of electricity. Although the elasticity of residential electricity consumption with respect to tariff is not high in Brazil, this study shows that it is sufficient to control the electricity demand in residences. As a future work, we intend to develop an algorithm that could effectively implement such a policy considering the Brazilian regulation framework.