ESTIMATING ENERGY RATIONING COSTS ON GENERAL EQUILIBRIUM ENVIRONMENT WITH COMPENSATING VARIATION

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Overview

Brazilian electricity sector is characterized by a hydrothermal composition and centralized operational procedures, including the dispatch of energy sources available to maintain the interconnected system. Among the fundamental information needed for planning of expansion and operation the cost of rationing plays a central role. In summary, it represents the maximum amount of money that could be attributed to a new venture able to avoid power rationing or, more generally, the economic cost or deadweight loss associated to some level of energy supply not available to the consumers. As part of a wide research within National Energy Commission (ANEEL) Research and Development program, that has aimed to develop and implement new methodologies for energy deficit cost estimation in Brazil, and taking advantage of a general equilibrium model environment, we propose a method based on compensating variation concept, capable to estimate the amount of consumption needed to get representative consumer back to its utility level prior to the simulated change on energy supply. This approach constitutes another alternative tool for energy policy makers in Brazil, in combination with current methodology, based on national accounts system and Leontief´s input-output matrix and those based on direct research with consumers and contingent valuation methods.

The paper is organised as follows: after the introduction, giving more details about the role of energy deficit cost in Brazilian energy system, the second section describes the approach, that starts with the simulation of a previous general equilibrium model. The third section describes the strategy used to compute compensating variation and the preliminary results. The final section discusses policy implications and research extensions.

Methods

Welfare analysis, Computable General Equilibrium Models (CGE).

Results

In a computable general equilibrium model (CGE) consumers are represented by some utility function. For example, equation (1):

$$u = \frac{c^{1-\sigma}}{1-\sigma} - \frac{h^{1+\psi}}{1+\psi} \quad (1)$$

where *c* is the consumption level and *h* the total amount of working hours. As a result of the simulations, both for the benchmark economy (without rationing) and the counterfactual (with some level of energy rationing), optimum values are obtained for consumption, working hours and other endogenous variables (quantities and prices). Thus, c_b represents consumption and h_b the total amount of working hours in the benchmark economy; c_r e h_r are the corresponding variables for economy under some level. Defining γ as the compensating variation in terms of consumption that representative agente must receive to get its prior level of utility (benchmark situation), we have the relationship:

$$u_b = \frac{c_b^{1-\sigma}}{1-\sigma} - \frac{h_b^{1-\psi}}{1+\psi} = \frac{(\gamma c_r)^{1-\sigma}}{1-\sigma} - \frac{h_r^{1-\psi}}{1+\psi} \quad (2)$$

Solving for γ:

$$\gamma = \frac{1}{c_r}\left\{(1-\sigma)\left[u_b + \frac{h_r^{1+\psi}}{1+\psi}\right]\right\}^{\frac{1}{1-\sigma}} \quad (3)$$

Therefore, $\gamma = 1.0026$, for example, means that consumption level must be 0.26% higher (considering that a rationing occured) in a manner that welfare is equivalent to the original level (benchmark situation). Generally, for each simulated γ, one compensating variation may be obtained in terms of consumption percentage Δc; with Δc and rationing level Δe it is possible to express, using data from National Accounts System, this measure of deadweight loss as BRL/MWh (brazilian reais per MWh) – this is a measure of average cost of energy rationing (CD):

$$CD(\Delta e) = \frac{\Delta c\ (\Delta e)}{\Delta e}\frac{C_{2014}}{E_{2014}} \quad (4)$$

Where C_{2014} e E_{2014} represents, respectively, Family consumption (BRL) e and energy consumption (MWh) in some year, in this example 2014 – base for the calibration of original computable general equilibrium model.

Conclusions

This paper introduces an alternative approach to evaluate welfare costs related to an energy rationing based on computable general equiblibrium models (CGE) and the traditional compensating variation analysis from Microecomics. As part of an agenda devoted to develop new methodologies for energy rationings costs estimation in Brazil, this tool has the potential to contribute to the debate concerning this parameter in the country.

References

Botelho, V (2016): Using General Equilibrium Models to Estimate the Rationing Cost in a Power System. ANEEL Research & Development Program. Presented at 39ª IAEE Conference, Bergen, Norwey, 2016

Sue Wing, I. (2009). Computable General Equilibrium Models for the Analysis of Energy and Climate Policies, in J. Evans and L.C. Hunt (eds.), International Handbook On The Economics Of Energy, Cheltenham: Edward Elgar, 332-366.