Electricity Tariff Rebalancing in Emerging Countries: The Efficiency-equity Tradeoff and Its Impact on Photovoltaic Distributed Generation

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A recurrent problem in many economies is that residential electricity tariffs fail to achieve economic efficiency. This simple diagnosis imply that the true marginal cost of energy is not reflected into the service rates afforded by households in their electric bills. As a result, these users end up consuming above or below the efficient level. In several developing countries, this problem can be exacerbated when other objectives, different from economic efficiency, are pursued by means of complex tariff designs. Among the additional goals, income redistribution goals and conservation goals are likely the most popular. However, the use of a single instrument –i.e., existing tariffs– neither produce a fair distributional outcome nor provides the right incentives for optimal consumption decisions. In some cases, highly disbalanced tariffs discourage the investment in energy efficiency improvements and deter the adoption of renewable sources of energy supply such as solar PV systems. In addition, when subsidies to energy consumption are sizeable, distorted tariffs generate unsustainable fiscal positions for government with critical financial constraints.

In this paper we illustrate the points mentioned above using household-level and hourly-industry data for the Mexican residential electricity sector, where 98% of residential users are highly subsidized and the fiscal cost associated is sizeable. In an arbitrary scenario with a 30-percent subsidy reduction, we exemplify how a more efficient pricing mechanism consisting of a two-part tariff, a well-targeted transfer program, and a tailored environmental regulation can simultaneously improve economic, social, and environmental outcomes. The proposed variable (volumetric) charge in each locality is composed of the externality cost of pollution plus the corresponding nodal price, which incorporates the energy cost, the transmission cost due to congestion, and energy losses (technical and non-technical). The fixed charge –i.e., the second component of the two-part tariff– plays the essential role of recovering fixed costs related to financing, installation, maintenance, management, operation, and expansion of the infrastructure necessary to provide the electricity service. In this paper, we propose a particular set of non-uniform fixed charges that are reflective of households' total income –i.e., a valid proxy variable for the true willingness-to-pay. Since the proposed fixed charges do not depend upon observed consumption, and because the marginal prices are set equal to the social marginal costs, the differences across users do not distort the electricity consumption choices but ameliorate the distributional impact of the proposed subsidy reduction.

Finally, we present a concrete example that shows the undesired effects of electricity price distortions on investment decisions in the medium and long term: solar photovoltaic systems. With the simulated tariff schemes and customized PV system characteristics and prices, we simulate different adoption scenarios using a household optimization model. The simulated outcomes are also used to quantify the subsidy changes and the environmental impacts of the proposed policy reforms.

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Most relevant findings are summarized as follows. The average deadweight loss per residential consumer is between 0.79 and 0.99 US dollars per month, depending on the demand specification used, which represent, on average, 6.5% and 8.2% of the monthly average electricity expenditure, respectively. With the proposed tariff schemes we correct the allocative distortions and reduce the subsidy burden. By avoiding the negative distributional consequences that a typical two-part tariff has, our proposed tariff scheme applies discounts to the fixed charges with the help of a means tested mechanism. Even with the 30% reduction in the electricity subsidy, the final electric bill afforded by household located in the first three income deciles are practically unaffected. The bill increments are progressively passed to more advantageous households located in upper income deciles. Going to the medium- to long term impacts of the tariff rebalancing application, we identified the set of potential PV system adopters, which roughly amounts to 49% of Mexican households, and then simulate the optimal adoption choice. We find that under the current (inefficient) increasing block tariff, the predicted PV penetration would reach 12% of residential users at most, whereas under the two-part tariff scheme with subsidized fixed charges, it could reach between 16% and 39% of users, depending on whether cross-subsidies are allowed, and on what fraction of network costs are recovered from the net-metering bills.

Regarding air pollution abatement, the proposed alternative tariff scheme could reduce between 4 to 16 million tons of equivalent carbon dioxide emissions per year. These numbers would critically help Mexico to accomplish with the emissions reduction goals set under the Paris Agreement (UNFCCC) in 2015, and also represent considerable resources in monetary terms (between 135 and 551 million of USD dollars per year). The savings could be even more significant if the tariff rebalancing policy comes along with a DPV adoption subsidy program. For instance, any sort of financial aid program that transfers money from the current electricity consumption subsidy to a technology adoption subsidy, like price discounts or tax rebates. Finally, the overall subsidy reduction –i.e., incorporating rebalanced tariffs and simulated solar panels adoption– could reach a total of 345 million USD per year. As the main conclusion, we show that a complete tariff rebalancing towards a social efficient scheme would have very positive outcomes. It would enhance economic efficiency, improve air quality, and reduce the fiscal resources needed for the electricity subsidy. The latter resources, in turn, could be used for a long list of better social welfare enhancing purposes in a country with severe poverty, education and health issues.