Subsidy Determination on Industrial Electricity Tariffs for an Emerging Country

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Abstract- Energy subsidies are considered negative since they promote over-consumption, technological biases, increase pollution and decrease welfare. However, in emerging countries electricity subsidies are used to promote universal access and national development. Industrial tariffs in several countries such as Brazil and China receive subsidies to provide a competitive edge. This paper using price-gap approach evaluates the extent of subsidies in industrial tariffs for Colombia for the period from 2000 to 2012. Colombia is an emerging country which underwent a restructuring process of public services around 1994 after a period of blackouts due to a very dry season that made hydro generation capacity not available to cover the demand. Deregulation sought to promote competition, attract investors and lower electricity prices. Market design also included the provision of subsidies for less affluent groups in the electricity tariffs by charging prices lower than the cost of supply. More affluent social groups, industrial and commercial sector are charged higher than the cost of supply to provide for the subsidies. The price gap analysis presented here shows that in general industrial tariffs in Colombia do not receive subsidies as compared to international prices.

Keywords- electricity, industrial tariffs, subsidy, market design.

I. INTRODUCTION

Subsidies occur when products or services are priced below their marginal costs. Subsidies also occur when the government provides a payment to either producers or consumers directly or indirectly to lower the price of the product or to lower production costs [1]. Subsidies have been used in the telecommunications industry in France and Canada [2,3]; postal services in the US [3]; the water industry in Scotland [4]; fossil fuels in China, India, Indonesia, Egypt, Thailand, Venezuela, Saudi Arabia, Iran, Iraq and Mexico [1,5,6]; natural gas in Ukraine [6] and China [7]; and in the electricity sector in China, Colombia, Brazil, Bolivia, Honduras, Panama, Nicaragua, El Salvador, Mauritania, Jordan, Senegal, Lebanon and Canada [1,6,8,9].

Energy subsidies are considered negative since they promote inefficient allocation and over-consumption of resources, distort market signals, produce technological biases, produce environmental damage, act as a market entry barrier and decrease welfare [1, 10, 11, 6, 12]. However, in emerging countries with public networks that are not mature, subsidies are often used to achieve social goals of universal access [2] to public services and to promote national development. Tariffs to promote universal access often price basic services low relative to costs, whereas other services are priced high relative to costs to compensate [2]. Subsidized customers are encouraged to consume more, whereas subsidizing customers reduce their consumption below the so-called “efficient level of consumption” [1, 5, 10, 11]. These type of subsidies between and among consumers groups are more relevant for regulators and public policy makers [13]. In India, cross-subsidies were employed to provide lower cost electricity to the residential and agricultural sector by raising the tariffs of the industrial sector [10, 12]. In China, industrial and commercial tariffs are higher than residential tariffs, leading to subsidies [1, 8]. In 2007 almost 90% of the residential subsidies in China went to payments towards subsidized electricity service [8]. In Brazil the large industrial sector receives subsidies financed by residential, commercial and small industrial sectors [11]. In Colombia, an emerging country, electricity subsidies are given to the less affluent social residential classes by collecting contributions from more affluent residential classes, industrial and commercial sectors. This creates a revenue transfer from the contributing groups to the subsidized groups. The objective of this research is to evaluate the existence of subsidies in industrial electricity tariffs in Colombia as compared to international prices.

Industrial tariffs in several countries such as Brazil and China receive subsidies to provide a competitive edge [5, 11]. Low industrial electricity tariffs in reference to international prices could create issues of unfair competition in global markets; whereas high industrial electricity tariffs in reference to international prices could cause national industries to be unable to compete against international products. The contribution of this paper is to evaluate the existence of subsidies in industrial tariffs for Colombia for the period from 2000 to 2012 by using a price-gap approach.

The discussion presented here continues as follows: section II describes characteristics of the electric sector in Colombia. Section III introduces the reader to the tariff structure adopted for the system. Section IV describes the market composition and industrial prices. Section V develops the price-gap
analysis for the industrial tariffs for the electricity sector in Colombia using as reference price the industrial tariffs for neighboring countries. Section VI, gives final remarks and conclusions.

II. CHARACTERISTICS OF THE ELECTRICITY SECTOR IN COLOMBIA

In emerging countries in Latin American deregulation has been considered a means to generate the financial resources to add system capacity to guarantee the provision of public services. Because these services are considered common goods, the government generally assumes regulatory oversight and maintains shared ownership of certain assets, as in the case of Colombia. Unlike unbundled deregulated markets in the US, the Colombian electric system is partially unbundled [14]. Companies are allowed to participate in generation and distribution provided they act independently and do not discriminate against other companies [14]. There is also mixed ownership of electricity assets between the government and private sectors.

The energy crisis of 1992 motivated the restructuring of the electricity sector in Colombia. During this year hydrological generation capacity was reduced due to an extremely dry season resulting in a long period of load rationing to prevent blackouts. This crisis also had political consequences, transforming politicians and energy planners into risk avoiders favoring over generation capacity [14, 15]. This restructuring led to the passing of Laws 142 and 143 of 1994 [14, 16, 17] which provide the legal framework for the deregulation of the sector. Law 142 [16] establishes the government’s ability to oversee and regulate the provision of residential public services. This law dictates principles of equity and social responsibility in the tariffs and the provision of subsidies towards less affluent sectors. Law 143 [17] is directed specifically towards the electricity sector in all its activities of generation, transmission, distribution and commercialization. This law gives authority to the Gas and Energy Regulatory Commission (CREG) to define the methodology to determine electric tariffs [18–22] as presented in the next section.

III. TARIFF STRUCTURE

CREG resolution 012-93 [23] mandates that electricity distribution companies in Colombia should apply residential tariffs according to the same residential classification employed in the provision of residential public water service. This system is based on a residential classification of homes to identify the target population in neighborhoods for the purpose of tariff assignment [24]. Based on the classification of homes, there are six residential groups from 1 to 6 in increasing order of financial wealth. Groups 1 to 3 are considered less affluent groups and are the beneficiaries of the subsidies. Group 4 is considered neither a contributor nor a subsidized sector; it should pay solely for the cost of supply. Groups 5 and 6 are considered more affluent. These groups contribute to the subsidies in addition to the contributions made by the industrial and commercial sectors. Residential electricity tariffs are defined in resolutions CREG 80-95 [18], CREG 09-96 [19] and CREG 78-97 [21], whereas non-residential electricity tariffs are defined in resolution CREG 79-97 [22].

Based on the rules for the sector a simplified general expression to compute electricity tariffs is provided below:

\[
T(t)_{j,k} = (1 + \rho_{j,k}(t)) C_{j,k}(t)
\]

(1)

Where:

- \(T(t)_{j,k}\): tariff for customer type \(i\) at voltage level \(j\) provided by company \(k\) at time \(t\).
- \(\rho_{j,k}(t)\): subsidy or contribution factor for customer type \(i\) at time \(t\) provided by company \(k\).
- \(C_{j,k}(t)\): cost of supply at voltage level \(j\) provided by company \(k\) at time \(t\).

Initial contribution factors for customers in groups 5 and 6 were, on average, 60 and 68%, respectively [25]. CREG 78-97 [21] defines equivalent for the thirty companies serving the sector during the beginning of the restructuring process. Subsequent residential contribution factors per company defined in CREG 80-95 [18] range from 20 to 35% for customer type 5 and from 20 to 48% for customer type 6. Non-residential contribution factors were as high as 30% in 1998 [22]. All contribution factors were established to be lower or equal to the limiting factor of 20% after 2000 [22]. Initial maximum subsidy factors [21] are negative 50, 40 and 15% for customer types 1, 2 and 3 respectively. Group 4 is only required to cover its cost of supply. Then \(\rho_{j,k}(t) = 0 \forall k\). Subsidized prices are provided to a maximum of the subsistence level of consumption; additional consumption is priced higher at the cost of supply [18]. The subsistence level was set at 200 Kwh per month [18, 21].

The design of the tariff structure aims to collect funds from contributing sectors to pay for subsidies given to less affluent social groups. It is important to notice that even when the industrial tariff includes a positive factor to collect money towards subsidy payments the objective of this paper is to evaluate the existence of subsidies in the industrial tariffs as compared to international prices in neighboring countries.

In China, to provide a competitive edge, electricity tariffs are lower than the cost of supply [1] and cheaper than in developed countries [5]. In Brazil, large industries also benefit from lower tariffs to increase their competitiveness [11].
IV. MARKET COMPOSITION AND INDUSTRIAL PRICES

Average non-residential demand for years 2003-2012 [26] represents approximately 60% of the total demand consumption, as displayed in figure 1. Industrial demand represents almost 54% of this non-residential consumption (figure 2) making this the most important contributing sector.

Almost 80% of this residential demand belongs to the groups receiving subsidies, figure 3.

Industrial electricity consumption has been declining since 2009 (figure 4) when electricity prices start to increase sharply (Table 1). Residential demand experiences a decrease in 2011 but increased again in 2012. Since the industrial sector is the most important contributor decreases in industrial consumption due to increases in prices need to be covered by budget subsidies [27]. Any attempt to modify these tariffs needs to consider this aspect.

V. PRICE GAP ANALYSIS

A new technique for the application of a ZRC that designed for the two-dimensional approach. The price-gap approach is analytically simple, broadly used to study subsidies and focus on end user subsidies [1]. This method determines subsidies as the difference between the reference price and the price paid by the final user [6]. The reference price could be established as the international price plus distribution costs and taxes [5] or as the opportunity cost estimated using long-term production costs [1]. Estimating long-term production costs is complex since it requires knowledge of the different generating technologies. Limitations of this method are that it determines end-user subsidies and requires exact information about international.
prices, domestic taxes and transportation costs [1]. In the analysis presented here to overcome this limitation when computing the price-gap it is assumed a constant 20 percent above the international price to cover taxes and transportation costs. This assumption can be removed easily.

The price gap approach is used to determine the existence of fossil fuel subsidies in China [1,5]. This study recommends that removing subsidies could improve energy consumption but would increase households cost for less affluent classes [5]. Savings from removing fossil fuels subsidies could provide the money to grant direct subsidies to these families [1, 5, 8]. In China, the residential sector receives most of the subsidies. Approximately 90% of the residential subsidies were used for electricity in 2007 [28]. The price gap approach was also used to determine the existence of subsidies for the residential electric sector in British Columbia, Canada [9]. In this case, high-income households consuming more electricity than low income households received, in total, more than twice the quantity provided in subsidies to low income households [9]. The reference price for this market was set as the export price to the U.S. It is found that discontinuing the practice of selling electricity at average cost would provide additional revenues after increasing electricity tariffs [9].

Industrial electricity prices for neighboring countries for Colombia are presented in Table 1 [27] for the period from 2000 until 2012 in USD/Kwh. Oil rich Venezuela has consistently the lowest industrial electricity tariffs; whereas Panama has the highest industrial electricity tariffs most of the time with the exception of years 2010 for which industrial tariffs in Brazil are the highest and 2011 and 2012 for which industrial tariffs in Colombia are the highest.

Values presented in Table (2) correspond to the difference from the reference price per country and the industrial tariffs for Colombia, as mentioned before the reference price is set at the international price plus 20 percent to cover taxes and distribution costs. Negative gaps indicate industrial tariffs in Colombia are higher; whereas positive gaps indicate the opposite which may signal the existence of subsidies from the state to lower the tariffs for industrial customers.

Industrial tariffs in Colombia are always higher than industrial tariffs in Venezuela. Industrial tariffs in Panama are always higher than industrial tariffs in Colombia except in years 2011 and 2012. Industrial tariffs in Ecuador are higher than industrial tariffs in Colombia for years 2001 until 2006, afterwards they are always lower. Industrial tariffs in Brazil are almost always higher than industrial tariffs in Colombia even when large industrial customers receive subsidies in Brazil [11].

Reported values in Table (2) do not provide enough positive gaps consistently to support a strategy from the State to have used subsidies to lower industrial tariffs in Colombia to provide a competitive edge. In any case the price gap analysis shows that for year 2012 industrial tariffs in Colombia are higher than industrial tariffs for all neighboring countries. It is important to highlight the behavior of the price-gaps after 2009 when most of them start to become negative, this coincides with the behavior in figures 4 and 5 presented in the previous section. However, it is beyond the scope of the present research to analyze the impact of reducing industrial tariffs in Colombia since this requires evaluating its effects in industrial demand, contributions towards subsidies, total welfare and budget subsidies from the State.

<table>
<thead>
<tr>
<th>Year</th>
<th>Colombia</th>
<th>Ecuador</th>
<th>Peru</th>
<th>Brazil</th>
<th>Venezuela</th>
<th>Panama</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.05</td>
<td>0.04</td>
<td>0.06</td>
<td>0.05</td>
<td>0.03</td>
<td>0.1</td>
</tr>
<tr>
<td>2001</td>
<td>0.04</td>
<td>0.07</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
<td>0.11</td>
</tr>
<tr>
<td>2002</td>
<td>0.06</td>
<td>0.08</td>
<td>0.05</td>
<td>0.04</td>
<td>0.02</td>
<td>0.11</td>
</tr>
<tr>
<td>2003</td>
<td>0.06</td>
<td>0.08</td>
<td>0.05</td>
<td>0.05</td>
<td>0.02</td>
<td>0.09</td>
</tr>
<tr>
<td>2004</td>
<td>0.08</td>
<td>0.07</td>
<td>0.05</td>
<td>0.06</td>
<td>0.02</td>
<td>0.16</td>
</tr>
<tr>
<td>2005</td>
<td>0.08</td>
<td>0.07</td>
<td>0.06</td>
<td>0.1</td>
<td>0.02</td>
<td>0.1</td>
</tr>
<tr>
<td>2006</td>
<td>0.08</td>
<td>0.07</td>
<td>0.06</td>
<td>0.12</td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>2007</td>
<td>0.09</td>
<td>0.06</td>
<td>0.06</td>
<td>0.14</td>
<td>0.03</td>
<td>0.14</td>
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<tr>
<td>2008</td>
<td>NA</td>
<td>0.07</td>
<td>0.07</td>
<td>0.15</td>
<td>NA</td>
<td>0.18</td>
</tr>
<tr>
<td>2009</td>
<td>0.13</td>
<td>0.06</td>
<td>0.06</td>
<td>0.16</td>
<td>NA</td>
<td>0.16</td>
</tr>
<tr>
<td>2010</td>
<td>0.17</td>
<td>0.07</td>
<td>0.06</td>
<td>0.18</td>
<td>0.01</td>
<td>0.17</td>
</tr>
<tr>
<td>2011</td>
<td>0.2</td>
<td>0.06</td>
<td>0.06</td>
<td>0.19</td>
<td>0.01</td>
<td>0.16</td>
</tr>
<tr>
<td>2012</td>
<td>0.22</td>
<td>0.06</td>
<td>0.17</td>
<td>0.17</td>
<td>0.01</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Table (1): Industrial electricity tariffs per country (USD/Kwh) [27].

<table>
<thead>
<tr>
<th>Year</th>
<th>EC-CO</th>
<th>Peru-CO</th>
<th>Brazil-CO</th>
<th>Vzla-CO</th>
<th>Panama-CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>-0.002</td>
<td>0.02</td>
<td>0</td>
<td>-0.012</td>
<td>0.036</td>
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<tr>
<td>2003</td>
<td>0.044</td>
<td>0.02</td>
<td>0.008</td>
<td>-0.004</td>
<td>0.092</td>
</tr>
<tr>
<td>2002</td>
<td>0.036</td>
<td>0</td>
<td>-0.012</td>
<td>-0.036</td>
<td>0.072</td>
</tr>
<tr>
<td>2003</td>
<td>0.036</td>
<td>0</td>
<td>0</td>
<td>-0.036</td>
<td>0.048</td>
</tr>
<tr>
<td>2004</td>
<td>0.004</td>
<td>-0.02</td>
<td>-0.008</td>
<td>-0.056</td>
<td>0.016</td>
</tr>
<tr>
<td>2005</td>
<td>0.004</td>
<td>-0.008</td>
<td>0.04</td>
<td>-0.056</td>
<td>0.04</td>
</tr>
<tr>
<td>2006</td>
<td>0.004</td>
<td>-0.008</td>
<td>0.064</td>
<td>-0.044</td>
<td>0.064</td>
</tr>
<tr>
<td>2007</td>
<td>-0.018</td>
<td>-0.018</td>
<td>0.078</td>
<td>-0.054</td>
<td>0.078</td>
</tr>
<tr>
<td>2008</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2009</td>
<td>-0.058</td>
<td>-0.058</td>
<td>0.062</td>
<td>NA</td>
<td>0.062</td>
</tr>
<tr>
<td>2010</td>
<td>-0.086</td>
<td>-0.098</td>
<td>0.046</td>
<td>-0.158</td>
<td>0.034</td>
</tr>
<tr>
<td>2011</td>
<td>-0.128</td>
<td>-0.128</td>
<td>0.028</td>
<td>-0.188</td>
<td>-0.008</td>
</tr>
<tr>
<td>2012</td>
<td>-0.148</td>
<td>-0.148</td>
<td>-0.016</td>
<td>-0.208</td>
<td>-0.016</td>
</tr>
</tbody>
</table>

Table (2): Price-gap values per country per year (USD/Kwh).

VI. CONCLUSION

Energy subsidies are considered negative since they promote inefficient allocation and over-consumption of resources, distort market signals, cause technological biases, produce environmental damage, act as a market entry barrier and decrease welfare [1, 10, 11, 6, 12]. However, in emerging countries with public networks that are not mature, subsidies are often used to achieve social goals of universal access [2] to public services and to promote national development. This is the case of Colombia, studied in this research. Restructuring of the electric sector in Colombia includes principles of equity and social responsibility in the tariffs and
the provision of subsidies towards less affluent sectors. These subsidies are financed by contributions from more affluent residential groups, industrial and commercial sectors. Industrial tariffs in several countries such as Brazil and China receive subsidies to provide a competitive edge [5, 11]. Low industrial electricity tariffs in reference to international prices could create issues of unfair competition in global markets; whereas high industrial electricity tariffs in reference to international prices could cause national industries to be unable to compete against international products. The contribution of this paper is to evaluate the existence of subsidies in industrial tariffs for Colombia for the period from 2000 to 2012 by using a price-gap approach. The reference price is set as the international price from neighboring countries. The price gap analysis presented here do not provide enough positive gaps consistently to support a strategy from the State to have used subsidies to lower industrial tariffs in Colombia to provide a competitive edge. The price gap analysis also shows that for year 2012 industrial tariffs in Colombia are higher than industrial tariffs for all neighboring countries. Further research is needed to evaluate the trade-offs involved in reducing industrial tariffs in Colombia.

VII. REFERENCES