



An Assessment of Energy Consumption and Price Responsiveness: Evidence from Dominican Republic

Jose Antonio Hernandez¹, Camilo Koch²

School of Economics, Wuhan University of Technology, Wuhan, P.R. China, 430070

Email: jos.hernandez.gomez@gmail.com

School of Management, Wuhan University of Technology, Wuhan, P.R. China, 430070

Email: iam@camilokoch.com

Abstract: Electricity has a high impact in the activities and sectors of any economy. A considerable amount of studies relates the importance of electricity to economic growth of nations. Dominican Republic, though, has been in a process of energy reform, has not yet developed a stable electric delivering. This study is firstly conducted to ensure an overview of the electricity sector of Dominican Republic, describing the energy mix, national electricity situation, and main concerns on the sector reform that have been in process including other Latin American countries. Secondly, the paper aims to determine the elasticity of demand on energy generation sector through log linear regression method; analyzing the variation of price and quantity of demand interaction. Related researches concerning elasticity of demand in other countries such as Australia, Israel, China and United States, shows close similarity to our result, where elasticity tends to be inelastic (0.57) but not perfectly inelastic to variation on price. While the energy market structures by sectors may be complex, customers' response to pricing signals can promote efficient investment in the long-run term, help mitigate short-run market power by generators and transmission owners, reduce price spikes, low price volatility, and consequently support price mechanism.

Keywords: Electricity responsiveness, price elasticity of demand, energy price mechanism, energy consumption

1. Introduction

Energy sector plays a determinant role on economy's growth and quality life of nations. The power sector in the Dominican Republic has traditionally been, and still is, a bottleneck to the country's economic growth. According to the World Bank, the revitalization of the Dominican economy depends mainly on a sound reform of the sector^[2]. Energy production, transmission, and distribution operate on a massive and pervasive scale, and take years — often over a decade, to be designed, organized, financed, built, and operated.

Power sector reform has been extended across Latin America and the Caribbean. Those reforms and Energy Programs intent to enhance electricity utility, from generation, transmission, distribution and commercialization; and opening the sector to private participation as well. With only a few exceptions, lack of efficiency incentives and tariffs that did not reflect actual costs led to the poor performance of state-owned enterprises (SOEs), which have accumulated enormous financial deficits^[3]. As we study the Energy current situation of Dominican Republic, the research aims to determine the elasticity of demand on the electric generation sector, through a log linear regression model, analyzing the variation of price and quantity of demand. We have seen closely similarity in the structure of market, but we will try to situate and focus on the factors that characterize the Energy sector of Dominican Republic as a developing country.

2. Literature Review

Price elasticity of demand (PED or Ed) is a measure used in economics to show the responsiveness of the quantity demanded of a good or service to a change in its price, *ceteris paribus*. Specifically, it gives the percentage of change in quantity demanded in response to a percent change in price. Energy price elasticity reflects the impact of energy price fluctuations on energy consumption. In order to provide effective reference to the energy pricing mechanism, quantifying the full influence of energy prices on energy consumption involves acquiring the response characteristics of all kinds of customers to energy prices, which is based on energy price elasticity. Due to the importance to market stability, analyses of energy price; energy demand; and energy price elasticity have been suggested for many researches. For nearly a century, the whole electricity sector has been thought of as a “natural” monopoly industry, where efficient provision requires a regulated public or private monopoly. Most utilities have historically met their obligations by jointly providing the four primary electricity supply functions: generation, transmission, distribution and retailing. The generation segment of this sector involves the creation of electricity using different technologies (e.g., falling waters and steam turbines powered by fossil fuel); the transmission of electricity involves the utilization of wires, transformers and sub-station facilities to transport electricity between generation and distribution centers, which includes the interconnection and integration of generating facilities into a synchronized network. This function includes: scheduling and dispatching generating facilities to balance demand and supply (in real time); and management of equipment failure as well as network constraints. Finally, the distribution and retailing functions are related to the final distribution of electricity to residential and business consumers at relative low voltages. It requires the use of wires and transformers along and under streets to get to customers; and then, retailing function which include metering, billing, making arrangements for supplies of power from generators, and other demand management services. Normally, retailing and distribution have been viewed as integrated functions. According to economic theory, on a free market, electricity demand will fall as the energy price increases, holding all other factors constant. The consumer’s sensitivity to price changes can be measured by the coefficient of price elasticity — the percentage change in demand divided by the percentage change in price. Customers react to changes in prices that they recognize by adjusting their desired quantity of demand: as prices rise, customers will reduce the quantity demanded; as prices drop, customers will increase the quantity demanded. As electricity markets are liberalized, consumers become exposed to more volatile electricity prices and may decide to modify the profile of their demand to reduce their electricity costs.

3. Data and Methodology

The study is conducted firstly to have an overview of the Electricity Sector of Dominican Republic. Important issues to considerate are the in-process sector reform, which might have an important impact in the short and long run of the economy development. Likewise we will analyze the electricity supply, installed capacity, principals sources for energy generation, quantity of demand, principal’s obstacles and problem on energy losses, among others issues. In addition, we took into consideration the fluctuation of price and quantity demand in order to determine the price elasticity of demand. We aimed to investigate the hypothesis “though the electric market is an inelastic market by definition, is not perfectly inelastic; and the responsiveness of customer on demand play a role for the regulation and efficiency of market.” With this in consideration, the elasticity of demand equation can be converting from (1) to (2):

$$\epsilon = \frac{\% \Delta \text{demand}}{\% \Delta \text{price}} = \frac{\Delta q / q}{\Delta p / p} \quad (1)$$

$$\epsilon = \frac{P}{Q} \times \frac{\delta Q}{\delta P} \quad (2)$$

In terms of partial-differential calculus, point-price elasticity of demand can be outlined as follows:

$$\epsilon_{x_1, p_K} = \frac{\partial x_1(p, w)}{\partial p_K} \times \frac{p_K}{x_1(p, w)} = \frac{\partial \log x_1(p, w)}{\partial \log p_K} \quad (3)$$

In other way, we substitute Elasticity for the next equation:

$$\frac{1}{Q} \times \frac{\partial Q}{\partial P} = \varepsilon \frac{1}{P} \quad (4)$$

From this derivate equation, we can convert it into a linear model. Henceforth, holding constant all the other determinants of demand, we can analysis the influence of price variation on the customer’s Energy Consumption.

$$\text{Ln } Q = \varepsilon \text{ Ln } P + b \quad (5)$$

We considered historic data from the National Energy Commission (CNE), Superintendence of Electricity and the three distribution-retailing companies from Dominican Republic: Edesur, Edenorte and Edeste. Similarly, we considered the CPI USD Index of the World Bank database in order to deflate electricity price, and then apply log regression method to discover with more accuracy the Price Elasticity Estimation.

Case Description

Dominican Republic, like many countries in Latin America, ahead of final 1990's faced a process of reform of electricity subsector to solve problems associated with high generation costs, energy rationing and inefficient management of a vertically integrated state monopoly. The reform introduced a market model with private participation and regulation independently, maintaining hydro generation and transmission controlled by the state.

On early 2001, the reform was modified with the capitalization of private investors of three new distribution companies and two thermal generation companies, which resulted from the restructuring of the Dominican Electricity Corporation (CDE), the state monopoly, the creation of the Superintendence of Electricity (SIE) and the Commission National Energy (CNE); independent bodies responsible for regulation and policy formulation, respectively. General Electricity Law came into place giving the regulatory and institutional framework. The process had difficulties essentially due to substantial rise in international oil prices, political difficulties to transfer electricity rates rising production costs in a generation system approximately 85% dependent on imported fuels, inability to reduce commercial losses of electricity and improve the collection in sustainably, and macroeconomic imbalances that caused a devaluation and accelerated inflation.

Electricity Supply

The Electricity Generation in the Dominican Republic network is produced from steam turbines, gas turbines, diesel and fuel oil engines (mostly utilizing imported oil or liquefied natural gas); and other important portion by hydroelectricity and combined cycle. At the end of 2006, the total installed capacity of public utilities was 3,394 MW, of which 86% was thermal and 14% was hydroelectric ^[6]. The installed capacity for every technology stands as follow:

Table 3-1: Installed Capacity by technology as of Dec-06.

Technology	Installed Capacity-Mw	Percentage-%
Steam Turbines	606.2	17.9
Gas Turbines	527.7	16.9
Combined Cycle	804.0	23.7
Fuel Oil Engines	912.0	26.9
Diesel Oil Engines	30.0	0.9
Hydroelectricity	469.3	13.8
Total Installed Capacity	3,394.2	100

Source: Operations Coordinating Agency Report

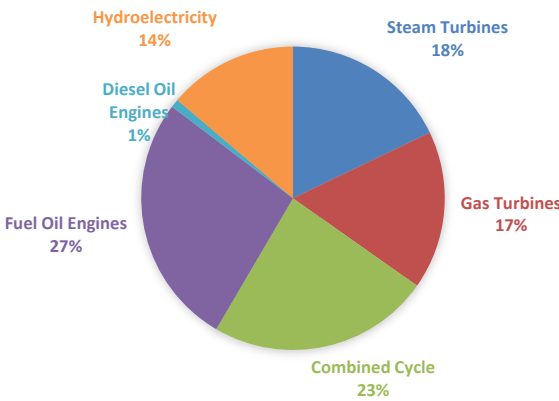


Figure 3-1 Energy generation Mix (Gwh)

Currently, there are plans for the construction of two 600MW-coal fired plants; Montecristi and Azua, by the private sector. It was also expected that, by 2012, an additional 762MW of hydroelectric capacity will have been added to the generation system. Total electricity generated in 2006 was 10.7 TWh ^[7]. Generation experienced a 7.7% annual increase between 1996 and 2005. However, between 2004 and 2006, there has been an average annual decrease of about 10% in total electricity generated.

3.3 Electricity Price and Demand

Electricity demand in the Dominican Republic has grown considerably since the early 1990s, at a yearly average of 10% between 1992 and 2003. Consumption is very close to the regional average, with annual per capita consumption of 1,349 kWh in 2003 ^[8]. Total electricity sold in 2005 was 3.72 TWh. Demand has constrained supply, which in turn is limited by subsidies.

Electricity tariffs in the Dominican Republic are among the highest in the Latin American and Caribbean region. The reason of this is caused from several factors: Dependence on imported oil, weak institutional environment, difficulties to pursue large non-payers, high prices negotiated in power purchase agreements with the generators, high commercial risks faced by generators such as non-payment or delayed payment by the distribution companies and/or the government, low cash recovery index (CRI), and high operating costs in the distribution companies ^[9].

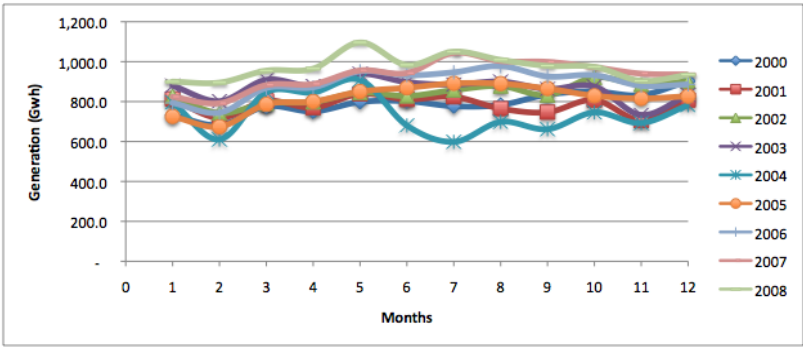


Figure 3-2 Net Electricity generated curve (Gwh)

The country's policy of cross-subsidizing residential tariffs disparate increase in commercial and industrial tariffs, is translated into higher rates for industrial and commercial consumers compared to residential consumers. For example, in 2007, the average residential tariff was US\$0.160 per kWh (LAC weighted average was US\$0.115 in 2005) ^[10],

while the average industrial tariff was 0.230 (LAC weighted average was US\$0.107 per kWh in 2005) and the average commercial tariff was as high as US\$0.290 per kWh ^[11].

Table 3-2 Pondered Tariff of Electricity (US \$/Mwah)

Year	Months	Nominal Price (\$US/Mwah)	Price CPI (\$US/Mwah)	Year	Months	Nominal Price (\$US/Mwah)	Price CPI (\$US/Mwah)
2007	May	105.42	105.42	2008	Nov	136.69	133.81
2007	Jun	112.28	112.06	2008	Dec	91.19	90.20
2007	Jul	115.75	115.56	2009	Jan	86.09	84.79
2007	Aug	121.88	121.90	2009	Feb	101.33	99.30
2007	Sep	105.42	105.15	2009	Mar	105.23	102.88
2007	Oct	124.20	123.61	2009	Apr	99.50	97.03
2007	Nov	136.07	134.63	2009	May	109.76	106.73
2007	Dec	136.07	134.72	2009	Jun	128.03	123.43
2008	Jan	144.08	141.94	2009	Jul	143.46	138.53
2008	Feb	161.07	158.22	2009	Aug	143.10	137.87
2008	Mar	158.61	154.47	2009	Sep	155.42	149.65
2008	Apr	165.66	160.36	2009	Oct	151.36	145.60
2008	May	173.35	166.40	2009	Nov	157.19	151.10
2008	Jun	190.42	180.96	2009	Dec	165.42	159.29
2008	Jul	208.11	196.74	2010	Jan	161.08	154.58
2008	Aug	234.33	222.42	2010	Feb	165.77	159.05
2008	Sep	216.66	205.93	2010	Mar	162.62	155.39
2008	Oct	187.23	179.77	2010	Apr	162.52	155.02

For our regression analysis, we used data adjusted with the Consumer Price Index for USD from the World Bank database. This enables to make sensible comparisons across time periods even as prices move, due to inflation.

4. Results

The results obtaining the Price Elasticity of demand for the electric sector are showed on the following table. We may note that R Square rounds in 99.98%, which shows that the coefficient ϵ (elasticity) has strong approximation on the linear regression equation.

Table 4-1 Result of Linear Regression Equation

Regression Statistics					
R	0.9998084157				
R Square	0.9996168682				
Adjusted R	0.9996168682				
Standard E	0.1381271087				
Total Numb.	20				
A = 0.5792 * B					
ANOVA					
	d.f.	SS	MS	F	p-level
Regression	1.	945.7945240216	945.7945240216	49,572.2867402625	0.E+0
Residual	19.	0.3625028648	0.0190790981		
Total	20.	946.1570268863			
Coefficients	Standard Error	LCL	UCL	S Stat	p-level H0 (2%) rejected?
Intercept B	0				
	0.5791790739	0.0026013176	0.5725730714	222.6483477151	0.E+0 Yes
T (2%)	0.5791790739				
LCL - Lower value of a reliable interval (LCL)					
UCL – Upper value of a reliable interval (UCL)					

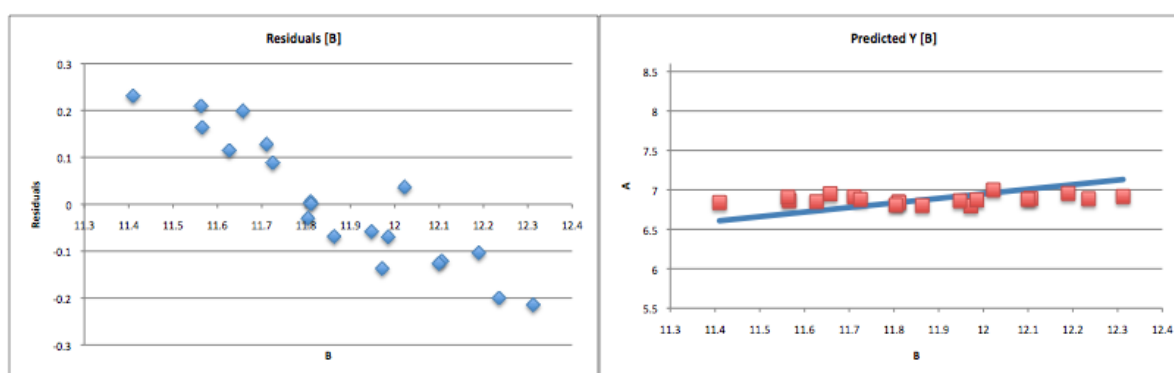


Figure 4-1 Residual and Log n Equation Graphics

The overall price elasticity in Dominican Republic, estimated by using the historical data is 0.57, showing a moderate responsiveness of electricity consumption to changes in prices. This level of responsiveness for Dominican Republic has an adequate similarity to the elasticity of other countries of our literature review. For example the research made by Dr. Fan and Hyndman^[12] conclude that South Australia rounds about $-0.036 - 0.43$; and Israel rounds from $-0.02 - 0.58$, $0.002 - 0.44$ for residential and industrial sector, correspondingly. Likewise in USA rounds in -0.2 for the short run and -0.70 for the long run in the residential sector. Nevertheless, in the short run we can observe that in peak months of summer, the absolute value of elasticity decrease to 0.18, (2008) on relation with previously months. It could be attributable to the weather conditions of high temperature.

5. Conclusion

Dominican Energy Sector is affected by high dependence on petroleum for electricity generation, financial crisis of distribution companies, lack of investment, non-payment of the purchase of energy, unmet distribution demand, higher tariffs and subsidies, electricity non-payment culture, and high losses in commercial energy, among others. Although significant progress has been made about it, those factors are, still, an impediment for economy growth. We can note the similarity of the consumer responsiveness in the variation of price for different countries (from 0.40 – 0.60 in log run)^[12]. We observe that, even different conditions does not represent a higher gap of discrepancy. It may allow saying that while the market framework tends to have a low level of price elasticity — because high cost of substitutes — no necessarily is a perfectly inelastic market. Furthermore, this responsiveness can be an important indicator for energy suppliers, especially for the generation sector rather than transmission and distribution.

When the customers do not react to market prices, all pricing mechanisms are left in the hands of the market suppliers. In the presence of competition, the suppliers will, on their own, be unable to raise prices above the production cost of the least efficient unit in operation. In this competitive situation the market price will adequately reflect the production costs. The reacting of customers to pricing signals (demand response) in the electricity marketplace can promote efficient investment (in the long-run term), help mitigate short-run market power by generators and transmission owners, reduce price spikes, lower price volatility and reduce customers' bills.

Lack of demand response also increases the ability of electricity suppliers to exercise market power and raise prices. In order to achieve efficiency in the marketplace, prices should reflect the cost of the good. Market power contributes to price volatility and price spikes observed in today's electricity markets, including Dominican Republic. Likewise, an investment in improving generation capacity, efficiency and electricity transmission and distribution network is imperative to meet the growing energy demand^[13]. A substitute may be the transition to Renewable Energy, such as solar PV grid, wind, biomass, etc.; that will reduce the oil import dependence, green house gas emission and promote environment conservation. This will require a acutely study to determine whether what may be the best alternative, relatively to cost investment on Dominican economy, and when is the appropriated implementation time.

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