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Electricity as a Factor of Competitiveness: Empirical Evidence in the Free Customer Market in the Context of Camisea Natural Gas

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ABSTRACT

The exploitation of Camisea natural gas implied benefits for industries with respect to the electricity rates of which they are large consumers. The national electricity market is based on three prices: busbar price, marginal cost, and free customer price. This study aims to establish whether the advantage of the low price of natural gas is reflected in the price for free customers, who are those who can directly negotiate their electricity tariff with the electricity generators or distributors. This was achieved through a time series analysis with econometric models linking the three national electricity market prices, which indicated the correlation between them. A review of the proposed models, their correlational analysis and the autocorrelation analysis of the residuals revealed a strong correlation between free market price and its first lag, which dissociates a correlation with the other prices; therefore, there is no real transfer of the gas price for a better tariff for the free costumer.

Keywords: energetic mix; unregulated customers; busbar price; cost.

INTRODUCTION

With the enactment of the Ley de Concesiones Eléctricas[2] (Law No. 25844, November 19, 1992) the role of the State in the electricity sector changed from one of administration to one of supervision. For this, the roles of existing regulatory entities were reformulated and strengthened, and afterwards others were created with specific tasks. This Law specifies aspects such as the new structure of the sector, existing markets and activities, and price regimes. It also defined the functions and structure of the Comisión de Tarifas Eléctricas[3] (today known as Gerencia Adjunta de Regulación Tarifaria[4], which belongs to Osinergmin), the procedures to be followed for concessions, the rights and obligations of the concessionaires, and the functions of the body in charge of the efficient operation of the system (COES). At the same time, the transactions related to price regulation were defined, as well as the procedures for setting rates.

Although the Electrical Concessions Law disintegrated the state monopoly, the subsequent privatization had to make sure that vertical and horizontal integration did not occur; thus, the law was designed with the assignment of this responsibility to the regulatory agency Osinergmin.

On the other hand, some authors see vertical integration as an advantage because it offers the possibility of sharing synergies and risks (Viscusi, Vernon & Harrington, 2005). Reduced competition, associated with fewer options for consumers and the monopolistic exploitation of a series of specificities such as location, idiosyncratic investments, etc., not only affects the consumer, but also distorts the market. Regarding horizontal concentration, since 2012 the Herfindahl-Hirschman Index (HHI) was less than 1800, which means that this market was moderately concentrated; it should be mentioned that the HHI trend is that of reduction (Cuadros & López, 2016).

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2 Electricity Concessions Law

3 Electricity Rates Commission

4 Deputy Management of Rate Regulation

The price of electricity for free customers, also called the unregulated price (Morandé & Soto, 1996), is established through the contracts acquired in the negotiation with the bidders, which in this case are the generators and distributors of the electricity market (Dammert, Mollinelli & Carbajal, 2011). Most of these free customers are large companies from the mining, smelting, cement, chemical, metallurgical and industrial sectors, among others. The price these customers pay is of great importance, since it is precisely in this customer segment where, according to the regulation, competition has the greatest potential.

Regulated customers, those whose rates are regulated, are under the protection of Osinergmin, which sets the maximum rates for generation, transmission and distribution. Regulated market prices are related to busbar prices, which is the price that generators or distributors guarantee until a physical busbar or supply point located within their network, and marginal costs. Both busbar prices (Osinergmin, 2017) and marginal cost (Resolución de Consejo Directivo Osinergmin No. 013-2016-OS/CD, 2016) are influenced by fuel value, since it is the cause of the differentiation of technology investment and costs; for example, hydroelectric power plants require a large initial investment with a low value of the "fuel" (dam water) for their operation, while diesel turbogenerators require low capital investment with a higher fuel (hydrocarbon) cost against water resources.

Osinergmin has established that the rate for regulated customers must not differ neither more nor less than 10% of the weighted average of the bid prices in which free customers participate, which means that regulated market prices are sensitive to the free market price (Resolución del Consejo Directivo Osinergmin No. 273-2010-OS/CD, 2010). Thus, it is reasonable to think that if the prices for free customers were manipulated, this would be transferred to the regulated price (De La Cruz & García, 2002). It must be considered that the electricity suppliers in the free customer market can be, and in fact are, energy suppliers in the regulated market. This study is about the way free market prices are behaving with respect to the regulated market prices (regulated price) and whether Camisea gas really contributes to making the free customer sector more competitive.

It is common to hear that Camisea gas has been considered since the beginning an energy source that improves and will improve the economy of the country; however, there has not been a reliable study of its influence on the improvement of production costs in industries, even though it is known that electricity is a supply with great specific weight in the cost of production.

Since electricity is an important supply in the production process of most industries, especially in mining, smelting, refining, etc., this study aims to establish whether the inclusion of natural gas into the new Peruvian energy mix is really contributing to benefit the industry in general and to make it more competitive through lower rates due to the fact that natural gas is a cheaper fuel than other hydrocarbons. It is re-emphasized that the prices established in the electricity market are free customer prices, regulated prices (which depend on the busbar prices and the marginal cost) and the marginal cost. As the busbar price and the marginal cost are strongly influenced by the fuel cost, there is the need to know whether the benefits of a lower gas price are being passed on to free customers.

The objective of this work is to investigate whether natural gas, as a new source in the energy mix, contributes to improve the competitiveness in the Peruvian industry. For this purpose, significant relationships in the electricity market prices that influence the price of the free customer market will be established. This work also aims to determine at how the lagged free customer prices influence the free customer price, and how the current marginal cost and its lags influence the free customer price.

This work seeks to investigate the relationships that occur within electricity market prices. It seeks to establish whether there is a transfer of the benefit of having a cheaper hydrocarbon, such as natural gas, to an industry that intensively uses electricity in its production process. It will also show how the busbar prices, the marginal cost and its lags, including even the free customer price, influence on the free customer price. This research can be extended to other regulated markets such as telecommunications, clean water service and transportation.

METHODOLOGY

Since the influence of Camisea gas development in the free client market is an element of analysis in this research, it is necessary to specify when this hydrocarbon began to be used for thermoelectric generation. The Camisea gas project concluded with the start-up of the Malvinas compressor station and the LNG pumping stations in August 2004 (El

Comercio, 2014). The generators that at the date of this study use Camisea gas began operating at the end of 2004, and one of the most important is the Etevensa Plant in Ventanilla, which began operations with a simple-cycle application and in the second half of 2006 was consolidated with the entry of its combined-cycle application. Additionally, the large thermogenerators located in Chilca, which are powered exclusively by Camisea gas, started commercial operation as Kallpa I and Chilca I in 2006 and 2007 with their T1 and T2 gas turbines, respectively. All the data presented above allows to have confidence that the sample to be chosen as the study population is the information referring to the electricity market from 2008 onwards, where the operation, dispatch and the market itself is consolidated and stabilized.

This research is based on the analysis of documents provided by Osinergmin and COES, which are the competent authorities that monitor and prepare the statistics related to the performance of the electricity market in Peru.

The information was collected as follows:

Free Market Price. Through the website http://srvgart07.osinerg.gob.pe/SICLI/principal.aspx, option “Evolución del Mercado Libre”, menu “Variable”; then option “Precio medio (ctm/S/./kW.h)”; menu “Clasificado por” and then “Mercado Libre”. Lastly, the period to be consulted was seleted.

Busbar Price and Marginal Cost. Through the website http://www.coes.org.pe/Portal/Publicaciones/Estadisticas/, option “Publicaciones”, followed by “Estadísticas Anuales”; the folder corresponding to year 2017 was accessed, then “01_EXCEL”, “16_COSTOS MARGINALES DE CORTO PLAZO” and finally the file “Gráfico No 16.3_ COSTO MARGINAL PONDERADO Y TARIFA EN BARRA MENSUAL”.

This research is quantitative, inductive, basic, longitudinal, correlational and non-experimental. The units of analysis are taken from the reports of the Peruvian electricity market values obtained through the Portal del Sistema de Usuarios Libres de Osinergmin (Osinergmin Free Users System Portal) (http://srvgart07.osinerg.gob.pe/SICLI/principal.aspx) and the COES portal (http://www.coes.org.pe/Portal/Publicaciones/Informes/).

Three correlational models applied to this study and which link the prices in the Peruvian electricity market are presented below:

- Model 1 $\ln PL_t = \alpha + \beta \ln PB_t + \varepsilon_t$
- Model 2 $\ln PLt = \alpha + \beta^* \ln CMgt + \varepsilon t$
- Model 3 $\ln PL_t = \alpha + \beta^* \ln PL_{t-1} + \varepsilon_t$

Where:

- α, β are coefficients.
- ε_t is defined as a random or stochastic shock.
- ln is the natural logarithm function.
- PL_t is the free market price in period t.
- PL_{t-n} is the free market price with lag n.
- PB_t is the busbar price in period t.
- CMg_t is the natural logarithm of the marginal cost in period t.

If the variability of the data grows with the level of the data, that is, if there are changes in the data that causes that the time series fluctuates vertically from one period to another, (for example, if the minimum and maximum of the series increases or decreases from one year to the next one), it will be necessary to make a correction, since it would represent a problem; this is usually done through a logarithmic transformation, applying natural logarithms to the observations and achieving stationarity in the variance (Chong & Aguilar, 2016).

The study population is the Peruvian electricity market, and for the sample size, the prices and costs of the electricity market from February 2008 to December 2016 have been selected. These values are shown in Table 1.

RESULTS

For the correlational analysis, software IBM SPSS Statistics 23 was used and Pearson and R^2 correlation tests plus Durbin Watson’s correlation test were considered (Daza, 2016). The results of each of the proposed models are shown in Appendix A.

Table 2 shows the values of the coefficients, constants and statistics that were considered for the present evaluation.

The Pearson correlation coefficient explains the linear dependence between two quantitative random variables: when its values are closer to 1, a strong relationship between the variables is evident. Of the three models studied, it was observed that the one with the highest correlation with the variables considered for its own case is model three, since it was the one that obtained the highest Pearson correlation coefficient; this result was confirmed

Table 1. *Free market prices, Busbar Price and Marginal Cost (ctv $/kW.h) of period February 2008 to December 2016.*

Month/year	Free Market	Regulated Busbar Price Lima	Marginal Cost	Month/year	Free Market	Regulated Busbar Price Lima	Marginal Cost
Feb-08	49.4999	43.5792	18.3336	Aug-12	58.5272	50.8816	35.0912
Mar-08	48.2512	45.0487	20.8422	Sep-12	58.9011	52.1772	36.4090
Apr-08	50.2247	44.4016	20.9027	Oct-12	59.5905	52.4412	28.7611
May-08	53.0576	44.1790	47.8629	Nov-12	58.0696	51.3352	14.3501
Jun-08	61.7507	44.8090	148.8524	Dec-12	57.7426	51.7424	13.7504
Jul-08	57.8397	40.1050	235.3823	Jan-13	59.1261	52.2300	19.3484
Aug-08	68.9169	41.5437	157.8758	Feb-13	60.2324	52.7082	31.4054
Sep-08	68.0654	39.8481	185.2081	Mar-13	57.7833	51.3073	19.7176
Oct-08	54.5291	40.9945	63.3530	Abr-13	59.7752	51.8077	18.7835
Nov-08	54.5909	41.1696	60.6917	May-13	59.3034	50.2321	27.1427
Dec-08	55.0423	39.1783	81.7817	Jun-13	58.1775	50.5006	26.6098
Jan-09	48.1669	37.7910	28.8897	Jul-13	58.7349	50.2361	44.8607
Feb-09	49.6494	37.5074	42.3859	Aug-13	58.5656	49.8932	34.7275
Mar-09	47.3418	37.8923	26.4559	Sep-13	58.6253	48.2247	28.2676
Apr-09	45.7491	41.1450	25.4261	Oct-13	58.0340	50.4502	19.4460
May-09	46.6875	39.7411	28.6713	Nov-13	58.7762	50.2010	23.0011
Jun-09	49.5528	39.9566	65.7041	Dec-13	58.6221	50.4372	24.8975
Jul-09	48.1972	39.8324	41.2193	Jan-14	59.3035	50.1908	21.3909
Aug-09	47.2772	39.4824	33.8807	Feb-14	60.1234	55.0746	29.8533
Sep-09	47.7056	40.1442	36.2248	Mar-14	59.6457	54.4080	34.3143
Oct-09	46.8315	40.5292	19.7863	Apr-14	60.7635	55.0021	28.1039
Nov-09	49.6828	40.7031	20.3717	May-14	59.7786	54.8269	25.4199
Dec-09	53.2740	38.5393	17.2423	Jun-14	60.6186	54.8215	30.9638
Jan-10	53.2165	39.0021	23.1519	Jul-14	60.1494	54.6584	24.9118
Feb-10	53.7494	39.8040	24.5490	Aug-14	61.0708	54.2496	27.4186
Mar-10	50.7876	39.1649	21.9672	Sep-14	61.2980	53.7230	23.8568
Apr-10	53.8770	39.8972	16.6041	Oct-14	60.9968	52.4992	17.9716
May-10	47.0575	37.0416	18.1607	Nov-14	60.2288	50.0767	23.4544
Jun-10	47.9560	36.9624	20.4322	Dec-14	59.7798	49.3496	15.1614
Jul-10	48.3525	37.1588	19.8814	Jan-15	59.9644	48.8229	14.1122
Aug-10	48.8606	37.5823	22.8932	Feb-15	60.9203	50.9184	16.2237
Sep-10	50.3119	38.0923	23.8426	Mar-15	58.9541	49.6404	17.0768
Oct-10	49.3977	37.6483	24.2287	Apr-15	59.5711	49.6373	13.1058
Nov-10	50.0032	37.6004	23.1013	May-15	58.8955	55.9126	14.8277
Dec-10	50.0807	37.2586	18.7580	Jun-15	59.0806	55.9179	16.9142
Jan-11	51.6746	37.7511	17.4892	Jul-15	58.2973	58.0145	10.9362
Feb-11	54.5046	38.4420	21.7420	Aug-15	57.9421	57.1395	21.4953
Mar-11	53.4987	37.6326	21.6263	Sep-15	59.0000	58.0990	14.4870
Apr-11	55.0812	39.2423	17.9153	Oct-15	58.0086	57.3931	14.2471
May-11	53.2369	41.8831	18.7874	Nov-15	57.5160	55.5090	11.5861
Jun-11	53.2595	42.2603	25.8559	Dec-15	56.0025	54.0816	11.3972
Jul-11	53.8045	42.4235	20.4480	Jan-16	54.7017	56.6792	10.9870
Ago-11	54.0971	42.4162	31.5137	Feb-16	53.6933	54.9479	12.4248
Sep-11	55.4634	42.7455	33.6255	Mar-16	50.8376	55.8568	12.3632
Oct-11	53.5310	42.4366	27.0617	Apr-16	52.0433	54.5576	13.2597
Nov-11	54.9701	43.2516	28.5765	May-16	No data	No data	19.9034
Dec-11	53.7427	43.1351	21.5721	Jun-16	No data	No data	60.3911
Jan-12	55.3760	43.4912	20.9235	Jul-16	53.7055	55.1906	34.1345
Feb-12	56.1628	44.3116	23.7337	Aug-16	53.3021	56.7516	18.9263
Mar-12	56.6856	43.6561	39.8348	Sep-16	52.8905	56.3791	27.5588
Apr-12	56.1615	44.1915	26.6761	Oct-16	51.5354	56.4675	17.9264
May-12	58.3578	49.7053	27.1751	Nov-16	51.8879	58.8807	27.5979
Jun-12	59.0050	50.1692	45.5229	Dec-16	50.9509	58.8439	23.0784
Jul-12	58.6341	51.0439	58.0489				

Source: Prepared by the author based on the information of http://srvgart07.osinerg.gob.pe/SICLI/principal.aspx and http://www.coes.org.pe/Portal/Publicaciones/Estadisticas/

by the coefficient of determination R^2. This model, confronted with the real values, produces residuals that must also be analyzed to rule out an autocorrelation, thus, if autocorrelation is found among the residuals, there is certainty that the model is not adequate to explain the relationships of the variables and it is presumed that a variable was not taken into account and therefore it must be included. The Durbin Watson is the statistic that shows with certainty if the residuals of the samples are not correlated and, for model 3, this value is in the no autocorrelation area so the model presented produces no autocorrelated residuals and better explains the relationship of the variables under study. The ARIMA model was run as a contrast test to validate the model.

Table 2. *Results of the Proposed Models in Software IBM SPSS Statistics 23.*

Values	Models		
	1	2	3
α	2.784	4.097	0.602
β	0.319	-0.078	0.850
R^2	0.564	0.081	0.725
Adjusted R^2	0.318	0.072	0.722
Pearson	0.311	-0.285	0.852
F	48.863	9.270	269.120
Durbin Watson	0.387	0.093	2.133

Source: Prepared by the author based on the results of software SPSS.

DISCUSSION

The model proposed must also demonstrate that there is no autocorrelation; for that, the Durbin Watson statistic (DB) provided by SPSS software was used (Gujarati, 1997). According to Table 2, the DB of the model presented is 2.132 and must be compared with the null hypothesis, which indicates that there is no autocorrelation for the values of DB between d_u and $4\text{-}d_{u,}$ which, for 5% significance, gives a value of d_u equal to 1.694 and a value of $4\text{-}d_u$ equal to 2.346. Therefore, the null hypothesis of no autocorrelation is validated. The ARIMA model provides a value of the Ljung Box statistic of 0.529, higher than the minimum accepted value of 0.05, so the model is valid.

CONCLUSIONS

There is a decoupling of the free customer price with busbar prices and marginal costs, since although these values are dependent of fuel cost, the free customer price is not related to the price of natural gas. The model that best explains the relationship of the free customer price with electricity market prices is precisely model 3, which links the one-period lagged free customer price; in the study, that period is one month.

Large industries should have the same benefits as the generators that, for example, are able to generate their own energy. Natural gas rates for industrial consumption and for generation are differentiated and, likewise, the largest consumers of gas for generation have better rates. The deconcentration of high voltage lines, thanks to self-generation, can improve the quality of the service, which is quite poor in extreme areas of the lines and, in turn, can be reinforced with the injection of surpluses from industries.

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APPENDIX

Appendix A. *Results of software IBM SPSS Statistics 2 for the proposed models.*

Summary of the Models(e)

Model	R	R-Squared	Adjusted R-Squared	Pearson	Durbin-Watson
1	0.564(a)	0.318	0.311	0.564	0.387
2	0.091(b)	0.008	-0.001	-0.091	2,232
3	0.285©	0.081	0.072	-0.285	0.093
4	0.852(d)	0.725	0.722	0.852	2,133

a. Predictors: (Constant), lnPB
b. Predictors: (Constant), var(lnPBt-1)
c. Predictors: (Constant), ln(CMg)
d. Predictors: (Constant), ln(PLt-1)

Coefficients(a)

Model		Unstandardized coefficients		Standardized Coefficients	T	Sig.
		B	Standar Error	Beta		
1	(Constant)	2.784	0.176		15.857	0.000
	lnPB	0.319	0.046	0.564	6.990	0.000
2	(Constant)	0.001	0.005		0.191	0.849
	var(lnPBt-1)	0.120	0.131	-0.091	-0.923	0.358
3	(Constant)	4.097	0.084		48.733	0.000
	ln(CMg)	-0.078	0.026	-0.285	-3.045	0.003
4	(Constant)	0.602	0.208		2.893	0.005
	ln(PLt-1)	0.850	0.052	0.852	16.405	0.000

a. Dependent variable: ln(PLt)

Contrast with ARIMA model

Model Statistics

Model	Number of Predictors	Adjustment Statistics of the Model	Ljung-Box Q (18)		
		Stationary R square	Statistics	GL	Sig.
ln(PLt)-Modelo_1	1	0.728	15.931	17	0.529