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Application of Alfred Marshall model for estimating Vietnam electricity demand

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C H R O N I C L E

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A B S T R A C T

This study aims to analysis the factors influencing on demand for Vietnam Electricity. In this paper, the author builds the Vietnam Electricity Quantity Demand function based on the Alfred Marshall model. The data used to build this function contains 276 observations (from Jan 1995 to December 2017). The author also analyzes the elasticity and the impacts of different factors to influence the Vietnam Electricity Quantity demanded. The study uses multiple linear regression model and the results indicate that all observations were meaningful when the level of significance was five percent. The results also indicate that demand for electricity will increase over the next few years and policy makers have to take some action for the development of the electricity industry.

1. Introduction

During the past few years, there have been tremendous efforts for electricity demand forecasting in the world. According to Akay and Atak (2007), there is a growing demand for energy supply and more especially for electricity in the world. They used grey prediction with rolling mechanism (GPRM) method for estimating the Turkey's electricity consumption. Filippini and Pachauri (2004) estimated the seasonal price and income elasticities of electricity demand in the residential sector of all urban areas of India based on disaggregate level survey data for about 30,000 households. They reported that electricity demand was income and price inelastic in all studied seasons. Ozturk et al. (2005) used genetic algorithm to estimate electricity demand. Zhou and Teng (2013) used some surveyed data for electricity demand estimation. There are also many studies to use Marshall's curve (Marshall, 1893) estimation method for energy estimation (Arbués et al., 2003; Weron, 2007; Keat & Young, 2006; Bacon & Besant-Jones, 2001; Pollitt, 2004, 2007). Nogales et al. (2002) presented two highly accurate yet efficient price prediction techniques based on time series analysis; namely dynamic regression and transfer function models. Keat and Young (1996) performed a comprehensive study on demand for goods, services, and price elasticity of demand. They explained that price elasticity of demand was the percentage change in quantity demanded divided to percentage change in price of goods and services.

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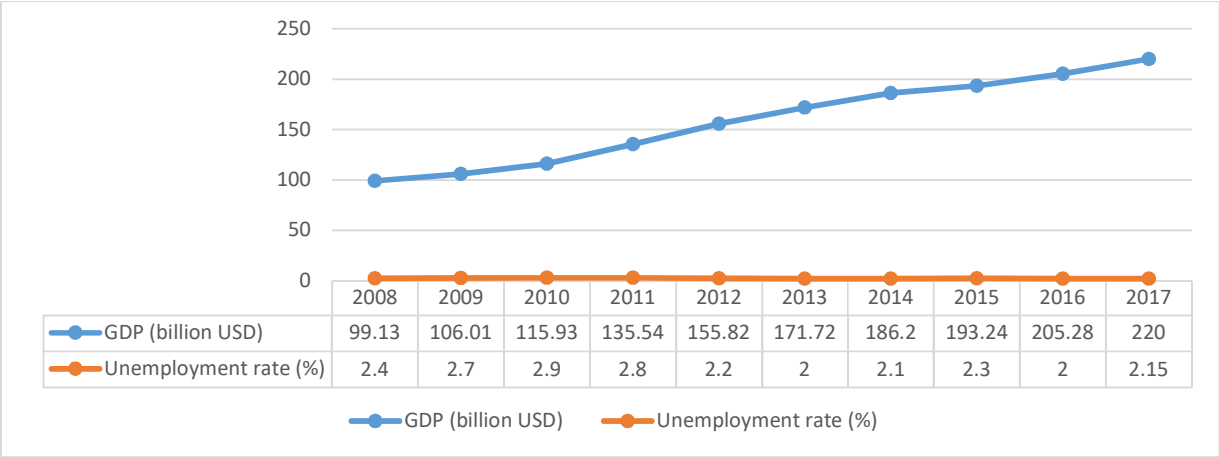
Dawson et al. (2006) performed an investigation on price elasticity of demand and reported that demand was elastic when percentage change in quantity demanded was more than percentage change in price. In addition, demand was inelastic when percentage change in quantity demanded was less than the percentage change in price. Lehtonen (2015) in his work studied the pricing operations in demand and supply of goods and services in Finland. Hattori and Tsutsui (2004, Japan) examined the impact of regulatory reform in the electricity price career. Steiner (2000) with a team of scientists used panel data for 19 OECD countries over the period 1987-1999 and found that the expansion had the ability to lower the retail prices for industrial. Pollitt (2009) examined the impact of price reforms that later Ernst & Young and Thomas continued research in 2006. In the research, report prepared for the Government figures and the Department of Trade and Industry (DTI) of the UK, the scientists from Ernst & Young used a sample of EU-15 countries and provided some policy implications for gas power with a large numbers of regression estimations. Their results showed that liberalization could reduce costs, improved profitability, and free market increased price volatility, investment and market liberalization helped to provide power quality information reliable and safe.

2. The overview of Vietnam Economy

During the past few years, there has been a steady growth on Vietnam' economy. Fig. 1 demonstrates the trend on growth domestic product (GDP) and the rate of unemployment.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
GDP (billion USD)	99.13	106.01	115.93	135.54	155.82	171.72	186.2	193.24	205.28	220
Unemployment rate (%)	2.4	2.7	2.9	2.8	2.2	2	2.1	2.3	2	2.15

Fig. 1. The trend of GDP and unemployment rate in Vietnam (Source: World bank report 2017)

Fig. 1 shows that Vietnam GDP was significantly increased from 99.13 billion USD in 2008 to 220 billion USD in 2008. The Vietnam nominal GDP growth rate has the average increase more than 6% a year. This data is very meaningful, Vietnam used to have a deficit in trade for more than 20 year, but some year recently, Vietnam has surplus in trade. The Vietnam labor market with the population of 95 million in 2018, the unemployment rate was just more than 2% for ten years. This figure is very meaningful if we compare to the EU countries, especially in Poland where the unemployment rate is approximately 6 to 8 percent a year.

3. Using the Alfred Marshall to build the Vietnam Electricity demanded function:

To estimate the demand function for electricity in Vietnam, we first consider a demand function of Alfred Marshall of any product on the market will have the form:

$$Q_x = f(P_x, P_y, I, N, T, E,...)$$

where Q_x is the quantity demanded for good x, P_x is the price of commodity x, P_y is the price of the substitute or complement, I represents income of consumers, N is the number of consumer, T is tastes and preferences of consumers and finally, E is the expectation of the consumer. Of course, here are

some basic factors that influence the quantity demanded of a specific commodity. In fact, there may be some other factors affecting demand that we have not listed here such as advertisement (A), or credit incentives or policies of the government. In most cases, in order to simplify the model, we often build bridges with linear functions to facilitate the analysis. Based on the data collected by the authors from various sources described the quantity demanded for electricity in Vietnam during Jan 1995- Dec 2017, we have 276 samples or observations. Based on the data, the price of electricity is related to crude oil (Pg) or petroleum products. Crude oil is an important input in the gas power plants, in addition to products such as gasoline from crude oil may be substituted for electricity generators to run when a sudden power loss or crash. The effective monitoring of changes in the world price of crude oil and electricity prices in Vietnam shows that electricity prices in Vietnam fluctuated with changes in oil prices during a period of 23 years (1995-2017). This is the usual movements in countries around the world. Evidence for this is to build electricity demand function, resulting in estimated electricity demand is related to the volatility of crude oil prices in the world and electricity prices, oil prices are related to each other in Vietnam. Vietnam's power sector in the last 23 years was in the corporate monopoly of power (EVN). In summary, the author builds on electricity demand functions in Vietnam based on the following:

$$Q_e = f(P_e, I, N, t, CPI, GDP, P_g \ldots)$$

where Q_e, P_e, I, N and t represent demand for electricity (billion kwh), average electricity price (VNĐ/kwh), income to power purchasing parity (Million VND/capita/month), time (number of months), respectively. Moreover, CPI, GDP and P_g represent Consumer Price Index (%/year), Gross Domestic Product (billion USD) and Gasoline Price (USD per barrel), respectively.

Since there is a link between the world price of crude oil and electricity prices in Vietnam, so the crude oil is considered as the substitute for electricity. Electricity customers in Vietnam have no choice but to buy electricity directly from EVN. Based on the model proposed, we have determined the demand for electricity in Vietnam in recent years as follows:

$$Q_e = 8.5252 + 0.006Pe + 2.2505I - 0.3272N + 0.1367t + 0.2041CPI + 0.5567GDP + 0.1732Pg$$

P-value	(0.0381)	(0.0092)	(0.0357)	(0.0131)	(0.000)	(0.0088)	(0.0000)	(0.0000)
t-value	8.759	9.954	2.8479	(2.4967)	(5.5123)	(2.6380)	(10.4429)	(8.5457)

Adjusted R-Square = 0.9909 F-value = 4255.7421 (0.000)

Based on the results of the P-values and t-statistics, we can observe that all coefficients are meaningful when the level of significance is five percent. The calculation results give us some thoughts, as the relationship between the average electricity price and the demand for electricity in Vietnam is proportional. That is, electricity prices in Vietnam have increased steadily over the past 23 years with the increase in demand for electricity and the steady growth of the economy. This is on contrary to the rule of demand in the market economy. The result reflects the power sector in Vietnam during the last period still shows the monopoly. The power sector in Vietnam is currently the only sector with high monopoly power and EVN's monopoly power is huge. If this does not change, EVN will continue to increase electricity prices along with the increase in demand for electricity in Vietnam over the next years. Based on the demand for electricity in Vietnam, we see electricity is very important in the economic development of the country. We need to look directly at the fact that there is a need for rapid liberalization of the electricity sector. The abolition of monopoly will contribute to the growth of the economy. The author predicts the demand for electricity in Vietnam based on the demand just built above. Assuming electricity prices are regulated by the government and will increase by an average of 1% over the next 20 years from 2018, average per capita income will increase by an average of VND 200,000 /person/month over the next 20 years. In addition, the population of Vietnam will increase by 0.5% per year, CPI: assuming increase 1% per year; GDP: assuming increase 6% per year; Pg: assuming increase 4% per year; we will calculate the quantity demanded for electricity as given in Table 1.

Table 1
The forecast of Vietnam electricity quantity demanded based on the demand function

y	Qe	Pe	I	N	t	CPI	GDP	Pg
Dec-18	200.633	1683.0	11.89	96.002	288	2.50	245.00	60.00
Dec-19	211.272	1699.8	12.09	96.48201	300	2.53	259.70	62.40
Dec-20	222.418	1716.8	12.29	96.96442	312	2.55	275.28	64.90
Dec-21	234.103	1734.0	12.49	97.44924	324	2.58	291.80	67.49
Dec-22	246.358	1751.3	12.69	97.93649	336	2.60	309.31	70.19
Dec-23	259.216	1768.8	12.89	98.42617	348	2.63	327.87	73.00
Dec-24	272.714	1786.5	13.09	98.9183	360	2.65	347.54	75.92
Dec-25	286.890	1804.4	13.29	99.41289	372	2.68	368.39	78.96
Dec-26	301.783	1822.4	13.49	99.90996	384	2.71	390.49	82.11
Dec-27	317.437	1840.7	13.69	100.4095	396	2.73	413.92	85.40
Dec-28	333.897	1859.1	13.89	100.9116	408	2.76	438.76	88.81
Dec-29	351.210	1877.7	14.09	101.4161	420	2.79	465.08	92.37
Dec-30	369.428	1896.4	14.29	101.9232	432	2.82	492.99	96.06
Dec-31	388.604	1915.4	14.49	102.4328	444	2.85	522.57	99.90
Dec-32	408.794	1934.6	14.69	102.945	456	2.87	553.92	103.90
Dec-33	430.060	1953.9	14.89	103.4597	468	2.90	587.16	108.06
Dec-34	452.465	1973.4	15.09	103.977	480	2.93	622.39	112.38
Dec-35	476.078	1993.2	15.29	104.4969	492	2.96	659.73	116.87
Dec-36	500.969	2013.1	15.49	105.0194	504	2.99	699.31	121.55
Dec-37	527.215	2033.2	15.69	105.5445	516	3.02	741.27	126.41

(Source: authors forecast based on the Vietnam Electricity Demand Function)

Y: time at December, year t, Pe: Vietnam Electricity Price, assuming increase 1% per year, I: Vietnam average Income to Power Purchasing Parity, assuming increase 200 thousand VND per year, N: Vietnam Population, assuming increase 0.5% per year, t: time to month, CPI: assuming increase 1% per year, GDP: assuming increase 6% per year, Pg: assuming increase 4% per year

4. Demand Analysis

4.1. Price elasticity of demand for Vietnam electricity

Based on the calculation results, the authors can estimate the elasticity of demand for electricity in Vietnam in 2018 as follows:

$$Edp = Q'p.\ P/Q = 0.006x1683/200.633 = 0.05$$

Price elasticity of the demand for electricity in 2018 for the positive coefficient is left completely with the demand curve of Alfred Marshall. Edp = 0.05 indicates that electricity demand in Vietnam is sloping up, if there is no government regulation and regulation, EVN can completely raise electricity prices as much as they like. This factor reflects that if the electricity price increases by 1%, the quantity demand for electricity in Vietnam will increase by 0.05%, meaning that the higher the electricity price, the higher the demand for electricity.

4.2. Income elasticity of demand for Vietnam electricity

Next, the author calculates the income elasticity of the demand for electricity in 2018 as follows:

$$Ei = Q'i.\ I / Q = 2.2505 \times 11.89 / 200.633 = 1.33$$

The income elasticity of the demand for electricity in Vietnam is 1.33 and more than 1, like luxury commodity such as cars, homes and motorcycles. Vietnamese must accept electricity as luxury commodity. This coefficient is 1.33, indicating that if the Vietnamese income increases by 1% the demand for electricity increases by 1.33%. This is what many economists and politicians need to consider in managing the electricity market.

4.3. Population elasticity of demand for Vietnam electricity

Next, the author calculates the elasticity of the demand for electricity by population in 2018 as follows:

$$En = Q'n.\ N / Q = -0,3272 \times 96 / 200.633 = -0.1566$$

The elasticity indicates that Vietnam's population is negatively correlated with the demand for electricity. En = -0.1566 indicates that if Vietnam's population increases by 1%, the quantity demand for electricity in Vietnam decreases by -0.1566%. This reflects a monopoly power market that does not benefit the people and consumers.

4.4. Time elasticity of demand for Vietnam electricity

Next, the author calculates the elasticity of the demand for electricity by time in Dec 2018 as follows:

$$Et = Q't \times t / Q = 0{,}1367 \times 288 / 200.633 = 0.1962$$

This elasticity indicates that time is positively correlated with the demand for electricity. Et = 0.1962 indicates that if time increases by 1%, the quantity demand for electricity in Vietnam increases by 0.1962%. These results are not consistent with the Marshall model when the time increases, the consumers can easily find the substitutes, so the quantity demand will decrease more and the demand is elastic. The figures also reflect a monopoly power market that does not benefit the people and consumers.

4.5. CPI elasticity of demand for Vietnam electricity

Next, the author calculates the elasticity of the demand for electricity by CPI in Dec 2018 as follows:

$$Et = Q'cpi \times CPI / Q = 0{,}2041 \times 2.5 / 200.633 = 0.00254$$

This elasticity indicates that CPI is positively correlated with the demand for electricity. Ecpi = 0.00254 indicates that if CPI increases by 1%, the quantity demand for electricity in Vietnam also increases by 0.00254%.

4.6. GDP elasticity of demand for Vietnam electricity

Next, the author calculates the elasticity of the demand for electricity by GDP in Dec 2018 as follows:

$$Et = Q'gdp \times GDP / Q = 0{,}5567 \times 245 / 200.633 = 0.6798$$

This elasticity indicates that GDP is positively correlated with the demand for electricity. Egdp = 0.6798 indicates that if GDP increases by 1%, the quantity demand for electricity in Vietnam also increases by 0.6798%.

4.7 Gross elasticity of demand for Vietnam electricity

Finally, the author calculates the elasticity of the demand for electricity by price of crude oil in Dec 2018 as follows:

$$Et = Q'pg \times Pg / Q = 0{,}1732 \times 60 / 200.633 = 0.0517$$

This elasticity indicates that crude oil is positively correlated with the demand for electricity. Epg = 0.0517 indicates that if Pg increases by 1%, the quantity demand for electricity in Vietnam increases by 0.0517%.

5. Conclusions and recommendations

The findings of Vietnam electricity quantity demanded function are very meaningful. These results help us understand the situation of the Vietnam electricity monopoly market. This function helps us forecast the Vietnam electricity quantity demanded for the future. The author hopes that the Vietnam government and ministry of industry and trade will help us construct and development the Vietnam electricity competitive in the next year. In addition, such an enormous contribution of the supply and demand theory of Marshall remains valid until today for the supply and demand model to explain the

volatility of all the goods and services on the market. Vietnam applied the market economy-oriented socialist, i.e. applying the model of supply and demand of Marshall in solving problems of social and economics. All decisions about the economy in view of Marshall are based on the theory of interest. So, in all decisions on economic and social, economists and the politicians should be based on the theory of supply and demand to make a decision. Marginal analysis methods should be prioritized for use in economic analysis. To apply the doctrine of Marshall effectively in the process of economic development, Vietnam should consider some measures. First, the need to respect the application of the doctrine of Marshall as a mainstream ideology that the Party and State concern. Second, the policy makers should actively promote the movement of learning and following the moral example of Ho Chi Minh. The movement must be built upon the foundation of the theory of supply and demand and the theory about the benefits of Marshall.

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