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Price elasticity of residential electricity demand in Vietnam 2012-16

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Outline

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About us

Vietnam Initiative for Energy Transition is a newly established research and advocacy think tank specialized on the energy transition.

VIET SE is not affiliated with an academy, institute, university, company or ministry.

VIET SE is funded by philanthropic foundations and consulting work.

Team expertise in energy modeling

Wrote the Technical Summary and Policy Brief for:

WWF and VSEA (2016) Power Sector Vision. Towards 100% Renewable Electricity by 2050 In Greater Mekong Region – Vietnam Report.

→ We want more regional energy modeling studies.

Team expertise in energy policy

Collaborating with GIZ on the IKI project “Clean Affordable and Secure Energy in Southeast Asia”

- Improve the evidence base for strategic decisions on the future energy sector development
- Contribute to the strengthening of the dialogue between public entities on both the socio-economic and the technical aspects of the future energy sector development
- Strengthen the capacities of key energy sector stakeholders for the implementation of the transition

→ With Indonesia, Laos, Philippines, and Thailand think tanks

Research context

- Previous researches
  - Aggregate data
  - Micro data at household level without national data on tariff structures
    - At national scale – has to use imputed data on price
    - Narrowed to regional scale to get detail price

- Vietnam has micro data with detail of price schedule at national scale
  - Residential electricity market is monopoly with an unique sellers of Vietnam Electricity (EVN)
  - Electricity price is in increasing block tariffs form (IBTs) since 1994
  - The IBT schedule is proposed by EVN and set by the Government

- Issues relating the increasing block tariffs form
  - March 2019, government has just increased price by 8.3 per cent in all blocks
  - Dilemma between increasing IBTs for promoting more RE and remaining IBTs for social purposes

Aims of the research

- Estimate price elasticity using household data at national scale with full detailed IBT schedules.
- Investigates whether households respond to marginal price (MP) or average price (AP) under an IBT schedule.

Model specification – Short-run model

- Short run model

$$lnE = \alpha_0 + \alpha_1 lnI + \alpha_2 lnP + \alpha_3 Z + \boldsymbol{\alpha_{4j} A_j D_j} + \varepsilon$$

- Where
  - E = household electricity consumption
  - I = income vector
  - P = price
  - Z = related variables such as CDD/HDD, price of gas
  - A_j = vector of appliance
  - D_j = dummy vars = 1 if the household owns the asset j, = 0 otherwise

Model specification – Long-run model

- Long run model

$$lnE_{it} = \alpha + \beta lnp_{it} + \gamma lny_{it} + \theta Z_{it} + \boldsymbol{\delta lnE_{i,t-1}} + \varepsilon_t$$

- Where
  - E_{it} = electricity consumption at period *t*
  - $E_{i,t-1}$ = electricity consumption at period *t-1*
  - p_{it} = price of electricity at period *t*
  - y_{it} = household (per capita) income at period *t*
  - Z_{it} = *a vector of other factor such as price of gas, CDD/HDD*

Model specification – AP vs MP

- Consumption of 250kWh
  - MP = 2,536
  - AP = 1,995.2
- Which price?

Block	*Lower bound*	*Upper bound*	*Mar 2019 – present*
1	1	50	1,678
2	51	100	1,734
3	101	200	2,014
4	**201**	**300**	**2,536**
5	301	400	2,834
6	401		2,927
ASP			1,864.44

Note. Unit '000 VND per kWh; ASP: average selling price VAT excluded.

Table 1. The most recent retail electricity prices for residential

Source. Author compiled

Which prices AP or MP?

- Shin (1985) model for perceived price

$$P^* = MP\left(\frac{AP}{MP}\right)^k$$

$$lnQ = \alpha_0 + \alpha_1 lnX + \alpha_2 lnY + \alpha_3 lnMP + (\alpha_3 k)\ln(\frac{AP}{MP})$$

  - If $k = 0$ customers fully react to MP.
  - If $k = 1$ customers react to AP.
  - If $0 < k < 1$ then customers react to a perceived price which lies between MP and AP.
  - If $k > 1$ then the perceived price goes beyond AP

Econometric technics

- Endogeneity:
  - Price and kWh consumption are determined jointly though price structure is known prior
  - Apply McFadden, Puig and Kirschner (1977)‘s instrument variables: use predicted price as IVs for actual price.
- Dynamic panel bias for long-run function
  - Dynamic panel for long-run model introduces a correlation between the lag and unobserved demand shocks in error terms that results in endogeneity.
  - Apply Blundell and Bond (1998) system GMM estimators to redress

Data

- Vietnam Household Living Standard Surveys (VHLSS) 2012, 2014 and 2016
  - Rotated surveys
  - Has data on electricity bills and kWh consumption of “last month”
- Electricity prices from various legal documents
- Temperature from US National Oceanic and Atmospheric Administration (NOAA)
  - 14 stations across Vietnam

Data

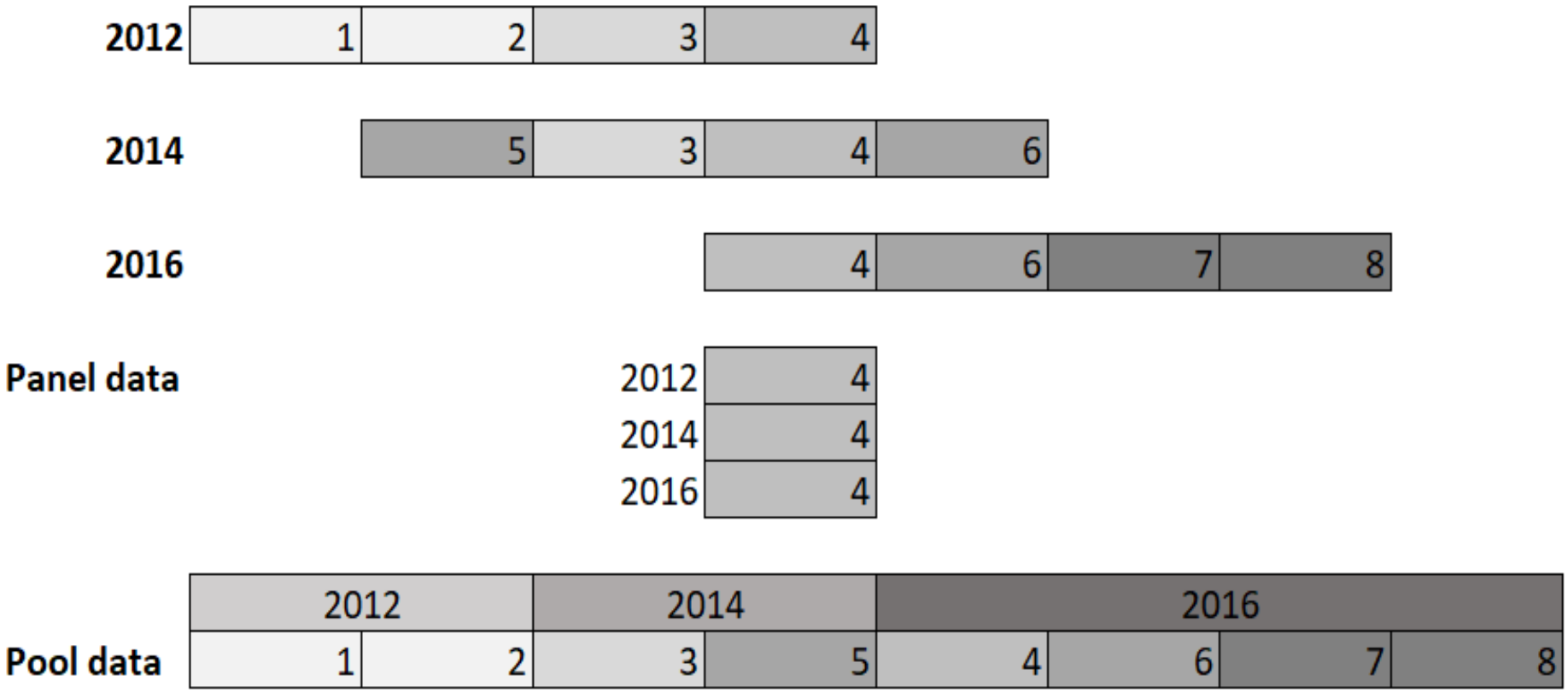

Figure 1. The construction of data sets for short-run and long-run functions
Source. Author illustrated

Data

- Data for prices
  - The retail price schedule applied to roughly 85 per cent of households who can buy electricity directly from EVN.
  - The wholesale prices applied to remote rural areas. The retail price for the group is unknown.
- The study applies the retail price schedules for the whole sample
  - the wholesale price is applied to a small fraction of the population
  - The wholesale price is also in IBTs form thus, there is no decreasing block tariffs in the retail price for the second group

Data

- Data for kWh
  - There is a significant difference between original kWh and derived kWh from electricity bills and corresponding prices.
  - Choose the kWh derived from electricity bills because people normally remember their last month's bill rather than remember how many kWh they consumed
- Data on temperature: geographic proximity procedure
  - Identify the nearest station for each household
  - Assign the temperature of the station for the household
- All money term variables are adjusted to 2012 by CPI index

Data

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Demographic					
Household size	19,297	3.77	1.57	1.00	15.00
Sex ratio	19,296	0.48	0.21	0.00	1.00
Elder ratio	19,296	0.17	0.30	0.00	1.00
Children ratio	19,296	0.21	0.21	0.00	1.00
Economics					
Monthly income per cap	19,291	2,838.26	2,853.47	102.00	110,143.00
Housing condition					
Area in square meter	19,278	80.97	53.70	5.00	750.00

Table 2. Data statistics for some main variables
Source. Author illustrated

Data

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Assets					
Air conditioner	19,229	0.15	0.36	0.00	1.00
Fan	19,229	0.91	0.29	0.00	1.00
Fridge	19,229	0.63	0.48	0.00	1.00
Washing	19,229	0.31	0.46	0.00	1.00
Oven	19,229	0.08	0.27	0.00	1.00
Computer	19,229	0.22	0.41	0.00	1.00
Television	19,229	0.94	0.24	0.00	1.00
Water heater	19,229	0.24	0.43	0.00	1.00
Generator	19,229	0.02	0.13	0.00	1.00
Energy					
Liquid Petroleum Gas	19,294	107.63	114.26	0.00	4,500.00
Electricity					
Electricity bill last month	19,297	241.61	254.67	2.00	7,320.00
kWh consumed last month	19,297	134.20	111.71	1.23	2,661.54

Table 2. Data statistics for some main variables (cont.)
Source. Author illustrated

Results – short run model

If MP increases 1.0 per cent, the kWh consumed by households decreases 1.53 per cent, *ceteris paribus.*

	MP model			
	OLS	*IV*	*OLS*	*IV*
lnmp1	1.9324***	-1.5309***		
	[0.0449]	[0.2086]		
lnrsp1	0.0100***	0.0041***		
	[0.0004]	[0.0008]		
lnap1			4.7069***	-2.0321***
			[0.2174]	[0.2293]
Income				
lnincpc1	0.1363***	0.2409***	0.1630***	0.2414***
	[0.0095]	[0.0145]	[0.0112]	[0.0144]

Note. Std. Err. in brackets; *** p<0.01

Table 3. Estimated results of the short-run demand function

Source. Author estimated

Results – long run model

	OLS	*LSDV*	*XTIVREG*	*XTABOND2*
L.lnkwh1	0.1575***	-0.1103***	-0.2949***	0.0616**
	[0.0110]	[0.0219]	[0.0634]	[0.0291]
lnincpc2	0.0776***	0.0656***	0.1106***	0.0598***
	[0.0089]	[0.0221]	[0.0364]	[0.0107]
lnmp2	2.3253***	2.1986***	-0.7698	2.6250***
	[0.0438]	[0.0862]	[0.8099]	[0.0907]
lnrsp2	0.0159***	0.0132***	-0.0011	0.0202***
	[0.0004]	[0.0008]	[0.0066]	[0.0009]

Note. * p<0.10, ** p<0.05, *** p<0.01; Standard errors in brackets
L.lnkwh1: the lag of dependent variable

Table 5. Estimated long-run function of MP model

Source. Author estimated.

	OLS	*LSDV*	*XTIVREG*	*XTABOND2*
L.lnkwh1	0.3138***	-0.1563***	-0.2624***	0.2488***
	[0.0158]	[0.0267]	[0.0271]	[0.0349]
lnincpc2	0.1561***	0.1107***	0.1057***	0.1842***
	[0.0142]	[0.0316]	[0.0275]	[0.0183]
lnap2	4.3761***	5.3752***	-0.1339	4.2118***
	[0.1353]	[0.2513]	[0.5511]	[0.1793]

Note. * p<0.10, ** p<0.05, *** p<0.01; Standard errors in brackets
L.lnkwh1: the lag of dependent variable

Table 6. Estimated long-run function of AP model

Source. Author estimated.

- The estimated coefficients of prices are positive – against theory prediction

Results – Perceived Price

- *k* is insignificant at 0.05 level. Households do respond to MP rather than AP.
  - Up to 2017, electricity invoices were usually delivered monthly to customers, mostly in person.
  - The bill details all information implying that customers have perfect information.

	OLS	*IV*
lnincpc1	0.1249***	0.2417***
	[0.0092]	[0.0144]
lnrsp1	0.0129***	0.0037***
	[0.0003]	[0.0013]
lnmp1	3.8332***	-1.6497***
	[0.0842]	[0.2277]
lnapmp1	3.5368***	-0.2525
	[0.1043]	[0.5527]
k		0.153
		[0.3219]
N	18971	18971
R-sq	0.873	0.602
adj. R-sq	0.872	0.600

Note. * p<0.10, ** p<0.05, *** p<0.01; Standard errors in brackets. The table presents estimates of selected variables.

Table 7. Estimates for perceived price model

Source. Author estimated.

Conclusion

- Household electricity demand is elastic in the short-run. This contradicts the findings of studies made in other countries but agrees with Phu (2017) results in Vietnam, with different data and method.
- Households in Vietnam respond fully to marginal price rather than to average price.
- The long-run elasticity appeared positive, a surprise which may be caused by the lack of price variation in the long-run data set.

Policy implication

- Policy context:
  - EVN (2015) proposed three options for the changes in electricity tariff schedule including a single price schedule, a three-block schedule and a six-block schedule as the current schedule.
- Policy implication:
  - The option of single price schedule is not appropriate if government follows the objective of stimulating electricity savings.
  - Since households do respond fully to marginal price, a six-block schedule will not cause any trouble for households in perceiving the price schedule.

Policy implication

- March 2019, electricity price raised by 8.3 per cent in all blocks: is it right time?
- Implication:
  - Households kWh demanded decrease by 12.71 per cent
  - In 2016, the total residential electricity consumption per month is 3,651.94 GWh (interpolated from VHLSS survey) (equi. to generation of 1 thermal unit of 80MW in one year)
  - So, the increase in price leads to saving of 464.16 GWh

Future research

- Updating data for more precise estimates
  - 173 weather stations across Vietnam
  - The fraction of data with unknow price is diminishing
- Need other method to estimate long-run function under the condition of lacking price variation

Q & A

- Thank you for your attention!