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Tính kinh tế theo quy mô trong tiêu dùng điện của các hộ gia đình tại Việt Nam

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Translated abstract, introduction and conclusion of:
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Economy of Scale in Electricity Consumption of Households in Vietnam

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Summary for policymakers:

This study examines how of electricity consumption by Vietnamese households between 2014 and 2018 depends on households size, income and other factors. It utilizes instrumental variables to adjust for the effects of increasing block tariffs. The result confirm the existence of economies of scale in electricity use among Vietnamese households: each additional member in the household decreases the per capita power consumption by 15%.

Results imply that the observed social trend towards smaller households may contributes to the electricity demand increase. Indeed, between 2014 and 2020, the average household size in Vietnam decreased, correlating with a large increase in per capita electricity consumption. However, the study finds that diseconomies of scale only explain a small part (5%) of the households electricity demand increase. The majority of the increase is due to other factors, such as the number of households, their income growth, and urbanization.

Technical abstract: The study retests the economy of scale in electricity consumption under the tiered electricity pricing conditions with panel data constructed from the Vietnam Household Living Standards Survey (VHLSS) for the years 2014, 2016, and 2018. Using instrumental variables developed by McFadden, Puig, and Kirschner (1977) to represent tiered prices, the study has separated the impact of tiered pricing to estimate the economy of scale in electricity consumption of households in Vietnam from 2014 to 2018. The results show that even under the influence of tiered pricing, households still exhibit economies of scale in electricity consumption. With each additional member, the per capita electricity consumption of each household decreases by 5.36 kWh/month, equivalent to a 15% reduction. This result has a small deviation compared to the results estimated in other Asian countries such as China.

Keywords: Economy of scale, electricity demand function, tiered pricing, Vietnamese households.

1. General introduction

Nations are confronting a trend where household sizes are diminishing. In China, the household size has shrunk from the 1970s to about three persons by the year 2011, and although there was a temporary increase in 2015 due to the abolition of birth control policies, this trend has not reversed, and household sizes continued to decrease from 2017 (Wu et al., 2021). In Vietnam, statistics from the General Statistics Office (GSO) show that the household size has decreased from 3.9 persons per household in 2010 to 3.6 persons per household in 2020 (GSO, 2021).

This trend will affect the issue of energy security and the environment in countries. This is because electricity consumption has economies of scale (Ironmonger, Aitken, and Erbas, 1995; Brounen, Kok, and Quigley, 2012; Wu et al., 2021). As household sizes decrease, per capita electricity consumption will increase. Given that household electricity consumption accounts for a relatively significant proportion of a country's total electricity consumption, this trend will put pressure on ensuring electricity supply and make reducing coal-generated electricity more challenging (Wu et al., 2021). In that context, estimating the economies of scale in household electricity consumption is practically significant in providing input parameters for demand forecasting and electricity supply planning.

To date, there have been numerous studies on economies of scale in household electricity consumption. These studies take various approaches, such as determining the elasticity of expenditure or electricity consumption (kWh) according to scale (Zhou and Teng, 2013) or identifying the threshold scale change (Filippini and Pachauri, 2004). However, these studies are often set in the context of fixed electricity prices.

If electricity is priced on a tiered basis, particularly increasing block tariffs, the conclusions may no longer be applicable or may be erroneous. This is because as household sizes increase, the total kWh consumed by the household also increases, leading to higher prices. At that point, the reduction in per capita consumption may be due to the higher prices and not economies of scale. To determine economies of scale, it is necessary to eliminate the influence of prices. The most recent empirical study related to and addressing the issue of tiered pricing is by Phu (2020). Phu (2020) estimated the price elasticity of electricity demand by Vietnamese households using 2016 survey data from the World Bank in five provinces and cities: Hanoi, Ho Chi Minh City, Da Nang, Binh Duong, and Dak Nong. This study used instrumental variables including household registration, grid connection form, payment method, and urban/rural areas. These variables are relatively difficult to collect data on, especially nationally representative data.

Therefore, this study will focus on retesting economies of scale in electricity consumption under the conditions of increasing block tariff pricing using more suitable instrumental variables given data limitations, particularly nationally representative data. The study will use instrumental variables developed by McFadden, Puig, and Kirschner (1977), which will be derived from initial prices and do not require additional data.

The research context will be defined as Vietnamese households during the period from 2014 to 2018. According to the authors' calculations using 2018 VHLSS data, 98% of Vietnamese households can access the national power grid, making it an ideal context for research with large, nationally representative data sets. The period from 2014 to 2018 was chosen because this period saw many changes in electricity prices, which are beneficial for estimation. Besides, data from this period allows for the construction of panel data for three years: 2014, 2016, and 2018. Since 2020, VHLSS uses a new sample from the General Population Census, so it is not feasible to construct a panel data set.

The research is presented in five parts. The first part is the general introduction, followed by the theoretical foundation. Part 3 describes the methodology and data. Part 4 includes the results and discussion. Part 5 is the conclusion. [...]

Table 4: Elasticity and Marginal Impact of Household Size on Electricity Consumption per Person

Indicator	Formula	Value	Meaning
1. Elasticity	dln(kWh)/ dln(hhsize)	0.42	If the household size doubles, electricity consumption increases by 42%.
2. Average household size	Mean(hhsize)	3.86	persons
3. Average household electricity consumption	Mean(kWh)	137.78	kWh/month
4. Marginal impact of household size on household electricity consumption	dkWh/ dhhsize	15.00	If the household size increases by 1 person, the household electricity consumption increases by 15kWh/month.
5. Marginal impact of household size on per capita electricity consumption of the household	d(kWh/ hhsize)/ dhhsiz e	-5.36	If the household size increases by 1 person, the per capita kWh consumption decreases by 5.36 kWh/month.
6. Semi-elasticity of per capita electricity consumption according to household size	d[ln(kWh/ hhsize)]/dh hsize	-0.15	If the household size increases by 1 person, per capita electricity consumption decreases by 15%.

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5. Conclusion and Policy Implications

The study retests the economy of scale in electricity consumption under the tiered electricity pricing conditions with panel data constructed from the Vietnam Household Living Standards Survey (VHLSS) for the years 2014, 2016, and 2018. Using instrumental variables developed by McFadden, Puig, and Kirschner (1977) to represent tiered prices, the study has separated the impact of tiered pricing to estimate the economy of scale in electricity consumption of households in Vietnam for the period 2014 - 2018. The results show that even under the influence of tiered pricing, households still exhibit economies of scale in electricity consumption. With each additional member, the percapita electricity consumption of each household decreases by 5.36 kWh/month, equivalent to a 15% reduction. This result has a small deviation compared to the results estimated in other Asian countries such as China.

The estimation results confirm the presence of economies of scale in electricity consumption of Vietnamese households during the period 2014-2018. Currently, the social trend toward smaller household sizes will increase the demand for electricity: when a young couple moves out of their parents' home, they will buy a new refrigerator. However, the impact of economy of scale on the total electricity demand of households is relatively small compared to other factors.

From 2014 to 2020, the total electricity sold by Vietnam Electricity Group increased from 128.43 TWh to 216.95 TWh (EVN, 2015, 2021). The electricity consumption increased by 88.5 TWh. However, households and government agencies only use one-third of the electricity sold in Vietnam in 2020 (EVN, 2015, 2021). This customer group consumed 45.46 TWh in 2014 and 73.8 TWh in 2020, an increase of 28.3 TWh.

From 2014 to 2020, according to the General Statistics Office's data, the average household size in Vietnam decreased from 3.81 persons/household to 3.6 persons/household. Therefore, the per capita electricity consumption would increase (3.6-3.81)*(-5.36) = 1.12 kWh/person/month. Based on Vietnam's population of 97.58 million people in 2020, the increase in electricity consumption is about 1.12 * 97.58 = 109 million kWh/month, or 1.31 TWh per year. The change in household size explains 1.5% of the increase in total electricity demand, or 4.6% of the increase in demand of the household and government agency customer group.

What explains the remaining 95.4%? The study lacks data and therefore does not comment on the government agency customer group. However, for households, three factors likely have a significant and clear impact: the number of households, household income, and urbanization rate. All three factors have increased sharply during this period, so they are

likely to explain most of the increase in household electricity demand (See Table 5). The increase in the rural electrification rate and the decrease in real electricity prices also contribute to the impact. Accurate estimation of the impact of these factors is beyond the scope of this study.

Table 5: Changes in Some Factors During the Period 2014 - 2020

Factor	2014	2020
Average income per capita at current prices (thousand VND/month)	2,637	4,250
Population (million people)	91.20	97.58
Number of households (million households)	23.9	27.1
Urbanization rate (%)	33.19	37.12
Rural electrification rate (%)	98.22	99.3

Source: (GSO, 2015, 2020).

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