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Socio-Economic Determinants of Household Electricity Demand in Pointe-Noire, Congo-Brazzaville

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Abstract

The study estimates the main drivers of household electricity demand in Pointe-Noire using household-level survey data (n = 496) and a linear approximation Almost Ideal Demand System (LA/AIDS). Explanatory variables include dwelling characteristics, appliance ownership and proxies for price and income. The model finds that electrical power subscribed, type of house, connection type, kWh consumed in the previous six months, number of rooms, electrified shower, education of the household head and ownership of a hotplate significantly affect the budget share spent on electricity. The authors conclude that policy should consider these socio-economic factors when planning electricity supply and subsidies.

Keywords

Socio-Economic Determinants, Electricity Demand, Households, AIDS Model, Pointe-Noire

1. Introduction

Electricity has become a necessary commodity worldwide, both for everyday life and for national economies, and even the smallest electrical problems can have a significant impact on the continuity of economic activities. To date, energy is considered a source of wealth and an essential driver of development. Furthermore, energy consumption is the basis of all economic activities (Dahmani & Mouhoubi, 2023).

According to the International Energy Agency, access to energy has improved considerably in recent years, with the number of people living without electricity falling from 1.2 billion in 2010 to 840 million in 2017.

The global electrification rate has reached 91%. This means that around 733 million people worldwide still do not have access to electricity (World Bank, 2021).

In Africa, the electrification rate varies considerably from one country to another, but on average, it is lower than in the rest of the world. According to the World Bank, approximately 567 million people in Sub-Saharan Africa did not have access to electricity, representing more than 80% of the global energy access deficit. As a result, electricity production in African countries, particularly in Central Africa, is at the heart of discussions.

In the Central African sub-region, for example, several energy policies have been implemented at both the regional and national levels to increase energy production capacity (Bayale et al., 2021). Congo, like other Central African countries, is experiencing electrification problems. Indeed, the electrification rate is low, with less than 10% of the population having access to electricity.

Although electricity is at the top of the energy ladder (Leach, 1992), most studies conducted in the past have focused on the determinants of household energy consumption (Narasimha Rao & Reddy, 2007), rather than on an in-depth understanding of the use of electricity for two major domestic purposes, namely lighting and cooking (Leach, 1975; Narasimha Rao & Reddy, 2007; Özcan et al., 2013).

Several empirical studies have documented the existence of an energy ladder with an increase in household income (Özcan et al., 2013). In addition, household demographic characteristics, consumption habits and the gender of the head of household can play an important role in a household's decisions regarding electricity use. However, according to Rahut et al. (2017), these characteristics have been little studied in the literature, particularly in rural areas. Consequently, the identification of the relative importance of factors influencing residential electricity demand is essential for policy-making in the context of the Congo. Furthermore, Saele, Rosemberg, and Feilberg (2010) estimated household electricity demand using an econometric model based on the household appliances used and the socio-demographic characteristics of the household in relation to their consumption, such as income, area of residence, household size and electricity prices. In addition, Dedjinou (2022) analyses the determinants of household electricity demand in a context of supply rationing due to low electricity production capacity in Benin. This study reveals that connection costs, income and place of residence are the main significant determinants of demand for access to the distribution network, while consumption costs, household income and electricity resale are the main significant determinants of household electricity demand in Benin. As for Tchagnao and Bayale (2021), they analyzed the determinants of household expenditure on electricity consumption of 2367 households in Togo based on the survey data from the Basic Welfare Indicators (QUIBB, 2015). The results indicate that household expenditure on electricity consumption is positively affected by income level, size, gender, place of residence and level of education, but negatively affected by the age and marital status of the head of household. Also, the socio-economic characteristics of households are often cited as explanatory factors for household consumption. For example, the study by Agbandji et al. (2020) in Benin shows that the gender of the household head, household size and income, as well as the possession of appliances such as fans, blenders, refrigerators, and radios, influence the overall residential demand for electricity. Conversely, the study by Eakins (2013) on Irish households included household characteristics such as income level and certain housing characteristics like the number of people in households, the age of household heads, occupation, education, place of residence, and appliances. However, Kristiansen (2012) focused on the education level of the household head; this variable helps reduce energy expenditure only when the education level exceeds secondary education. The mechanism by which this is possible is that higher education would enhance the individual's ability to optimize energy expenditure and its use, particularly by regulating the kilowatt-hours used by household appliances. The studies by Grossman (1972) and Elnakat, Gomez, and Booth (2016) also show that education increases individuals' ability to be more sensitive to electricity use. The electricity demand of the residential sector would be influenced by the price of electricity, household appliances (Silk & Joutz, 1997), and the type of connection (Kamdem, 2010). In India, Tewathia (2014) will determine the average monthly domestic consumption by season for households in the Delhi district. In his analysis, he will use the increase in the rate of urbanization, the rise in income, and the change in household lifestyles. The results obtained from data collection on 395 households indicate that the ownership of electrical appliances (light bulb, refrigerator, heating, air conditioning, television, oven, etc.) and their importance strongly contribute to electricity consumption in households. The multiple regression used also showed that income, household size, housing size, temperature, etc. explain household electricity consumption. Finally, several studies have shown that household electricity consumption is also influenced by socio-economic and demographic characteristics (Zhou & Teng, 2013; Brounen et al, 2012; Dalen & Larsen, 2012; Thioune, 2016).

The objective of this study is to identify the main socio-economic determinants of household electricity demand in Pointe-Noire, Congo-Brazzaville.

2. Methodology

2.1. Theoretical Framework of the Model

The history of the early days of empirical demand analysis does not stem from a marked interest in economic theory. Rather, it comes from a methodology of simple equations focused on measuring elasticities. Keynes (1933) stated that Marshall was delighted to have discovered the concept of elasticity, an enthusiasm that spread to all economists. This is not surprising, as elasticity is an easy concept to understand. It can be measured using the parameters of a linear regression with the logarithm of expenditure and prices as variables. The restrictions on the aggregation of goods were well understood. However, they usually proved to be irrelevant, since all studies at that time considered only a fraction of the total budget as a dependent variable.

Stone's (1954) study presents a model written in this tradition, but it stands out for its use of economic theory to define and modify the equation used. It thus forms a bridge between the old methodology and the new. The starting point for this study is a logarithmic demand function that depends on income and prices. He introduces a Linear Expenditure System (LES) starting with Marshallian demand. Before attempting to estimate the demand equation, he chooses a logarithmic functional form to reduce the number of parameters to be estimated. In addition, he applies the restrictions of goods aggregation, homogeneity and symmetry to further reduce the number of parameters to be estimated. In practice, this could make the difference between being able or unable to estimate at the time of Stone. It is not surprising that econometricians of the time favoured this methodology. The increase in degrees of freedom means that this method is only applicable to a relatively small number of product groups. The highest disaggregation of total expenditure that proved successful was Barten's (1969) study. He broke down total expenditure into 16 product groups. By comparison, the linear expenditure system can be applied to 40 or more goods, as in Deaton's (1974) study. Stone's linear expenditure system is the first generation of demand models and remains somewhat restrictive.

One model has been frequently used to test economic theory. It was proposed by Barten (1964) and Theil (1965). It is called the Rotterdam model. It represents the second generation of demand systems. This model is not based on a particular utility function but more generally on a first-order approximation of the demand function. This approach is similar to the linear expenditure system method. It differs in that it is differential rather than logarithmic in level, as in Stone's (1954) study. The Rotterdam model does not allow the restrictions of economic theory to be imposed with aggregate data.

In the direct or indirect transcendental logarithmic utility function (Translog) approach, an unknown direct or indirect utility function is approximated by a second-order Taylor expansion. The problem with this model is that the demand equation must be written as a function that depends on the endogenous quantity variable. To solve this problem, Roy's theorem must be used. This transcendental logarithmic system is widely used in demand analysis. However, the implications of the model as a second-order approximation for a utility function are strongly criticised by Simmons and Weiseirbs (1979), Blackorby et al. (1977) and McLaren (1982). Essentially, the arguments are that many utility functions produce the same demand equations. Naturally, it must respect the symmetry of the Hessian matrix. Simmons and Weiserbs identify three utility functions for which this property does not hold. The indirect demand utility functions of the Translog model are complicated and imperfect to estimate. Meanwhile, the Translog model with direct utility functions is usually estimated under the strong assumption that, for all goods, prices are determined by quantities rather than the other way around.

However, the most appropriate functional forms for modelling the behaviour of economic agents are those that aim for flexibility (Yankam, 2004). Among these flexible functional forms, the AIDS and Rotterdam models are the most widely used in the analysis of demand behaviour, especially in the field of agricultural economics (Taljaard, Alemu, & van Schalkwyk, 2004). The AIDS (Amost Ideal Demand System) model, developed by Angus Deaton and John Meulbauer in the late 1970s, has become the benchmark model in demand analysis and has since been widely adopted by agricultural economists. According to Deaton and Muellbauer (1980), Alston and Chalfant (1993), Eales and Unnevehr (1994), and Yankam (2004), the popularity of the AIDS model stems from the fact that it has several advantages. Among these, it should be noted that the linear approximation of this model (LA/AIDS) is relatively easy to estimate and interpret. Its flexibility and compatibility with consumer aggregation allow it to be used to interpret economic models estimated from aggregate (macroeconomics) or disaggregated (household surveys) (Glewwe et al., 2001). It can also satisfy the zero-degree homogeneity restriction of demand functions at the income and price levels and the symmetry condition of the Slutsky matrix (Abdelkrim, 2000). Thus, for the purposes of our study, we identify the socio-economic determinants of household electricity demand using the AIDS model inspired by the work of Deaton and Muellbauer (1980).

2.2. Tools and Analysis Model

The AIDS (Almost Ideal Demand System) model was proposed by Deaton and Muellbauer (1980). As its name suggests, it remains the best model for estimating a consumption function. Its popularity is justified by the fact that the AIDS model is very general (it does not require an explicit specification of the utility function), easy to estimate (being linear) and consistent with the necessary restrictions of economic theory to ensure maximisation of consumer utility.

This model is comparable to the Rotterdam and Translog models, which have comparative advantages over those mentioned first, and is called the Almost Ideal Demand System (AIDS) as it gives approximately the first-order derivative of the demand system. Several characteristics of the model are found in the Rotterdam model, or in the Translog model, but not in both simultaneously. Indeed, the Rotterdam and Translog model is commendable because it:

- Satisfies the axioms related to choice theory;
- Allows for the aggregation of consumers without invoking Engel curves;
- Results in a functional form requiring the budgets of the different households in the sample;
- Allows homogeneity and simultaneity restrictions on the parameters to be tested;
- Remains simple to estimate;
- Makes it possible to avoid non-linear estimation.

Next, we will discuss the AIDS model and the steps to follow to arrive at the linear AIDS model, which will serve as the basis for explaining certain modifications in order to apply the latter to our empirical framework. In most literature focused on demand systems, the starting point is generally the second-order approximation of the direct or indirect utility function. It rarely comes from the cost or expenditure function, and it is still possible to use the approximation of the first derivative in the demand function, as in the Rotterdam model. The AIDS model also stems from this type of approach, which, however, does not start with arbitrary preferences, but with so-called specific preferences. This stems from Muellbauer's (1974) theorem and allows for perfect aggregation of consumers. The representation of market demand comes from consumption decisions linked to the budget of a representative rational consumer. These preferences are represented by the expenditure function, which is defined by minimising expenditure to achieve a specific level of utility, with prices given. The cost function is represented by $c(p, u)$. Where is the level of utility, and p is the price vector. The log-linearised equation is then written as follows:

$$\log c(u,p) = (I-u)\log(a(p)) + u\log(b(p)) \tag{1}$$

Generally, utility (u) must be between 0 and 1. The functional forms $\log a(p)$ and $\log b(p)$ depend on $a(p)$, which is the cost of necessary goods, and $b(p)$, which is the cost of luxury goods. The author therefore develops two general cost functions for each type of good:

$$\log a(p) = \alpha_k + \sum_k \alpha_i \log p_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj}^{*} \log p_k \log p_j \tag{2}$$

$$\log b(p) = \log a(p) + \beta_k \prod_k p_k^{\beta_k} \tag{3}$$

So, the AIDS cost function can be written as follows:

$$\log c(u,p) = \alpha_k + \sum_k \alpha_k \log p_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj}^{*} \log p_k \log p_j + u\beta_k \prod_k p_k^{\beta_k} \tag{4}$$

where α_k, β_k and γ_{kj} are parameters. The function is linearly homogeneous in p, which can be explained by the following restrictions:

$$\sum_{i=1}^{n} \alpha_i = 1,\ \sum_{i=1}^{n} \gamma_{ij} = 0,\ \sum_{i=1}^{n} \beta_i = 0,\ \sum_{j=1}^{n} \gamma_{ij} = 0$$

Hicksian demand functions can be directly derived from Equation (4). This stems from the fundamental properties of the cost function (Shephard, 1953, 1970). The properties of the cost function are as follows:

1) $c(p, u)$ is non-decreasing with respect to p;
2) $c(p, u)$ is homogeneous of degree 1 with respect to p;
3) $c(p, u)$ is concave with respect to p;
4) $c(p, u)$ is continuous with respect to p, for $p > 0$.

The partial derivative of the cost function with respect to the price of good i gives the compensated demand for good i ($\delta c(p, \mu)/\delta p_i = q_i$). Multiplying both sides by $p_i/c(p, \mu)$ gives the share of expenditure devoted to good i:

$$\frac{\delta \log c(\mu,p)}{\delta \log p} = \frac{p_i q_i}{c(u,p)} = w_i \tag{5}$$

where the term w_i is the share of the budget for good i. The differential of the cost function gives the share of the budget for each good as a function of prices and utility.

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \times u \times \beta_o \prod p_k^{\beta_k} \tag{6}$$

where

$$\gamma_{ij} = \frac{1}{2}\left(\gamma_{ij}^* + \gamma_{ji}^*\right) \tag{7}$$

By maximising consumer utility, total expenditure (x) is equal to the cost function $c(p, u)$. This equality can be reversed to give the indirect utility function u, which is a function of income and prices. Substituting the utility function into the share function yields the equation for the budget share as a function of expenditure and prices:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log\left(x/P\right) \tag{8}$$

where P is a price index defined by the following equation:

$$\log P = \alpha_0 + \sum_j \alpha_k \log p_k + \frac{1}{2}\sum_j \sum_k \gamma_{kj}^* \log p_k \log p_j \tag{9}$$

Restrictions on the parameters of the cost function imply restrictions on the parameters of the AIDS equation.

$$\sum_{i=1}^{n} \alpha_i = 1,\ \sum_{i=1}^{n} \gamma_{ij} = 0,\ \sum_{i=1}^{n} \beta_i = 0, \tag{10}$$

$$\sum_{j=1}^{n} \gamma_{ij} = 0 \tag{11}$$

$$\gamma_{ij} = \gamma_{ji} \tag{12}$$

The popularity of this model stems from both its flexibility and simplicity. Indeed, it does not require specification of household utility functions, and its linear form makes estimation easy. Estimating these functions is of great interest to economic theory, as it allows us to predict household consumption behaviour following changes in their total consumption expenditure or the general price level through price elasticities and total expenditure elasticities.

2.2.1. LA/AIDS Model

In the context of this study, the specification of the LA/AIDS model with a single good is chosen to model residential electricity demand. This choice is justified by the particular nature of electricity, which is considered an essential good, difficult to substitute in domestic uses and consumed regularly. Unlike multi-good demand models, using a single good specification helps avoid the complexities associated with modeling interdependencies between goods and is better suited to the constraints of available data in the Congolese context. Indeed, survey data is primarily focused on electricity, and adopting a multi-good system would have compromised the reliability of the estimates. This choice is also consistent with several previous applications, notably those of Clements et al. (1994) and Reiss and White (2005), which demonstrated the relevance of the single good LA/AIDS approach for the analysis.

The objective is to convert the non-linear demand system into a linear system. The previously identified price index must be substituted into the equation to be estimated. This substitution of the index implies that the demand function to be estimated is not linear.

$$w_i = (\alpha_i - \beta_i\alpha_i) + \sum_j \gamma_{ij} \log p_j + \beta_i \left(\log x - \sum_k \alpha_i \log p_k - \frac{1}{2}\sum_j \sum_k \gamma_{kj}^* \log p_k \log p_j \right) \quad (13)$$

This non-linear system can be estimated using the maximum likelihood method or other methods. Asset aggregation restrictions are difficult to test. In many situations, it is still possible to exploit price collinearity to simplify the estimation technique. When P is known, the model should be linear with respect to the parameters α, β and γ. This should make it possible to estimate equation by equation, using ordinary least squares in the case where the error distribution is normal. It is also possible to estimate using maximum likelihood or generalised least squares regression. In this case, the asset aggregation constraints are automatically satisfied by the estimation. When prices are nearly collinear, it becomes appropriate to approximate P as proportional to a certain known index P^*. Stone's price index ($\log P^* = \sum w_i \log p_k$) is an obvious factor to replace the index in the AIDS demand function equation. If $P \cong \phi P^*$, $\phi \in \mathbb{R}^+$, it is still possible to estimate the linear equation, which is written as follows:

$$w_i = (\alpha_i - \beta_i \log\phi) + \sum_j \gamma_{ij} \log p_j + \beta_i \left(\log \frac{x}{P^*} \right) \quad (14)$$

By writing $\alpha_i^* = (\alpha_i - \beta_i \log\phi)$, it is easy to see that the restrictions ($\sum \alpha_k^* = 0$ and $\sum \beta_k = 0$) are still required to comply with the conditions for aggregating goods. By substituting the approximate price index, the demand equation of the AIDS model becomes linear. We obtain the approximate Linear Almost Ideal Demand System (LA/AIDS) model.

2.2.2. Model Estimation Method

It is necessary to ensure that the linear constraints identified above are respected in order to remain consistent with demand theory. The maintenance of the aggregation restriction of goods is easily observed. First, it must be ensured that the sum of the shares must be equal to one ($\sum w_i = 1$).

When estimating, only $n-1$ equations should be estimated to avoid the singularity problem of the variance-covariance matrix. This particularity implies that the estimator of an independent variable in the unestimated equation (good k) is defined by the negative of the sum of the estimated estimators ($\beta_{kl} = -\sum_{i=1}^{n-1} \beta_{kl}$).

The combination of these two requirements validates the first three restrictions, leaving the restrictions of homogeneity and symmetry. The homogeneity restriction is fundamentally resolved by using relative prices in the specification, and the demand system (AIDS) can thus be written as follows:

$$w_i = \alpha_i^* + \sum_{j=1}^{n-1} \gamma_{ij} \log\left(\frac{P_j}{P_n} \right) + \beta_i \left(\log \frac{x}{P^*} \right) \quad (15)$$

This constraint prevents testing this restriction equation by equation, as suggested in Deaton and Muellbauer's (1980) article. Furthermore, by using prices relative to the specification, it is not necessary to adjust prices for inflation.

Equation (15) is reasonably the basis for the entire analysis of the AIDS model.

1) Characteristics of the AIDS model

It is important to first define the methodological framework and analysis using the model to be estimated, then explain the choice of variables and provide the data sources, and finally present the assumptions and expected signs of the coefficients.

2) Methodological framework for analysis: the model to be estimated

The consumption of good *i* will be our estimation equation, rather than its share of the budget. After algebraic manipulation, we arrive at the following model:

$$\begin{aligned}\log\left(w_i\right) = {} & \beta_0 + \beta_1 \text{Household size}_j + \beta_2 \text{Number of pieces}_j \\ & + \beta_3 \text{Marital status of the head of household}_j + \beta_4 \text{Type of house}_j \\ & + \beta_5 \text{Connection type}_j + \beta_6 \text{Level of education of the head of household}_j \quad (16) \\ & + \beta_7 \text{electric toilet}_j + \beta_8 \log\left(\frac{\text{kWh consumed}}{P}\right)_j + \beta_9 \text{Electrified shower}_j \\ & + \beta_{11} \log\left(\frac{\text{Electrical appliances}}{\text{Electrical power}_j}\right) + u_i\end{aligned}$$

It should be noted that electricity consumption is broken down as follows:

Electricity consumption = price × quantity;

log((electricity consumption)/*P*) = log(electricity price × quantity).

Analysis of this model enabled us to establish a list of important variables that explain household electricity consumption. The R software enabled us to perform the regression and a few tests.

3. Materials and Methods

3.1. Data

The data used in this study comes from the Survey on Household Electricity Consumption in the city of Pointe-Noire (Congo), conducted in 2022 by the Laboratory of Financial Economics and Institutions (LEFI).

This survey aims to better understand households' behaviour with regard to electricity consumption and to assess their willingness and ability to pay for quality energy. These data also have the advantage of providing information on the socio-economic and demographic characteristics of households, which we need in order to analyse their demand for electrical energy.

3.2. Study Population and Sampling Method

The Pointe-Noire Electricity Consumption Survey was conducted among a sample of households spread across all six districts of the city of Pointe-Noire. The statistical unit observed is the ordinary household, which is defined as a group of related or unrelated persons who recognise the authority of a single individual known as the "head of household" and whose resources and expenses are also shared. They usually live under the same roof, in the same courtyard or on the same property. The survey on electricity consumption in the city of Pointe-Noire used a two-stage sampling plan, as was the case for ARTELIA. In the first stage, Enumeration Areas (EAs) were drawn proportionally to their size in terms of the number of households in the districts. At the second stage, households were systematically selected within the ZDs. A total of 30 ZDs were selected and 20 households were scheduled to be surveyed in each ZD, i.e. 600 households. The study population comprised the entire 1,398,812 inhabitants (INS, 2022). A stratified random sample of 600 residents was selected from the population based on the percentage of residents in each of the six districts of the city of Pointe-Noire (see **Table 1**). The sample was calculated using a 95% confidence interval employing the sample size determination formula, which gives the researcher a margin of error of 4%. After selecting the variables involved in our study and cleaning up the database, our database consists of 496 households.

Table 1. Distribution of the sample by district.

Districts	Population number	%	Sample size
Lumumba	132,484	9.47	57
Mvou-Mvou	76,995	5.50	32
Loandjili	351,528	25.13	151
Tié-Tié	303,309	21.68	130
Mongo-Mpoukou	297,849	21.29	128
Ngoyo	236,647	16.92	102
Total	**1,398,812**	**100**	**600**

Source: Data taken from INS (2022).

3.3. Identification of Variables

In order to estimate our econometric model, we need to define the dependent variable and the independent variables. These are as follows.

3.3.1. Dependent Variable

Our dependent variable is electricity consumption, which is shown as the proportion of the budget spent on electricity consumption by households. It is a quantitative variable.

3.3.2. Explanatory Variables

Table 2 presents the explanatory variables suggested by the literature and selected for this study.

Table 2. List of variables and expected signs.

No	Variables	Description	Sources	Expected signs
1.	Household size	Indicates the number of people in the household	Dalen and Larsen (2013), Agbandji et al. (2020)	+
2.	Number of pieces	Indicates the number of rooms in the household's dwelling	Dalen and Larsen (2013), Agbandji et al. (2020)	+

Continued

3.	Electrical power	Indicates the power subscribed by the household or the price per kWh, considered here as the price of electricity	Kamdem (2010), Saele, Rosemberg, and Feilberg (2010)	+
4.	Type of house	Indicates the type of dwelling occupied by the household	Eakins (2013), Kamdem (2010)	+
5.	Connection type	Indicates the connection chosen by the household	Kamdem (2010)	+
6.	Electrified shower	Indicates shower lighting for cleaning purposes	Dalen and Larsen (2013)	+
7.	electric toilet	Indicates the toilet lighting for cleaning purposes	Dalen and Larsen (2013)	+
8.	Joule effect: Microwave oven	Indicates whether the household has at least one microwave oven	Tewathia (2014)	+
9.	Marital status of the head of household	Indicates the marital status of the head of household	Tchagnao and Bayale (2021)	+
10.	Level of education of the head of household	Indicates the level of education of the head of household	Tchagnao and Bayale (2021)	+
11.	kWh consumed during the last six months	Indicates the variable used to assess household living standards, but used here as a proxy for household electricity expenditure	Zhou and Teng (2013)	+
12.	Joule effect: Heating plate	Indicates whether the household has at least one hotplate	Tewathia (2014)	+
13.	Joule effect: Iron	Indicates whether the household has at least one iron	Tewathia (2014)	+

Source: Author (2025).

4. Results

The results obtained clearly identify the socio-economic determinants of residential electricity demand in Congo (Table 3).

Table 3. Results of electricity demand model estimates.

Electricity consumption	Coef.	St. Err.	t-value	*p*-value	[95% Conf	Interval]	Sig.
Household size	0.069	0.044	1.58	0.114	−0.017	0.156	
Number of pieces	−0.178	0.068	−2.61	0.009	−0.312	−0.044	***
Electrical power	0.113	0.026	4.30	0.000	0.061	0.164	***
Type of house	0.112	0.042	2.65	0.008	0.029	0.195	***
Connection type	0.194	0.092	2.12	0.035	0.014	0.374	**
Electrified shower	−0.334	0.122	−2.73	0.006	−0.574	−0.094	***
Electric toilet	−0.199	0.121	−1.64	0.101	−0.437	0.039	
Joule effect: Microwave oven	−0.603	0.367	−1.65	0.101	−1.323	0.117	

Continued

Marital status of the head of household	0.032	0.020	1.62	0.106	−0.007	0.071	
Level of education of the head of household	−0.108	0.032	−3.38	0.001	−0.171	−0.045	***
kWh consumed during the last six months	0.087	0.017	5.17	0.000	0.054	0.121	***
Joule effect: Heating plate	−0.228	0.131	−1.74	0.083	−0.486	0.030	*
Joule effect: Iron	−0.098	0.065	−1.51	0.132	−0.225	0.030	
Constant	12.011	0.789	15.23	0.000	10.462	13.561	***

Mean dependent var	10.159	SD dependent var	0.720
R-squared	0.279	Number of obs	496
F-test	14.316	Prob > F	0.000
Akaike crit. (AIC)	946.430	Bayesian crit. (BIC)	1005.322

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Source: Author's calculations using R software based on data from the Pointe-Noire electricity consumption survey in 2022.

4.1. Analysis of the AIDS Model Results

Table 3 shows that the R^2 value is 27.9%, which means that the fluctuations in the 13 factors explain 27.9% of electricity consumption. Also, all variables are significant except for household size, electrified toilet, the two Joule effects, and marital status. Furthermore, the probability associated with Fisher's statistic (0.000) is significant at the 1% threshold, which means that the model is good and can be interpreted (Figure 1).

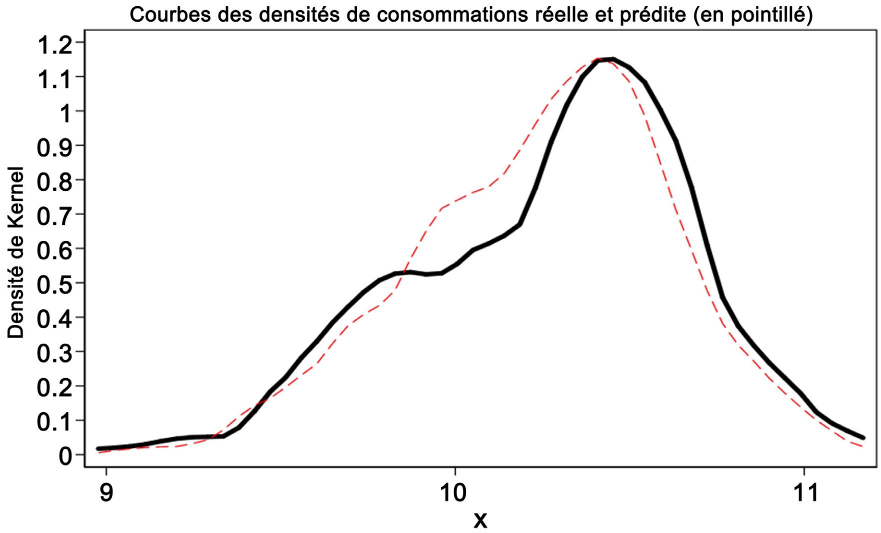

Figure 1. Comparison of kernel densities of actual and predicted consumption.

The dotted curve evolves almost in tandem with the kernel density curve, indicating that the fit is good and the model converges towards reality.

4.2. Discussion of Results

The beta coefficient for the number of rooms variable is negative and significant at the 5% threshold, which means that an increase of one unit in the number of rooms results in a decrease in electricity consumption of 0.17 units. Our results contradict the work of Thioune (2016), who, in the context of residential electricity pricing and demand in Senegal, found that the number of rooms does not influence electricity consumption. Furthermore, electrified showers show a negative and significant sign at the 5% threshold. This means that if the number of electrified showers is increased by one unit, electricity consumption decreases by 0.11 units. This result appears to contradict the work of Tewathia (2014), who found that the possession of electrical appliances (light bulbs, refrigerators, heaters, air conditioners, televisions, ovens, etc.) contributes significantly to household electricity consumption.

On the other hand, the beta coefficient of the electrical power variable is positive and significant at the 5% threshold. This means that if we increase the electrical power by one unit electricity consumption increases by 0.113 units. Here, we consider electrical power as a proxy for the price of electricity. This result is therefore consistent with the work of Silk and Joutz (1997), who showed that the price of electricity and electrical appliances influences electricity demand in the residential sector. As a result, the beta coefficient of the house type variable is positive and significant at the 5% threshold. This means that if the size of the house is increased by one unit, electricity consumption increases by 0.112 units. This result is similar to the work of Tewathia (2014), who showed that the size of the dwelling explains domestic electricity consumption.

However, the beta coefficient for the connection type variable is positive and significant at the 5% threshold. This means that if the number of connections is increased by one unit, electricity consumption increases by 0.194 units. This result contradicts the work of Kamdem (2010), who demonstrated that the type of connection does not contribute to explaining electricity consumption.

However, the beta coefficient for the variable representing the head of household's level of education is negative and significant at the 5% threshold. This means that if the educational level of the head of household is increased by one unit, electricity consumption decreases by 0.108 units. This result is similar to the work of Kristiansen (2012), who showed that the educational level of the head of household contributes to reducing energy expenditure (consumption). Contrary to the studies by Grossman (1972) and Elnakat, Gomez, and Booth (2016) also showed that education increases individuals' ability to be more sensitive to electricity use. However, the beta coefficient of the variable for kWh consumed during the last six months is positive and significant at the 5% threshold. This means that if the kWh consumed during the last six months is increased by one unit, electricity consumption increases by 0.087 units. This result contradicts the work of Brounen et al. (2012), which showed that per capita kWh usage reduces electricity consumption.

Indeed, the hotplate variable has a negative and significant sign at the 5% threshold, which means that if the number of hotplates is increased by one unit, electricity consumption decreases by 0.228 units. This result is consistent with the work of Dalen and Larsen (2013), who showed that the ownership of household appliances influences overall residential demand for electricity in Benin. Consequently, electrified toilets, household size and the two Joule effects (irons and microwaves) are not significant at the 5% or even 10% threshold. This means that these factors are not determinants of electricity consumption.

5. Conclusion

In this study, we identify the main socio-economic determinants of household electricity demand in Pointe-Noire, Congo-Brazzaville. To identify these determinants, we used estimation techniques applicable to an AIDS model by Deaton and Muellbauer (1980), based on data from the household electricity consumption survey conducted in 2022 by the Laboratory of Financial Economics and Institutions (LEFI), in order to establish our results and identify the economic policy implications.

The results obtained show that socio-economic characteristics such as: kWh consumed during the last six months, type of connection, type of house and electrical power significantly determine electricity consumption. These results also prove that the number of rooms, electrified showers, the level of education of the head of household and the Joule effect (hotplates) also affect household electricity consumption.

Ultimately, the kWh consumed over the last six months, the type of connection, the type of house, the electrical power, the number of rooms, the electrified shower, the level of education of the head of the household and the Joule effect (hotplate) are the main significant socio-economic determinants of household electricity demand in Pointe-Noire, Congo-Brazzaville. Thus, to promote social inclusion throughout the country, public authorities must take into account the socio-economic characteristics of households in the city of Pointe-Noire in order to better adjust supply to electricity demand.

Finally, an ambitious policy of subsidising supply and promotion targeting households in precarious urban neighbourhoods would stimulate electricity consumption. Furthermore, promoting investment in electricity infrastructure and the development of renewable energy sources are excellent ways to stimulate and decentralise electricity supply in order to guarantee access to this basic service for all Congolese people, in line with Sustainable Development Goal (SDG) 7, which aims to achieve universal access to electricity by 2030.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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