AN ECONOMETRIC ANALYSIS OF ELECTRICITY CONSUMPTION IN NIGERIA

1955/56 TO 1975/76

BY

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D E D I C A T E D

TO

MY FATHER AND MY MOTHER WHO IN THEIR GOOD AND BAD TIMES HAVE CONSTANTLY SUPPORTED MY ELITIST EDUCATION.

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S. A. Odeneye.

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CHAPTER ONE

THE PROBLEM

Introduction

Electricity is one of the five major sources of energy in Nigeria; the others are coal, petroleum, natural gas and fuelwood (commonly referred to as firewood). And, it is next in importance to petroleum as an energy source in this country. Over the years, the consumption of electricity has been growing rapidly (about 20 percent per annum in the last two decades), and its contribution to the overall development of the country has increased tremendously. Between 1961 and 1976, for instance, its share of the Gross Domestic Product (GDP) rose from 0.29 percent to 0.75 percent. In that same period while the GDP itself trebled, the contribution of electricity to the GDP rose six-fold. Yet during the same time, per capita consumption of electricity increased from 7 KWH to 35 KWH thus emphasising the rapid growth in consumption. The demand for electricity has in fact been taxing the country's generating system, and the latest rationing and constant outages have aggravated the situation. It was against this background that the study was initiated.

Objectives of the Study

Our aim is to use the methods of econometrics to achieve the underlisted goals:

(a) to find out those factors responsible for determining the level of electricity consumption in Nigeria;

(b) to quantify and assess the relative influence of each of these factors on the level of electricity consumption;

(c) to spell out, briefly, the implications of the results obtained in (a) and (b) above.

The subject matter will be pursued as follows: In the next chapter, we discuss the state of the electricity industry in Nigeria. Chapter 3 reviews some of the related literature. In Chapter 4, the sources, nature and limitations of the data employed are enumerated. Chapter 5, is a presentation of the models and the results from their specification, estimation and evaluation. Chapter 6 is a discussion of the implications of the results from the preceding chapter. Finally in chapter 7, we summarise and draw conclusions.

CHAPTER TWO

THE STATE OF ELECTRICITY INDUSTRY IN NIGERIA

Historical Background

The first major electricity undertaking in Nigeria was established in Lagos in 1898.[1] It was then operated as part of the Public Works Department (PWD). Following that, other electricity undertakings were set up in various towns, many of them by the Government (under the aegis of the P.W.D), some Native Authorities and one or two large municipal authorities.[2] The principal users of these early undertakings were the local waterworks, hospitals and the inhabitants of the Government (Reservation Areas) (G.R.A.)[3]. It is to be noted that the stations were not established for large-scale commercial or industrial use nor for general public consumption.[4]

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1. I.B.R.D (1954), p.279.
2. Federal Ministry of Information (1967), p.13-14.
3. Dikko (1973), p.3.
4. Ibid.

All along during this early period (1900-1950), some private industrial organisations had been developing their own sources of electric energy. The oldest privately-owned electricity generating company is the Nigerian Electricity Supply Corporation (NESCO) based in Jukuru, Jos. Established in 1929, NESCO exploited the hydro-electric potentials in and around the Jos Plateau to generate substantial amounts of electricity the bulk of which is consumed on the tin minesfield.[5] In addition, NESCO has been selling its surplus power to National Electric Power Authority (N.E.P.A.).

The other major private effort was not primarily set up for power generation. In fact, African Timber and Plywood Factory, Sapele generated power for its own internal use. Owned originally by the Miller Brothers (it was then only a sawmill) it was taken over in 1935 by the United Africa Company Ltd. (U.A.C.). By 1948, the African Timber and Plywood Ltd. (A.T. & P) was firmly established and presently began to generate its own power. In addition to satisfying

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5. NESCO's concession only allows it to supply the tin minesfield and also sell in bulk to NEPA, which then resells to the general public in Plateau State.

its internal demand, A.T. & P. could sell power in bulk to the then Electricity Corporation of Nigeria, for distribution around Gapele township.[6]

In 1946, the Nigerian Government Electricity undertakings was established as a separate department to take over the running and maintenance of all the undertakings under the P.W.D.[7] Later in 1950, the Electricity Corporation of Nigeria Ordinance (No. 15) was passed by the Government.[8] This in effect transferred all installations under the Nigerian Government Electricity Undertakings to the new authority (E.C.N.). E.C.N. began operations on the 1st April 1951 as a commercial electricity supply organisation with powers to generate, transmit and distribute electricity to all parts of the country.[9]

E.C.N. took over 16 installations in various parts of the country. Most of them (11) were complete generation, transmission and distribution installations.[10] The fact must not be ignored that

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6. I.B.R.D., loc. cit.
7. Ibid
8. Federal Ministry of Information (1967), loc. cit.
9. Dikko, loc. cit.
10. I.B.R.D., op. cit., p. 280.

E.C.N. came into being at a time when the demand for electricity had begun to increase. Coming after the Second European War, and the boom that followed it, potential industrial and commercial demand for electricity had reached a threshold that could support an independent commercial electricity organisation. But the generating plants (hence capacity) proved inadequate, for they were mostly, as already noted, small-scale undertakings. Moreover these stations were not interconnected. Consequently new stations were built, e.g. Ijora 'B', Kano 'B' (both using diesel), and Oji River (using coal) as well as other smaller stations.[11]

Towards the end of the 1950s, a decision was taken to build a hydro-electric power station on the Niger River at Kainji.[12] This was to meet not only current demand then, but also anticipated future demand for electricity, and provide a larger generating base for the country. To accommodate post-independence growth in demand while Kainji was under construction, short term measures were taken. The chief of these was the development of gas-using generating stations in Afam (Rivers State) and Ughelli (Bendel State).

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11. Dikko, loc. cit.

12. Ibid.

In addition the Kaduna Diesel Station was expanded.

The civil war (1967-70) caused a sharp drop in the level of electricity consumption, especially with the whole Eastern Region disconnected from the system. Moreover, the war-time recession in the areas unaffected by the war further dampened demand for electric energy. In December 1968, Kainji Dam was commissioned; this increased the total generating capacity available by nearly a hundred percent.[13] When the civil war ended, electricity demand rose sharply. This, of course, was attributed to the post-war boom, much of it propelled by the increase in government expenditure on development and reconstruction.[14]

To meet this rapid increase in demand, government took certain measures. In 1975, the E.C.N. and the Niger Dams Authority (set up in 1962 to run and maintain Kainji Dam) were merged to form one organisation called National Electric Power Authority (N.E.P.A.). The main aim of the merger was to reduce overlaps in their functions, especially transmission and generation of power. Since, NEPA has been the sole[15] generator, transmitter and distributor of electric energy in Nigeria.[16] Apart from the operational reorganisation,

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13. From 441 MW in 1967/68 to 771 MW in 1968/69.

14. Dikko, op. cit., p. 4-5.

15. Daily Times May 23, 1978, p.7.

16. NESCO's concession still stood, though.

several expansion projects were commenced: these included the installation of additional capacity in Kainji, expansion of Afam and Ughelli stations, and reinforcement of the transmission and distribution system. In spite of all these, NEPA could still not cope with the fast-growing demand. Probably the problem of explosive demand was foreseen but at the time (1969) the financial position of the government was weak and the country's credit rating abroad was below par.[17]

In 1971, an attempt was made to break NEPA's "monopoly": state governments were allowed to generate and distribute power in their areas of jurisdiction.[18] This arose out of the need to extend electricity to more users. States Rural Electrification Boards (REB) were set up to supplement Federal Government effort in the area of rural electrification. The impact of the States' Board is not quite apparent.[19] But definitely, they have not broken NEPA's "monopoly". In addition some communities undertook electrification projects by themselves if they could muster the needed resources. In sum, rural electrification is being pursued

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17. Dikko, ibid.

18. Olayide (ed.) 1976, p.89.

19. It does seem that some of these boards were afflicted by technical and manpower problems. In the case of Bendel State R.E.B., the generators purchased broke down quickly due to lack of maintenance.

by (1) Federal Government, with NEPA as the executing agency; (2) the State Governments (with NEPA in an advisory role)(3) local communities.[20]

The Present Situation

What then is present state of the electricity industry? NEPA remains the only public electricity supplier with nation-wide generation and distribution concessions. Kainji power station serves as the generation system's base, but interconnected with Afam, Oji, Ughelli and Ijora Stations. On the other hand, NESCO in Jos still controls the supply to the tin minesfield while selling spare energy to NEPA for general public use in Plateau State. Moreover States' Rural Electrification also generate and distribute electricity in their areas of authority. For instance NESCO is assisting the Plateau State Government in its rural electrification scheme.[21]

In the face of a huge annual increase in demand, the electricity industry is bound to face some problems in its activities. Though much has been written on them, it is still pertinent to examine a few here.

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20. NEPA (1976), p. 2-5.

21. Personal communication from NESCO official.

(i) Manpower shortage. The lack of skilled engineers and technicians, to design, run and maintain the supply system has been a great handicap.

To ameliorate the situation, NEPA has been training more personnel. The long-term strategy has been to shift emphasis from thermal generation to hydro-electric.[22] The argument is that the latter requires far less operation and maintenance staff than the former. This in the long-run will reduce the need to hire and train more technicians. However, it is precisely this strategy that has aggravated NEPA's short-term problem of constant outages in the distribution system. For a hydro-station requires far more lead-time lag, (project preparation and physical construction period) than thermal stations, so that while demand is moving up rapidly, additional supply may not forthcome until about five years after the rise in demand has been observed.[23] Meanwhile excessive pressure on the existing capacity causes power supply interruptions. This has led to the suggestion that NEPA change its policy and concentrate

22. Olayide(ed.) (1976), p.90.

23. Ilumoka (1973),p.5. Also, see Ayeni (1978),p.12.

on building large thermal generating stations so as to meet short-term rise in demand.[24]

(ii) The problem of personnel and organisation. The manpower shortage facing NEPA is not helped by the relatively poor remuneration it offers its staff. Consequently, it finds it difficult to retain its staff and more difficult to attract experienced ones. Tied to this is the Civil Service rules under which it operates; this reduces the level of efficiency and productivity of NEPA personnel. One can contrast NEPA's organisation with NESCO, which runs a better well-managed company. Full-scale commercialisation of NEPA has been prescribed as solution so that it can determine its salary and grade structure with no reference to the Public Service system.[25]

(iii) Materials supply. The transmission and distribution of electricity is being hampered by delays in arrival and shortage of the necessary gadgets. While NEPA may have planned to meet local increases in demand, this may be frustrated by lack of replacement materials like transformers and fuse boxes.[26] Invariably this partly explains why many neighbourhoods frequently suffer constant load-shedding, since it is likely that existing distribution

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24. Ukpong (1976), p.163. See also Ayeni (1978), p.12.

25. Mba (1977), p.13.

26. Ayeni (1978), p.13

facilities may have been stretched above their rated capacity. The problem stems from the reliance of the industry on external sources of supply of these essential materials. Effort is now directed at producing some of them locally, e.g. meters, cables and transformers.

(iv) Coordination. There is lack of coordination between NEPA on one hand, and Government agencies and private organisations on the other in the process of development planning. Most public and private agencies plan projects that have physical and power supply implications without consulting NEPA right from the conception stage. It is only when the physical facility is ready that NEPA is invited to connect in their power supply. Thus it is not unusual to find a new residential neighbourhood springing up without adequate arrangements for power and water connections. The effect has always been to disrupt NEPA's plans, especially where such facility (e.g. a new industry) requires a large power demand.[26]

The Future

What future for the industry? We may expect improvements in the supply of power, when and if the new and current projects are fully realised. With further reductions in Government expenditures anticipated, total money income may not grow as fast as it did in early 70s:

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26. Ayeni, op. cit.

yet, the rate of growth of electricity demand may not decline.[27] Furthermore, provisions have been made in the new constitution for states to own and operate electric utilities. The repercussions are likely to be great especially if states can gather the necessary resources.[28] The implications in terms of generation and transmission development, tariff structure, and distribution system will need careful analysis by the Federal Ministry of Mines and Power.

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27. See Chapter 6.

28. Developments in this direction seem to be taking place. Prior to this, the Plateau State Government was planning to take 60 percent shares in NESCO. And Kaduna State Government is resuscitating its Water and Power Development Company as a joint venture with a German firm. See New Nigerian of 5th June, 1978, p.15.

CHAPTER THREE

REVIEW OF RELATED LITERATURE*

Houthakker (1951b) undertook a cross section analysis of residential electricity consumption in Britain for the year 1937/38. Taking a sample of 42 towns, he sought to find out the significant explanatory variables in the demand for electricity by the residential consumer group facing a two-part electricity tariff.[1] The general form of his model was:

$$(1) \quad x = f(m, p, g, h, e)$$

where

x = average annual electricity consumption per consumer

m = average money income per household with a domestic two-part tariff

p = marginal price of electricity

g = marginal price of gas on domestic tariffs

h = average holdings of heavy domestic equipments[2] per customer

e = distubance term

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* We are not entirely certain if there has been any explicit attempt at an econometric estimation of electricity consumption in Nigeria. Ukpong (1976) dwelt on the supply side and also tried to forecast future level of demand from a simple regression model of income and electricity demand.

1. Different electricity tariff systems are reviewed in Bolton (1951), Houthakker (1951a) and Caywood (1956).

2. These include cookers and boilers, according to Houthakker.

For estimation, he used the linear and logarithmic function of (1)

(2) i.e. $x = am + b/p + cg + dh + e$

Houthakker experimented with different forms of p and g in his estimation: these are p, p_{-2}, p_{-4}, g and g_{-2}. Using the correlation coefficients between the variables as a choice criterion, the final form of his model included m, p_{-2}, g_{-2}, h as the arguments in the function (2). He presented the result of the estimation of

(3) $x = a + am + b/p_{-2} + cg_{-2} + dh + e$

(4) $\log x = \alpha \log m + \beta \log p_{-2} + \gamma \log g_{-2} + \delta \log h + \log a + \varepsilon$

All the coefficients in the two equations have the right sign: nearly all were significant at 0.05 confidence level except g_{-2} in (5).[3] The elasticities were positive for m, negative for p and positive for g. Thus for those British towns surveyed marginal price of electricity and gas and money income of households were the important determinants of electricity consumption.

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3. He however doubted the coefficient of h but did not state why.

Houthakker, in the same study, gave the results of a time-series estimation of electricity demand for the years 1920-38:

(6) $\log x = 0.89 \log Y - 0.61 \log p/\pi + 0.045\ t$

where

x = annual domestic electricity consumption per consumer

Y = calculated average income of domestic electricity consumers.

p = average price of electricity

t = time trend.

π = price level index.

Regrettably he did not elaborate on this aspect of his study (see p.368).

Fisher and Kaysen (1962) (henceforth F-K) used pooled time-series cross-sectional data (1946-1957) from each of 47 American States to estimate electricity demand for both residential and industrial consumers.[4] For residential, F-K estimated electric energy demand (indirectly) by hypothesising that it is proportionate to the stock of electric appliances held by households. Thus they built demand models for each of four electric appliance types: washing machines, refrigerators, ranges[5] and ironing machines. For instance their

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4. F-K's work itself was not accessible to us. What follows therefore relies on the accounts of Wilson (1971), Halvorsen (1975) and Mount, Chapman and Tyrell (1974). Wilson and Halvorsen discussed F-K's results for residential class only.

5. Refers to cook-stove.

specification for electric ranges was

$$(R_t - R_{t-1})' = A + b_1 (Y_{t-1})' + b_2 Y_t' + b_3 E_{rt}' + b_4 G_{rt}' + b_5 (H_{t,} - H_t - 1)' + b_6 (F_t - F_{t-1})' + b_7 M_t' + b_8 P_{et}' + b_9 P_{gt}' + b_{10} N_t + U$$

and the variables were defined as

R_t = stock of electric ranges

Y_t = present income

E_{rt} = price of electric ranges

G_{rt} = price of alternate gas ranges

H_t = number of wired households

F_t = change in population

M_t = marriages

P_{et} = average price of electricity

P_{gt} = average price of Natural Gas

N_t = average electricity consumption per hour of normal use.

A and U are respectively constant and error terms, the b's are coefficients, and the prime notation is for natural logarithms.

In their estimation, F-K used state-wide averages of all the variables specified for the eleven years 1949-51 and 1951-57.

F-K's results seemed contrary to theoretical expectation. The most significant explanatory variables were demographic factors (H_t, P_t, M_t); the price of electricity was not a significant determinant of changes in the stock of appliances. Furthermore, P_{et} usually carried a positive sign, and its elasticity was less than unity. They inevitably concluded that in the long run price effects were "small on the whole". (p.112; Fisher and Kaysen, (1962))

F-K's results and conclusions have since been seriously questioned. Wilson (1971) made four observations on their analysis. First, that the data employed were of "uncertain quality". Second, that they examined only a restricted group of appliances which had no "adequate" substitutes (i.e. gas-using alternates) and whose consumption of electricity was only a fraction of total potential electricity requirement. Third, that they relied rather exclusively on "state-wide" averages, especially in the price of electricity, when in fact state and market boundary usually do not concide. Further, he asserted, average price of electricity was partly endogenous since it depended also on the amount consumed.[6]

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6. This would necessarily be the case if the tariff were the block type. See Houthakker (1951a), p.4.

Finally, that F-K's analysis merely brought out a fairly predictable time-dominated association among population, income, and electricity sales, without adequately defining the "all-important" price-quantity relationship.

Halvorsen (1975) attributed the apparent lack of significance of economic variables (P_{gt}, G_t, P_{et}) in F-K's analysis to the "nature of the specification of their demand equation". While all economic variables (save long-run income) were expressed as levels, the non-economic variables were stated as growth rates. He observed that they in effect regressed the growth rate of appliance stocks on the growth rates of non-economic variables and the levels of the economic variables. In such a case the equation would not show the true causal relation between the economic variables and the stock of appliances.

Baxter and Rees (1968) (henceforth B-R) examined the industrial demand for electricity in Britain. For the purpose of their study, they employed quarterly data (for the period 1954-64) to quantify the determinants of electricity demand in 16 industry groups. B-R's main approach was to treat electricity as an input entering into the production function of an industry. On this basis, they were able to develop specific hypotheses as to the forms of relationships involved in industrial electric energy demand.

They noted that electricity consumption was growing faster than output and adduced "three broad sets of reasons" which might account for this phenomenon; and these three reasons constituted the basis of their hypotheses:

(a) relative price movements may induce substitution of electricity for other fuel inputs and possibly labour.

(b) technological change may be such as to lead to innovations which are based on the use of electricity and which induce substitution against other fuels. They argued that price movements need not occur in this case; or else the increase in efficiency easily outweighs any neutral or adverse price changes.

(c) the economic theory of returns to scale which may explain the non-proportional variations in input and output. They observed, however, that electricity's relationship to output is indirect (through the medium of plant and machinery), casting doubt on the relevance of this theory.

They proceeded to derive three forms of model:

(a) The general form: this embodies the theory of demand for an input. A Cobb-Douglas production function was assumed for each industry, defining inputs to be labour, capital, oil, gas, coal and electricity.

$$(1)\quad Q = \alpha_o x_1^{\alpha_1} x_2^{\alpha_2} \ldots\ldots\ldots x_k^{\alpha_K}$$

where

Q is output

x_j is input

α_j is a parameter ($j = 0, 1, 2, \ldots\ldots, k$)

Assuming firms wish to minimise the cost of any given output, then total outlay is given by

$$(2)\quad C = p_1 x_1 + p_2 x_2 + \ldots\ldots + p_k x_k$$

where

C is total cost of production

p_j is input price ($j = 1, 2, \ldots., k$)

The minimisation of (2) subject to constraint in (1) can be obtained by introducing a Langrangian multiplier. Thus if the constrained equation is solved for the k^{th} input (electricity) then k^{th} demand function would be:

$$(3)\quad x_k = p_o p_1^{\beta_1} p_2^{\beta_2} \ldots\ldots\ldots p_k^{\beta_k} Q^{\beta_{k+1}}$$

This implies that electricity demand is an exponential function of the k input prices and output,

where

β_j ($j = 0,1,2,\ldots,k+1$) are parameters representing combinations of α_j ($j = 0, 1, \ldots\ldots, k$)

(b) The second form of model placed emphasis not on relative price and output as in (a) but on the effect of changes in fuel technology. This was postulated to be reflected in the declining demand for coal by industries; hence declining coal consumption stood as surrogate for more efficient technological change.

(c) The third form was constructed upon the promise that there exists a one-for-one relationship between changes in output and electricity, so that deviations from this relation are contended to be induced by changes in relative prices, and changes in labour and capital intensity. Hence

$$(4) \quad D_t = \gamma Q_t \quad \text{or} \quad D_t/Q_t = \gamma_t \quad (t, 1, 2, \ldots\ldots, n)$$

where

D_t is electricity demand in time t

Q_t is output and

$$(5) \quad \gamma_t = f(Y_{1t}, Y_{2t}, \ldots\ldots, Y_{mt})$$

where

Y_{mt} are relative prices, labour and capital intensities.

B-R estimated thriteen equations broadly subdivided into three categories corresponding to hypotheses (a) to (c) above.
The first category comprised four exponential equations relating electricity demand (consumption in kwh) to five explanatory variables.

The general form is

$$(6)\quad D_t = f\ (Q_t,\ T_t,\ (P/F)_t,\ t,\ (P/W)_t)$$

The second category specified 5 linear equations of the general form

$$(7)\quad Z_t = f(Q_t,\ T_t,\ C_t,\ t,\ (M/Q)_t,\ (I/Q)_t)$$

The third category contained four exponential equations whose general form is

$$(8)\quad (D/Q)_t = f\ (T_t,\ (P/F)_t,\ (P/w)_t,\ (M/Q)_t)$$

and the variables were defined as

D_t = electricity consumption in kwh.

Q_t = index of production

T_t = temperature

$(P/F)_t$ = $\frac{\text{Price of electricity}}{\text{Price index of all other fuels}}$

t = Time

$(P/W)_t$ = $\frac{\text{Price of electricity}}{\text{Average Wage-rates}}$

Z_t = electricity consumption in coal equivalent tons.[7]

C_t = Coal consumption

$(M/Q)_t$ = $\frac{\text{Numbers employed}}{\text{Index of production}}$

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7. A base measure for all types of energy. B-R employed it to facilitate comparison between coal and electricity.

$(I/Q)_t$ = Gross fixed capital formation / Index of production

$(P/Q)_t$ = Consumption ratio.

In addition, the thirteen equations were estimated using time lags: the lag form being the geometrically distributed type.[8]

Judging from the results, B-R felt that the first and second categories of equations performed better than the third group in terms of goodness of fit (R^2) and standard error of estimate (SE). Furthermore, results indicated that the lagged dependent variables $\log D_{t-1}$, Z_{t-1}, $\log (D/Q)_{t-1}$ were found to be significant in nearly all the industries groups.

C_t and Q_t were significant in 7 to 10 groups, $(P/F)_t$ $(T/Q)_t$ and $(P/W)_t$ in 7 groups each and $(I/Q)_t$ also in 7 B-R's analysis of each industry group's results showed that:

(1) the output variable (Q_t) is significant in all the capital-intensive industries, but only in half of the labour intensive industries. This tended to lend credence to their earlier contention that the relationship between output and electricity demand may to a large extend be determined by characteristics of the capital stock (the (b) hypothesis above);

(2) there does not appear to have been a greater responsiveness of electricity demand to changes in the price-wage relative in the labour-intensive industries;

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8. B-R did not say which estimation technique they used.

(3) the significance of the fuel price relative is fairly distributed over capital and labour-intensive industries;

(4) in nine of the sixteen industry groups price elasticity of demand is zero.

They concluded

(a) relative price changes are not "unambiguously" (p.295) an important determinant of growth in industrial electricity consumption,

(b) the chief determinants are growth in output and changes in technology;

(c) electricity demand is highly responsive to changes in output and fuel technology, but relatively unresponsive to price.

Wilson (1971) discussed the results of a cross-section analysis of electricity consumption in U.S. urban households for the year 1966. His objective, as he put it, was "to estimate and evaluate intermarket variations in the quantity of electricity demanded by households in response to intermarket variations in electric power rates" (p.7). Wilson approached the subject-matter from two angles. In the first, in which the observation unit was the city, he regressed average electricity consumption per household (kwh per year) on its price, the price of its substitutes and other

variables. In the second case, where the observation unit was the standard metropolitan statistical area (SMSA), he regressed the "percentage of homes" possessing a particular type of appliance on specified explanatory variables.[9]

For the first part he employed a sample of 77 major American cities. His hypothesis was that

$$(1) \quad Q = K + b_1 P + b_2 G + b_3 Y + b_4 R + b_5 C$$

where

Q = average electricity consumption per household

P = price of electricity

G = price of natural gas

Y = medium family income

R = average size of housing units (rooms per unit)

C = degree days.[10]

K and b_i ($i=1 \ldots\ldots, 5$) are the intercept and the parameters respectively. Both the linear and log form of (1) were estimated,

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9. This part of his study is akin to Fisher and Kaysen's residential analysis; though he pointed out that there exists methodological differences between the two studies.

10. It is the product of the number of degrees below 65°F and the corresponding number of days (Berndt and Watkins (1977), p.101, (footnote 2).

and the results conformed substantially to apriori expectation. Electricity price, gas price and income variables were statistically significant. Moreover, the Beta coefficients showed that the own-price variable is "the dominant determinant of Q" (p.12). But while the two prices had the right signs, the coefficient of income carried a negative sign (contrary to what one might expect). The logarithmic estimates of the coefficients showed:

(a) price elasticity to be greater than unity

(b) cross-elasticity of gas price was of substantial magnitude.

The second part involved a sample of 83 SMSAs and the following relationship was specified:

(2) $S_x = K + b_1 P + b_2 G + b_3 Y + b_4 C$

(3) $\log S_x = K + b_1 \log P + b_2 \log G + b_3 \log Y + b_4 \log C$

S_x refers to the percentage of homes with at least one unit of appliance X: i.e. electric water heaters (S_w), electric ranges, drier(S_d), space heaters (S_h) (S_r), food freezers (S_f) and air conditioners (S_a). G was not included in the equations for S_a and S_f since they have no gas substitutes; C did not feature in the equations for S_r and S_f, as climate does not greatly influence their use.

For the six equations estimated (one for each appliance) the results contradict Fisher and Kaysen's findings.

In all cases, except for airconditioners, the own-price coefficient was both statistically significant and dominant (Beta coefficient). For S_h, S_w, and S_r, the G coefficient was also significant with a positive sign. Except again for S_a, the elasticity values of P exceeded unity; the cross elasticities of G were also substantial for S_r, S_v, S_d and S_h. The climate factor (C) was fairly important in the case of air conditioners (S_a) dryers (S_d) water heaters (S_w) and space heaters (S_h). In conclusion, Wilson wrote:

(a) price is a major determinant of intermarket variations in the average volume of residential electricity consumption;

(b) residential demand for electricity is price elastic and is influenced substantially by the price and availability of natural gas.

Anderson (1973) did a study almost similar to Wilson's. But there are differences; he (Anderson) incorporated a "dynamic formulation that explicitly distinguishes between customers who choose to remain locked into a particular level of electricity consumption because of the cost of altering their stock of appliances and those who choose to modify their stock" (p.527).

Secondly he examined more closely "the important case of all electric homes"[11] (p.528). Thirdly, he undertook a time-series study of the Californian residential demand for electricity, in addition to the cross-section study. With respect to the latter, he selected 1969 for his analysis: the observation unit was the state (cf:Wilson, cities and SMSAs). For the Californian time-series study the period covered was 1947-69.

Anderson tried to distinguish between two groups of consumers of electric power: those who stay locked into particular patterns of energy use because of the cost of altering their equipment, and those willing to make major changes in their stock. The "locked-in" customers (i.e. those in short-run equilibrium situation) may control their electricity consumption by "varying the intensity of use of their equipment." (p.529) Because of the low variable/fixed cost ratio for most electrical appliances and the element of habit, short-run demand may be nearly unresponsive to changes in income and, gas and electricity costs. On the contrary, those customers who choose to modify their stocks would influence demand significantly.

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11. Defined as those with electrical central heating. In addition, some had central airconditioning.

Consequently his model was structured to reflect the assumption that locked-in consumers were entirely "unresponsive to energy and income." He further assumed that a given constant fraction δ of the customers in year t-1, will be locked in year t, so that the number of flexible customers will be $(1-\delta)$ of year t-1 customers plus all "new" customers in year t. If the locked in customers are a representative cross-section of all customers in year t-1 then locked-in demand in year t would be δD_{-1}. Flexible demand would therefore be equated to the number of flexible customers times a function $F(.)$, that determines average demand per flexible customer. Total demand would be:

$$(1) \quad D = \delta D_{-1} + F(.)\,(H - \delta H_{-1}); \text{ or}$$

$$(2) \quad \frac{D - \delta D_{-1}}{H - \delta H_{-1}} = F(.)$$

(2) is in fact the general form of demand equations estimated by Anderson. He argued that marginal rather than average price was more appropriate for estimation.[12] He specified the demand equation as

$$(3) \quad \ln DE = a_0 + a_1 \ln DCE + a_2 \ln PG + a_3 \ln RYPH + a_4 \ln SOH + a_5 \ln NMP + a_6 WTEMP + a_7 STEMP + u$$

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12. Due to quantity discounts inherent in block tariff consumers are likely to look at the marginal cost of using additional power, not the average.

where

D = total quantity of electricity consumed annually by residential customers

H = average number of residential customers

DE = quantity of electricity consumed annually per flexible customer i.e. $(D - \delta D_{-1}) / (H - \delta H_{-1})$

CE = average real cost to residential customers of 500 kwh/month

DCE = average real cost to residential customers of 1000 kwh/month-CE (defined above)

PG = average real cost of gas to residential customers

RYPH = average real personal income per household

SOH = average size of household (persons per household)

NMP = fraction of population living in non-metropolitan areas

STEMP = average January temperature

WTEMP = average July temperature

U = error term

OLS technique was used to estimate (3).

The problem that arose in the estimation process was how to get at the value of δ as no data was available for it. Anderson got round the difficulty by estimating his equations with five different values of δ (0,0.5,0.75,0.90,0.95). Surprisingly, the results revealed a good degree of stability in the coefficient estimates

obtained; only the constant terms were affected whenever the value of δ was altered. Also, the coefficients of DCE, RYPH and NMP were consistently highly significant (for $0.75 \leq \delta \leq 0.95$)
But PG and WTEMP tended to be marginally significant (even then only for low values of δ). Comparing his results with Wilson's, they differed in regards to the sign of the income variable where his carried a positive sign; the size of the price and cross-elasticities were lower than Wilson's.

For the estimation of demand by the all-electric homes, (a) he replaced DE with FAEC (fraction of residential consumers classified all-electric), (b) he introduced FAEC as an additional argument in equation (2). The results (from (a)) confirmed that the level of electricity demand in the all-electric homes "is sensitive to energy costs" (p.544) and that variations in electricity cost, in particular, "may affect demand significantly by influencing the desirability of all-electric homes" (ibid). On the other hand, the results (from (b)) showed that energy costs and income exert more influence strongly through factors other than the all-electric home saturation.

In the time-series analysis for California, Anderson altered the explanatory variables in (3) above. WTEMP, STEMP and SOK were not included, while time, T, was introduced, NMP was excluded on the

grounds that it was strongly time-trended. So only Y,T, CE and PG were included as arguments in the function F(.), where Y is per capita income.

(4) $\ln DE = a_0 + a_1 \ln CE + a_2 \ln PG + a_3 \ln Y + a_4 \ln T$

OLS was again applied here. Also different δ values were exogenously specified and used in the estimation of (4). The results indicated that cost and income coefficients contrasted with their cross-section counterparts. They also lacked statistical significance for $\delta \geq 0.5$. He attributed this to the intercorrelation between CE,PG and Y, on one hand and T on the other. To avoid multicollinearity, he developed a new dependent variable, based on estimates for the coefficients of CE, PG and Y in the cross-section results, and regressed it on T. The outcome of this led him to conclude that the estimate of the T-coefficient in (4) might have overstated the effect of time-related variables other than income and energy costs.

Anderson devoted the final part of his study to making "illustrative" projections of electricity demand in California for the years up to 2000. He assumed some constant future rates of growth for DCE, PG, RYPH and H, and then projected the expected increases in consumption. He also illustrated the effects of changes in the energy costs on the growth of demand; these revealed that

moderate changes in energy costs would have "limited impact" on electricity growth. He then argued for a program to limit the growth of demand, since a high growth rate would increase the environmental hazards associated with electricity production and distribution.

Mount, Chapman and Tyrell (1974) estimated the demand for electricity in the U.S. using annual pooled time-series (years) cross-section (states) data. They stated: "the main objective of our analysis is to determine the magnitude of the relationships between the quantity of electricity demanded and causal factors such as price" (p.318). The other causal factors listed are population, income, price of substitute fuels such as gas, and the price of complementary products such as household appliances, electrical machinery and equipment. The time-series data covered the period 1947-1970 involving data from "47 contiguous" American States.

Mount et al departed from others in their model specification. Previous writers usually postulated constant elasticity models (CEM), but Mount et al argued that (with the use of cross-section data) CEM estimates would be "statistically sound only if the elasticity for each factor is the same in each state" (p.319). Instead, they specified a variable elasticity model (VEM) to "permit some degree of heterogeneity between states" (ibid). In a VEM, the

elasticity value of a factor depended on the level of that factor. They went further to build a separate model for each of the electricity consumer classes; residential, commercial and industrial. The lagged form of the dependent variable (geometric lag structure was assumed) was included in models as an argument to reflect what they referred to as "the relationship between the use of electricity and existing stocks of electrical equipment and appliances" (ibid). Both the long and the short run elasticities were estimated from the models. The general forms of the latter are:

Constant Elasticity Model

$$(1)\quad Q_{it} = Q_{it-1}^{\lambda}\ V_{1it}^{\beta_1} \ldots\ldots V_{Nit}^{\beta_N}\ \exp\ (\alpha_j)$$

and

Short-run elasticity for V_n is β_n

Long-run elasticity for V_n is $\beta_n/(1-\lambda)$

Variable Elasticity Model

$$(2)\quad Q_{it} = Q_{it-1}^{\lambda}\ V_{1it}^{\beta_1} \ldots\ V_{Nit}^{\beta_N}\ \exp\ \alpha_j + \frac{\gamma_1}{V_{1it}} + \ldots\ \frac{\gamma_N}{V_{Nit}}$$

and

Short-run elasticity for V_n is $\beta_n - \gamma_N/V_N$

Long-run elasticity for V_n is $(\beta_N - \frac{\gamma_N}{V_N})/(1-\lambda)$

where

i denotes the i^{th} state

j denotes the j^{th} region (e.g. South Atlantic)

t denotes the t^{th} year

Q is quantity of electricity demanded

V_n is the level of the n^{th} factor e.g. income

λ, β_n, γ_n, α_j are unknown parameters.

The log forms of (1) and (2) were estimated by the OLS procedure while the instrumental variable (IV) technique was applied only to (2)

The major conclusion from their results was that the price of electricity was a more important determinant of demand than either population or income in terms of the long-run elasticities (LREs). Demand for each consumer class was price elastic but income inelastic. The LRE for appliance prices was inelastic for residential consumers, and statistically insignificant for the industrial and commercial consumers.[13] The difference between the OLS and the IV estimates obtained from the VEM was that the implied rate of adjustment (λ)

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13. The coefficient of the price index for electrical machinery and equipment (of industrial and commercial consumers) was actually constrained to zero due to incorrect sign and lack of statistical significance of initial estimates. (p.320).

is faster using IV, especially for commercial and industrial consumers. As a result, the short-run elasticities were generally larger with IV. The LRE for own-price further indicated that as the own-price increased, demand would become increasingly elastic. Invariably price would become a more important determinant of electricity demand. Mount et al concluded that if prices increased in the near future "in response to increased fuel cost etc, the growth of electricity demand will gradually decrease from the present rate"(p.325).

Tyrell (1974) was a follow-up on the work of Mount et al (1973). He used the latter's model to make projections of future electricity demand. For that purpose, he assumed some likely future levels of the significant causal factors in the model (own-price, gas price, population and income for all consumer classes plus, appliance prices for residential). Tyrell chose for his projections, the variable elasticity model estimated by the OLS procedure. He argued that this version had a better predictive power than others: the criterion of choice was the 1971 ex-post forecast performance of the equations.

Three different rates of change were assumed for the future levels of electricity price, income, gas prices, and price of appliances (for residential), but only two for population.

The ultimate aim was to make high, medium and low projections of electricity demand based on the varying magnitudes of each of these rates of change. Yet, as a point of reference, Tyrell made what he called a "base case" projection from the model assuming the medium growth rates of income and prices, and the upper rate for population as the future growth paths of these causal factors. The results of his predictions were lower than the forecasts from earlier studies. On the other hand, he acknowledged that there might be some uncertainty in his projections "due to the sensitivity of the model to alternative assumptions about the explanatory variables". (p.354).

Halvorsen (1975) considered the determinants of residential demand for electric energy. He estimated a static demand model with pooled data from 48 states for the nine years (1961 - 1969); and a dynamic model with 1969 cross-section data. He had two equations in his model: demand and price equations. The latter was incorporated since the marginal price paid for electricity depends on the level of consumption (cf: block tariff).
The general form of his model ran thus:

(1) $Q = Q(P_m, W, u)$ - demand equation

(2) $P_m = P_m(Q, Z, u)$ - price equation

Q is the average electricity consumption per customer, P_m is marginal price of electricity, W and Z are vectors of all other variables, u and v are error terms. However, because of the lack of data on P_m, (1) and (2) could not be estimated directly by the 2-stage least squares to obtain consistent elasticity estimates. In order to derive elasticities, Halvorsen used average price data to estimate (2) having proved that only the magnitude of the constant term would be affected by the substitution. It was also possible, he argues, to use another price variable, the Typical Electric Bill[14] to estimate directly the reduced form of (1) and (2) which is given by:

$$(3) \quad Q = Q(B, W, w)$$

The specified static demand equation estimated by Halvorsen was

$$(4) \quad Q = b_o + b_1 P_m + b_2 Y + b_3 G + b_4 A + b_5 D + b_6 J + b_7 R + b_8 M + b_9 H + b_{10} T + U$$

All variables are in logarithm except T and

Q = average annual sales (kwh) per customer

P_m = marginal real price of residential electricity

Y = average real income per capita

G = average real price per therm for gas

A = index of real whole-sale prices of electrical equipment

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14. The Typical Electric Bill (TEB) is the monthly cost per kwh of 500 or 1000 kwh of electricity for different locations in U.S. It is constructed by the U.S. Federal Power Commission.

D = heating degree days

R = percentage of population living in rural areas

M = percentage of housing units in multi-unit structures

H = average size of households

T = time

$\bar{u}$ = disturbance term

The static price equation was given as

(5) $N_m = b_o + b_1 Q + b_2 L + b_3 K + b_4 F + b_5 R + b_6 I + b_7 T + V$

where all variables are in logarithms: Q, R and T are as defined above and

N_m = nominal marginal price of electricity

L = cost of labour

K = percentage of generation produced by publicly-owned utilities

F = cost of fuel per kwh generated

I = ratio of industrial to residential sales

V = error term

N_m was deflated by the price index to obtain real marginal price.

The 2-stage least-squares technique was applied to the structural equations (4) and (5). Halvorsen's results corroborated some earlier findings. Own-price elasticity was close to unity, income elasticity was less than unity, while gas cross-elasticity was rather small. The signs of the coefficients conformed: negative for own-price, positive for income and gas coefficients.

The coefficient of R was positive; this implied that the greater the proportion of rural dwellers, the more electricity consumed, since there are less substitutes for electricity in the rural areas. J was positive: the higher the temperature, the more the need for cooling. Finally there was little difference between the results obtained from the dynamic and static formulations of (4) and (5).

Only direct (partial) elasticities can be obtained from the structural equations (4) and (5); the total elasticities (which account for both direct and indirect effects of the explanatory variables on quantity purchased) can be obtained by solving the reduced form equation. But Halvorsen tried to estimate total elasticities in two ways: (a) by solving the estimated demand and price equations for the reduced-form equation for Q; (b) by estimating the reduced form directly using the TEB variable. The magnitude of the elasticity values obtained from both approaches differed for all variables except G: this meant that these values were sensitive to the choice of methods. The results here were less reliable than those obtained for the direct elasticities.

Halvorsen, in his conclusion, analysed the implications of his results for future electricity demand, especially if certain growth paths were assumed for gas price, population, household size and electricity price. He noted that the last-named might increase in the future, consequently dampening demand. So, like Tyrell (1974), he felt that forecasts of long-run demand made by earlier writers might have been too high.

Wilder and Willenborg (1975) identified the limitation on past studies as the lack of "micro-level" data. The aggregation of data did not permit in-depth analysis of household-level determinants of electricity demand. So they undertook a cross-section study of households for a single metropolitan area and attempted to estimate the relationships between electricity demand and its causal factors. They contended that household electricity consumption depended on three household characteristics:

(a) the stock of electrical appliances;

(b) the size of the residence; and

(c) the intensity with which appliances were used.

Mainly on the basis of the preceeding they constructed a model of household demand containing four equations:

$$(1)\quad H = a_o Y^{a_1} F^{e_2} e^{a_3} U_1$$

$$(2)\quad A = b_o Y^{b_1} e^{b_2 R} N^{b_3} U_2$$

$$(3)\quad E = c_o Y^{c_1} H^{c_2} A^{c_3} e^{c_4 D} P_a^{c_5} U_3$$

$$(4)\quad P_a = d_o E^{d_1} e^{d_2 L} U_4$$

where

e stands for exponential

H = the residence size measured in number of rooms

A = stock of appliances from the list: range, washer, dryer, dishwasher, water-heater.

E = household annual electrical consumption (kwh)

P_a = average price per kwh

F = family size

R = race dummy 0 - white households

1 - non-white

Y = annual gross family income

L = dummy 0 - "all-electric households"

1 - others.

N = classification variable measuring age of the household head, taking values 1 to 6 for teens through sixties respectively.

D = season dummy 0 - if an element of summer sample

1 - if an element of spring sample

(1) to (4) can be linearised taking the logarithms exceptfor the dummies. (1) and (2) were estimated by OLS, (3) and (4) simultaneously by the 2-stage least squares.

Like Halvorsen (1975), they derived partial elasticities from the structural equations (3) and (4) and total elasticities from the reduced form equation (5).

$$(5) \quad E = f_o \; Y^{f_1} \; p^{f_2} \; e^{f_3 D} \; U_5$$

The data used came from a survey of 158 households in spring and 116 in summer. Usable response rate were 73 percent for the spring survey and 55 percent for summer.

Estimates obtained from (1) and (2) indicated that family income (Y) family size (F) and race (R) are important determinants of residence size and appliance stock holding. Age of household head was significant only for the stock of appliances. Both the partial and total elasticities estimates of electricity price obtained from the 2SLS estimation of (3) and (4) were close to unity.

For income, it was less than unity for both types of estimates. Therefore they confirmed the findings in earlier studies. But the income elasticities were rather low, lower than the estimates of previous studies. They attributed this to the absence (in their sample) of households with income below 5000 dollars. The other significant variable was the size of residence. They concluded that "a unitary price elasticity of demand would suggest that the price mechanism could be an effective way of rationing electricity during potential future shortages" (p.217).[15]

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15. We wish to note the absence of a substitute fuel (or its price) as an argument in their equation; much unlike previous authors.

CHAPTER FOUR

THE DATA*

The source and nature of the data used in the estimation of the models are presented here. In addition, the limitations imposed on the study by the deficiencies in the data are enumerated. To mitigate the deficiencies, certain modifications were necessary: these are also discussed.

Electricity Consumption: Annual figures of electric energy consumption were obtained from two sources: (a) the Annual Reports of the old E.C.N. for the years 1954/55 through 1969/70; (b) statistical worksheets of the N.E.P.A. Commercial Department, Electricity Headquarters, Lagos, for the years 1970/71 to 1975/76. The figures were analysed into the different component groups of electricity consumers (residential, commercial, industrial and others), though the classification was inconsistent over the period examined. In 1954/55 and 1955/56, for instance, consumption was divided between five groups: residential, commercial, power[1], public lighting, general purposes and other tariffs.[2] In 1956/57 the classification

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* The data figures are listed in Appendix IV.

1. As a matter of fact, it refers to industrial consumption of electricity.

2. See Appendix IIA for the definitions of these consumer groupings and others that may follow.

changed: commercial and industrial energy consumption (formerly separated) came under one column, while a new class, special agreement and bulk supply, emerged. This classification pattern remained so till 1965/66. Meanwhile what was tagged "public lighting" was changed to "street lighting" in 1958/59. And from 1959/60 the "special agreement and bulk supply" class was simply referred to as "special agreement."

The pattern altered again in 1966/67: essentially, commercial and industrial consumption were separately accounted for, and a new column, "combined rate", appeared. In that year, there were seven consumption groups. The following year, reclassification led to the deletion of the "general purposes and other tariffs"; "commercial" and "combined rate" came under one column. Yet, a new column "miscellaneous" was added to existing ones.[3] The "special agreement" column was done away with in 1968/69 leaving only five groups: residential, commercial, industrial, street lighting and miscellaneous. The latter did not appear in 1969/70, leaving only four groups. The classification format remained like this till the end of 1973/74. The year following that, a new column

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3. The 1968/69 Annual Report seems to suggest that it was the "general purposes and other tariffs" that was renamed "miscellaneous."

designated "commercial and industrial", was inserted, making five groups. The column disappeared in 1975/76 but a new one took its place: "schedule A commercial".[4] The same year, there was no "street lighting" column.

It is proper to note here that the consumer classifications have varied over the years in consonance with the structure of the tariffs operated by the then E.C.N. (the tariffs are reviewed later). For thirteen years (1956-1969), the tariff remained unchanged (Appendix IIA). A new tariff was introduced in September 1969: so the "special agreement" and "general purposes," columns disappeared. In October 1973, the tariffs were rationalised to take account of the decimal currency system: though the opportunity was used to reduce the sizes of the energy blocks in the commercial tariff. Table 4.1 is a schematic illustration of the foregoing.

Another point of interest is the consistency of the residential consumer group in the classification. This means that the data on residential consumption might be more reliable than others. This is to be expected since it is easy to distinguish between residential and other consumers: such distinction becomes blurred between commercial and industrial users.[5] In fact, we have seen

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4. Refers to those commercial consumers who are connected to single-phase, small voltage current. See Appendix IIB.

5. For example, Ahmadu Bello University, Main Campus takes a heavier power load (KVA) than some small industries (e.g. bakeries) in Zaria, yet by definition the latter are classified industrial, the former commercial. See Appendix IIA

TABLE 4.1

Electricity Consumption Classification 1956 - 76

Period	Groups
1954/55 and 1955/56	1) Residential 2) Power 3) Commercial
	4) General Purposes and Other Tariffs
	5) Public Lighting.
1956/57 to 1965/66	1) Residential 2) Commercial and Industrial.
	3) Special Agreement and Bulk Supply
	4) General Purposes and other tariffs
	5) Street Lighting.
1966/67	1) Residential 2) Commercial and Combined Rate
	3) Industrial 4) Special Agreement
	5) Miscellaneous 6) Street Lighting.
1968/69	Exclude Combined Rate and Special
	Agreement from the the preceding.
1969/70 to 1973/74	1) Residential 2) Commercial 3) Industrial
	4) Street Lighting.
1974/75	1) Residential 2) Commercial 3) Industrial
	4) Commercial and Industrial 5) Street Lighting.
1975/76	1) Residential 2) Schedule A Commercial
	3) Commercial 4) Industrial.

that the commercial and industrial groupings were not coherent over time (hence, such group as special agreement, etc.). This, as we shall later discover, introduced some complications into the estimation of the models.

To make the data suitable for the study, consumption figures for commercial, industrial, special agreement, general purposes and other tariffs (later miscellaneous) and combined rate were summed up into one group under the generic term "commercial and industrial". Why? The "specialy agreement" groups referred to users with high power demand (see Appendix IIA), who invariably were industrial concerns. The "general purposes and other tariffs" and the "combined rate" consumers were essentially commercial electricity users (again, see Appendix IIA).[6] Finally the combination of all these groups was necessitated by the fact that the commercial and industrial consumption were not separately analysed for a long period (1956/57 through 1965/66). This last factor has an implication for the derivation of electricity prices for the period concerned.

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6. I am grateful to Mr. P. B. Akande, Chief Statistician N.E.P.A. Headquarters, and Mr. Duntoye, District Commercial Manager, Kaduna, for their useful explanations on the classification of consumers as has been discussed here.

The residential group, being identifiable, was left alone. Street-lighting consumption was not included in the estimation of the models. This was to avoid complications in the results. Moreover the proportion involved is rather small.

Three variants of total electricity consumption were used in the estimation of the models. The first is the ratio of commercial/industrial energy (kwh) sales to residential sales. It was derived by dividing commercial/industrial consumption by the residential consumption. The second is the proportion of the commercial/industrial energy sales actually consumed in Lagos. From the town-by-town breakdown of energy sales obtained from N.E.P.A. records the percentage due to Lagos was worked out for each year. The third variant refers to the part of national residential energy sales consumed in the tariff Area I. The latter refers to some parts of the country which enjoyed lower tariff charges than the rest (see Appendix IIA, IIB and IIC). From the town-by-town sales figures, residential energy consumption figures for Area I were extracted, and the percentages calculated.

Prices

Electricity Price: Electricity pricing is part of a larger subject involved with electric utility tariffs.[7] Before discussing how we derived the price data used in the model estimation, we would like to review the different tariffs (old and present) operated by N.E.P.A. since 1956.

The old E.C.N. operated, in 1956-69 period, more or less a two-part tariff for residential, commercial and industrial consumers; and a flat-rate for general purposes (Appendix IIA). The two-part tariff consisted of:

a) Fixed (power demand) charge

b) Running (energy) charge

Part (a) was based on the size of the floor area of a user's premise in the case of residential consumers; for commercial and industrial, it was based on the maximum (power) demand measured in kilovolt-amperes. Part (b) was computed from the amount of energy (kwh) used. In fact energy charges were the same for the three consumer groups. But the tariff discriminated between one part of the country and another. Lagos, Port-Harcourt, Enugu, Kano and Jos enjoyed discount for all energy used after the first 200 kwh, while the rest of the country faced a flat-rate

7. This topic is well-discussed by Caywood (1956) and Bolton (1951) and Garfield and Lovejoy (1964).

charge. The general purposes tariff also discriminated on an areal basis. The nature of the "special agreement" tariff was dictated by the terms of contract of supply.

In September 1969, the E.C.N. introduced a new tariff system (Appendix IIB), it contained a block tariff for residential, and a Hopkinson two-part tariff for industrial and commercial users. Divided into four parts, schedule A,B,C, (corresponding roughly to residential, commercial, and industrial) and street lighting, its main features were:

a) the elimination of areal price discrimination for consumers in the industrial and commercial classes.

b) lower rates per kwh were charged for industrial users: the blocks were also very large. Voltage discounts were introduced.

c) areal price discrimination was still maintained for residential users.[8] The floor area charge was jettisoned and instead, a minimum charge (₦2) was imposed on each user based on the first 20kwh consummed.

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8. It may be argued, though, that the areal differences reflect the cost of transmission or nearness to generation source; viz Jos and NESCO H.E.P. stations around the Plateau, Afam near Port-Harcourt, Oji River near Enugu, and Ijora in Lagos. Much of Lagos power now comes from Kainji, anyway.

The October 1973 tariff merely rationalised charges on accounts of the decimal currency system. But the block sizes in schedule B tariff were contracted.

The latest tariff (October 1977: Appendix IID) raised both the fixed and running charges. It contains four schedules, A,B,C, and D (referring to street lighting). Its features are:

(a) redefinition of each class of consumer.

(b) introduction of Hopkinson's two-part block tariff in schedule A (residential).

(c) areal discrimination of (Schedule A) residential consumers was abolished.

(d) introduction of block tariff for street-lighting.

To arrive at a single value for electricity price, there are four possible approaches: the average price, the marginal price, the Typical Electric Bill (T.E.B.) and the average revenue per kwh of sales. The derivation of the first has been given by Bolton (1951) and is illustrated in Appendix III. But we must note that it is appropriate only where consumers face a block tarriff (e.g. 1969-77 residential tarriff). For the two-part tariff, it becomes difficult to account for the fixed charge especially if the fixed charge also varied according as the consumer. Of course, it is possible to contest this on the grounds

that for larger amounts of energy consumption the average "fixed charge" per kwh may approach zero and this may be ignored. However, a majority of residential users, for instance, consume small amounts of energy (1976 national average was 172 kwh), which means the average "fixed charge" cost per kwh would form a considerable portion of the average "total"cost per kwh. In the short run, economic theory postulates that fixed costs may be ignored, but for long-run equilibrium, it must be accounted for; we expect consumers of electricity to react to a two-part pricing system in the same manner.

Similar argument can be advanced against marginal prices (see Appendix III for its derivation). In the flat rate tariff both the average and marginal prices coincide, in which case either would serve the required purpose. In fact, to compute the average or marginal price of electricity requires reliable information on the number of consumers in each user-class. Such details were not available in the old E. C.N. records for the year 1955/56 to 1962/63. Prior to 1964, only total numbers of consumers, without distinction as to user-class, were recorded (Appendix IV, Table V). It was from 1963/64 that analysis of consumer population into different classes began. To obtain marginal or average price, average consumption per consumer is worked out, to which the formula in Appendix III is applied.

The Typical Electric Bill such as constructed by the U.S. Federal Power Commission is inexistent here. It is simply an attempt to account for both the fixed and running charges; how much will a consumer pay for obtaining on demand 500 kwh or 1000 kwh of energy? We did not venture to construct a TEB for Nigeria; the fixed charge would be difficult to determine especially for the years 1956-1969 as there was no data on the average floor area of residential consumers' premises, nor on the average maximum demand load (KVA) of commercial and industrial consumers. It could even be asked: what is the value of the "typical" electric energy consumption for industrial, commercial or residential users? With growing consumption, this value may not be constant over time.

To avoid the complications enumerated above, the annual total revenue figure for each consumer class was divided by the annual total energy consumed to arrive at some average revenue per kwh. For the purpose, revenue from sales under the general purposes, special agreement, combined rate and miscellaneous tariffs (whenever they occurred) were added to revenue from commercial and industrial consumption as was done in the case of energy sales (kwh).

The advantages of this method are:

(a) It was possible to account for both fixed and variable energy costs. In fact, the average revenue figures were consistently higher than the computed average prices based on running charges only.

(b) It would accommodate the problem posed by the change of tariffs in the middle of both 1969/70 and 1973/74 fiscal years, and also the areal price variations operated in the 1956/69 period.

(c) The total revenue under commercial and industrial embraces all other tariff types that were formerly in use but done away with. This removes the problem that might have arisen in determining price per kwh for the special agreement, since the exact tariff varied, as earlier mentioned, according to the terms of the agreement.

The main disadvantage is that it assumes revenues for all energy consumption for a particular year were collected in that year. The approach ignores the outstanding case of debtors. The "accounts receivable" item on N.E.P.A's balance sheet has grown rapidly in recent years.[9]

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9. "Accounts Receivable":

1972/73	1974/75	1976/77
₦19.01million	₦29.89 million	₦40.52 million

Source: NEPA Annual Reports and Statement of Accounts for 1972/73, 1974/75 and 1976/77.

Gas: The prices for domestic (liquefied petroleum) gas were obtained from the Nidogas Company Ltd. in Lagos, marketers of Nidogas (and until recently Sungas brand) of bottled gas. Nidogas maintained uniform prices all over the country before the Federal Government introduced it to other companies in 1973. The company is about the oldest (started in 1955) gas distributor in Nigeria and probably controls a large part of the gas market. Its product is used as well in commercial, (hotels, restaurants, schools, hospitals) and industrial establishments. Price quotations of other distributors were sought but the information received was incomplete.[10]

Natural Gas prices were made available by Shell-BP Petroleum Development Company. Supply to customers started in 1963, and has been restricted to buyers in Aba/Port-Harcourt axis. Shell-BP charges different prices for its gas, using a two-part tariff: a monthly fixed charge, and a running charge based on the volume of gas consumed (thousand standard cubic feet (S.C.F.)).[11] The fixed charge varies with the consumer. It is based on sum

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10. The author visited Utilgas Ltd. but the officials could not get at their old records. They had only current quotations.

11. Defined as the volume of gas at a temperature of $15^{o}C$ and a pressure of 1,013.25 mbar dry.

stated in the contract of supply (Appendix IV, Table IX). 10k, 12½k and 18½k were the rates charged for each thousand SCF. A pattern emerged in which Aba consumers pay 18½k, Port-Harcourt users 12½k, while N.E.P.A. Ughelli is charged 10k. This suggests that distance from the oil-fields (where natural gas is also produced) may be a crucial factor in the fixing of the running charges. Our choice price was 12½k for two reasons. First, it does seem Shell-BP can supply consumers at that price without levying a fixed charge if we take a look at what NEPA pays for gas used at Afam. Secondly NEPA is the biggest consumer of natural gas. In 1971 and 1976 it used up 70% and 90% respectively of total gas sold to industrial consumers. It is also important to observe that the running charge for natural gas has remained same in the last fifteen years, while the fixed charge has varied slightly.

Kerosene and Fuelwood: It was possible to get monthly prices series for each of these two for Lagos (1955-1976) Ibadan, (1960-76) Kaduna (1962-1976) Port-Harcourt (1970-76) and Enugu (1971-75). The consumer price index worksheets for other towns were not available for most of the early years. Furthermore, the Federal Office of Statistics (F.O.S.) does not build an "all-cities" indices for each particular item. Since they were more complete,

for our analysis, we took Lagos prices of both items. It is believed unlikely that the trend pattern would have been different even if we had a representative (all-cities) annual price series. The price of Kerosene was fixed by oil marketing companies and it was not until the early 70s when demand rose sharply that the fixed price broke down, giving way to forces of supply and demand. Figures 1 and 2 depict the pattern of variation of Lagos, Kaduna and Ibadan prices of fuelwood and Kerosene. The monthly prices were averaged on March to April basis to obtain annual prices of the two commodities. Adjustments were also made for the metric system.

Coal: This is the weakest link in our analysis. It was not possible to get a clear picture of the movements in the price of coal. We had to glean figures from various sources.[11] Prices for 1955/56 to 1964/65 were deduced from Schatzl (1969b) and cross-checked with the average revenue per ton of coal sales extracted from the annual reports of the Nigerian Coal Corporation, for those years. From that point (1964/65) the figures become

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11. The author visited the Enugu headquarters of the Coal Corporation; officials claimed documents were lost during the civil war. A letter followed the visit, but it yielded little. We have therefore to rely on the verbal account of the former Acting Marketing Manager of the Corporation, especially for the War years. An earlier check at Federal Ministry of Mines and Power did not help.

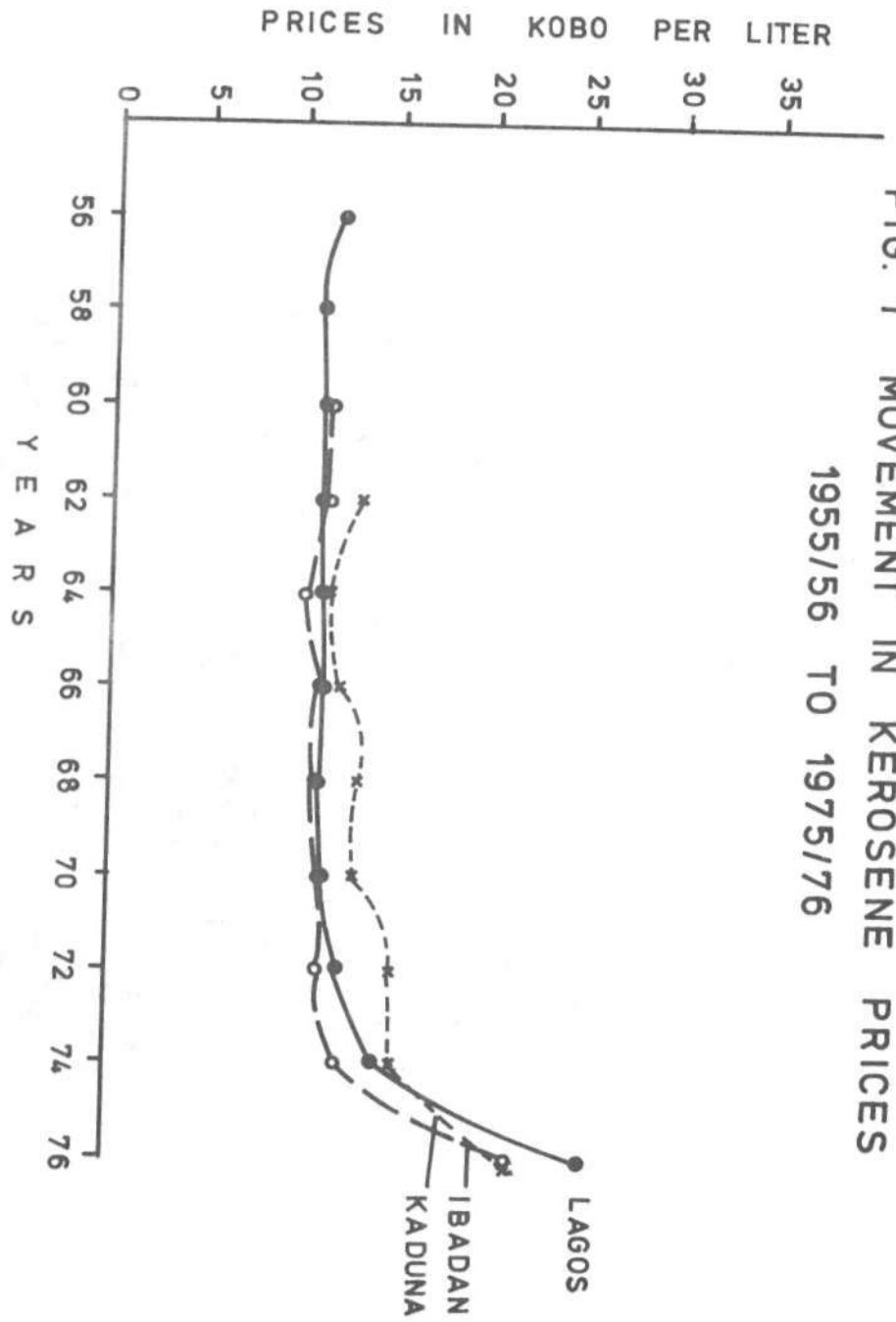
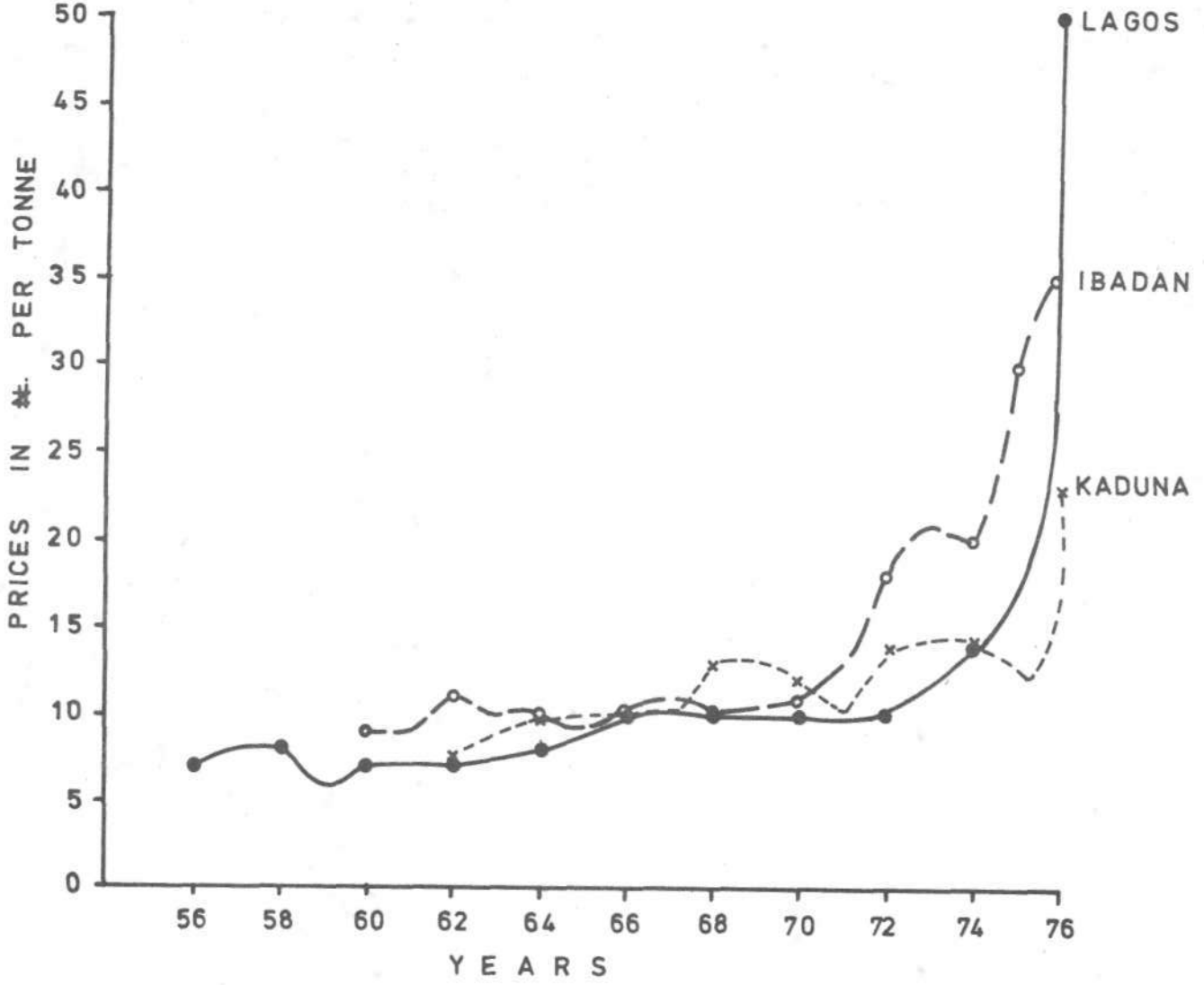


FIG. 1 MOVEMENT IN KEROSENE PRICES 1955/56 TO 1975/76

FIG. 2 MOVEMENT IN FUELWOOD PRICES
1955/56 TO 1975/76



uncertain. Schatzl (1969b, p.19) said that prices moved up to ₦6 per (long) ton in the year 1964/65. When the price changed upward to ₦8 per (long) ton is what is not clear. The Nigerian Coal Corporation (N.C.C.) official spoken to could say (not with much certainty) that from sometime in the 60s till 1974/75, the price was ₦8 per (long) ton. We found it difficult to believe this. An enquiry was made at the Headquarters of the Nigerian Railway Corporation (N.R.C.) in Lagos on how much they had been buying coal from the Coal Corporation. Once again, the records there were scanty. Yet, we got some evidence concerning prices in 1966, 1972 and 1977. For instance coal was delivered to the Eastern District (Enugu) of N.R.C. at the following rates:[12]

1966	60/-	or ₦6.00 per ton (₦5.91 per tonne)
1972	90/-	or ₦9.00 per ton (₦8.86 per tonne)
1977		₦8.90 per tonne

The 1966 figure suggests coal price was still six naira per (long) ton in 1966/67. The 1972 figure compared very well with the average revenue per ton of coal sales implying coal

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12. Source: Nigerian Railway Corporation, Fuel Purchases Returns, Eastern District, 1966, 1972 and 1977.

price of ₦9.00 per ton. The big gap on which we had little information occurred in the years 1967/68 to 1970/71. Here we simply relied on and assumed the quotation of ₦8 per long ton given by the Coal Corporation official. The 1970/71 average revenue per ton (₦7.96) suggests that might have been the price that year. For 1975/76 prices, a check with N.E.P.A. put the cost of coal at Oji River Power Station between eleven and twelve naira per tonne (transport cost inclusive): this tallies with the figure ten naira from the Coal Corporation, if the difference is attributed to transport cost. Essentially the price of coal over the years follows the schema in Table 4.2 below.

TABLE 4.2

Coal Prices

Year	Price	Sources
1955/56	₦4.00 per long ton (₦3.94 per tonne)	(a) Schatzl (1969b) (b) Annual Reports of N.C.C for the years 1955/56 to 1963/64.
1956/57	₦4.80 per long ton (₦4.75 per tonne)	
1957/58 to 1963/64	₦5.00 per long ton (₦4.92 tonne)	
1964/65 to 1966/67	₦6.00 per long ton (₦5.91 per tonne)	(a) Schatzl (1969b) (b) N.R.C. Fuel Purchase Returns File for 1966.
1967/68 to 1970/71	₦8.00 per long ton (₦7.87 per tonne)	(a) Acting Marketing Manager, N.C.C. (b) Annual Report of N.C.C. 1970/71
1971/72 to 1974/75	₦9.00 per long ton (₦8.86 per tonne)	(a) Annual Reports of N.C.C. for the years 1971/72 to 1974/75 (b) N.R.C. Fuel Purchases Returns File for 1972
1975/76	₦10.00 per tonne	(a) N.E.P.A.: Oji River Station Generation Returns. (b) Acting Marketing Manager, N.C.C. Enugu.

All-Cities Composite Consumer Price Index (C.P.I.)

All money variables were deflated by the C.P.I. for each year to reflect the movements in real prices. The source of the C.P.I. data is the Central Bank of Nigeria's "Economic and Financial Review", Volumes 8, 13 and 14. Monthly indices were available for the years 1960/61 through 1975/76. The composite index embraced nine towns, until after the Civil War when one more town, Enugu, was included. The monthly figures were averaged to obtain annual (1st April to 31st March) series. For the earlier years, (before 1960) no data was available: this made it necessary to construct indices using the weights applied by the Central Bank to compute the 1960/76 series (see Table 4.3).

TABLE 4.3

Weights for the Composite Index

Lagos	543
Ibadan	169
Kaduna	111
Zaria	34
Kano	12
Benin	44
Sapele	19
Warri	12
All-Cities	1000

Source: Central Bank: Economic and Financial Review, vol.8,1,p.24

The indices available for 1955, 1956 and 1957 were those for Lagos, Ibadan and Enugu. The series for Kaduna and other towns began in 1958. Moreover, the 1960 price indices for Delta (Warri and Sapele) were not published by the Federal Office of Statistics. Consequently the composite indices for 1955/56 to 1959/60 resonate only Lagos, Ibadan and Kaduna (as from the 4th quarter of 1957/58) weights. Since the three cities were allotted eight-tenths of the computing weights (Lagos and Ibadan have 712), it is hoped that there will not be much distortion in the indices derived for those early years. 1960 was the base year and we realigned the indices for the five years to reflect this before computing the composite index.

Gross Domestic Product: The figures for 1958/59 to 1975/76 were available at the Federal Office of Statistics (F.O.S.). The 1955/56 to 1957/58 figures relied on P. Okigbo's estimates as reported by the F.O.S. (Annual Abstract of Statistics 1965). The problem of base year was also encountered here (1957 prices for Okigbo, 1962/63 for F. O. S.). Since the 1962/63 GDP was quoted in 1957 prices as well, we inflated the 1955/56, 1956/57 and 1957/58 figures by the simple ratio.

$$\frac{\text{GDP 1962/63 Current Prices}}{\text{GDP 1962/63 1957 prices}}$$

It is proper to point out here that the F.O.S. late ... its G.D.P. estimates for 1962/63 upwards based on ne information, especially population. For the inflatic r revised we used the old (lower) estimates as the revised estin e not quoted in 1957 prices.

Population: Two sets of population figures were used:- te was

(a) Total population of the country: the figures, 1963 ce result and the mid-year estimates thereafter, were obtaine the National Population Bureau in Lagos. For the years pre nsus 1963, a "backward" projection (2.5% rate) supplied the estin d from that period.[13]

(b) Urban population of the country: 1960-75 estimates were tes for extracted from Olayide (ed.) (1976) while 4% growth rate was assumed for 1956-1959, and 5.8% for 1976; these are suggested rate estimates from Economic Commission for Africa.[14] With 1960 (=100) as base, an Index of Urbanisation was computed.

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13. 2.5% is the average of the 1963-76 growth rates.

14. See Segal, B., "Urbanisation in Tropical Africa" in Ominde S.H. and Ejiogu C.N. (eds.) (1972), p.279.

Data Coverage: For consumption of electricity, only figures from N.E.P.A. were used. Because of the cost involved it was not possible to obtain consumption figures from African Timber and Plywood Ltd. in Sapele. Consumption of electricity on the tin minesfield in Jos was also left out due to incomplete information on the price and revenues of NESCO.[15]

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15. A visit to Bukuru, Jos, and a letter delivered by hand did not help. The Acting Manager of NESCO wrote back that tariffs and revenue figures were company secrets which he could not divulge.

CHAPTER FIVE

THE MODELS AND THE RESULTS

THE MODELS

Method and Procedure

The method of approach is the application of the tools of econometrics to analyse electricity consumption in Nigeria. The basic steps in this method are model specification, estimation and evaluation.

Specification of the Models: There are two major aspects of specification; the functional form of the model and the choice of variables to be included in it.

In the particular case of electricity consumption, the general form of the model derives from the basic economic theory of demand. This states that, for any commodity, the quantity demanded is a function of its price, the price of its substitutes or complements, the income, population and taste of its consumers. However, the functional form specified depends on the nature of the interrelationship between the variables.

On one hand, some argue that since the price of electricity is fixed by public authorities, consumers are more or less price takers; consequently the single equation model is an

adequate representation of the market situation.[1] On the other hand, others contend that with the quantity discounts inherent in the block-tariff price system operated by electric utilities, an interdependent relationship would subsist between the price and the quantity of electricity consumed - a case for simultaneous-equation model.[2] In this analysis both types of models are specified and estimated.

The precise mathematical form of the functional relationship is even more difficult to postulate and the final choice may be somewhat arbitrary. Nonetheless, it is the practice in econometric studies to assume initially a linear mathematical relationship between the dependent and independent factors since it is simple and easy to explain.[3]

The mathematical form postulated for electricity demand in Nigeria is

$$(1) \quad Q_t = b_o + b_1 X_{1t} + b_2 X_{2t} + \ldots + b_{nt} X_{nt} + U_t$$

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1. Cramer (1971), p.213 .
2. Halvorsen (1975), p. 12. Also Ruffell (1978), p.23-26.
3. Hu (1973), p.60.

where

Q_t is quantity of electricity consumed in year t

$X_1, X_2, \ldots, X_n$ are explanatory variables

$b_o, b_1, \ldots, b_n$ are parameters to be estimated.

U is the stochastic error term.

Equation (1) depicts a static relationship between Q and the arguments; i.e. it shows how the exogenous variables generate the values of the endogenous variables at a given point in time and not over a period of time.[4] We may therefore specify a dynamic relationship of the form

(2) $Q_t = b_o + aQ_{t-k} + b_1X_{1t} + \ldots + b_nX_{nt} + U_t$

where

Q_{t-k} is the lagged dependent variable

a is the adjustment factor

k is the lag number

$Q_t, X_1, \ldots, X_n, b_o, \ldots, b_n$ are as defined above.

Equation (2) suggests that electricity consumption in year t is partly dependent on the past levels of consumption Q_{t-k}, and partly on other factors $X_1, \ldots, X_n$.

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4. Kmenta (1971), p.589.

The mathematical form of the price equation in the simultaneous-equation model is a static relationship between the price of electricity and its determinants, viz:

$$(3) \quad E_t = k_o + k_1 Z_{1t} + \ldots + k_n Z_{nt} + W_t$$

where

E_t is the price of electricity in year t

$Z_1, \ldots, Z_n$ are the determinant factors

$k_o, k_1, \ldots, k_n$ are parameters to be estimated

W_t is the error term.

The choice of variables to be included in the models is also governed by the theory of demand for a commodity. That apart, other variables may be included in a model on the basis of "information about the individual (market) conditions in a particular case."[5] Published results of previous studies can also provide additional knowledge as to which variables should be included or not. The ultimate determinant is the availability of data on the relevant variables. As an example, previous studies (reference, Chapter 3) would suggest the inclusion of the wholesale price index for domestic electrical appliances in the residential model. But the data on this is hard to come by in Nigeria.

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5. Koutsoyiannis (1973), p.13.

In this analysis, the procedure is to look at electricity consumption through each major consumer group, specify and estimate a model for each. Electricity consumers usually fall into three broad categories: residential, commercial and industrial. All three are subject to the influence of certain common variables (e.g. population and income). Yet other factors exist that are sufficiently peculiar to each category. Firstly, they face different tariffs: hence they pay different prices. Secondly, they face different substitutes; for instance kerosene is a substitute domestic fuel, but not a vital industrial fuel. The commercial and industrial groups have been combined under one class, commercial/industrial, for reasons already stated (Chapter 4). The included explanatory variables in this analysis are:

1. Residential Model

(a) Demand Equation:

(i) price of electricity to residential users

(ii) price of gas (LPG) to residential buyers

(iii) price of kerosene

(iv) price of fuelwood

(v) income

(vi) population

(b) Price Equation:

(i) quantity of electricity consumed by residential users

(ii) ratio of total commercial/industrial sales to total residential sales

(iii) percentage of Area I consumption.

2. Commercial/Industrial Model

(a) Demand Equation:

(i) price of electricity to commercial/industrial users

(ii) price of gas (LPG) to commercial/industrial buyers

(iii) price of natural gas

(iv) price of fuelwood

(v) price of coal

(vi) income

(vii) population

(b) Price Equation:

(i) quantity of electricity consumed by commercial/industrial users

(ii) ratio of total commercial/industrial sales to residential sales

(iii) percentage of total commercial/industrial sales consumed in Lagos.

Coal is excluded from 1(a) above because its use as an alternative fuel in households is not yet widespread. One reason may be the non-availability (locally) of domestic coal-using equipment, i.e. cook-stove, boiler or oven. It is only recently the Nigerian Coal Corporation turned attention to the development of coal-using equipment: it set up a "Domestic Appliances Center" in Enugu for that purpose.[6] Table X in Appendix IV reveals that coal consumption has been largely restricted to a few big commercial and industrial consumers.

Kerosene is excluded from 2(b) since apart from its use as an aviation fuel, it has limited application in commercial and industrial undertakings. Most commercial houses (e.g. restaurants, hospitals) usually turn to fuelwood as an alternative to gas or electricity for cooking purposes.[7] Furthermore, the necessary kerosene complements such as cook-stove are probably not available in the required large sizes of convenient application in commercial houses.

Both the liquefied petroleum and natural gases are included in 2(a) since the former is an important alternative fuel to electricity for commercial users, while the latter is the main

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6. See Nigerian Coal Corporation (1977), NCC/PRD/INF/001.

7. A good example is Ahmadu Bello University, Zaria where the student cafeterias switch to fuelwood when they run short of cooking gas.

substitute industrial fuel in Aba/Port Harcourt area.

In 1(b) and 2(b) the ratio of commercial/industrial sales to residential sales is an attempt to examine the influence of the relative shares of both consumer groups in the energy market on the price paid by each. As Halvorsen (1975) argued, "the composition of total sales may affect the price of electricity to ..... consumers" (p.14) This becomes decisive where total demand is limited by available capacity; invariably, the more a particular set of customers consumes, the less some others are able to get. As storage of electricity is virtually impossible, utilities must have adequate capacity to meet demand at any given moment. If this is not so, then some users may be consuming energy at the expense of others.

The preferential tariff rates enjoyed by Area I consumers suggests that these parts of the country should on the average pay less per kwh. If this is true, then we may expect Area I energy consumption to influence the price of (or properly, average revenue from) electricity. Hence the inclusion of Area I consumption in the residential price equation.

In the same vein, it is presumed that Lagos having always been the main commercial and industrial center in the country, the average electricity consumption per consumer should be higher than in other

parts of the country. Combined with the preferential rates it enjoyed (1956-69) and the block tariff Lagos consumers faced (1969-76), average revenue per kwh from commercial consumption in Lagos would be lower. In short, one would expect the proportion of Lagos consumption to influence the price of electricity. It therefore enters as an argument in the price equation.

Estimation of the Models:

The general forms of the estimated demand and price equations are:

Residential

(4) $QR_t = a_o + a_1 ER_t + a_2 GR_t + a_3 K_t + a_4 F_t + a_5 Y_t + a_6 N_t + a_7 P_t + a_8 M_t$

(5) $ER_t = b_o + b_1 QR_t + b_2 I_t + b_3 J_t$

Commercial/Industrial

(6) $QL_t = a_o + a_1 EL_t + a_2 GL_t + a_3 NG_t + a_4 F_t + a_5 C_t + a_6 Y_t + a_7 N_t + a_8 P_t + a_9 M_t$

(7) $EL_t = b_o + b_1 QL_t + b_2 I_t + b_3 S_t$

where

QR = the quantity of electricity sold to residential customers

QL = the quantity of electricity sold to commercial/industrial customers

ER = real price of electricity - residential

EL = real price of electricity - commercial/industrial

GR = real price of gas - domestic

GL = real price of gas - commercial/industrial

NG = real price of natural gas

GK = real price of kerosene

F = real price of fuelwood

C = real price of coal

Y = income (represented by the real GDP)

N = index of urbanisation

P = total national population

M = dummy for civil war years { 0 for 1967/68, 1968/69 and 1969/70.
1 for all other years.

I = ratio of commercial/industrial energy sales to residential sales i.e. QL/QR

J = percentage of Area I energy consumption in total energy sales

S = percentage of Lagos consumption in total commercial/industrial energy sales.

$a_0, a_1, \ldots, a_9, b_0, b_1 \ldots, b_3$ are parameters to be estimated

t subscript denotes period.

Two variants of each of the equations (4) and (6) formed the basic static and dynamic demand equations actually estimated.[8]

8. Natural gas is not included in (10) and (11) because of incomplete data. The estimates obtained from constraining the missing data to zero are given in Appendix III.

(8a) $QR_t = a_o + a_1 ER_t + a_2 GR_t + a_3 K_t + a_4 F_t + a_5 Y_t + a_6 N_t$

(8b) $QR_t = a_o + a_1 ER_t + a_2 GR_t + a_3 K_t + a_4 F_t + a_5 Y_t + a_6 P_t$

(9a) $QR_t = a_o + a_1 QR_{t-1} + a_2 ER_t + a_3 GR_t + a_4 K_t + a_5 F_t + a_6 Y_t + a_7 N_t$

(9b) $QR_t = a_o + a_1 QR_{t-1} + a_2 ER_t + a_3 GR_t + a_4 K_t + a_5 F_t + a_6 Y_t + a_7 P_t$

(10a) $QL_t = a_o + a_1 EL_t + a_2 GL_t + a_3 F_t + a_4 C_t + a_5 Y_t + a_6 N_t$

(10b) $QL_t = a_o + a_1 EL_t + a_2 GL_t + a_3 F_t + a_4 C_t + a_5 Y_t + a_6 P_t$

(11a) $QL_t = a_o + a_1 QL_{t-1} + a_2 EL_t + a_3 GL_t + a_4 F_t + a_5 C_t + a_6 Y_t + a_7 N_t$

(12a) $QL_t = a_o + a_1 QL_{t-1} + a_2 EL_t + a_3 GL_t + a_4 F_t + a_5 C_t + a_6 Y_t + a_7 P_t$

The essential difference between the a- and the b-equations is the specification of the population variable. Electricity has for long been an urban phenomenon in this country. Consequently one would expect total consumption to be influenced by the growth in urban population. But it is all the same not proper to neglect the fact of urban population being a subset of the total. Moreover, the growth in urban population is more attributable to the influx of migrants from the countryside than to natural (procreation) rate of increase. Thus, in the long-run total population would influence electricity consumption, more so now that electricity is being

extended to rural areas.[9]

The ordinary least squares technique was applied to equations (8) to (11) to obtain OLS estimates. The dummy variable was later introduced into the equations and also estimated by the OLS.

Equations (8) and (9) were each simultaneously estimated with the price equation (5) using the two-stage least squares (2SLS) technique. The same was also applied to equations (10) and (7), and (11) and (7). The 2SLS procedure yields more consistent estimates than the OLS, though it still retains the OLS assumptions about the error term.[10]

The generalised least squares (GLS) procedure was applied to jointly estimate both the Residential and Commercial/industrial single-equation models. The GLS has been shown to yield more efficient estimates than the OLS since it utilizes information concerning the residuals in each equation to estimate the coefficients. The GLS (or Zellner's method) is appropriate in estimating a system of seemingly unrelated regressions possessing one of the following properties:

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9. Another underlying factor is the uncertain and disputable nature of population figures in Nigeria.

10. Koutsoyiannis (1973), p.381.

(a) the set of explanatory variables are not identical

(b) disturbances of the equations are contemporaneously correlated.[11]

If (a) or (b) does not hold then the GLS estimates would be equivalent to the OLS estimates of the equations involved.

The rationale for applying Zellner's method to our models lies in the fact that both consumer classes are each a subset of the total electricity market: therefore the errors in their demand functions would expectedly be contemporaneously correlated. Moreover, the equations, as specified, do not contain entirely similar set of explanatory variables.

Furthermore, the generalized and three-stage least-squares (G3SLS) procedure were applied to jointly estimate both the residential and the commercial/industrial simultaneous-equation models earlier specified. The first two stages of the procedure are identical to the two-stage least squares. The third involves the application of the generalised least squares to obtain parameter estimates using information on cross-equation variances and covariances.[12] Accordingly Zellner's method and the G3SLS were applied to the

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11. Theil (1970), p.506 - 511.

12. Pindyck and Rubinfeld (1976), p.282.

following equation systems:

System A: equations (8) and (10)

System B: equations (9) and (11)

System C: equations (8), (10), (5) and (7)

System C: equations (9), (11), (5) and (7)

Evaluation of the Models: This was based on certain statistical, economic and econometric criteria.

The statistical factors refer to the statistical significance of the parameter estimates (t or F test); and the "goodness of fit" of the estimated regression line ($\bar{R}^2$).

The econometric evaluation aims at investigating whether or not the assumptions underlying the estimation techniques used are satisfied. If any of these is violated, then the estimated parameter loses some of its desirable properties. In this regard Durbin-Watson (D-W) test for autocorrelation is appropriate for checking the OLS error term assumptions.* D-W is inapplicable when lagged demand becomes an argument in the function: the OLS assumptions break down in this instance. Another test, the h-statistic was appropriately employed to test for autocorrelation in the dynamic OLS equations. The h-statistic has a distribution approximating the standard normal with mean zero and variance unity.[13] Finally, the rank and order

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13. Durbin (1970), p.410-421.

conditions were applied to ascertain the identifiability of the simultaneous-equation models estimated.

Paramount in an applied work like this are the econometric criteria. These refer to the size and sign of the estimated coefficients. The sign, for instance, should conform to postulated economic theory.

Following therefore from the theory of demand, we expect the sign of the own-price coefficient to be negative, and those for gas, fuelwood, kerosene, coal, income and population to be positive. The sign of the coefficient of the (war) dummy variable is difficult to determine apriori and, as Ghosh and Kazi put it: "whatever results one may come up with need to be rationalised ex-post."[14]

In the price equation, the coefficient of the quantity factor is expected to be negative because, as already noted, of the quantity discounts inherent in electricity tariffs. The sign of I in equation (5) is expected to be negative; the higher the ratio, the less residential users are able to consume, the less the revenue therefrom. Conversely I should carry a positive sign in equation (7). The coefficient of J ought to appear negative in (5) if indeed the

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14. Ghosh and Kazi (1977), p.12.

discount enjoyed by Area I is appreciable. The S coefficient in (7) is also expected to be negative, if Lagos industries and commercial houses actually exert substantial influence on the level of total demand and price.

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* The computer program for the 2SLS and G3SLS neither outputs $\bar{R}^2$ nor analyses residuals to give D-W. But it produces the necessary figures to enable the user calculate $\bar{R}^2$, but not sufficient to compute the D - W. (See Kaikow et. al. (1977), p.5) Hence the D-W coefficients of the estimated 2SLS, GLS and G3SLS equations are not given in the results.

THE RESULTS

Residential Models

The results from the OLS and 2SLS estimation of the residential models are on tables 5.1 to 5.3. The GLS and the G3SLS estimates are listed on tables 5.9 to 5.12.

The equations: The dynamic equations seem to have higher $\bar{R}^2$(.99) than the static equations (.98). The price equations have lower $\bar{R}^2$ values(.94). Nevertheless it is reasonable to infer that the variables as a group explain a considerable part of the variations in the dependent factor in each of the equations. Furthermore the dynamic equations generally have lower standard errors of estimate (SEE) than the static. This is to be expected as there is an inverse relationship between $\bar{R}^2$ and the SEE.

The D - W coefficients for the static equations (Table 5.1) all lie in the inconclusive region. It is difficult then to determine possible serial correlation of the disturbances. The computed h-statistic for the dynamic equations do not refute the null hypothesis (at 5% level) of non-autocorrelation of the errors in the equations. This should not be surprising since the OLS assumption of serial independence of the error is easily violated by the introduction of the lagged demand as an explanatory variable.

Be that as it may, it is difficult to overcome the problem since no other estimation technique has been shown to yield "better" results;[15] yet the GLS is usually suggested as an alternative procedure when the errors follow a first-order auto-regressive scheme.[16]

The simultaneous equations in Table 5.3 are identified. Proof for this is in Appendix III.

The variables: The own-price variable is consistently negative but insignificant in the OLS and 2SLS estimates. But in the static G3SLS model (system C1) it appears to be marginally significant, with an elasticity of 0.28. However, the consistent insignificance and the low elasticity value (in C1) imply that the own-price variable may not be an important factor determining electricity consumption, nor is the latter readily responsive to the changes in the former.

The gas coefficient is positive in all the equations. This is as it should be. Its significance is less clear-cut, for it appears to be quite significant in the dynamic equations but only

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15. Rao and Miller (1971), p.176.

16. Koutsoyiannis (1973), p.312 - 315.

marginally so in a few static equations. The elasticity for G varies from .28 to .42, which leads us to infer that residential electricity consumption is not highly responsive to price of gas, at least in the short run. The long-run elasticity (LRE) is higher, but still less than unity. From Table 5.12(i), system DI, the short-run cross elasticity for domestic gas is given by 0.34 whilst the LRE works out to 0.59.[17]

The kerosene price variable carries a positive sign in all equation (except in system A1) but is throughout insignificant. This is rather surprising since casual observation would tend to suggest that kerosene is a cooking fuel substitute for electricity especially in the middle-and lower-income urban households. The insignificance may have arisen from the fact that kerosene prices remained stable for a long period of time (in the 1950s and 1960s).

The coefficient of the fuelwood price variable (F) contrary to expectation, has a negative sign in all equations. In addition, it appears as a significant determinant in all the dynamic equations but insignificant in the static. This pattern of result suggests that where lag interactions (expectation and adjustment) occur, as often is the case, then fuelwood is a complement to rather than substitute for electricity. It is difficult to accept the above

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17. Long-run elasticity is obtained by $A = \frac{a}{1-b}$
where a is short-run elasticity and
b is the coefficient of lagged demand.

deduction. Anyway the suggested degree of responsiveness (short and long run elasticities are less than -0.5) are quite low.

The income coefficient is highly statistically significant (except in ST-3) and of the appropriate sign. The income elasticity is greater than unity in nearly all cases, wherefore the LRE approaches 2 in some cases. Our results confirm prior hypothesis that income is a determinant of residential energy consumption. And the elasticity values imply a high degree of responsiveness of energy use to changes in income.

The population variables, N and P yield unexpected results. The sign is correct, yet in nearly all cases (save in model 2a, Table 5.3) they are insignificant. The suggested elasticities in equations ST-3 and ST-4 ironically imply a high degree of responsiveness of electricity to population growth. Perharps the inclusion of the war dummy in both equations is the key factor in the sudden significance of N and P. Hence the result in ST-3 and ST-4 would tend to reflect the war-time conditions rather than the actual peace-time situation.[18]

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18. Actually, the explicit specification of dummy presumes that only the value of the constant term would be altered. The value of other variables ought not to change, i.e. a parallel shift in the function.

The dummy variable is positive and insignificant in both the static and dynamic equations. Nevertheless it is considered that the war-time recession could have had an adverse effect on the electricity consumption. In such a case, the addition of the war dummy ought to cause a down-ward shift in the function; there would be a discernible reduction in the magnitude of the constant term. Our results correborate this contention.

The lagged demand variable estimates were positive and statistically significant. It thus conforms to apriori expectation. Of greater interest is the magnitude of the coefficient estimates as this has implications for the long-run adjustments of consumers to the equilibrium. The higher the value of the coefficient, the larger would be the long-run values of the coefficients of the other explanatory variables, the slower the implied rate adjustment to equilibrium. In other words, it is also an indication of the level of habit-persistence in the consumption of electricity. Our estimates are in the region 0.42 to 0.48. In effect the long-run impact of the significant explanatory variables may be nearly twice their short-run influence.

Turning to the price equations in the simultaneous-equation models, the quantity variable yields the expected results and is highly significant. It means the quantity of electricity consumed

exerts some influence on the price paid for it, though the estimate of the quantity elasticity (about -0.3) indicates a rather small degree of responsiveness. In effect the discount accruing to consumers may not be very decisive.

The coefficient of I is negative and statistically significant. Thus, the ratio QL/QR and the price of electricity, ER, move in opposite directions. In addition, it seems the composition of total sales has an impact on the price of electricity. But the magnitude of response of the I-variable given by the elasticity estimates (-0.2) is rather small. It shows that price is perhaps only slightly sensitive to changes in the composition of total sales.

Our hypothesis about the influence of Area I consumption is not borne out by the results. The coefficient of J carried the expected sign but lacked statistical significance.

Table 5.4 contains the Beta coefficients of the variables in the residential model. The Beta coefficient is a measure of the relative effect on the dependent variable of each independent variable.[19] It is, as it were, a measure of the "importance" of each variable in explaining the variations in the dependent variable. The income factor is clearly dominant in virtually all the equations. As expected, the habit-persistence element (QR_{-1}) in the dynamic equations carries a substantial weight.

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19. Nie et. al. (1975), p.327.

On the other hand, the table illustrates the slight impact of the price variations on the level of electricity consumption. And surprisingly, despite its consistent significance, the influence of fuelwood is rather minimal. It may afterall be that the seeming complementarity between fuelwood and electricity (evident in the negative sign of the coefficient) is infinitesimal. The gas coefficient also displays a similar pattern; it appears to explain very little of the variations in electricity consumption. Finally, the population factor is also down-played, though its Beta weights in ST-3 and ST-4 are quite large.

The same pattern is encountered in the GLS and G3SLS Beta estimates (see Table 5.13). Not withstanding the sudden significance of the own-price coefficient in the system C 1, income still emerges the dominant variable in the residential demand equations. The GLS Beta coefficient for fuelwood inevitably adds more scepticism to the probable complementary relationship between fuelwood and electricity.

The quantity factor (QR) is the dominant variable in the price equations. It suggests then that nearly all the variations in the price of electricity may be explained by variations in the quantity consumed. In contrast, the impact of the composition of total sales (I) and the percentage of Area I consumption (J) is slight.

Commercial/industrial models

Tables 5.5 to 5.7 contain the OLS and 2SLS results. The GLS and G3SLS estimates are presented on tables 5.9 to 5.12.

The equations: All the demand equations have remarkably high $\bar{R}^2$ values (.94 to .99); the price equations have lower but still good $\bar{R}^2$ values (.91). This indicates that the variables entered in each equation satisfactorily explain the variations in the consumption of electricity. Generally, the dynamic equations, like in the residential models, have higher $\bar{R}^2$ and lower SEE than the static.

The Durbin-Watson (D-W) coefficients for the static OLS equations (table 5.5) fall virtually in the inconclusive region. Unfortunately, the h-statistic derived for the dynamic OLS equations (table 5.6) do not allow us to reject the null hypothesis of non-autocorrelation in the disturbances. As previously noted, this is to be anticipated since the lagged demand variable introduces some autocorrelation in the models.

The rank and order conditions for identification of the simultaneous-equation models are satisfied: this is demonstrated in Appendix III.

The variables: The own-price coefficient is statistically insignificant in the OLS, 2SLS and the dynamic G3SLS demand equations. In the static G3SLS estimates, where the coefficient appears to be manifestly significant, the elasticity value exceeds unity. This is quite substantial, raising the possibility that electricity consumption may be very sensitive to price after all.

The gas coefficient carries a negative sign in all the demand equations (save in models 3a and 3b). It is statistically significant, marginally in most cases, in six of the 20 equations estimated. It would be indiscreet to suggest some likely complementarity between gas and commercial/industrial electricity consumption. What one may infer is that gas may not be a significant determinant of electricity.

The fuelwood variable conforms to apriori postulation: statistically significant and positive. The elasticity value ranges from 0.3 in the dynamic equations to 0.7 in the static equations. Taking into account adjustment factor in the dynamic equations, the LRE for fuelwood should approach unity, indicative of an appreciable degree of responsiveness of electricity to fuelwood price changes.

The coal coefficient is negative in a majority of the equations. But it is in all cases insignificant. The pervasive negative sign may be due to stickiness in coal prices over the years, so that its real price tended to fall over time. Nevertheless, our results demonstrate that coal consumption is not a determinant of industrial electricity demand.

The income factor carried the appropriate sign and (except in four cases) is statistically significant. The elasticity estimates range from 0.42 to 0.98, an indication of an income-inelastic commodity. The long-run elasticity (LRE) however exceeds unity. Thus, income is one of the determinants of commercial/industrial electricity consumption.

The population variables appear to be highly significant in the static OLS (table 5.5) and in the static GLS (table 5.9) equations; the urbanisation factor is marginally significant in equations DY-5 and DY-7 and in system B1; both factors turn negative in the 2SLS estimates (table 5.7). The elasticity values of the significant estimates are in the range 0.73 to 2.43 for N and 2.14 to 3.33 for P.[20] The LRE for urbanisation index works out at between 1.5 to 2.3.

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20. The elasticities should be cautiously interpreted since the N - variable is an index. Hence one percent change in N and P means one percent change in the index of urbanisation and one percent change in total population.

These values are quite large and suggest a high degree of responsiveness on the part of electricity consumption. This may be far-fetched. For, it will be observed from the tables that the population coefficients become increasingly insignificant as one moves from the OLS to the G3SLS. It is contended here that since the GLS and G3SLS demonstrably yield more efficient parameter estimates, it is doubtful if the population factor (as was the case in the residential models) is in fact a significant determinant of electricity consumption.

The war dummy is insignificant but positive. However, the important question is whether equations ST-7, ST-8, DY-7 and DY-8 sufficiently depict the war-time demand for electricity. Since the values of the intercepts in these four equations are lower than in the corresponding"peace-time" equations, we may equally accept that the "war-time" situation caused a downward shift in the demand for electricity.

The estimate of the coefficient of lagged demand is in the region 0.44 to 0.63. It implies that the long-run impact of the significant explanatory variables would be twice their short-run influence on electricity consumption. The estimates also bring out the level of habit persistence in the demand for electricity

amongst commercial/industrial users.

The coefficient of QL in the price equation is highly significant in all the simultaneous-equation models, it also has the right sign. The elasticity value (-.34) is visibly higher than was the case in the residential estimates (-.30). Thus price is rather more sensitive to quantity changes in the commercial/industrial model. Does this imply that quantity discounts are favorable to commercial/industrial buyers, than to resiential users?

The coefficient of I is negative; it is marginally significant (at 10 percent level) in the G3SLS estimates. Theoretically, this ought not be the case. On the other hand, it could be reinforcing the speculation in the preceding paragraph concerning the influence of quantity discounts on the price of electricity by commercial/industrial users; if the composition of total sales changes in favour of the latter group then the price they pay per kwh would probably decline. The magnitude of possible change (e = -.24) is not quite considerable.

The coefficient of S is positive and also marginally significant (in the G3SLS models). This is contrary to our hypothesis: it seems price tends to increase as the proportion of Lagos consumption in total commercial/industrial sales increases.

The Beta weights of the parameters are listed in tables 5.8 (OLS estimates) and 5.13(G3SLS estimates). The fuelwood and income variables appear dominant. But the population factors overshadow others in the static OLS equations; the urbanisation factor carries some weight in the dynamic OLS equations. The lagged demand seems to be more important than others in all the dynamic equations: it again emphasises the habit-formation element in the demand for electricity.

Far more than in the residential case, the variable QL is easily the most dominant factor in the price equation. The I coefficient is rather subdued by the large weight of the quantity variable. Thus, unit variation in the quantity of electricity consumed may lead to nearly a unit variation in the price paid for electricity.

The Econometric Model of Electricity Consumption: The estimates from the OLS procedure would be reliable once the drastic assumptions about the behaviour of the error term are fully satisfied. This is unlikely in an empirical work such as this, and as we have seen in the results, the D-W coefficients do not give a conclusive proof of non-serial correlation. With a dynamic demand model, the OLS breaks down due to the violation of its assumptions.

Though the 2SLS yields more consistent estimates than the OLS, it has already been noted that it thrives on some of the assumptions of the OLS. In fact our results seem to suggest that the 2SLS estimates are not a strong improvement over the OLS estimates.

The results from the GLS are a modest departure from those of the other two techniques. This is a natural out-come since the GLS yields more efficient parameter estimates, resulting in smaller variances for the coefficients. However, the problem with the lagged demand would still persist in the GLS procedure so long as the error scheme does not follow a first-order autoregressive. The specific form of autocorrelation in our models is not known for certain.

It appears therefore that the estimated equations in system A-2 (table 5.9) and system C2(table 5.11) are likely to represent electricity demand in Nigeria. Apart from the fact that they yield efficient estimates by virture of the estimation technique, their coefficient estimates are less controversial in terms of the evaluation criteria earlier enumerated in this chapter.

Table 5.1

Residential Demand: OLS Single-Equation Estimates (Static)

	Variables in the Equation											
Equation	Constant	ER	GR	K	F	Y	N	P	M	$\bar{R}^2$	SEE	D-W
ST-1	-338.78	-45.53	6.027	4.879	-2.777	0.147[a]	1.601			.986	30.54	1.35
	(-1.177)	(-0.927)	(1.058)	(0.300)	(-0.502)	(6.017)	(1.077)					
		(e=-.35)	(e=.26)	(e=.14)	(e=-.07)	(e=1.45)	(e=.58)					
ST-2	-645.33	-38.21	6.068	10.701	-2.875	0.154[a]		6.648		.987	29.91	1.43
	(-1.449)	(-0.782)	(1.183)	(0.611)	(-0.562)	(7.677)		(1.347)				
		(e=-.30)	(e=.26)	(e=.31)	(e=-.07)	(e=1.53)		(e=1.19)				
ST-3	-628.92	-44.80	8.903[c]	12.05	-3.341	0.088[c]	4.179[c]		78.84	.986	30.13	1.63
	(-1.672)	(-0.925)	(1.452)	(0.703)	(-0.61)	(1.571)	(1.585)		(1.176)			
		(e=-.35)	(e=.38)	(e=.35)	(e=-.08)	(e=.87)	(e=1.51)		(e=.20)			
ST-4	-1092.22	-37.62	9.86[c]	17.05	-2.199	0.119[a]		13.08[c]	64.16	.987	29.55	1.77
	(-1.867)	(-0.779)	(1.635)	(0.94)	(-0.432)	(3.249)		(1.771)	(1.159)			
		(e=-.29)	(e=.42)	(e=.49)	(e=-.05)	(e=1.18)		(e=2.35)	(e=.16)			

a: coefficient Significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios are in parentheses

e: refers to elasticity at the mean.

Table 5.2

Residential Demand: OLS Single-Equation Estimates (Dynamic)

	Variables in the Equation												
...	Constant	QR_{-1}	ER	GR	K	F	Y	N	P	M	$\bar{R}^2$	SEE	D-W
DY-1	-156.63 (-0.739)	0.479[a] (3.773) e=.42	-32.94 (-0.932) e=-.26	7.998[b] (1.942) e=.34	2.294 (0.197) e=.07	-10.35[b] (-2.33) e=-.25	0.111[a] (5.588) e=1.10	0.112 (0.098) e=.04			.993	21.90	2.42 h=-1.18
DY-2	-241.29 (-0.703)	0.468[a] (3.645) e=.41	-29.93 (-0.837) e=-.23	7.573[b] (2.011) e=.33	4.837 (0.376) e=.14	-10.53[b] (-2.458) e=-.25	0.112[a] (5.977) e=1.11		1.234 (0.317) e=.22		.993	21.82	2.43 h=-1.22
DY-3	-333.62 (-1.16)	0.457[a] (3.509) e=.40	-33.11 (-0.931) e=-.26	9.575[b] (2.134) e=.41	6.578 (0.521) e=.19	-10.32[b] (-2.308) e=-.25	0.079[b] (1.92) e=.78	1.678 (0.816) e=.60		45.76 (0.917) e=.12	.993	22.04	2.42 h=-1.20
DY-4	-549.85 (-1.196)	0.448[a] (3.444) e=.39	-29.92 (-0.837) e=-.23	9.973[b] (2.24) e=.43	9.229 (0.68) e=.27	-9.752[b] (-2.242) e=-.24	0.091[a] (3.216) e=.90		5.656 (0.965) e=1.02	41.74 (1.009) e=.11	.993	21.81	2.535 h=-1.54

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t-ratios in parentheses

e refers to elasticity at the mean

Table 5.2

Residential Demand: OLS Single-Equation Estimates (Dynamic)

	Variables in the Equation												
	Constant	QR_{-1}	ER	GR	K	F	Y	N	P	M	$\bar{R}^2$	SEE	D-W
DY-1	-156.63 (-0.739)	0.479[a] (3.773) e=.42	-32.94 (-0.932) e=-.26	7.998[b] (1.942) e=.34	2.294 (0.197) e=.07	-10.35[b] (-2.33) e=-.25	0.111[a] (5.588) e=1.10	0.112 (0.098) e=.04			.993	21.90	2.42 h=-1.18
DY-2	-241.29 (-0.703)	0.468[a] (3.645) e=.41	-29.93 (-0.837) e=-.23	7.573[b] (2.011) e=.33	4.837 (0.376) e=.14	-10.53[b] (-2.458) e=-.25	0.112[a] (5.977) e=1.11		1.234 (0.317) e=.22		.993	21.82	2.43 h=-1.22
DY-3	-333.62 (-1.16)	0.457[a] (3.509) e=.40	-33.11 (-0.931) e=-.26	9.575[b] (2.134) e=.41	6.578 (0.521) e=.19	-10.32[b] (-2.308) e=-.25	0.079[b] (1.92) e=.78	1.678 (0.816) e=.60		45.76 (0.917) e=.12	.993	22.04	2.42 h=-1.20
DY-4	-549.85 (-1.196)	0.448[a] (3.444) e=.39	-29.92 (-0.837) e=-.23	9.973[b] (2.24) e=.43	9.229 (0.68) e=.27	-9.752[b] (-2.242) e=-.24	0.091[a] (3.216) e=.90		5.656 (0.965) e=1.02	41.74 (1.009) e=.11	.993	21.81	2.535 h=-1.54

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t-ratios in parentheses

e refers to elasticity at the mean

Table 5.3(i)

Residential Demand: 2SLS Estimates Demand Equation

	Variables in the Equation										
	Constant	QR_{-1}	ER	GR	K	F	Y	N	P	$\bar{R}^2$	SEE
MODEL 1a	150.04		-157.20.	9.60.	2.718	-3.299.	0.127[a]	0.279		.981	35.75
	(0.228)		(- 1.11)	(1.223)	(0.142)	(-0.508)	(3.457)	(0.121)			
			e=- 1.22	e=.41	e=.08	e=-.08	e=1.26	e=.10			
MODEL 1b	-35.72		-139.13	8.878	6.054	-3.518	0.131[a]		2.315	.982	34.16
	(- 0.034)		(- 0.87)	(1.234)	(0.286)	(-0.594)	(3.147)		(0.271)		
			e=- 1.08	e=.38	e=.17	e=-.09	e=1.30		e=.42		
MODEL 2a	-93.37	0.474[a]	- 47.49	8.454[c]	2.033	-10.34[b]	0.109[a]	-0.05		.993	22.05
	(- 0.23)	(3.623)	(- 0.538)	(1.749)	(0.172)	(- 2.31)	(4.623)	(-0.034)			
		e=.42	e=- .37	e=. 36	e=.06	e=- .25	e=1.08	e=-.02			
MODEL 2b	-162.57	0.465[a]	- 43.46	7.938[c]	4.256	- 10.56[b]	0.109[a]		0.691	.993	21.94
	(- 0.244)	(3.549)	(- 0.417)	(1.720)	(0.313)	(-2 .449)	(3.916)		(0.125)		
		e=.41	e=- .34	e=.34	e=.12	e=- .26	e=1.08		e=.12		

a: coefficient significant at 0.01 level

b: coefficient significant at 0.05 level

c: coefficient significant at 0.10 level

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.3(ii)

2SLS Estimates: Price Equations

	Variables in the Equation					
	Constant	QR	I	J	$\bar{R}^2$	SEE
MODEL 1a	4.234	-0.0024[a]	-0.298[b]	-0.0054	.949	.1519
	(6.366)	(-14.15)	(-2.48)	(-0.588)		
		e=- .31	e=-.19	e=-.14		
MODEL 1b	4.233	-0.0024[a]	-0.298[b]	-0.0054	.949	.1519
	(6.365)	(-14.15)	(-2.48)	(-0.587)		
		e =-.31	e=-.19	e=-.14		
MODEL 2a	4.209	-0.0024[a]	-0.303[b]	-0.0050	.949	.1518
	(6.336)	(-14.09)	(-2.53)	(-0.544)		
		e=- .31	e=-.19	e=-.13		
MODEL 2b	4.210	-0.0024[a]	-0.303[b]	- 0.005	.949	.1518
	(6.337)	(-14.10)	(-2.53)	(-0.545)		
		e=- .31	e=-.19	e=-.13		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.4

BETA COEFFICIENTS (Residential Models)

	EQUATIONS							
VARIABLES	ST-1	ST-2	ST-3	ST-4	DY-1	DY-2	DY-3	DY-4
QR_{-1}					.445*	.434*	.457*	.415*
ER	-.118	-.099	-.117	-.098	-.086	-.078	-.086	-.078
GR	.048	.049	.072*	.079*	.064*	.061*	.076*	.080*
K	.035	.077	.086	.122	.016	.035	.047	.066
F	-.024	-.025	-.029	-.019	-.089*	-.091*	-.089*	-.084*
Y	.736*	.773*	.439*	.595*	.557*	.561*	.393*	.454*
N	.221		.577*		.015		.232	
P		.244		.48*		.045		.207
M			.11	.089			.064	.058

*Parameter estimate significant at 10 percent level

Table 5.5

Commercial/Industrial Demand: OLS Single-equation Estimates (Static)

Equation	Variables in the Equation									R^2	SEE	D-W
	Constant	EL	GL	F	C	Y	N	P	M			
ST-5	-793.61	32.197	-14.83[c]	38.98[a]	-39.94	0.092[c]	9.032[a]			.987	55.09	1.27
	(-1.989)	(0 .309)	(- 1.525)	(5.424)	(- 0.937)	(1.704)	(3.107)					
		e =-.14	e=- .37	e= .54	e = -.34	e=.53	e=1.87					
ST-6	-1786.38	55.70	-8.225	44.43[a]	-47.08	0.145[a]		29.06[a]		.988	54.33	1.65
	(-2.89)	(0.509)	(-0.876)	(6.686)	(- 1.089)	(3.377)		(3.214)				
		e= .23	e=-.21	e= .62	e =-.40	e=.82		e=3.00				
ST-7	-1096.48	24.85	-7.807	41.61[a]	-36.75	0.017	11.75[a]		122.12	.987	55.02	1.48
	(-2.207)	(0.233)	(-0.656)	(5.456)	(-0 .861)	(0.182)	(2.981)		(1.02)			
		e= .10	e=-.19	e= .58	e=- .31	e=.10	e=2.43		e = .18			
ST-8	-2011.18)	47.90	-4.227	46.40[a]	-44.05	0.12[b]		32.21[a]	54.25	.987	55.84	1.76
	(-2.588)	(0.422)	(-0.338)	(5.893)	(-0.983)	(1.811)		(2.872)	(0.502)			
		e=.19	e=-.11	e=.65	e=-.38	e=.68		e=3.33	e=.08			

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.6

Commercial/Industrial Demand: Single-Equation OLS Estimates (dynamic)

	Variables in the Equation												
Equation	Constant	QL_{-1}	EL	GL	F	C	Y	N	P	M	$\bar{R}^2$	SEE	D-W
DY-5	-180.93 (-0.573)	0.509[a] (4.021) e=.43	-11.93 (-0.16) e=-.05	-14.11[b] (-2.093) e=-.35	24.63[a] (4.022) e=.34	-26.51 (-0.892) e=-.23	0.073[b] (1.93) e=.42	3.519[c] (1.494) e=.75			.994	38.17	2.35 h=-.98
DY-6	-367.07 (-0.607)	0.525[a] (3.572) e=.45	-34.05 (-0.403) e=-.14	-11.60[c] (-1.661) e=-.29	26.53[a] (3.786) e=.37	-18.38 (-0.559) e=-.16	0.099[c] (2.915) e=.57		8.11 (0.914) e=.84		.993	40.05	2.41 h=-1.27
DY-7	-399.25 (-1.023)	0.493[a] (3.851) e=.42	-15.88 (-0.212) e=-.07	-9.504 (-1.145) e=-.24	26.81[a] (4.091) e=.37	-24.83 (-0.831) e=-.21	0.024 (0.373) e=.14	5.578[c] (1.755) e=1.16		80.36 (0.956) e=.12	.994	38.30	2.27 h=-.76
DY-8	-472.21 (-0.642)	0.52[a] (3.380) e=.44	-36.40 (-0.413) e=-.15	-9.933 (-1.050) e=-.25	27.51[a] (3.40) e=.38	-17.41 (-0.508) e=-.15	0.089[b] (1.788) e=.51		9.596 (0.898) e=.99	22.17 (0.274) e=.03	.993	41.56	2.38 h=-1.23

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.7(i)

Commercial/Industrial Demand: 2SLS Estimates: Demand Equations

	Variables in the Equation										
	Constant	QL_{-1}	EL	GL	F	C	Y	N	P	$\bar{R}^2$	SEE
MODEL 3a	1792.68		-741.06	14.32	52.59[b]	68.997	0.161	-7.815		.939	120.33
	(0.704)		(-0.985)	(0.417)	(2.614)	(0.503)	(1.197)	(-0.465)			
			e=-3.05	e=.36	e=.73	e=.59	e=.92	e=-1.62			
MODEL 3b	3956.62		-998.24	12.85	49.04[b]	116.84	0.114		-41.94	.906	150.01
	(0.402)		(-0.554)	(0.292)	(2.461)	(0.388)	(0.886)		(-0.343)		
			e=-4.11	e=.32	e=.68	e=.99	e=.65		e=-4.33		
MODEL 4a	404.19	0.550[a]	-175.75	-8.014	26.28[a]	-2.874	0.086[b]	-0.309		.992	44.68
	(0.609)	(3.592)	(-0.992)	(-0.822)	(3.582)	(-0.07)	(1.867)	(-0.066)			
		e=.47	e=-.72	e=-.20	e= .37	e -.03	e=.49	e=-.06			
MODEL 4b	973.71	0.634[a]	-244.69	-8.458	23.66[b]	17.44	0.084[b]		-9.172	.990	48.69
	(0.54)	(2.841)	(-0.88)	(-0.907)	(2.566)	(0.294)	(1.861)		(-0.385)		
		e=.54	e=-1.01	e=-.21	e=.33	e=.15	e=.48		e=-.95		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.7(ii)

2SLS Estimates: Price Equations

	Variables in the Equation					
	Constant	QL	I	S	$\bar{R}^2$	S.D.
MODEL 3a	3.159	-0.0014[a]	-0.211	0.010	.909	.2217
	(7.573)	(-10.56)	(-1.049)	(0.947)		
		e=-.34	e=-.16	e=.17		
MODEL 3b	3.16	-0.0014[a]	-0.212	0.010	.907	.2217
	(7.576)	(-10.55)	(-1.051)	(0.946)		
		e=-.34	e=-.16	e=.17		
MODEL 4a	3.177	-0.0014[a]	-0.219	0.009	.909	.2216
	(7.625)	(-10.49)	(-1.091)	(0.921)		
		e=-.34	e=-.16	e=.16		
MODEL 4b	3.179	- .0014[a]	-0.22	0.0096	.909	.2216
	(7.63)	(-10.48)	(-1.097)	(0.918)		
		e=-.34	e=-.16	e=.17		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.8

BETA COEFFICIENTS (Commercial/Industrial Models)

	EQUATIONS							
VARIABLES	ST-5	ST-6	ST-7	ST-8	DY-5	DY.6	DY-7	DY-8
QL_{-1}					.424*	.438*	.411*	.434*
EL	.049	.084	.037	.072	-.018	-.051	-.024	-.055
GL	-.065*	-.036	-.034	-.019	-.062*	-.051*	-.042	-.044
F	.177*	.201*	.189*	.210*	.112*	.120*	.122*	.125*
C	-.06	-.071	-.055	-.066	-.04	-.028	-.037	-.026
Y	.244*	.382*	.044	.317*	.193*	.262*	.063	.237*
N	.658*		.856*		.263*		.406*	
P		.562*		.623*		.157		.186
M			.09	.04			.059	.016

* Parameter estimate significant at 10 percent level

Table 5.9

Joint Estimation of the Single-Equation Models:
GLS Estimates (Static)

	Variables in the Equation										
	Constant	E	G	K	F	C	Y	N	P	$\bar{R}^2$	SEE
SYSTEM A1											
Residential	-432.39	-7.299	5.871	-0.78	-0.891		0.159[a]	1.575		.985	31.37
	(-1.842)	(-0.176)	(1.146)	(-0.063)	(-0.186)		(7.136)	(1.315)			
		e=-.06	e=.25	e=-.02	e=-.02		e=1.57	e=.57			
Commercial/ Industrial	-748.12	-20.30	-15.69[c]		42.36[a]	3.305	0.137[a]	6.588[a]		.986	57.20
	(-2.238)	(-0.242)	(-1.709)		(6.182)	(0.099)	(2.881)	(2.848)			
		e=-.08	e=-.38		e=.59	e=.03	e=.78	e=1.36			
SYSTEM A2											
Residential	-627.37	-9.044	6.747[c]	1.611	-0.44		0.166[a]		5.443	.986	30.66
	(-1.681)	(-0.211)	(1.404)	(0.114)	(-0.095)		(8.757)		(1.312)		
		e=-.07	e=.29	e=.05	e=-.01		e=1.64		e=.20		
Commercial/ Industrial	-1419.31	-13.60	-10.48		46.31[a]	-2.044	0.173[a]		20.73[a]	.987	56.57
	(-2.721)	(-0.15)	(-1.169)		(7.06)	(-0.06)	(4.395)		(2.745)		
		e=-.06	e=-.26		e=.64	e=-.02	e=.98		e=2.14		

a ; coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.10

Joint Estimation of the Single-Equation Models: GLS Estimates (dynamic)

	Variables in the Equation											
	Constant	Q_{-1}	E	G	K	F	C	Y	N	P	$\bar{R}^2$	SEE
SYSTEM B1												
Residential	-152.49	0.466[a]	-31.9	8.166[b]	0.995	-9.754[b]		0.114[a]	0.066		.993	21.92
	(-0.723)	(3.672)	(-0.906)	(1.989)	(0.086)	(-2.205)		(5.727)	(0.058)			
		e=.41	e=-.25	e=.35	e=.03	e=-.24		e=1.13	e=.02			
Commercial/	-200.38	0.499[a]	-13.84	-14.36[b]		25.26[a]	-21.85	0.079[b]	3.498		.994	38.22
Industrial	(-0.638)	(3.955)	(-0.187)	(-2.134)		(4.129)	(-0.741)	(2.089)	(1.454)			
		e=.42	e=-.06	e=-.36		e=.35	e=-.19	e=.45	e=.73			
SYSTEM B2												
Residential	-239.39	0.453[a]	-28.8	7.678[b]	3.836	-10.01[b]		0.114[a]		1.169	.993	21.85
	(-0.702)	(3.539)	(-0.809)	(2.045)	(0.301)	(-2.345)		(6.106)		(0.302)		
		e=.40	e=-.22	e=.33	e=.11	e=-.24		e=1.13		e=.21		
Commercial/	-363.16	0.517[a]	-37.82	-11.99[c]		27.09[a]	-12.74	0.105[a]		7.530	.993	40.11
Industrial	(-0.604)	(3.525)	(-0.451)	(-1.721)		(3.87)	(-0.391)	(3.078)		(0.854)		
		e=.44	e=-.16	e=-.30		e=.38	e=-.11	e=.60		e=.78		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.11(i)

Joint Estimation of the Simultaneous-Equation Models: G3SLS Estimates (Static)

	Variables in the Equations										
	Constant	E	G	K	F	C	Y	N	P	$\bar{R}^2$	SEE
SYSTEM C1											
RESIDENTIAL	-173.04	-69.48[c]	6.602[c]	0.827	-4.162		0.146[a]	1.13		.985	31.44
	(-0.701)	(-1.462)	(1.457)	(0.078)	(-0.999)		(6.75)	(1.013)			
		e=-.54	e=.28	e=.02	e=-.18		e=1.44	e=.41			
Commercial/	80.93	-245.53[b]	-4.182		37.12[a]	14.16	0.135[a]	2.759		.979	70.27
Industrial	(0.204)	(-2.306)	(-0.482)		(5.989)	(0.442)	(3.003)	(1.05)			
		e=-1.01	e=-.11		e=.52	e=.12	e=.77	e=.57			
SYSTEM C2											
Residential	-490.25	-46.92	6.684[c]	5.123	-4.228		0.156[a]		5.311	.986	30.69
	(-1.259)	(-0.927)	(1.514)	(0.405)	(-1.015)		(7.954)		(1.320)		
		e=-.36	e=.29	e=.15	e=-.10		e=1.54		e=.95		
COMMERCIAL/ INDUSTRIAL	55.49	-289.73[b]	-1.383		38.79[a]	23.96	0.154[a]		4.947	.977	74.34
	(0.082)	(-2.376)	(-0.167)		(6.515)	(0.676)	(4.087)		(0.539)		
		e=-1.19	e=-.03		e =.54	e=.20	e=.78		e=.51		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.11(ii)

Price Equations: G3SLS Estimates

	Variables in the Equation						
	Constant	Q	I	J	S	$\bar{R}^2$	SEE
SYSTEM C1							
Residential	4.100	-0.0023[a]	-0.333[a]	-0.003		.951	.1481
	(7.109)	(-14.35)	(-2.878)	(-0.362)			
		e=-.30	e=-.21	e=-.08			
Commercial/ Industrial	3.112	-0.0014[a]	-0.322[c]		0.015[c]	.907	.2242
	(8.147)	(-10.69)	(-1.693)		(1.683)		
		e=-.34	e=-.24		e=.26		
SYSTEM C2							
Residential	4.122	-0.0023[a]	-0.334[a]	-0.003		.948	.1523
	(7.003)	(-14.25)	(-2.841)	(-0.395)			
		e=-.30	e=-.21	e=-.08			
Commercial/ Industrial	3.102	-0.0014[a]	-0.319[c]		0.015[c]	.907	.2242
	(8.109)	(-10.65)	(-1.665)		(1.705)		
		e=-.34	e=-.24		e=.26		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.12(i)

Joint Estimation of the Simultaneous-Equation Models: G3SLS Estimates (dynamic)

	Variables in the Equation											
	Constant	Q_{-1}	E	G	K	F	C	Y	N	P	$\bar{R}^2$	SEE
SYSTEM D1												
Residential	-92.49	0.427[a]	-49.24	7.86[b]	1.382	-9.114[b]		0.113[a]	0.0052		.993	22.25
	(-0.393)	(3.428)	(-1.135)	(1.915)	(0.122)	(-2.097)		(5.648)	(0.0044)			
		e=.38	e=-.38	e=.34	e=.04	e=-.22		e=1.12	e=.002			
Commercial/ Industrial	-55.78	0.447[a]	-67.28	-11.27[c]		24.22[a]	-19.60	0.08[b]	3.137		.993	40.45
	(-0.146)	(3.662)	(-0.698)	(-1.632)		(4.104)	(-0.659)	(2.188)	(1.131)			
		e=.38	e=-.28	e=-.28		e=.34	e=-.17	e=.46	e=.65			
SYSTEM D2												
Residential	-302.00	0.432[a]	-21.63	7.089[b]	4.676	-9.693[b]		0.118[a]		1.762	.993	21.96
	(-0.798)	(3.320)	(-0.485)	(1.828)	(0.359)	(-2.234)		(5.949)		(0.433)		
		e=.38	e=-.17	e=.30	e=.13	e=-.23		e=1.17		e=.32		
Commercial/ Industrial	111.81	0.473[a]	-143.52	-7.997		24.94[a]	-2.59	0.102[a]		2.865	.992	44.77
	(0.142)	(3.243)	(-1.229)	(-1.174)		(3.688)	(-0.076)	(3.021)		(0.263)		
		e=.40	e=-.59	e=-.20		e=.35	e=-.02	e=.58		e=.30		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.12(i)

Joint Estimation of the Simultaneous-Equation Models: G3SLS Estimates (dynamic)

	Variables in the Equation											
	Constant	Q_{-1}	E	G	K	F	C	Y	N	P	$\bar{R}^2$	SEE
SYSTEM D1												
Residential	-92.49	0.427[a]	-49.24	7.86[b]	1.382	-9.114[b]		0.113[a]	0.0052		.993	22.25
	(-0.393)	(3.428)	(-1.135)	(1.915)	(0.122)	(-2.097)		(5.648)	(0.0044)			
		e=.38	e=-.38	e=.34	e=.04	e=-.22		e=1.12	e=.002			
Commercial/ Industrial	-55.78	0.447[a]	-67.28	-11.27[c]		24.22[a]	-19.60	0.08[b]	3.137		.993	40.45
	(-0.146)	(3.662)	(-0.698)	(-1.632)		(4.104)	(-0.659)	(2.188)	(1.131)			
		e=.38	e=-.28	e=-.28		e=.34	e=-.17	e=.46	e=.65			
SYSTEM D2												
Residential	-302.00	0.432[a]	-21.63	7.089[b]	4.676	-9.693[b]		0.118[a]		1.762	.993	21.96
	(-0.798)	(3.320)	(-0.485)	(1.828)	(0.359)	(-2.234)		(5.949)		(0.433)		
		e=.38	e=-.17	e=.30	e=.13	e=-.23		e=1.17		e=.32		
Commercial/ Industrial	111.81	0.473[a]	-143.52	-7.997		24.94[a]	-2.59	0.102[a]		2.865	.992	44.77
	(0.142)	(3.243)	(-1.229)	(-1.174)		(3.688)	(-0.076)	(3.021)		(0.263)		
		e=.40	e=-.59	e=-.20		e=.35	e=-.02	e=.58		e=.30		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.12(i)

Joint Estimation of the Simultaneous-Equation Models: G3SLS Estimates (dynamic)

	Variables in the Equation											
	Constant	Q_{-1}	E	G	K	F	C	Y	N	P	$\bar{R}^2$	SEE
SYSTEM D1												
Residential	-92.49	0.427[a]	-49.24	7.86[b]	1.382	-9.114[b]		0.113[a]	0.0052		.993	22.25
	(-0.393)	(3.428)	(-1.135)	(1.915)	(0.122)	(-2.097)		(5.648)	(0.0044)			
		e=.38	e=-.38	e=.34	e=.04	e=-.22		e=1.12	e=.002			
Commercial/ Industrial	-55.78	0.447[a]	-67.28	-11.27[c]		24.22[a]	-19.60	0.08[b]	3.137		.993	40.45
	(-0.146)	(3.662)	(-0.698)	(-1.632)		(4.104)	(-0.659)	(2.188)	(1.131)			
		e=.38	e=-.28	e=-.28		e=.34	e=-.17	e=.46	e=.65			
SYSTEM D2												
Residential	-302.00	0.432[a]	-21.63	7.089[b]	4.676	-9.693[b]		0.118[a]		1.762	.993	21.96
	(-0.798)	(3.320)	(-0.485)	(1.828)	(0.359)	(-2.234)		(5.949)		(0.433)		
		e=.38	e=-.17	e=.30	e=.13	e=-.23		e=1.17		e=.32		
Commercial/ Industrial	111.81	0.473[a]	-143.52	-7.997		24.94[a]	-2.59	0.102[a]		2.865	.992	44.77
	(0.142)	(3.243)	(-1.229)	(-1.174)		(3.688)	(-0.076)	(3.021)		(0.263)		
		e=.40	e=-.59	e=-.20		e=.35	e=-.02	e=.58		e=.30		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.12(ii)

Price Equations: G3SLS Estimates

	Variables in the Equation						
	Constant	Q	I	J	S	$\bar{R}^2$	SEE
SYSTEM D1							
Residential	4.084	-0.0023[a]	-0.325[a]	-0.0029		.948	.1523
	(6.83)	(-14.23)	(-2.725)	(-0.352)			
		e=-.30	e=-.22	e=-.07			
Commercial/	3.094	-0.0014[a]	-0.284[c]		0.014[c]	.908	.223
Industrial	(7.927)	(-10.58)	(-1.438)		(1.51)		
		e=-.34	e=-.21		e=.24		
SYSTEM D2							
Residential	4.078	-0.0023[a]	-0.326[a]	-0.0028		.948	.1524
	(6.768)	(-14.17)	.727)	(-0.339)			
		e=-.30	e=-.22	e=-.07			
Commercial/	3.087	-0.0014[a]	-0.28[c]		0.014[c]	.908	.223
Industrial	(7.93)	(-10.59)	(-1.422)		(1.523)		
		e=-.34	e=-.21		e=.24		

a: coefficient significant at 0.01 level

b: " " " 0.05 "

c: " " " 0.10 "

t - ratios in parentheses

e refers to elasticity at the mean

Table 5.13

Beta Coefficients: GLS Models

	EQUATION SYSTEM			
	SYSTEM C1		SYSTEM D2	
Variables	Residential	Commercial/ Industrial	Residential	Commercial/ Industrial
Q-1			.401*	.395*
E	-.18*	-.371*	- .056	-.217
G	.053*	-.018	.057*	-.035
K	.006		.033	
F	.036	.168*	- .083*	.113*
C		.021		-.004
Y	.731*	.356*	.591*	.269*
N	.156	.201		
P			.065	.055
Q	-.884*	-.929*	-.884*	-.929*
I	-.164*	-.144*	-.16*	-.125*
J	-.019		-.018	
S	.12		.111	

* Parameter estimate significant at 10 percent level

CHAPTER SIX

SOME IMPLICATIONS OF THE RESULTS

In brief, the main features of the results of the preceding chapter are:

(a) Price is not an important determinant of residential consumption of electricity; price may be important to the commercial/industrial consumers.

(b) Residential demand is rather insensitive to price changes; commercial/industrial demand may be price-responsive.

(c) Demand by both consumer groups is influenced by the price and availability of substitutes fuels; fuelwood in the case of commercial/industrial consumers, and gas in the case of residential consumers. But electricity demand is inelastic with respect to the price of these substitutes.

(d) Income is clearly the strongest determinant of demand for electricity: residential demand is more income-elastic than commercial/industrial consumption.

(e) The population factor appears rather ambiguously important: where it is a significant determinant of consumption, the magnitude of responsiveness of demand to changes in population is substantial.

Comparison with Previous Studies: Whereas most of the studies reviewed in Chapter 3 came up with significant own-price coefficient, our results do not conclusively affirm this: for commercial/industrial demand our results would seem to coincide with previous findings, since the own-price elasticity was , in some instances, greater than unity. But contrary to the results of Halvorsen, Wilson and Anderson, residential demand in Nigeria does not seem to be affected by the price of electricity.

Our results in the case of substitutes seem to be similar to those of previous studies. As well as being significant, the elasticity coefficients for fuelwood and gas were usually less than unity. But our results go further to stress that these substitutes are not "so important", in terms of their relative effect on the level of electricity consumption.

The income variable appeared highly significant and positive in this study just as in previous ones. But the elasticity estimates differ. Previous studies (Mount et. al., for example) came up with values less than unity for residential demand: ours exceeds unity. For commercial/industrial we obtained values less than unity - same as Mount et. al. in their study.

The population factor did not feature much in other studies. It appeared to be important in Fisher and Kaysen's study. Mount et. al. obtained elasticity values of less than one. In the few cases where population was manifestly significant in our study, the elasticity often exceeded one.

The foregoing comparison may also be an indication of the differences in the states of demand for electricity in the less developed (LDCs) and the more developed countries (MDCs). It would seem, from our study of the Nigerian experience, as though price is not very important in LDCs, whereas it is in the MDCs. When there is some suggestion of price-response, demand may also be more price-responsive in the latter than in the former. Income would appear to be important in both places: but demand seems less income-elastic in the MDCs. The price of substitutes is also important in both places. Finally, population is also crucial for both, but more for the LDCs than MDCs as indicated by the elasticity values.

Future Level of Electricity Consumption:

The non-significance of the own-price response for residential demand, implies that price may not be a deterrent to higher levels of consumption. It means (given the low price elasticity, -0.3) the recent (1977) tariff changes would not significantly reduce the level of demand or decrease the rate of growth of consumption. For a monthly

average residential energy consumption of 200kwh (1975/76 national average was 172kwh) the new tariff succeeded in raising the average price per kilowatthour from 4.5 kobo to 5.4 kobo[1]. This is an increase of 20 percent which may reduce consumption by about 5 percent.

The price increase for the commercial and industrial consumers was on the average about 40 percent for the former and 25 percent for the latter.[2] The consequence of the tariff change could be greater here given a price elasticity equal to unity. A partial reduction in consumption of 20 to 30 percent may result. But Iwayemi (1976) has argued that the price paid for electricity in Nigeria does not reflect its opportunity cost. If so, the new tariff may be an attempt to ensure the consumer pays the real cost of electricity he consumes.

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1. This refers to a hypothetical household paying (a) power charge of ₦2 (b) energy charge of ₦8.82 for 200 kwh.

2. These refer to (i) the commercial consumer consuming 400 kwh and paying minimum power charge of ₦2.60 (ii) the industrial consumer using 50,000 kwh and paying minimum ₦195 as power charge. See Appendix IID.

On the other hand, if the prices of substitutes rise over time, that may invariably lead to greater demand for electricity itself. Thus the future level of demand for electricity in Nigeria will also depend on the price and availability of substitute fuels. In the case of fuelwood its availability is very much tied to natural factors. The high rate of timber forest depletion, urban growth and the extension of farmlands are phenomena that are reducing woodlands in Nigeria. The likelihood is that in the years ahead fuelwood may become scarcer and its price may consequently increase.

Gas and kerosene, are expected to become more readily available in adequate quantities as soon as the two new oil refineries go into operation.[3] In that case we may anticipate their prices would not change much. The Federal Government now fixes the prices of all petroleum products, making price fluctuations in the case of gas and kerosene less likely. Hypothetically therefore, the demand for electricity ought to fall if the price of its substitutes fall. This assumes that electricity, gas and kerosene are all used for identical purposes in the household. This may not be true: the average monthly residential consumption (about 200 kwh) is very small and is used mainly for lighting and for running the radio,

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3. See Business Times of August 8, 1978, p.1.

pressing-iron , fan, refrigerator and television set . The latter two are mainly possessed by the middle-class and upper-class households. Thus electricity is used basically for lighting. And for this purpose it is technologically superior to either gas or kerosene. As a matter of fact, the latter two are used mainly for cooking, and in places where electricity is not available, kerosene is used for lighting; most households do not seem to be using electricity for cooking.[4] Furthermore, the anticipated increases in electricity consumption may not come from existing users but from new consumers who form a large proportion of the unsatisfied demand. For instance total residential demand doubled between 1970/71 and 1974/75, but average consumption per residential user rose by only 26 percent. Therefore the scope for substitution is limited.

The position of natural gas and coal is more subtle since they serve both as a complement (fuel for generating power) and as substitutes to electricity. We mentioned in chapter 4 that the price of natural gas has remained virtually the same in the last sixteen years: there is no likelihood of a future rise in price since a

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4. The small average monthly consumption testifies to this. If many households use electric cookers then average consumption would be considerably higher. One reason why most households would not use electricity for cooking may be the irregular power supply.

good proportion of the output is being flared off. It is also anticipated that when the mechanisation of the coal mines is completed the price of coal may even fall as a result of higher output and lower unit cost of production. All these notwithstanding, we should not expect a fall in industrial demand for electricity in the future since the technical operation of switching from one fuel to another involves long-term decisions on plant and equipment design.

Income and probably population growth may have the greatest impact on electricity in the coming years. The increase in the income of Nigerians, thanks to crude oil, led to higher demand for goods and services (such as electricity) in the last ten years. However, the demand for Nigeria's oil has slackened, consequently government earnings, hence income, have declined. Does it means a corresponding fall in demand for electricity? This is not a likely outcome since the potential demand for electricity has yet to be satisfied.

Table 6.1 is an illustration of the projected levels of electricity consumption in the country up to 1990/91, taking income as the only causal factor.[5] We assumed two different average annual rates of

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5. Projections were based on the elasticity values as given on Table 5.9, system A2. Other factors are held constant.

Table 6.1

Projections of Electricity Consumption (GWH)[a]

	r = 7.5%	r=7.5% (1975-1980) r = 9% (1981-91)	r = 9%	NEPA Projections[b]
1975/76	2707 (Actual Demand)	2707 (Actual Demand)	2707 (Actual Demand)	2715
1976/77[c]	2948	2948	2996	3375
1980/81	4166	4166	4525	7905
1985/86	6486	7062	7692	16,276
1990/91	10,223	11,563	13,303	n.a.

a: GWH = 1 gigawatthour = 1 million kwh

b: Source: NEPA (1976): Power System Development Plan. p.6

c: Actual Consumption in 1976/77 is 3266 GWH.

r = GDP annual rate of growth

n.a: not available

growth (AARG) for the Gross Domestic Product (GDP): 7.5% and 9%. The former figure was based on the average annual rate of growth (AARG) for the five years, 1971/72 to 1975/76; the latter is the estimated AARG projected for 1975-80 in the Third Development Plan. The last column of table 6.1 shows the projections made by NEPA itself. Our estimates reveal that consumption may treble by 1986; NEPA anticipates a six-fold increase.

On table 6.2 are the anticipated annual growth rates of electricity consumption resulting from the projections in table 6.1. It becomes apparent that NEPA expects consumption to grow at a rate twice our estimated AARG over the ten years 1976 to 1986. Since our projections were based on income alone, it may be an underestimate. But comparing the actual 1976/77 consumption to our projections for that year it will be observed that the difference (about 10% lower) due to other factors may not be considerable. Since our projections were based on the highest income elasticity values (obtained in the results) for both residential and commercial/industrial consumption, they might be rather optimistic. NEPA's estimates would therefore seem overly optimistic.

The projected AARGs on table 6.2 are very high and surpass the rates actually recorded in the last ten to fifteen years which was about 20 percent. Since NEPA has not been able to

Table 6.2

Growth rates of Electricity Consumption

1975 - 1986

	r = 7.5%	r = 7.5% (1975-80) r = 9% (1980-85)	r = 9%	NEPA Projections
1976 - 81	31%	31%	34%	58%
1981 - 1986	31%	34%	34%	41%
1976 - 86	24%	26%	28%	59%

cope with such rapid rate of growth in the past, would it not be a formidable task for it to keep up in the event of the increases in consumption we projected being actually realised?

Policy Implications:

We have so far argued that electricity consumption may continue to rise at a rather fast rate in the future. To satisfy such a demand, investment in power generation and distribution might have to be increased. At the same time we would suggest an overall energy use strategy that effectively maximises the benefits that can be derived from each type of energy resource available in this country.

For instance, industrial demand for electricity can be dampened by encouraging coal consumption in industries; that may be a lesser-cost approach than setting up a new generation station using coal as fuel input. In the same vein, more industries may also be encouraged to rely on natural gas as basic fuel in lieu of electricity. But such policy option can only be exercised as part of a long-term strategy since, as we have noted, switching from one fuel type to another is only technically feasible over the long run.

The high rate of growth in demand has to be met in the short run by expanding the system's output capacity. One way would be to invest in large thermal power stations using our neglected fossil fuel resources.[6] Thermal plants take shorter period to build than hydroelectric stations. They are also less affected by weather or climatic factors, which can demobilise hydro-electric stations, as we have recently experienced. Finally, we would be able to exploit our fossil energy resources to the fullest by setting up these plants. We wish to caution that investment in thermal stations should be carefully planned so that it does not eventually lead to regional imbalances with the concentration of power supplies only in those areas endowed with fossil fuels.

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6. This has already been suggested by Ukpong (1976).

CHAPTER SEVEN

SUMMARY AND CONCLUSION

This study has attempted to establish quantitatively those factors responsible for determining the level of electricity consumption in Nigeria. It also tried to find out the relative impact of each significant determinant factor on the level of consumption.

Our results revealed that income may be the most important causal factor in the demand for electricity in Nigeria. The price and the availability of fuelwood and liquefied petroleum gas (LPG) are other factors that may be determining the level of electricity consumption. The price of electricity and population appear, ambiguously though, to be significant factors as well. On the other hand, coal and kerosene apparently do not influence electricity consumption; this might be due to the stickiness of their prices over the years.

When we compare the results to those of previous studies, differences occur as to the magnitude of the own-price response, and the income and population elasticities. The magnitude of the cross-elasticities in this study followed the pattern observed in previous studies: they were usually less than unity.

Taking income as the main causal factor in electricity demand, our illustrative projections reveal that demand may increase to almost thrice its present level by 1986. These projections imply a faster rate of growth in consumption than in the past; yet, when compared with the growth rate, anticipated by the National Electric Power Authority (NEPA) in its own forecasts, our implied growth rate would seem conservative.

Nevertheless, the problem in the future as in the past will be how to cope with the huge increases in demand. A pertinent short-term solution would be to invest more in the system's power output capacity by accelerating the development of large thermal power stations. Such large stations are more likely to yield economies of scale than the small ones (operated by NEPA in the 1960s) which were dismantled (due to high maintenance cost) in favor of hydroelectric power stations.

Finally, a long-term strategy is however required for an effective exploitation of our energy resources which ensures that undue reliance is not placed on any particular energy source while others are suffering from neglect.

APPENDIX I

DEFINITIONS

Tariff: all the schedules, rules and regulations of the utility.

Kilowatt: unit of electric power. Power is the rate of doing work.

Ampere: unit measuring the rate of flow of electricity in a circuit.

Volt: unit of electric force or pressure.

Kilowatt-hour (kwh): unit of electric energy. Product of power (kw) and time measured in hours.

Kilovolt-ampere (KVA): Certain types of electrical circuits have a characteristic which causes them to take additional current with no increase in the amount of "real" power supply. The unit of this "apparent" electric power is the kilovolt-ampere .

Flat-rate tariff: A single unit charge per kwh for all energy used. Also referred to as straight-line tariff. It does not provide discounts for higher consumption.

Two-part tariff: It consists of a fixed charge reflecting power demand and a running charge for energy used.

Block Tariff: Energy consumption is partitioned into layers or strata called "blocks"; and in each block a different running charge applies; the charge declining as consumption increases. It does not include a "power demand" charge.

Hopkinson's two-part tariff: It is applied mainly to commercial and industrial consumers. It consists of a variable or "block" power demand charge measures in kilowatt or kilovolt-amperes, and a block energy charge equivalent to the block tariff.

Source: Caywood (1956).

APPENDIX II

THE OLD ECN AND NEPA TARIFFS

IIA

1956 - 1969

RESIDENTIAL

The Residential rate shall apply where energy is used in premises which are used wholly or principally as private residences for lighting, heating, cooking, or any other purpose.

Charges

1. Every consumer has to pay a fixed charge per month in respect of the supply of electric energy. This fixed charge depends upon the area of the premises and is calculated as follows:

For the first 400 sq. ft or less	50k per month
From 401 sq. ft. to 1,000 sq. ft.	12½k 100sq.ft or part thereof per month.
From 1,001 sq. ft. to 1,000 sq. ft... ...	10k per 100sq.ft or part thereof per month.
From 2,001 sq. ft. to 3,000 sq. ft.	8.33k per 100sq. ft or part thereof per month.
From 3,001 sq. ft. to 4,000sq. ft	5.83k per 100sq. ft. or part thereof per month.

Above 4,000 sq. ft . ... 4.17k per 100sq. ft. or part thereof per month.

2. In addition, the following running kwh charges are applicable.

(a) 2½k per kwh for the first 200 kwh per month and 1.25k per kwh for all kwh per month in excess of 200 kwh, for consumers living in:

LAGOS, PLATEAU (JOS, VOM & BUKURU) PORT-HARCOURT ENUGU

(b) 2.5k per kwh for the first 200 kwh per month and 1.67k kwh for all kwh per month in excess of 200 kwh for consumers living in:

KANO

(c) 2.5k per kwh for consumers living in:

ABA	CALABAR	IKOT EKPENE	ONITSHA	UMUAHIA
ABAKALIKI	EDE	ILARO	OSHOGBO	UYO
ABEOKUTA	IBADAN	ILESHA	OTTA	WARRI
AWKA	IFE	KADUNA	OTURKPO	ZARIA
BENIN	IFO	NSUKKA	SAPELE	

and the SHAGAMU/IJEBU-ODE area.

(d) 4.17k per kwh for consumers living in AMENITY UNDERTAKINGS as follows:

ADO EKITI	FUNTUA	IKIRUN	MAIDUGURI	ONDO
AKURE	GBONGAN	ILORIN	MAKURDI	OWERRI
ASABA	COMBE	IWO	MINNA	OWO
BACITA	GUSAU	KATSINA	NGURU	OYO

BAUCHI	IDANRE	KOKO	OFFA	SOKOTO
BIDA	IKARE	LOKOJA	OGBOMOSHO	YOLA
EJIGBO	IKERRE		OKITIPUPA	

COMMERCIAL AND INDUSTRIAL

The Commercial and Industrial Rate shall apply where energy is used in any premises not used wholly as private residence and shall include shops, offices, stores, hospitals, clubs, hotels, schools, wharves, railway stations, airfields, and premises used for industrial purposes. The monthly demand charge for any consumer will be the summation of the varying steps of charges per K.V.A. shown in the table below up to the consumer's Maximum Demand.

Charges

1. Every consumer must pay a monthly demand charge based on his maximum demand during the month and this charge will be calculated in accordance with the following table:-

Up to 10 K.V.A.	-	30k	per	100	V.A.	or	part	thereof per month
From 11 "	-	25 K.V.A.	₦2.75	per	K.V.A.	or	part	thereof p.m.
From 26 "	-	50 "	₦2.50	per	"	or	"	" "
From 51 "	-	100 "	₦2.25	per	"	or	"	" "
From 101 "	-	250 "	₦2.00	per	"	or	"	" "
From 251 "	-	500 "	₦1.75	per	"	or	"	" "
From 501 "	-	1000 "	₦1.50	per	"	or	"	" "
Above 1000 "			₦1.33	per	"	or	"	" "

2. In addition, running kwh charge as set out under RESIDENTIAL-CHARGES (2); except that for towns in Section 2(a) and 2(b) above the high rate applies up the value of the maximum demand charge.

MISCELLANEOUS

These tariffs are available only to consumers where the residential tariff would not be applicable, and with the exception of the General Purposes rate they are normally associated with the Commercial/Industrial Tariff.

(a) Shop Window Lighting

If separated from the main installation and separately metered, shop window lighting will be charged at a flat kwh rate 3.3k per kwh at all undertakings with the exception of the Amenity Undertakings where the rate will be 5k per kwh.

(b) Street Lighting

As for the Commercial/Industrial rate but in addition, in the event of an agreement with the Local Authority for the Corporation to maintain the street lighting systems an additional monthly charge per lamp.

(c) Welding

The Commercial/Industrial rate will apply and for any welding plant other than that incorporating a motor generator an additional fixed monthly charge of ₦2.00 per K.V.A. or part thereof of the manufacturer's rated input of the welding plant installed. In cases where capacitors are installed this additional fixed charge will be reduced in relation to the improvement of the power factor.

(d) General Purposes

The General Purposes rates as detailed hereunder shall apply where in the opinion of the Corporation none of the other rates are appropriate. It shall not be applicable to residential premises.

(i) 15k per kwh

ABA	EDE	ONITSHA	UYO
ABAKALIKI	IFE	OSHOGBO	WARRI
AWKA	IKOT EKPENE	OTURKPO	ZARIA
BENIN	ILESHA	SAPELE	
CALABAR	NSUKKA	UMUAHIA	

and all AMENITY UNDERTAKINGS

(ii) 12½k per kwh

KANO ABEOKUTA IBADAN KADUNA

and the SHAGAMU/IJEBU-ODE area.

(iii) 10k per kwh

LAGOS PORT HARCOURT ENUGU

PLATEAU (JOS, VOM & BUKURU)

(e) Combined

Where in the opinion of the Corporation a single premises has an installation to which the application of more than one of the other of the corporation's tariffs would be applicable they may charge as a single rate such combination of the other rates as in the circumstances they may deem appropriate.

NOTES

The above mentioned tariffs should be read in conjunction with the following notes.

1. Supplies which may be subject to special agreement

Where a consumer's load has special features such as high maximum demand, high load factor and a favourable Off Peak characteristic, the Corporation is prepared to consider the application of terms under Special Agreements. Standby and Emergency supplies shall in all cases be the subject of special agreement.

2. Separate Meters

Where it is necessary for a separate meter to be installed to enable the consumer to obtain supplies at more than one of the rates quoted in the Corporation's tariff, or where it is necessary to provide three phase supply to suit the consumer's apparatus, the Corporation may make a charge to cover the cost of the additional metering equipment.

3. Minimum Monthly Charges

In all premises the minimum charge to a consumer in respect of the kwh charges in any one month shall be 50k in addition to normal monthly fixed charge, except that where the Corporation has to incur expenditure on the provision of an extension to mains, sub-stations etc., for the purpose of supplying a particular consumer, they may require the consumer to agree to terms under special agreement.

4. Disconnection

The supply of energy shall be conditional on the payment of any amount due therefore on demand. Failure to comply with this condition shall render the consumer liable to have his premises disconnected without notice.

5. Maximum Demand Charge (Commercial/Industrial Tariff)

The consumer may be charged either assessed maximum demand or measured maximum demand at the discretion of the Corporation but any consumer who has an installed load of more than 5 K.V.A. and who

agrees to bear the cost of providing maximum demand metering may elect to be charged on measured and not assessed demand. The Corporation would normally measure maximum demand in all cases where this is likely to exceed 25 K.V.A.

Where the charge for the supply of energy is assessed on the number and capacity of the lamps or other apparatus installed in a consumer's premises no alteration in the number or capacity of such lamps or apparatus shall be made without the permission in writing of the electrical engineer in charge of the undertaking. Consumers with fixed permanent installation for space heating, air conditioning, water heating, cooking, shop window lighting and electric signs, may have such installations excluded from the measurement or assessment of their maximum demand, provided that they:

(i) provide separate circuits for these installations back to the metering point.

(ii) agree to pay such hire charge as the Corporation may determine in accordance with size of the installation for provision of automatic time switch control, under the control of the Corporation, whereby these installations may be automatically switched off for such peak load periods daily as the Corporation may from time to time determine.

6. Off Peak Concession (Restricted to Industrial and Commercial loads which normally operate over the Corporation's Peak Period).

Where the consumer's greatest demand occurs during Off-Peak periods of the system to which he is connected, and where the connected load exceeds 25 K.V.A., the demand for which the consumer shall be charged at the standard maximum demand charge shall be the On-Peak demand plus 20 per cent of the difference between the On-Peak and Off-Peak demands, provided that the consumer enters into an agreement to pay for the cost of the additional metering required. This however, will not reduce the number of kwh to be charged at the high rate. This will be calculated on the basis of what the consumer's fixed charge would be if he were not receiving the Off-Peak concession.

Source: Electricity Corporation of Nigeria. Annual Report and Accounts for the year ended 31st March 1965.

IIB

1956 - 1969

SCHEDULE A

(Single-Phase Service Tariff)

AVAILABILITY OF SERVICE

Applicable to all residential consumers and some small commercial/ industrial consumers who will normally be connected to the Corporation's single-phase 230 Volt supply. Biggest induction motor or welding transformer acceptable is 3 H.P. or 3KVA. A small commercial/ industrial consumer whose load exceeds 5KVA will not be connected to the Corporation's single-phase supply.

CONSUMPTION per apartment* per month;	AREA I Lagos, Jos, Enugu Port Harcourt	AREA II All other Undertakings
First 20 kwh or less	₦2.00(min. charge)	₦2.00(min. charge)
Next 40 kwh at	3.75 per kwh	4.58 per kwh
Next 40 kwh at	3.33 per kwh	4.16 per kwh
Next 100 kwh at	2.50 per kwh	3.33 per kwh
All over 200 kwh at	1.66 per kwh	2.50 per kwh

*Apartment-refers to a self-contained house or flat or each floor of a multi-storeyed house. The Corporation will ordinarily provide a meter for each apartment.

SCHEDULE B

(Three-Phase Service Tariff Without Maximum Demand Metering)

AVAILABILITY OF SERVICE

Applicable to small and medium commercial/industrial consumers who will normally be connected to the Corporation's three-phase 400-volt supply.

TARIFF PER MONTH: Applicable in all undertakings throughout the country.

Part (a) POWER DEMAND CHARGE

Installed Capacity

First 5 KVA of power demand ... ... No Charge

(equivalent to 1500 kwh and below)

Next 5 KVA at ... ... 30k per 100 VA or part thereof

All Additional KVA at ... ₦2.50 per KVA or part thereof

Part (b): ENERGY CHARGE

Fist	20 kwh or less	₦2.00 (min. charge)
Next	180 kwh at	4.58k per kwh
Next	300 kwh at	4.16k per kwh
Next	2000 kwh at	3.33k per kwh
All over	2,500 kwh at	2.50k per kwh

DETERMINATION OF DEMAND CHARGE

Demand charge shall be determined by the total installed electrical capacity in KVA connected at consumers' premises.

MINIMUM CHARGE

The minimum charge shall be ₦2.00

SCHEDULE C

(Three-Phase Service Tariff
With Maximum Demand Metering)

AVAILABILITY OF SERVICE

Applicable to medium and large commercial/industrial consumers who will normally be connected to the Corporation's three-phase medium or high voltage supply.

TARIFF PER MONTH: Applicable in all Undertakings throughout the country.

Part (a): POWER DEMAND CHARGE

First 75 KVA of Demand or less ₦150.00 (min. charge)

All additional KVA of Demand at ₦ 2.00 per KVA or part thereof

Part (b): ENERGY CHARGE

First	5,000 kwh at	3.33k per kwh
Next	5,000 kwh at	2.91k per kwh
Next	40,000 kwh at	2.50k per kwh
Next	100,000 kwh at	2.08k per kwh
Next	850,000 kwh at	1.666k per kwh
All over	1,000,000 kwh at	1.416k per kwh

DISCOUNT

There is discount on electricity bills of consumers supplied at high voltages as shown in the following table:

Supply Voltage	Discount
3,300 V; 6,600 V; 11,000 V	2%
33,000 V; 66,000V	3%
132,000 V	5%

DETERMINATION OF MAXIMUM DEMAND

The Corporation shall install maximum demand meter in the consumer's premises. The consumer shall pay a Maximum Demand Metering Contribution for each metering set depending on the size of the meter required.

Maximum Demand Meter will be read monthly at the Scheduled meter reading date. The normal billing demand is the highest single reading of the demand meter established during the billing period.

MINIMUM CHARGE

The minimum charge shall be ₦150.00 per month.

Source: E.C.N. (1969). Electricity Tariff and Service Regulation. (Lagos: Electricity Headquarters).

IIC

1973 - 1977

SCHEDULE A

(Single-Phase Service Tariff)

AVAILABILITY OF SERVICE

Applicable to all residential consumers and some small commercial consumers who will normally be connected to the Authority's single-phase 230-Volt supply. Biggest induction motor or welding transformer acceptable is 3 H.P. or 3KVA. A small commercial consumer whose load exceeds 5KVA will not be connected to the Authority's single-phase supply.

CONSUMPTION per apartment* per month:	AREA I Lagos, Jos, Enugu, Port-Harcourt	AREA II All other Undertakings
First 20 kwh or less	₦2 (min. charge)	₦2 (min. charge)
Next 40 kwh at	3.75k per kwh	4.58 per kwh
Next 40 kwh at	3.33k per kwh	4.16k per kwh
Next 100 kwh at	2.50k per kwh	3.33k per kwh
All over 200 kwh at	1.666k per kwh	2.50k per kwh

*Apartment refers to a self-contained house or flat or each floor of a multi-storeyed house. The Authority will ordinarily provide a meter for each apartment.

MINIMUM CHARGE: ₦2 per month.

SCHEDULE B

(Small Three-Phase Service Tariff)

(UP TO 75KVA LOAD)

AVAILABILITY OF SERVICE

Applicable in all Undertakings throughout the country to small commercial/industrial consumer whose load does not exceed 75KVA.

TARIFF PER MONTH:

Part (a): POWER DEMAND CHARGE

First 5 KVA of power demand	No Charge
Next 5 KVA at	25k per 100VA or part thereof
All additional KVA at	₦2.50 per KVA or part thereof

Pat (b): ENERGY CHARGE

First 20 Kwh or less	₦2 (min. charge)
Next 40 kwh at	4.58k per kwh
Next 40 kwh at	4.16k per kwh
Next 100 kwh at	3.33k per kwh
All over 200 kwh at	2.50k per kwh

DETERMINATION OF DEMAND CHARGE

The Authority shall install maximum demand meter in the consumer's premises. Maximum Demand Meter will be read monthly at the scheduled meter reading date. The normal power demand is the highest single reading of the demand meter established during the billing period.

MINIMUM CHARGE: The minimum charge shall be ₦2.

SCHEDULE C

(Large Three-Phase Service Tariff: Above 75 KVA load)

AVAILABILITY OF SERVICE

Applicable in all undertakings throughout the country to large commercial/industrial consumer whose load exceeds 75KVA.

TARIFF PER MONTH:

Part (a): POWER DEMAND CHARGE

First 75 KVA of Demand or less	₦150 (min. charge)
All additional KVA of Demand at	₦ 2 per KVA or part thereof.

Part (b): ENERGY CHARGE

First	5,000 kwh at	3.33k per kwh
Next	5,000 kwh at	2.91k per kwh
Next	40,000 kwh at	2.50k per kwh
Next	100,000 kwh at	2.08k per kwh
Next	800,000 kwh at	1.666k per kwh
All over	1,000,000 kwh at	1.416k per kwh

DISCOUNT

There is discount on electricity bills of consumers supplied at high voltage as shown in the following table:

Supply Voltage	Discount
3,300 V; 6,600 V; 11,000V	2%
33,000 V; 66,000 V	3%
132,000 V	5%

DETERMINATION OF MAXIMUM DEMAND

The Authority shall install maximum demand meter in the consumer's premises. Maximum Demand Meter will be read monthly at the scheduled meter reading date. The normal power demand is the highest single reading of the demand meter established during the billing period.

MINIMUM CHARGE

The minimum charge shall be ₦150 per month.

Source: N.E.P.A. (1973). Electricity Tariff and Service Regulations. (Lagos: Electricity Headquarters)

IID

1977 to date

Definitions

1. Residential Consumer

A consumer who uses his premises exclusively as a residence - house, flat or multi-storeyed house - is defined as a residential consumer.

2. Commercial Consumer

A consumer who uses his premises for any purpose other than exclusively as a residence or as a factory for manufacturing goods, is defined as a Commercial Consumer.

3. Industrial Consumer

A consumer who uses his premises for manufacturing goods is defined as an Industrial Consumer.

SCHEDULE A

(SINGLE-PHASE SERVICE TARIFF)

AVAILABILITY OF SERVICE

Applicable to residential and small commercial/industrial consumer whose load does not exceed 60 Amp (approx. 12 KW) and whose premises would normally be connected to the Authority's single-phase 230-Volts supply.

A residential consumer whose load exceeds 12 KW shall be connected to the Authority's 3-Phase supply.

TARIFF PER MONTH:

Part (a): POWER DEMAND CHARGE

First 5 KVA or less	₦2 (minimum power charge)
Next 5 KVA at	32.50k per 100 VA or part thereof.
All over 10 KVA at	3.25k per KVA or part thereof.

Part (b): ENERGY CHARGE

First	20 kwh or less	₦2.60 (minimum energy charge)
Next	40 kwh at	5.95k per kwh.
Next	40 kwh at	5.41k per kwh
Next	100 kwh at	4.33k per kwh
All over	200 kwh at	3.25k per kwh

DETERMINATION OF DEMAND CHARGE

The Authority shall install maximum demand meter in the consumer's premises. Maximum demand meter will be read monthly at the scheduled meter reading date. The normal power demand is the highest single reading of the demand meter established during the billing period.

MINIMUM CHARGE

The minimum charge shall be ₦4.60 per month.

SCHEDULE C

(LARGE THREE-PHASE SERVICE TARIFF: ABOVE 75 KVA LOAD)

AVAILABILITY OF SERVICE

Applicable in all undertakings throughout the country to large commercial/industrial consumer whose load exceeds 75 KVA.

TARIFF PER MONTH:

Part (a): POWER DEMAND CHARGE

First 75 KVA of Demand Charge or less — ₦195 (minimum charge)

All additional KVA of Demand at — ₦2.60 per KVA or part thereof

Part (b): ENERGY CHARGE

First 5,000 kwh at 4.33k per kwh

Next 5,000 kwh at 3.78k per kwh

Next 40,000 kwh at 3.25k per kwh

Next 100,000 kwh at 2.70k per kwh

Next 850,000 kwh at 2.17k per kwh.

All over 1,000,000 kwh at 1.84k per kwh.

DISCOUNT

There is discount on electricity bills of consumer supplied at high voltage as shown in the following table:

Supply Voltage	Discount
3,300 V; 6,600 V; 11,000 V	2%
33,000 V; 66,000 V	3%
132,000 V	5%

DETERMINATION OF MAXIMUM DEMAND

The Authority shall install maximum demand meter in the consumer's premises. Maximum demand meter will be read monthly at the scheduled meter reading date. The normal power demand is the highest single reading of the demand meter established during the billing period.

MINIMUM CHARGE

The minimum charge shall be ₦195 per month.

Source: N.E.P.A. (1977) Electricity Tariff and Service Regulation. (Lagos: Electricity Headquarters)

APPENDIX III

A. DERIVATION OF THE AVERAGE AND MARGINAL PRICES OF ELECTRICITY

Bolton (1951) gave the formula for average price as

$$\frac{n_1 p_1 + n_2 p_2 + \ldots + (n - n_1 - n_2 - \ldots) p_k}{n}$$

where

p_1 = cost per kwh for the first n_1 kwh

p_2 = cost per kwh for the next n_2 kwh

p_k = cost per kwh for all additional kwh

n = total kwh consumed

Taking the 1973 schedule A tariff for Lagos and using the average consumption of 348 kwh per month per consumer for that year in Lagos, then average price would be

$$\frac{(20 \times 10k) + (40 \times 3.75k) + (100 \times 2.5k) + (148 \times 1.666k)}{348}$$

$$= \frac{(200 + 150 + 133.2 + 250 + 246.6)k}{348}$$

$$= \frac{979.8}{348} = 2.82 \text{ kobo/kwh}$$

Marginal price is the price paid for the nth kwh used, (in the above case for the 348th kwh) which is 1.666k.

B. Identification of the Simultaneous-equation models

An equation in a model is identified if the rank and order conditions of identification are satisfied.

Order Condition: $(K - M) > (G - 1)$

where

G = total number of equations = total number of endogenous variables

K = total number of variables in the model

M = number of variables (endogenous and energenous) included in the particular equation.

Rank Condition: "In a system of G equations any particular equation is identified if and only if it is possible to construct at least one non-zero determinant of order (G - 1) from the coefficients of variables excluded from that particular equation but contained in the other equations of the model". (Koutsoyiannis (1973), p.343.)

Given the two residential equations:

(1) $QR = a_o + a_1 ER_t + a_2 GR_t + a_3 K_t + a_4 F_t + a_5 Y_t + a_6 N_t$

(2) $ER_t = b_o + b_1 QR_t + b_2 I_t + b_3 J_t$

Total number of variables in the model

$K = 9$

Total number of equations $G = 2$

Equation (1) is over-identified since the number of included variables

$M = 7$, hence

$(K - M) > (G - 1) \equiv (9 - 7) > (2 - 1)$

Equation (2) is also over-identified since

$(9 - 4) > (2 - 1)$

The order condition is satisfied.

Rank Condition

We rewrite (1) and (2) as

(3) $- QR_t + a_1 ER_t + a_2 GR_t + a_3 K_t + a_4 F_t + a_5 Y_t + a_6 N_t$

(4) $- ER_t + b_1 QR_t + b_2 I_t + b_3 J_t$

The variables can be arranged in an array as below:

	QR	ER	GR	K	F	Y	N	I	J
Equation (3)	-1	a_1	a_2	a_3	a_4	a_5	a_6	0	0
Equation (4)	b_1	-1	0	0	0	0	0	b_2	b_3

To check for the identification of equation (3)

we strike out the first row and the first seven columns in the array, leaving the matrix of the coefficients of the excluded variables:

$b_2 \quad b_3$

From this, we can form two determinants of order (G - 1) = 1 i.e.

$$\left|b_2\right| \qquad \left|b_3\right|$$

Equation (4) is also identifiable by striking out the second row, the first two and the last two columns leaving a matrix of the coefficients of excluded variables:

$$a_2 \; a_3 \; a_4 \; a_5 \; a_6$$

from which five determinants of order (G - 1) = 1 can be formed.

The commercial/industrial model can be similarly checked for identification since an equivalent number of variables and equations are involved.

C. Commercial/Industrial Model: The Case of Natural Gas

Data for the price of natural gas were available for only 14 of the 21 years covered in this study. For estimation, a zero value was attached to each of the first seven years. Since there was no variation in the running charge, a single value 12½k was imputed for each of the remaining fourteen years (see Chapter 4). The prices were accordingly deflated by the composite price index.

The following result was obtained using the OLS procedure:

$$QL = -871.06 + 147.91EL + 0.23NG - 155.09C$$
$$\quad (-1.17) \quad (0.87) \quad (0.04) \quad (-2.49)$$
$$+ 0.03Y + 14.22N$$
$$(0.3) \quad (3.18)$$
$$\bar{R}^2 = 0.96 \quad D - W = 1.07$$

(t - ratios in parentheses).

where NG is price of natural gas and all other variables as defined in Chapter 5.

That the coefficient of natural gas has the right sign is surprising since the real price was actually falling over the years. It is however insignificant. The own-price coefficient is positive but statistically insignificant. Population is highly significant with the expected sign. The sign of the coal coefficient is an antithesis. This may be due to (a) the stickiness of coal prices over the years, and (b) the nature of the specification of the estimated function. The function was specified on the pretext that industrial consumers (as opposed to commercial), strictly speaking, face only two substitutes: coal and natural gas.

APPENDIX IV

DATA TABLES

TABLE I

ELECTRICITY CONSUMPTION AND SALES REVENUE

YEAR (1st April to 31st March)	RESIDENTIAL			COMMERCIAL AND INDUSTRIAL		
	QUANTITY (MWH)[a]	TOTAL REVENUE (NAIRA)	AVERAGE REVENUE (kobo/kwh)	QUANTITY (MWH)	TOTAL REVENUE (NAIRA)	AVERAGE REVENUE (kobo/kwh)
1955/56	60,312	1,560,406	2.58	66,622	1,827,824	2.74
1956/57	72,461	2,315,442	3.20	78,068	2,429,802	3.11
1957/58	87,180	2,819,794	3.23	100.152	3,142,250	3.14
1958/59	99,079	3,207,610	3.24	133,800	4,099,386	3.06
1959/60	121,158	3,852,868	3.18	154,871	5,016,678	3.24
1960/61	148,910	4,660,304	3.13	199,229	5,270,422	2.65
1961/62	178,428	5,582,210	3.13	250,371	7,635,132	3.05
1962/63	204,855	6,380,984	3.12	312,333	9,279,030	2.97
1963/64	234,523	7,155,824	3.05	398,962	11,457,160	2.87
1964/65	256,066	7,970,564	3.11	488,044	13,633,936	2.79
1965/66	288,313	8,970,860	3.11	550,639	15,595,644	2.83
1966/67	311,071	9,536,316	3.07	635,838	17,800,060	2.80
1967/68	239,481	7,699,580	3.22	475,497	14,090,750	2.96
1968/69	259,234	8,500,544	3.28	533,993	15,423,040	2.89
1969/70	332,745	11,646,760	3.50	580,778	17,171,524	2.96
1970/71	445,197	15,940,858	3.58	699,033	20,566,018	2.94
1971/72	573,507	19,372,000	3.38	888,740	25,102,042	2.82
1972/73	633,593	21,214,902	3.35	1,113,593	32,449,732	2.91
1973/74	752,068	24,603,770	3.27	1,279,546	37,031,962	2.89
1974/75	894,779	29,087,954	3.25	1,442,708	40,302,198	2.79
1975/76	848,530	32,068,555	3.78	1,858,284	50,227,764	2.70

Source: National Electric Power Authority.

(a) 1 MWH = (megawatt -hour) = 1000 kilowatt hours

TABLE II

FUEL PRICES AND "ALL-CITIES" COMPOSITE LOWER-INCOME CONSUMER PRICE INDEX

YEAR	KEROSENE (kobo per kilogram)	FUELWOOD (kobo per kilogram)	COAL (kobo per kilogram)	LIQUEFIED PETROLEUM GAS		COMPOSITE PRICE INDEX (1960=100)
				RESIDENTIAL (kobo per kilogram)	COMMERCIAL & INDUSTRIAL (kobo per kilogram)	
1955/56	11.54	0.73	0.394	15	15	85.5
1956/57	11.14	0.82	0.472	15	15	92.0
1957/58	11.14	0.82	0.492	15	15	92.2
1958/59	11.14	0.62	0.492	15	15	92.1
1959/60	10.84	0.67	0.492	15	15	98.8
1960/61	11.14	0.68	0.492	15	15	101.3
1961/62	11.14	0.71	0.492	15	15	107.8
1962/63	10.82	0.77	0.492	15	15	111.8
1963/64	10.92	0.78	0.492	15	15	108.7
1964/65	11.14	0.89	0.591	15	15	111.0
1965/66	11.14	0.95	0.591	15	15	116.0
1966/67	11.14	0.99	0.591	15	15	126.3
1967/68	11.14	1.00	0.787	21	22.1	119.8
1968/69	11.17	1.03	0.787	21	22.1	122.4
1969/70	11.26	1.02	0.787	21	22.1	136.7
1970/71	11.91	1.04	0.787	21	22.1	155.75
1971/72	12.91	1.01	0.886	21	22.1	179.5
1972/73	12.51	1.22	0.886	21	22.1	180.2
1973/74	13.89	1.88	0.886	31.23	31.23	196.7
1974/75	18.82	2.09	0.886	31.23	31.23	226.1
1975/76	25.02	5.02	1.000	31.23	31.23	303.1

Sources: (a) Federal Office of Statistics (Kerosene and Firewood)
(b)(i) Nigerian Coal Corporation: Annual Reports for 1955/56 to 1975/76
(ii) Schatzl, L (1969b) p.19
(iii) Nigerian Railway Corporation; Coal Purchase Returns(Coal)
(c) Nidogas Company Ltd., Lagos (Gas)
(d) Central Bank of Nigeria: Economic and Financial Review, volumes 8, 13 and 14. (Price Index)

TABLE III

TOTAL AND URBAN POPULATION ESTIMATES

AND INDEX OF URBANISATION

YEAR	TOTAL POPULATION (million)	URBAN POPULATION (million)	INDEX OF URBANISATION (1963 = 100)
1956	46.08	7.944	74.2
1957	47.28	8.268	77.3
1958	48.52	8.605	80.4
1959	49.79	8.956	83.7
1960	51.09	9.321	87.1
1961	52.43	9.760	91.2
1962	53.80	10.220	95.5
1963	55.21	10.702	100.0
1964	56.61	11.184	104.5
1965	58.06	11.687	109.2
1966	59.54	12.213	114.1
1967	61.06	12.763	119.3
1968	62.62	13.397	125.2
1969	64.21	14.122	131.9
1970	65.85	14.188	139.1
1971	67.53	15.672	146.4
1972	69.25	16.496	154.1
1973	71.02	17.321	161.9
1974	72.83	18.187	169.9
1975	74.60	19.237	179.8
1976	76.60	20.391	190.5

Sources: (a) Total Population: National Population Bureau, Lagos.

(b) Urban Population: Olayide, S.O. (ed.)(1976) p.17.

TABLE IV

GROSS DOMESTIC PRODUCT (1962/63 CONSTANT PRICES)

YEAR	GROSS DOMESTIC PRODUCT (FACTOR COST) (million naira)
1955/56	2168.6
1956/57	2116.5
1957/58	2203.7
1958/59	2084.2
1959/60	2230.4
1960/61	2493.4
1961/62	2492.2
1962/63	2597.6
1963/64	2825.6
1964/65	2947.6
1965/66	3146.8
1966/67	3044.8
1967/68	2572.2
1968/69	2543.8
1969/70	3225.5
1970/71	4187.6
1971/72	4654.0
1972/73	4933.4
1973/74	5236.0
1974/75	5854.5
1975/76	6100.5

Source: Federal Office of Statistics

TABLE V

ELECTRICITY CONSUMER POPULATION

YEAR[a]	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	MISCELLANEOUS[b]	TOTAL
1955/56					61,905
1956/57					69,627
1957/58					81,364
1958/59					83,224
1959/60					92,659
1960/61					109,435
1961/62					127,440
1962/63					154,556
1963/64	129,732	34,969	1,572	4,501	170,774
1964/65	144,728	40,069	2,540	4,764	192,101
1965/66	154,488	42,799	2,539	5,527	205,353
1966/67	162,921	45,380	2,559	6,319	217,179
1967/68	141,352	39,845	2,347	5,850	189,394
1968/69	154,414	44,352	2,323	6,046	207,135
1969/70	173,774	47,651	2,210	6,792	230,425
1970/71	193,423	52,070	1,620	1,112	248,225
1971/72	234,810	63,701	1,634	294	300,439
1972/73	265,640	71,365	1,712	236	338,953
1973/74	309,041	79,027	2,012	257	390,337
1974/75	351,713	83,137	2,224	286	437,360
1975/76	410,569	89,588	2,579	286	503,022

Sources: (i) Electricity Corporation of Nigeria: Annual Reports, 1955/56 to 1969/70.

(ii) National Electric Power Authority; Consumer Statistics worksheets, Commercial Department, Electricity Headquarters, 1970/71 to 1975/76.

Notes: (a) Figures were not analysed into different consumer classes for the years 1955/56 to 1962/63

(b) Title changed to "others" in 1970/71 and to "street-lighting" in 1972/73

TABLE VI

RATIO OF COMMERCIAL/INDUSTRIAL ENERGY SALES TO RESIDENTIAL ENERGY SALES

YEAR	RATIO
1955/56	1.105
1956/57	1.077
1957/58	1.149
1958/59	1.350
1959/60	1.278
1960/61	1.338
1961/62	1.403
1962/63	1.525
1963/64	1.701
1964/65	1.906
1965/66	1.910
1966/67	2.044
1967/68	1.986
1968/69	2.060
1969/70	1.745
1970/71	1.570
1971/72	1.550
1972/73	1.758
1973/74	1.701
1974/75	1.612
1975/76	2.190

Source: Table I

TABLE VII

TARIFF AREA I RESIDENTIAL SALES

YEAR	QUANTITY (MWH)	PERCENTAGE OF TOTAL RESIDENTIAL SALES
1955/56	41,241	68.4
1956/57	48,072	66.3
1957/58	57,050	65.4
1958/59	67,050	67.7
1959/60	83,939	69.3
1960/61	103,195	69.3
1961/62	123,526	69.2
1962/63	143,064	69.8
1963/64	171,168	73.0
1964/65	174,200	68.0
1965/66	195,752	67.9
1966/67	212,739	68.4
1967/68	163,663	68.3
1968/69	169,304	65.3
1969/70	221,608	66.6
1970/71	301,862	67.8
1971/72	400,322	69.8
1972/73	419,259	66.2
1973/74	483,902	64.3
1974/75	569,069	63.6
1975/76	443,795	53.2

Source: Computed from NEPA's statistical worksheets.

TABLE VIII

LAGOS AREA COMMERCIAL/INDUSTRIAL ENERGY SALES

YEAR	QUANTITY (MWH)	PERCENTAGE OF TOTAL SALES
1955/56	29,515	44.3
1956/57	33,252	42.6
1957/58	39,732	39.7
1958/59	46,740	34.9
1959/60	56,124	36.2
1960/61	69,356	34.8
1961/62	83,599	33.4
1962/63	110,954	35.5
1963/64	148,847	37.3
1964/65	175,783	36.0
1965/66	229,103	41.6
1966/67	270,750	42.6
1967/68	253,752	53.4
1968/69	261,487	49.0
1969/70	280,880	48.4
1970/71	315,007	45.1
1971/72	339,566	38.2
1972/73	485,972	43.6
1973/74	572,039	44.7
1974/75	649,943	45.1
1975/76	968,525	52.1

Source: Computed from NEPA's Statistical Worksheets

TABLE X

COAL SALES IN 1973/74

Nigerian Railway Corporation	74,528 tons
N.E.P.A., Oji River Station	54,140 tons
Nigerian Cement Company, Nkalagu	148,730 tons
Domestic Sales	8,449 tons
Export	16,000 tons
Others	16 tons

Source: Nigerian Coal Corporation: Annual Reports, 1973/74.

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