

THE FUNCTIONAL FORM AND ENERGY STABILITY OF TRAVEL
EXPENDITURES IN NIGERIA

BY

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Ph.D/ENG/0080789-90

A

Dissertation submitted to the Postgraduate School, Ahmadu Bello University,
Zaria, in partial fulfillment of the requirements for the award of the degree
of Doctor of Philosophy in Highway and Transportation Engineering

Department of Civil Engineering

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Ahmadu Bello University, Zaria

April, 1998.

DECLARATION

I hereby declare that this thesis has been prepared by myself and that it is a record of my own research work. It has not been accepted in any previous application for a higher degree. All sources of information are specifically acknowledged by means of references.



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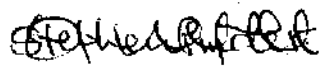
CERTIFICATION

The thesis entitled The Functional Form and Energy Stability of Travel Expenditures in Nigeria by Engr. Douglas O. A. Osula meets the regulations governing the award of the degree of Doctor of Philosophy of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.


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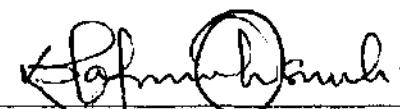
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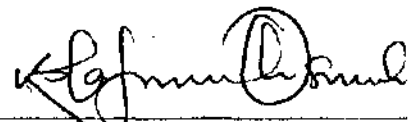
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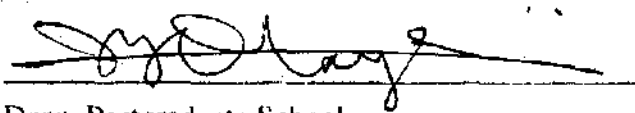
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DEDICATION

This work is dedicated to the memory of Late Engr. Lawrence Oluwemimo Arokodare, a founding Principal Partner of Etteh-Aro and Partners, a foremost Civil/Structural Engineering consulting firm in Nigeria.

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to all those who in their different ways contributed to the successful completion of this research work.

Special thanks are due to Prof. Olusegun Adebisi, who offered very useful criticisms in the course of his supervision of the work. Special thanks are also due to the Benin City branch of Etteh-Aro and Partners. The branch sponsored the field work of this research, after due approval by Late Engr. Lawrence Oluwemimo Arokodare. I also wish to thank Engr. P. J. I. Azagba for his contribution to the production of the draft copy of the thesis. Also to be thanked is Engr. John Onyegbule Imo, who sponsored the production of the final thesis. His own contribution came at a time it was most needed.

ABSTRACT

The characteristics of (ravel money expenditure in a Nigerian setting are examined, with special emphasis on the its functional form and energy stability, using the "before" and "after" the October 1994 fuel price increase situations.

Preliminary analysis of travel charatcristics show general reduction in trip rates, with the least average reduction of 7.08% in subsistence trips and the highest of 46.54% in leisure trips. Appreciable changes occurred in mode choice, with an average value of 40.30 % change being made from motorised modes to the walk mode. The highest average mode change stood at 52.90%; for leisure trips, while values for maintenance and subsistence trips stood at 36.80% and 36.20%, respectively.

The results of the main study show that while the established inverse relationship between travel expenditure and income did not change, significant increases occurred in travel expenditure across socio-economic strata, averaging at 114.18%. Shifts occurred in transport market segmentation, apparently because significant interactions occurred between travel expenditures and socio-economic characteristics. The results so far indicate that changes in life-style of respondents occurred, following the fuel price increase.

Elasticity calculations show that, generally, trip rates and travel money expenditures are fuel price inelastic. Specifically, -0.185, -0.060, -0.094, and -0.458, were recorded as average values for all trips, subsistence trips, maintenance trips, and leisure trips, respectively. It stood at 0.625 for travel money expenditure. Thus in real terms, the energy policy change cannot be said to have adversely affected travel behaviours of respondents, at least in the short-term.

The functional form estimation aspect of the study yielded statistically significant simple linear relationships between travel money expenditure and money available for

both periods. However, as prior results seem to have indicated, stability tests show that the functional Tonus estimated are not stable across the periods. Thus "travel budget" is, as yet, not usable as a term for travel expenditure in Nigeria, implying that there is as yet no basis for using the UMOT model for travel demand modelling in Nigeria, at least till further evidences prove otherwise.

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ABBREVIATIONS, NOTATIONS AND SYMBOLS

Av.	Average
CARMOT	Car motorisation
Dpdc	Developed countries
Dpdg	Developing countries
F.time	Full time
HNM	Household head not married.
HSTA	Household status
L.term	Long-term
LOS	Level of service
M'nance.	Maintenance
MSTA	Marital status
P.time	Part time
RSS	Residual sum of squares
S.term	Short-term
St. D.	Standard deviation
Subsist.	Subsistence
yrs	years
INC	Monthly Income.
DI	Monthly disposable income
EE	Monthly expenditure on essential items and services.
ME	Monthly travel money expenditure
TE	Monthly total expenditure on all items including EE and ME
DIA	DI after the fuel price increase
EEA	EE after the fuel price increase
MEA	ME after the fuel price increase
TEA	TE after the fuel price increase
DIB	DI before the fuel price increase

EEB	EE before the fuel price increase
MEB	ME before the fuel price increase
TEB	TE before the fuel price increase
MEDIA	Travel money expenditure-disposable income ratio after fuel price increase
MEINCA	Travel money expenditure-income ratio after fuel price increase
METEA	Travel money expenditure-total expenditure ratio after fuel price increase
MEDIB	Travel money expenditure-disposable income ratio before fuel price increase
MEINCB	Travel money expenditure-income ratio before fuel price increase
METEB	Travel money expenditure-total expenditure ratio before fuel price increase
L	Log-likelihood function
$L_{\max}$	Maximised log-likelihood function
E	Expectation
ln	Natural or Napierian logarithm
log	Common logarithm
R^2	Coefficient of determination of regression model
λ	Box-Cox transformation regression power transformation
$\sigma^2, s^2, \text{var}$	Variance

CHAPTER ONE

INTRODUCTION

1.1 Statement of Problem

One of the most daunting problems faced by the developing world is that of urban transport. Perhaps the most daunting of the problems is congestion which surpasses those of developed countries of comparable sizes, despite much lower level of automobile ownership (Churchill, 1983). Several developing countries are not able to provide adequate transport facilities to meet demand especially in the face of competition from development programmes in other sectors of the economy. The consequences of this undesirable situation include greatly increased trip durations and cost of transportation, lowered productive efficiency, and the placing of heavy burden (high travel cost expenditure in relation to income) on the urban poor.

These problems seem bound to be aggravated by the high growth rates of population and car ownership (Churchill, 1983) and the global economic downturn. The effect of the global economic downturn is continued inadequate spending on the development of transportation facilities in the face of reducing national currency value and rising cost of implementation of improvement schemes.

Most developing countries have been known to exist under severe constraints related to limited resources, the paying capacity of the average citizen and the effect of the cost of transportation on the overall economy (Ajgaonkar, 1974), and anti-inflationary policies (Abacounkin, 1981). The nature of the economy of most developing countries is such that for a long time to come, these countries will remain totally or partially dependent on monetary institutions, like the World Bank, for the funding of such infrastructural projects as those of transportation. Proposals that accompany requests for funding of transportation improvement programmes from such organisations will usually need to be backed by results of transportation planning studies based on approaches that

truly reflect the complex picture of situations in developing countries. Policies in these countries are known to change in the manner that most of their governments are unstable. A planning methodology to supply the required support data for loan requests will, therefore, need to be policy-sensitive (Roth and Zahavi, 1981). This is more so when it is realized that policies are usually conceived on the basis of the behaviour and needs of the people of a place or country.

Transportation planning commences with travel demand estimation. Methodologies currently in use (the conventional aggregate sequential models and the relatively new disaggregate behavioural models) for estimating travel demand have been developed in developed country settings. However, experience in the use of these models, even in these developed countries, has been far from satisfactory (Abacounkin, 1981; Churchill, 1983). Though some grounds for spatial stability of conventional trip generation models seem to have recently been established by Wilmot (1995) with data from a developing country, there is still the concern with the fact these models have been proved to have deficiencies and inherent inadequacies in describing reality (Richard and Ben-Akiva, 1975; Stopher, 1980). Moreover, Wilmot's feat of "87%" transferability was achieved only after adjustment of transfer-model parameters with local information, a situation he called "partial transfer". Thus complete transferability or stability seems yet an unsolved problem.

In another vein, conventional travel demand models have also been described as not being policy sensitive (Zahavi, 1976). Specifically, according to Oppenheim (1981), they are not adequate for the behavioural, cause-effect analysis required in an evaluation of policy alternatives. It is, therefore, less likely that conventional models will be appropriate for developing countries. Developing countries have been described as having more uncertainty and, by implication, less predictability concerning future growth, incomes, and land uses (Ajgaonkar, 1974; Zahavi, 1976; Churchill, 1983; Thomson, 1983). Other characteristics of developing countries as have been outlined by

others (Stopher, 1980; Willumsen, 1981; Abacoumkin, 1981; Banjo, 1987) seem intractable and very varied from country to country. Stopher, in fact, concluded outright that current operating methodologies of urban transport modelling cannot be transferred to developing countries. Empirical evidence in work carried out in a Nigerian setting (Haliru, 1982) supports this strongly.

However, one approach that seems to hold considerable promise for developing countries is the Universal Mechanism Of Travel (UMOT) approach conceptualised and developed by Zahavi (1979a, 1979b, 1979c, 1982) as an alternative to the conventional models. This model has been tested satisfactorily on data from Britain by Downes and Emmerson (1985). The model is based on the premise that the ability of an individual to avail himself of transport service (measured as travel distance by mode) depends on his ability to spend time and money on the service. A model based on this principle seems the closest to reality, since, in real life, it seems that people for whom spending (in monetary terms) is no problem (high income earners and/or those with lesser financial responsibilities) budget time for trip making, whereas those for whom spending needs strict control (low income earners and/or those with plentiful and relatively heavy financial burden) budget money for trips. Clearly, changes in regional policies are usually reflected in an individual's ability to allocate time and money to activities, of which trip making is one.

The UMOT model is formulated on the utility theory of decision making. The requirements for meeting the model's specifications are:

- (i) predictable functional form of travel expenditures;
- (ii) spatial and temporal stability of time and money expenditures (these qualify travel expenditures to be called "travel budgets"), and;
- (iii) temporal stability of the variabilities in travel budgets among individuals within groups.

Several works (as will be discussed in the literature review section) have been carried out in both developed and developing countries to determine if these requirements can be met. The summary is that while predictable trends and short-term temporal stability of money expenditure on travel for both developed and developing countries have been proved, there seems to be some controversy over the hypothesis of constancy of travel time expenditures and the spatial stability of both time and money expenditures. However, no attempt has yet been made to investigate the stability of travel expenditures to specific policy changes such as those of energy, even several years after it was first advocated by Kirby (1981). Energy stability test can be seen as a form of temporal stability test, since policy changes take place over time. The history of Nigeria is replete with fuel price changes (the most recent being in October 1994), not to talk of the role petroleum energy plays in world politics and national economies. The need for an investigation into this area in a country like Nigeria is thus apparent.

According to Zahavi (1976), while travel money budgets vary to a large extent with income, travel time budget seems to be relatively stable, since as expected, regardless of income, every trip maker has a 24-hour day available for all activities, making travel time budget to have less leeway for changes. Specifically, for Nigeria, travel time expenditure has been found to be invariant (for urban trips) with income (Ojumu, 1975), though a significant role played by supplementary employment in determining travel time was identified by Banjo and Brown (1982). These, put together, indicate that more gaps seem unfilled in the area of travel money budget, at least for Nigeria. Thus, travel money budget has been chosen as the focus of this present work in a Nigerian setting.

1.2 Goals and Objectives

The main focus of this study was to attempt to investigate if the UMOT requirements are met with respect to energy policy changes, in a developing country setting, using Nigeria as a case study.

In October 1994, the Nigerian government reviewed its energy policy resulting in the partial removal of petroleum subsidy. This translated to increases in the costs of petroleum products. Specifically, the pump price of gasoline or petrol went up from ₦3.25 to ₦11.00 per litre; a rise of about 240 %, and second highest in recent times. Expectedly, the cost of transportation and hence the out-of-pocket expenditure of the average individual or groups of individuals of similar travel behaviour increased, probably very significantly. Probably also, many other effects, such as changes in travel habits and life style, and hence in population groupings with respect to travel, occurred following this energy policy change.

This work has been conceived to contribute to the urgent need for continued research in the area of travel demand analysis. It was the hope that the work would pave the way for the acceptance or otherwise of the UMOT model, for, at least, energy-related transportation planning issues. While in the main, the work was energy policy-related, it was also to be seen as providing an opportunity for testing the short-term temporal stability of travel expenditures in Nigeria because of the closeness of the "before-and-after" energy policy change situation investigated in this work.

Specifically, the objectives of the work were; (a) to investigate the functional form of travel expenditures in a developing country setting; and (b) to investigate the stability of travel expenditures in terms of the functional forms that can be established for the "before" and "after" energy policy change situations. In other words, the work sought to provide answers to the following research questions:

- (i) What is a suitable basis for categorising the population for the proposed work?
- (ii) How stable with respect to energy policy change is the population segmentation obtained in (i)?
- (iii) What functional form can be established for travel expenditures for Nigeria?
- (iv) How stable with respect to energy policy change is the functional form established in (iii)?

1.3 History of *lhw* Price Increase in Nigeria

Data available show that (uel price has been increased in Nigeria as many as six times between 1986 and 1994, both years inclusive (Table 1.1). The highest percentage increase was in September 1993, when the pump price of petrol went up from -N0.70 to N3.25 - a rise of 364.3%. The latest increase, whose effects are being reported, involved a percentage increase of 238.5. Though penultimate to the highest in relative terms, it has been the highest in magnitude, having risen from N-3.25 to 4411.00. Figure 1.1 shows this jump in comparison with the other increases. However, had the price been kept at the N15.00 it initially was raised to, the percentage change would have been comparable at 361.5 with the highest.

TABLE 1.1 Available data on fuel price increase in Nigeria (kobo per litre oi' petrol)

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
		(Jan)		(Apr)	*		(Mar)		(Sept)	(Oct)
Price	20	39.5	39.5	39.5/42	42/60	60	60/70	70	70/325	325/ 1100
% increase	-	97.5	0.0	6.3	42.9	0.0	16,7	0.0	364.3	238.5

Months in brackets are months of year indicated fuel price change became effective.

(Source: Central Bank of Nigeria)

A two-tier pricing system for petrol became effective at the beginning of 1989, in which private vehicle owners paid 60 kobo per litre, while commercial vehicle owners paid 42 kobo. This system was unified at 60 kobo per litre towards the end of the same year due to abuse in its implementation.

It is to be noted that this latest increase, unlike the previous ones, was later accompanied by increases in salaries of workers to cushion the expected adverse effects of the fuel price increase. The salary increases did not come into effect until after several months, making travel expenditures and even non-travel expenditures heavy burdens on the average person.

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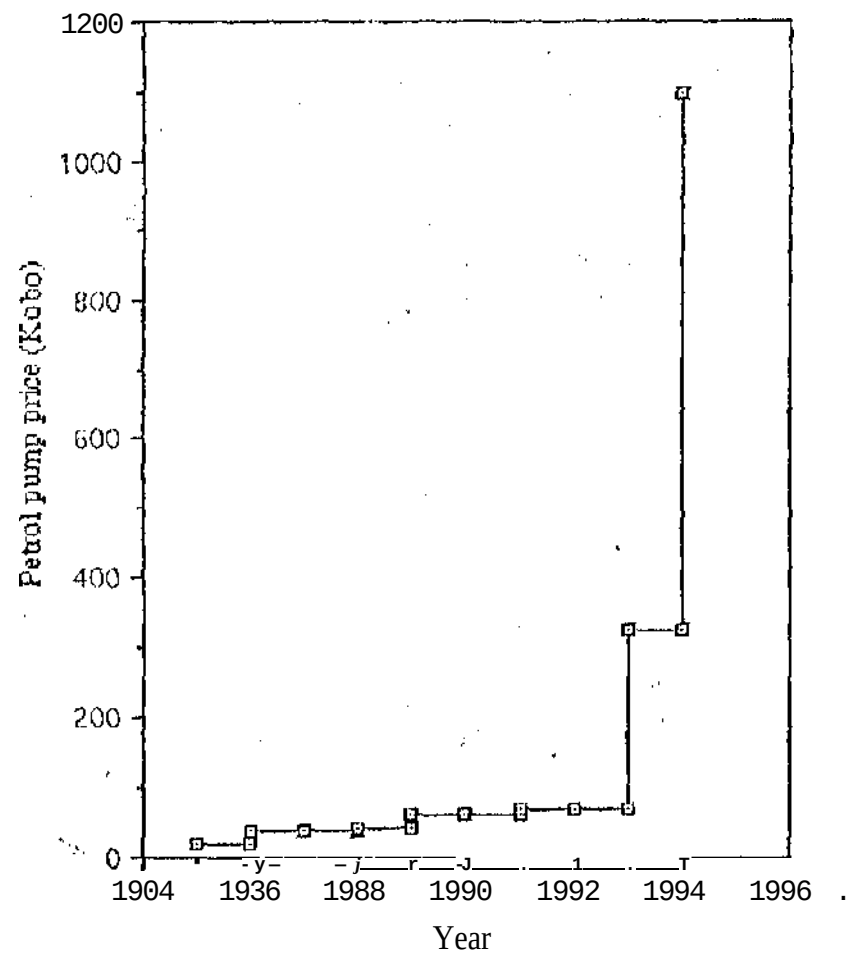


Figure I.I Time variation of petrol pump price in Nigeria

1.4 Scone of Work

The work involved, in the main, the use of data collected on travel behaviour of individuals in Nigeria "before and after" the October 1994 tuel price increase in estimating regression models relating travel money expenditure to money available for the "before" and "after" fuel price increase periods, and comparing them to ascertain if it can be inferred that a stable functional form exists for travel expenditures in Nigeria, thus paving the way or otherwise for the trial of the UMOT model in Nigeria. The Zaria setting was chosen as a case study.

White the primary focus ^/ the w ork was the investigation of functional form and stability of travel expenditure with respect to energy policy change in Nigeria, changes in

travel behaviour (exemplified by changes in mode choice, trip rate, and travel expenditure) and shifts in transport market segmentation arising from the energy policy change were also investigated, in order to establish how travel expenditures have interacted with socio-economic characteristics of individuals to alter the transport market segmentation and hence the life style of groups of individuals. Transport market was taken by Foulkes and Robertson (1981) in the wider sense "to be the underlying demand for transport arising from the structure of the city and city region in terms of location of employment, housing, town and shopping centres and other services and leisure areas." This definition seems to leave out the supply side of the market, i.e. the transport network and its associated facilities. For this present work, transport market is defined simply but more completely as the supply-demand interaction in transportation. This travel behaviour aspect of this work examined how a change in the price of fuel as a supply component of urban road transportation has affected the demand components of mode choice characteristics, trip rates and travel expenditures of trip makers in Nigeria. The trip rate aspect is particularly important because changes in it are made in the first instance in order to accommodate the changes in the cost of transportation. It is the accumulation of the effects of trip rate change that makes changes in travel expenditures. This latter investigation, which was a prelude to the main investigation (regression modelling and stability testing), apart from affording the opportunity of identifying the social, economic and transport implications of the energy policy change, was needed in order to be able to appreciate or more appropriately explain the results that would be obtained from the regression modelling and stability testing exercise in relation to the energy policy change.

1.5 Study Area

Zaria was chosen for the study mainly for ease of data collection, being the city in which is located the awarding institution (Ahmadu Bello University) of the degree for which this research is being carried out. Zaria is in Kaduna State, in the northern part of

Nigeria. With an estimated population of 305,348 (projected from the 1991 National Census figure of 284,318), it is next only to Kaduna (the state capital) in the state.

Historically, according to Nwafor (1982), Zaria is a "double twin city" made up of four sub units, namely; the pre-colonial walled city, the "new" city of Tudun Wada, the strangers' city of Sabo Gari, and Samaru, where the Ahmadu Bello University and an agricultural research station (the Institute of Agricultural Research, IAR) are located. The walled city, which was founded in the fourteenth century is said to be one of northern Nigeria's oldest traditional urban centres. The city is located in the heart of the cotton belt, and, as a railway junction, has been a loading point for cotton destined for the country's textile mills. Nwafor also noted that Zaria has witnessed a rapid increase in industrial activity since the 1960s, particularly in the areas of oil-seed processing, flour milling, cigarette manufacturing, cotton ginning, cosmetics and leather goods manufacturing, tanning and dyeing, and bicycle assembly.

Directly north of the walled city lie Tudun Wada and Sabon Gari, which are two residential areas occupied by "stranger elements" from other parts of the country and foreigners. The main campus of the medical school of the Ahmadu Bello University is located in Tudun Wada.

Samaru village, as it is commonly called, lies about seven kilometres to the north-west of the old city, towards Sokoto.

Zaria occupies a prominent position in the history of Nigeria, having as mentioned earlier, being a railway junction since colonial times. Information in Nwafor (1982) reveals that the Zaria railway station was built between 1911 and 1915. In addition to this, The international route planned to link Nigeria with her northern neighbour, Niger, i.e., the Kaduna-Kano-Daura-Kongalam-Niger border road passes through Zaria (Filani and Onyemelukwe, 1982) as Kaduna-Zaria-Kano expressway.

Zaria has its own fare share of important and employment generating establishments. The popular and only civil aviation training college in Nigeria, the Nigeria College Aviation Technology is located in Zaria, on the same road as the main campus of the Ahmadu Bello University. The Nigerian Institute of Transport Technology is also located in Zaria. In addition to employment provided by several government (local government, state and federal) establishments, employment is also provided by finance industries such as insurance companies and commercial bank, the four main banks in Nigeria (First Bank of Nigeria PLC, Union Bank of Nigeria PLC, United Bank for Africa PLC, and Afribank Nigeria PLC) being well represented in the town. While there are several primary and post-primary institutions in the town, of note are the tertiary institutions in the town, namely; the two campuses of the Ahmadu Bello University, the two campuses of the Kaduna State Polytechnic, and the Advanced Teachers College (ATC). One other notable employment generating establishment is the Electricity Meter Company of Nigeria (EMCON). The Ahmadu Bello University, on its own, has several research institutes and centres affiliated to it. Thus, while Zaria cannot be said to be a cosmopolitan city, with the various sources of regular employment mentioned above and the non-regular but servicing small businesses, it can be said to be an average Nigerian town.

1.6 Outline of Thesis

The chapters that follow describe the stages followed in the accomplishment of the tasks set out in this work. Chapter Two deals with the literature reviewed in the process of setting forth hypotheses for the work. Chapter Three describes the methodology adopted in gathering data for the work. Chapter Four describes how the raw data (in the questionnaires) were processed to the form required for the main analyses. Chapter Five describes the details of the analytical tools used in the work and the criteria against which the results were evaluated. Chapter Six presents the results obtained from using the analytical procedures in Chapter Five on the data processed in Chapter Four, and discussions of these results in relation to the hypotheses set for in

Chapter Two. The inferences made in this Chapter Five and the implications of the results of the work for policy and transportation planning in Nigeria are put together as conclusions in Chapter Seven, which ends with suggestions made for further research into the gaps that remain unfilled in the area of travel money expenditures in Nigeria in particular, and in developing countries in general.

CHAPTER TWO

LITERATURE REVIEW

2.1 The UMOT Model

The UMOT (Universal Mechanism Of Travel) model developed by Zahavi (1979a, 1979b, 1979c, 1982) describes the condition of maximum utility of travel or simply, modal mechanism of travel. As presented in Downes and Emmerson (1985), it is expressed as;

$$\frac{a_i}{1 + x_i} = \frac{b_1 c_i}{1 + M - \sum x_i c_i} + \frac{b_2 t_i}{1 + T - \sum x_i t_i} \quad (2.1)$$

where a_i is modal preference factor, b_1 and b_2 are utility weights for money and time spent other than travel, c_i and t_i are money and time spent in travelling 1 kilometre by mode i , x_i is the average daily modal distance travelled for households classified by income group and car ownership levels, and M and T are money and time available to the household by income group. This equation is used in conjunction with the equilibrium relationship between transportation supply and demand (expressed as in equation 2.2 below) in an iterative process to determine the highway network length (or characteristics) that interacts with speed and flow of traffic to yield an acceptable level of service (i.e., in the range between LOS C and LOS A) for a given travel demand, expressed as modal distance of travel.

$$V_n = \left(\frac{\alpha L}{CH A} \right)^{1/2} \quad (2.2)$$

In equation 2.2, V_n is the speed of traffic in the urban highway network, α is a measure of the quality of a highway network in vehicle-kilometres per hour per day, L is the total length of the highway network in the urban area in kilometres, C is the average number of cars owned per household, H is the number of households in the area, and A is average time per day that a car spends on the network in hour per car per day.

The main features of the UMOT model are:

1. Travel is measured in terms of daily travel distance and not trips;
2. Demand for travel distance is expressed in terms of modal costs and times;
3. Demand for travel as measured in 2 is subject to explicit constraints imposed by peoples daily travel budgets or the regularities in the amount of time and money people spend daily on travel.

The summation of modal costs and times incurred by individuals or households, as the case may be, yields travel money expenditures and travel time expenditures, respectively. These are the summations (i.e., $\sum x_i c_i$ and $\sum x_i t_i$ respectively) in the modal distance mechanism (equation 2.1). A relationship can be defined between travel money expenditure and money available, and between travel time expenditure and time available. For the former, which is the subject of this research, this can be written as;

$$B = f(M) \quad (2.3)$$

where B is travel money expenditure, and M is money available (as in equation 2.1), based on an appropriate functional form..

The requirements for meeting the UMOT model's specifications are:

- (i) predictable functional form of travel expenditures;
- (ii) spatial and temporal stability of time and money expenditures (these qualify travel expenditures to be called "travel budgets"), and;
- (iii) temporal stability of the variabilities in travel budgets among individuals within groups.

At the stage of developing the travel money expenditure-money available relationship, it is the first two requirements that are important. The first requirement is met if a regression estimation of equation 2.3 yields a statistically significant relationship at the chosen level of significance. The second requirement is met if the functional form so estimated is

stable with respect to time or space or a policy change. Ascertaining if these requirements are met in Nigeria with respect to energy policy change is the main focus of this research. Since such policies are implemented over time, work will also serve as a form of temporal stability test, in this case short-term stability, because of the short time interval (within one year) between the "before" and "after" policy implementation periods chosen for this study.

2.2 Energy Policy Effects on Travel Behaviour

2.2.1 Mode Choice and Trip Rate Trends

It may be more informative to start with the brilliant exposé by Mufti and Munson (1979), on potential energy policies and the possible ways in which they directly change the transportation system through the response to them by travellers. They grouped the energy policies into seven general classes. The first and the one that is related to this work is the class of policies that increase the cost of automobile or private car travel relative to travel by other modes. The first component of this class is "increase in fuel cost, either by tax or market rises in price."

The authors grouped the effects of the energy policies on the transportation system into five possible responses by travellers, all of which can occur with fuel price increase. The possible effects or responses are:

- (i) trip makers or consumers of transport services simply decide to travel less by making either fewer or shorter trips;
- (ii) trip makers may decide to change modes of travel, at least for some trips;
- (iii) trip makers (who can afford it) may decide to acquire more energy-efficient cars in order to be able to make the number of trips with less fuel;
- (iv) trip makers may decide to relocate their residences so as to have fewer travel requirements
- (v) trip makers may just change their daily pattern of trip making and thus modify patterns of peak-hour travel, e.g. by trip-chaining or trip-stringing.

They end up the presentation by saying that "consumers can adopt one or more of these general responses to various public policy actions." Empirical works, on fuel price increases and fuel shortages, by such as Sacco and Hajj (1976), Stearns (1976), Sullivan and Picha (1982), and Wolff and Clark (1982), have actually proved this statement true. All recorded strong correlation of trip making with fuel price and, by implication, cost of travel and hence travel expenditures of individuals. Specifically, Sacco and Hajj reported that though fuel shortage did not affect appreciably long-term transit patterns or amount of travel, it encouraged drivers to alter their driving behaviour to conserve fuel.

Stearns discovered from his work that;

- (i) energy shortage did not alter journey-to-work patterns or transit use of sub-urban respondent,
- (ii) energy shortage is associated with significant alterations in trip frequency, mode, and purpose in the total society and for certain income groups,
- (iii) the increased cost (of fuel and hence of travel) due to energy shortage markedly altered the trip making patterns of poor respondents in terms of mode and purpose but minimally influenced the trip making of other people.

The work by Wolf and Clark, in summary, reports that the change in fuel cost is the most significant factor affecting the choice of mode of by-choice riders (transit riders who have private cars or other mechanical device as mode of transport available to them, i.e. other than transit-captive riders).

Two very related works on mode choice changes following energy policy change are those of Murray et al (1974) and Peskin et al (1975). Murray et al reported from a survey of driving habits before and during the 1974 fuel shortage in the United States of America that driving for both shopping and leisure (social and recreational activities) purposes reduced during the shortage. Peskin et al studied driving habits during and after the same period and found out that nonwork private car travel decreased by 13 per

cent during the shortage. While they attributed this decrease to reduced availability of fuel, they found out that changes in fuel cost had little effect on driving habits. They also recorded that the method frequently considered by respondents for reducing private car use was to indulge in trip chaining.

The effects of petrol shortages have had to be reviewed along with those of price increases because petrol shortages also shoot up trip costs at least in the short term. Stearns (1976), for example, reported from a study of the 1973-74 fuel shortage in the United State of America that increased cost due to energy shortage markedly altered the trip making patterns of poor respondents in terms of mode and trip purpose but minimally influenced the trip making patterns of the other people.

Of particular interest are some of the findings or inferences on the effects of energy policy changes on the life-style of consumers of transport services. For example, Wolff and Clark (1982) posited that the choice to change transport mode for making a regular trip may involve a substantial change in life-style, though not when fuel shortages and price changes are perceived to be short-term temporary events. Thus, life-style changes and other strong impacts of this kind of energy policy change are expected in the Nigerian situation, probably modified and possibly made stronger by the differences between a developing country and a developed country. Developing countries have been described as having more uncertainties and, by implication, less predictability concerning their characteristics (Ajgaonkar, 1974; Zahavi, 1976; Churchill, 1983; Thomson, 1983). With the high magnitude of increase in the fuel price in the October 1994 energy policy change and this low level of predictability, it is considered safer to expect that the energy policy change will more significantly affect travel mode choice characteristics, trip rates, travel expenditures, and life-style of individuals or groups of individuals in Nigeria.

2.2.2 Travel Money Expenditure Trends

While literature are not available on how energy policy changes have affected travel money expenditures in the past, reviewing the general trends of travel money expenditures in normal times may give a clue to what are expected following a policy change like that of fuel price increase.

Works on travel expenditure trends available are those of Ojumu (1975), Zahavi (1976), Heraty (1980), Jacobs et al (1981), Zahavi and Ryan (1980), Zahavi and Talvitie (1980), Eastman and Pickering (1981), Tanner (1981), Jacobs et al (1982), Maunder (1984), and Fouracre and Maunder (1987). All are agreed on two findings, namely; that (i) travel money expenditure (in absolute terms or in magnitude) increases with income, and (ii) travel money expenditure (as a ratio of income) bears an inverse relationship with income. This inverse relationship was used only recently (Osula, 1998a) as a basis for proposing a procedure for estimating transit subsidisation requirements for developing countries. Marked deviations from these trends are not expected in this work. One of the works cited above (specifically Ojumu, 1975) was carried out in a Nigerian setting.

TABLE 2.1. Travel money expenditure as proportion of income in selected works.

Author(s)	Min. (%)	Max. (%)	Unit of study	City
Ojumu (1975)	4.8	20	Individual	Lagos; Nigeria
Heraty (1980)	9 [54]	21 [77]	Household	Kingston; Jamaica
Eastman and Pickering (1981)	[15]	[29]	Household	K. Lumpur; Malaysia
Jacobs et al (1982)	6	25	Household	New Delhi; India
	15	20	Household	Kingston; Jamaica
	8	11	Household	K. Lumpur; Malaysia
Maunder (1984)	5	35	Household	New Delhi; India
Fouracre and Maunder (1987)	2	19	Household	Jaipur, Patna, and Vadodara; India

[] Travel money expenditure as proportion of disposable income.

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With respect to the level of money expenditure on travel, the range of expenditures (as proportion of incomes) recorded for the different authors mentioned above are as in Table 2.1. Ojumu's values are for work trips only.

For the variation of travel money expenditures with socio-economic characteristics of individuals or households, two inferences are worth highlighting. The first, due to Zahavi and Talvitie (1980) is that travel money budget is a function of many variables, the most clearly related ones being income, car ownership and location of residence with respect to work and services. The other, which supports the first part of this statement very strongly for developing countries is that due to Heraty (1980) which has it that low income earners in Kingston, Jamaica, spend very high proportions (up to 30% in some cases) of their income on travel, and that the amount spent on travel (primarily to and from work) exceeded that spent on rent. Maunder (1984), in fact, recorded travel expenditure as percentage of income of the order of above 35% for low income earners in New Delhi, India. If as much as these proportions of income can be spent in normal times (i.e., no fuel price increase) on travel, then higher levels of expenditure in relation to income may be expected in a constraining period of excessive fuel price increase. Work by Corsi and Harvey (1977) has shown that conditions of excessive fuel price increases or restricted fuel availability have serious implications for transportation.

2.2.3 Elasticity of Responsiveness to Energy Policy Changes

The real effects of a policy change are usually better assessed through the examination of elasticity calculation results. For this work, it is the fuel price elasticities of travel expenditures that are of concern. Fuel price elasticity of trip rates will also be considered in order to have an appreciation of the trends in fuel price elasticities of travel expenditures.

From a computer simulation study of the effects of changing fuel price on the journey-to-work in West Yorkshire in the UK, Bonsall and Champenowne (1976) recorded an inelastic short-term price elasticity of demand for fuel and an elastic one for the long-term. Dansker et al (1981) used elasticity calculations to measure the price elasticity of fuel demand to examine the impact of a change in fuel supply in Massachusetts, U.S.A. for short-term periods, using both pump price and real price of fuel. They recorded inelastic values in all the cases considered but with values depending on time period and price definition. While the former is obvious, the reason given for the latter, where values based on real price (pump price factored by the consumer price index or retail price index) were higher than those based on pump price, was that the change in real price over a period is usually smaller than the change in pump price. DeJong (1981) recorded inelastic average elasticity estimates for both short-term (one year estimates) and medium-term (four-year estimates) for fuel price elasticities of travel demand for New Jersey, U.S.A., but with higher values for the medium-term estimates. This he explained on the fact that short-term elasticities are expected to be lower than medium-term (and by extension, long-term) elasticities because people would have had more time to react to the price change. Sullivan and Picha (1981), using econometric models to study the relative impact of energy problems (fuel shortages and price increases) on different recreational travel types, recorded elasticities ranging from very small negative values to high negative and positive (absolute values above unity) and explained the low values on fuel cost being an insignificant part of the total recreation cost because of the not too distant location of the recreational type concerned.

While work by Stearns (1976) on behavioural impacts of energy shortages in the U.S.A. was not directly on elasticities, an implication that was drawn for elasticity was that it is differently apportioned by income level. From this and the results obtained by Sullivan and Picha, a generalization that was considered reasonable to put forward as a hypothesis in this work is that fuel price elasticities are differently apportioned by the levels of several factors, including socio economic factors.

Two other works that are also related to the present one are those of Schou and Johnson (1979) and Wang and Skinner (1984). From an empirical model of the demand for petrol in Australia for the period 1955-1976, Schou and Johnson recorded very low negative values (the highest being -0.08) of elasticity of demand for petrol and suggested that an increased petrol tax is possibly of very little help as a conservation measure. Wang and Skinner estimated elasticities from empirical models of monthly ridership of public transport in seven U.S.A. public transport authorities in studying the impact of real fare and petrol prices upon monthly ridership. They found out that (i) the elasticities of monthly ridership with respect to real fare are negative and inelastic, ranging from 0.042 to 0.062, and (ii) the elasticities of monthly public transport ridership with respect to the real petrol price are positive and inelastic, ranging from 0.08 to 0.8. The implications that can be drawn from these results are that while in real terms the impacts of the changes in fare and petrol price are not severe or significant (since inelastic responsiveness were recorded), increasing fare has the effect of reducing transit patronage while increasing petrol price has the effect of increasing public transport usage, apparently from the transfer to public transport usage of private car owners or chooser public transport trip maker, though the level of transfer has not matched the level of the price increase.

Mention has been made in this review (in the work of Schou and Johnson's (1979)) of energy conservation also as an objective of increasing fuel price. Though the general trend in the review suggests that fuel price increase may not serve energy conservation objective, with the high magnitude of the October 1994 fuel price increase, it is expected that this energy conservation objective, though seemingly unplanned for, may be achieved, and for all intents and purposes, will serve as the opportunity cost for the increased travel money expenditure that the change would cause to the average trip maker, especially for the more frequent urban trips.

2.3 Functional Form of Travel Expenditures

The literature available to the present researcher on travel expenditure functional form are those of Houthaker (1957), Morris and Wigan (1979), Zahavi (1979), Heraty (1980), Downes and Emmerson (1983), Fouracre and Maunder (1987), and Olaoye (1989). Based on from the Engel function, Houthaker estimated a log-linear functional form of the form

$$\log Y_i = a + b \log X_{1i} + c \log X_{2i} + \epsilon_i \quad (2.4)$$

for different groups of items (including transportation), where Y_i is expenditure on the group of items in question, X_{1i} total expenditure, X_{2i} family size, a , b and c are model parameters, and ϵ_i the error term.

Morris and Wigan estimated a similar form as;

$$\log Y_i = a + b \log X_i + \epsilon_i \quad (2.5)$$

where Y_i is average expenditure on the commodity in question (including transportation) by income group class (running from 1 to 6), X_i the average total household expenditure by the i th income class, a and b the regression parameters, and ϵ_i the error term.

Zahavi used specifically the model below in demonstrating his UMOT concept;

$$B = 0.11I \quad (2.6)$$

where B is the travel money budget and I the household income, for two-mode internal travel in Washington.

Heraty, using data on public transport for low income earners in Kingston, Jamaica, estimated the form;

$$Y_i = a + bX_i + e_i \quad (2.7)$$

where Y_i is average amount of money spent on travel, X_i the household income per week, a and b the model parameters, and e_i the error term.

Downes and Emmerson, in testing the sensitivity of the UMOT concept used

$$B = 0.02047 + 0.01413I \quad (2.8a)$$

and

$$B = 0.1396 + 0.09575\ln I \quad (2.8b)$$

for non-car owning and car-owning households respectively for internal travel in Reading, where B is travel money expenditure and I is income.

Fouracre and Maunder estimated for medium-sized Indian cities the following form;

$$\begin{aligned} \text{LAEXPTRA} = & A_0 + A_1\text{VOWN} + A_2\text{PROPWORK} + A_3\text{PROPSTU} + A_4\text{LSIZE} \\ & + A_5\text{LONC} + A_6\text{LFAMDISTM} + A_7\text{PROBTRS} + A_8\text{CITY} \end{aligned} \quad (2.9)$$

where LAEXPTRA is monthly household expenditure on transport (log transform), VOWN is vehicle ownership category (no vehicle=1, motor cycle=2, motor vehicle=3), PROPWORK the proportion of workers in the household, PROPSTU the proportion of students in the household, LSIZE the size of the household (log transform), LFAMDIST daily per capita distance in kilometres (log transform), PROBTRS the proportion of

household trips undertaken by bus, and CITY a dummy variable taking value 1 and 0 for each of two cities, respectively, used in the study.

Olaoye, working on household expenditure patterns in Nigeria used the 1983 National Integrated Survey to fit an Engel function of the type

$$c_j/k = a_j + b_j e/k \quad (2.10)$$

where c_j is expenditure on the j th commodity, e total expenditure, i.e., on all commodities, k the number of people in the household, and a_j and b_j model parameters. Commodities for which the model were estimated include food, drinks and tobacco, accommodation, clothing, transport and other services, and monetary transactions. Data used were for all the states of the country. In addition to the model estimation, elasticities for the expenditure items with respect to total expenditure were estimated. Transport recorded the highest figure of 1.43, followed by monetary transactions and other services with the figures of 1.28 and 1.20, respectively. He said this implied that expenditures on these items are very responsive to changes in total expenditure and could be interpreted as being luxury items.

The range of functional forms in these works cannot to be said to be wide. There is, however, no reason to expect a wide range of functional forms. Those reviewed above include simple linear regression models, multiple regression models, log-log transformation models, and semi-log transformation models, all estimated on the basis of a maintained hypothesis about the functional form. While no specific functional form has been specified for this present work, a direction is expected to be given by the trends that will be exhibited by the travel money expenditure in relation to the money available variables (disposable income and total expenditure) in the preliminary analyses.

2.4 Stability of Travel Money Expenditures

The summary of the findings of past works on travel expenditures is presented in Table 2.2. It is seen that not much has been achieved in this area of research. While some appreciable works can be said to have been done in the other travel expenditure, i.e. travel time expenditure, though with conflicting results, very little seems to have been done in the area of travel money expenditure. For travel time expenditure, for example, Pendegast and William (1980) concluded outright that average daily travel time would not provide a representative

TABLE 2.2. Summary of past works on travel budgets

Type of Expenditure	Predictable trend		Temporal Stability				Spatial Stability		Energy Stability	
			Dpdc		Dpgc					
	Dpdc	Dpgc	S.term	L.term	S.term	L.term	Dpdc	Dpgc	Dpdc	Dpgc
Time	H	H	P	NYP	NYP	NYP	P	NYP	NYP	NYP
Money	P	P*	P	NYP	P	NYP	NYP	NYP	NYP	NYP*

P: Proven NYP: Not yet proven H: Hazy * Focus of present work

measure of travel behaviour and that travel time could not be used with confidence for the purpose of prediction. On the contrary, working on data from Singapore, Brazil, Chile, and Columbia, Roth and Zahavi (1981) found out that time budgets display predictable regularities with such factors as income, household size, vehicle availability, sex, age, and occupation, while work by Landrock (1981) on developed country setting gave an indication that daily travel time is more spatially stable than daily trip rate. Work in Nigerian settings by Banjo and Brown (1982) recorded similarities and differences in travel time variation between two cities and went ahead to hypothesize that relationships exist between mean daily travel time and transport system evolution to the extent of hoping that such relationships could be used in transport modelling and time valuation practice in third world cities.

In the majority of the works, where stability has been established for travel money expenditure, it has not really been through the estimation of a functional form. Such cases have been based solely on the comparison of basic statistics of data (such as average values and coefficient variation) for different cities in a country and for different periods (usually, very short-term periods i.e., daily regularity) for travel money expenditure. The ones considered the most categorical in their findings for travel money expenditures (the ones due to Zahavi and Talvitie (1980) and Zahavi and Ryan (1980)) were based on what can be considered poor data. Both works were on developed country settings. Travel money expenditures in both works were derived indirectly by multiplying travel distance per household by modal cost per unit distance of travel. Though the work of Zahavi and Ryan was based on the estimation of a functional form, the models estimated were not directly on travel money expenditure or travel time expenditure. They estimated linear regression models relating modal daily trip rate and modal trip distance per traveler to daily distance per traveler. Temporal stability was tested using Chow's (1960) test of equality of regression coefficients between two regression models.

It is considered more appropriate, as was done in the work of Zahavi and Ryan, to use estimated functional forms since it is these that are actually used in the UMOT model. However, one shortcoming of the approach of Zahavi and Ryan is that the estimation of the models has been on the basis of a maintained hypothesis, i.e., a definite functional was adopted and carried through the estimation exercise, without making room for the evolution of a more appropriate functional by the data. Such a desirable feature is accomplished by using some flexible functional. With this kind of estimation, stability when established would be accepted more confidently. This is the line along which the present research was conducted.

One strong reason inadvertently made by Zahavi and Ryan why stability testing should be as rigorous as advocated and adopted in this present research is that significant

changes in energy policy, tastes, life style, and technology can produce significant shifts in travel demand characteristics, particularly in travel money expenditure. These changes lead to different levels of variabilities within and between groups of persons in a population, whether on a short-term or long-term basis. The trends in the variabilities can be more appropriately captured in a flexible functional form regression modelling process as is the approach adopted in this work. It is possible that functional forms established can substantially or significantly remain the same in time and space, or with respect to a particular policy change, based on suitably chosen variables that describe travel demand and the characteristics of the population groups. This can happen, for example, in the case of simple linear regression when data sets for the different scenarios (time, space, policy change) exhibit reasonable continuity. Stability established in this manner is what should be sought for as travel demand models are usually based on empirically developed models or theoretical models calibrated with empirical data.

In making a strong case against travel budgets and asking that researchers come back to trip rates again, Hertz (1983) examined the issues of variability, stability, and flexibility of behaviours, and concluded that "it is the mean, the great illusionist, which generates stability from variability." Thus examining stability through functional forms established empirically has been adopted in this work in preference to comparing means or averages of travel expenditures across the policy change period.

From the conflicting results obtained in the literature on the stability of travel expenditures, some measure of caution needs to be exercised in accepting the hypothesis of stability of travel expenditures, at least for developing country settings.

2.5 Study Hypotheses

Intuitively, it is expected that in a situation where very rapid changes in economic policies have meant reduced purchasing power of the national currency in contrast to the income growth of an individual, as has been the case in Nigeria, frequent re-ordering of

an individual's priorities will be the norm. This situation will not make for constancy or regularity of spending on any particular activity, including trip making. What may ultimately happen is a situation where money expenditure on travel increases (even faster than income rise as has been proved for a developed country by Tanner (1981)) because of rise in cost of transport services.

In the light of this, the general characteristics of developing countries, the findings of past works, and the literature review, the following are set forth as main hypotheses for this study:

- (1) Travel expenditures generally follow predictable patterns or functional form in Nigeria;
- (2) The pattern or functional form of travel expenditures in Nigeria is not stable with respect to energy policy changes.

While the implication of hypothesis 1 is implicit in its statement, it is significant in confirming or rejecting the notion of predictable pattern of travel expenditures in developing countries in the context in which it is carried out in this work.

The implication of hypothesis 2 is that travel expenditures are not stable with respect to energy policy changes in Nigeria. This is in recognition of the fact that re-ordering of priorities with respect to the ultimate needs to be satisfied by travel, following the policy change (increased cost of transportation) may mean a drastic change from the old ordering in a way or manner that may not replicate the before-change functional form.

It was considered necessary to carry out additional investigation with the data to ascertain how travel behaviour of individuals have been affected by the fuel price increase, in order to facilitate the explanation of the outcome of the main investigation of functional form and energy stability of travel expenditures. Accordingly, subsidiary hypotheses were formulated based on the review of the literature carried out above. The

first of these hypotheses is that travel money expenditures in Nigeria are influenced by some specific socio-economic features of the individuals concerned. The implication of this hypothesis is that travel expenditures may be variable over time for an individual who experiences changes in his socio-economic circumstances. Despite these variations in travel expenditure, if a significant correlation can be established between travel expenditure and socio-economic variables, a useful planning tool would have been developed.

The contribution of Goodwin (1981) to the travel expenditure debate has followed the middle-of-the-road viewpoint. While not totally writing off the hypothesis of constancy of travel budget outlay, he raised the fundamental question of the behavioural implication of stable travel budget in conventional sequential demand models, i.e., bringing behavioural concepts into erstwhile behaviour-insensitive modelling approach. His investigation gave rise to several hypotheses, one of which was modified and adopted as the second subsidiary hypothesis, and that is that transport market can be segmented on the basis of the interaction between travel expenditures and socio-economic features of individuals in Nigeria.

Other subsidiary hypotheses which are set forth for this work are as follows;

- (i) Travel expenditures, as proportion of income and disposable income, are inversely related to income in Nigeria.
- (ii) Shifts are expected in population segmentation following the October 1994 fuel price increase.
- (iii) Life styles of individuals are affected by energy policy change in Nigeria.
- (iv) Travel behaviour (typified by mode choice characteristics, trip rate, and travel expenditure) is elastic with respect to energy policy change in Nigeria.
- (v) Fuel price elasticities are differently apportioned by the levels of socio-economic factors usually considered in travel demand studies.

(vi) Energy conservation objective will be met by the level of fuel price increase in this energy policy change in Nigeria.

The penultimate two hypotheses have more implications for policy than the others, considered from the point of view of a government and its responsibility to the society. While inelastic responses are what were recorded in all the literature reviewed, it is considered reasonable to expect elastic responsiveness in this present work because of the large increase in the fuel price.

The last hypothesis has been conceived to ascertain if this 1994 energy policy change in Nigeria was appropriate with respect to petroleum energy conservation. The conservation of a depleting resource as that of petroleum should be a prime objective of an oil producing nation, having regard to the role petroleum energy plays in world politics.

CHAPTER THREE

METHODOLOGY

3.1 General

The work involved the use of data collected through the use of questionnaires and travel activity diaries on travel behaviour of individuals (workers in regular employment) in Zaira before and after the October 1994 fuel price increase to investigate, in the main, the following;

- (i) the general trends in trip rates before and after the fuel price increase,
- (ii) the general trends in travel money expenditure before and after the fuel price increase,
- (iii) whether a shift occurred in transport market segmentation following the fuel price increase,
- (iv) whether a functional form can be established for travel expenditures in Nigeria,
- (v) whether the functional form (if established) is stable with respect to energy policy change in Nigeria.

Self-employed workers were not considered because a potential bias was expected in the reporting of their incomes. Reichman (1976) deleted self-employed households in a transport-related work for the same reason.

The statistical analyses and tests carried out on the data collected in this work were conducted at the 95% level of confidence. This is the level usually considered the middle-of-the-road in research. At this level, there is only a 5% chance that a conclusion drawn from the analysis of the data available is in error or that the researcher is 95% confident of the inferences made.

3.2 Field Work

The field work was carried out in the following phases;

- (i) initial design of questionnaire and activity diary,

- (ii) pilot testing of questionnaire and activity diary,
- (iii) final design of questionnaire and activity diary,
- (iv) data collection through administering questionnaires and activity diaries to would-be respondents.

The pilot study was conducted to aid in the following:

- (1) determination of the appropriate type and number of questions to use in the final questionnaire,
- (2) testing would-be respondents' reactions to the activity diary (Intuitively, it was felt that not many may have the time to complete the activity diary.);
- (3) estimation of the appropriate response rate and hence the number of questionnaire/activity diary booklet to make available for the data collection stage.

The pilot study was conducted among Ahmadu Bello University workers in Zaria, for ease of administering and collection of questionnaires and activity diaries. Of the 100 questionnaires/activity diaries given out, only 30 were received. Of these 30, less than 5 respondents attempted completing the activity diary section. Several respondents did not attempt filling the questionnaire and activity diary because they felt over-tasked by the number of questions (40 in all) and especially the extent of information required in the activity diary. The activity diary sought information not only on travel activities, but also on all daily activities engaged in, every hour of the day for a period of seven days. Had the questionnaire recovery been aggressive, the recovery rate would probably have been higher.

The study was conducted at a disaggregate level, in which individual trip makers were used as the study units. While making a seemingly tentative inference that travel money expenditure is related to the socio-economic characteristics of the households, from an aggregate study on the temporal stability of travel components, Zahavi and Ryan (1980) called for additional analyses at disaggregate levels. Another support for the

individual-based work here derives from an earlier call by Zahavi (1976) that travel behaviour should be based on the trip makers and their personal travel demand and responses to the transportation system supply. Moreover, households abound in Nigeria, and probably in many other developing countries, in which all that is shared is floor space and not income.

The questionnaire which was eventually used for the main study was a drastically scaled down version of that used for the pilot study. It was modified extensively from the experience of the pilot study. It was divided into four parts and contained a total of 24 questions. Part A contained 14 questions and was designed to collect information and data on the personal details and socio-economic characteristics of the respondents. Part B contained 3 questions and was designed to gather data on the travel characteristics of the respondents before and after the fuel price increase. Part C contained 5 questions and sought to gather data on the travel expenditure pattern of the respondents before and after the fuel price increase. Part D contained 2 questions and sought to gather data on expenditure pattern of respondents on non-travel items and activities. One notable feature of this last part of the questionnaire was the inclusion of expenditure on "extended family." While extended family management can be said to be part of the routine of the average Nigerian, Eastman and Pickering (1981) has found it to be an aspect of the difference in the social conditions between developing countries and the more developed countries. They stated truly that in this kind of system, three or even four generations of families live together. This family structure, according to them, creates different travel patterns from those generally found in the developed countries.

The travel activity diary was designed to gather data on time and money spent by respondents on actual trips made and the distance covered in making such trips. The mode used, the purpose, and the type of origin and destination of such trips were also to be indicated by the respondents on the activity diary. The major purpose of the activity diary was to help respondents in filling the questionnaire section as correctly as possible.

The activity diary was also to be used in checking the correctness of the entries on the questionnaires during the analyses of the data. The questionnaire/activity diary booklet is presented in Appendix A.

Less than 10 per cent of the respondents completed the activity diary section of the booklet. Most of these were not even completed correctly. Thus the analysis was limited to the data provided by questionnaire portion of the booklet.

The questionnaire/activity diary booklets were administered to would-be respondents and collected back between the months of January and June 1995. It was considered that this period was still close enough to the period just before the October 1994 fuel price increase for would-be respondents to remember their travel behaviours before the fuel price increase.

3.3 Sample Size Determination

Before administering the questionnaires and activity diaries to would-be respondents, it was necessary to determine how many should be given out in order to obtain a statistically significant sample size for the analysis.

It was desired to determine the mean travel expenditure to within plus or minus ₦200.00. This is 20% or a fifth of the interval used for income grouping in the questionnaire. Intuitively, this was considered adequate because of the expected bias in the reporting of expenditures by the respondents. Using 50% income as proxy for travel expenditures (in the "after" period), using also one-sixth of the expected travel expenditure range (i.e., 50% of total income range of ₦750.00 to ₦12,000.00 adopted in the questionnaire) as the estimate of the standard deviation of expenditures in the absence of any information on expenditure statistics of the population being sampled (Luck and Rubin, 1989), and using the standard relationship between error e , standard deviation σ and sample size n , as:

$$c = \frac{k_{\alpha/2}\sigma}{\sqrt{n}}$$

(3.1)

where $k_{\alpha/2}$ is 1.96, the minimum sample size was estimated as approximately 85. Banking on, say, 20% recovery rate with an aggressive recovery strategy, this came to a little less than 425. 480 questionnaire/activity diary booklets were initially administered to would-be respondents. This was increased to 640 when recovery proved difficult.

3.4 Trip Categories Used

The definition of a trip adopted in this work is a one-way movement by an individual between two locations (an origin and a destination) in an urban area, either by walking or by the use of a bicycle or a motorised device such as a motorcycle, a private car, or any public transport vehicle. In the words of Maunder (1984), this is a "single movement." Thus a to-and-fro journey is made up of two trips.

Several types of trip are made by individuals. For this work, nine trip types were distinguished by purpose, and used in the questionnaire. The choice of the trip purposes used was influenced by the impressive work of Town (1981) on "non-transport influences on travel patterns." His six trip purposes of work, shopping, social, education, personal business, and recreation, were modified and extended to reflect the prevailing travel determinants in Nigeria. The modifications were the separation of "work" into "full-time work" and "part-time work" and the conversion of "education" to "school run." The extensions were the addition of trips for "farm" and "worship."

While at the survey stage all trip purposes are used, it is the norm at analyses stage to categorise the trips into a smaller number. For example, Reichman (1976) defined three categories of trip purposes on an increasing scale of elasticity as:

- (1) subsistence trips : work, business; and farm trips;
- (2) maintenance trips : personal affairs and shopping trips;

(3) leisure trips: entertainment, social, and sport trips.

The increasing scale of elasticity is due to the higher degree of flexibility for the maintenance and leisure trips as to whether to make the trip, when to make the trip, and where to go (Town, 1981).

Neale and Hutchinson (1981) used four categories, as follows:

- (1) obligatory travel : work and school purpose;
- (2) personal business travel : personal business purpose;
- (3) shopping travel : shopping purpose;
- (4) leisure travel : social-recreational, eat meal, and stroll purpose.

For work on travel time expenditures on a Nigerian setting, Banjo and Brown (1982) categorised travel activities into two general classes as:

- (1) travel to work;
- (2) travel for other purposes.

Fouracre and Maunder (1987) used the rather limited categorisation of social/leisure, education, and employment.

Considering the trip purposes used in the questionnaire, it is clear that the Reichman's categorisation is what should be adopted. Thus for this work, the categories and the associated trip purposes are:

- (1) subsistence trips : full-time work, part-time work, farm, and business;
- (2) maintenance trips : shopping, worship, and school run;
- (3) leisure trips: recreation and social visit.

School run was substituted for education because time is allowed during working hours in Nigeria for workers to go to school to fetch their children. Only workers in regular employment were targeted for this work.

CHAPTER FOUR

DATA PREPARATION

4.1 Data Reduction and Outlier Removal

Of the 640 questionnaire/activity diary booklets administered to would-be respondents, 243 were recovered. Of these, a total of 195 were found useful for analysis. Most that were rejected had no information in vitally important areas. Some others had very scanty information, most of which were judged untruthfully filled, especially with regard to money expenditures on both travel and non-travel activities. Others yet had rather impossible or ridiculous information such as an engineer having had less than 10 years of formal education or earning ridiculously low income.

In order to reduce the bias in the reporting of travel expenditures, the data available were scanned for outliers. In doing this, values which did not fall within the range established by the deviation-spread criterion of "mean plus or minus three standard deviations", used extensively in Doane (1985), were discarded. However, some cases with high travel expenditures but with high car ownership were not discarded. The data set reduced to 192 after this outlier removal exercise. The summary statistics before and after the removal of outliers are presented in Tables 4.1a and 4.1b.

TABLE 4.1a. Summary statistics of key variables before removal of outliers. (195 units)

Statistic	AGE	CAR	INCOME	MEB	DIB	TEB	MEA	DIA	TEA
Min.	22.50	0.00	750.00	0.00	0.00*	450.00	0.00	0.00*	690.00
Max.	55.00	3.00	12500.00	4000.00	8200.00	19367.00	5700.00	7500.00	32900.00
Average	35.04	0.40	3639.74	569.31	1969.72	3585.29	1185.88	1119.00	6389.83
St.Dev.	7.63	0.61	2135.86	560.33	1600.05	2679.27	1200.68	1340.75	4703.35

TABLE 4.1b. Summary statistics of key variables after removal of outliers. (192 units)

Statistic	AGE	CAR	INCOME	MEB	DIB	TEB	MEA	DIA	TEA
Min.	22.50	0.00	750.00	0.00	0.00*	450.00	0.00	0.00*	690.00
Max.	55.00	2.00	12500.00	2280.00	8200.00	19367.00	4933.00	7500.00	32900.00
Average	34.27	0.38	3610.68	533.42	2014.82	3546.68	1142.50	1148.88	6344.68
St. Dev.	8.53	0.58	2129.89	471.09	1589.29	2681.78	1136.53	1341.55	4718.86

* Some values recorded as zero were actually negative.

4.2 Sample Size Validation

With data now available, a check was made to ascertain the adequacy of the sample size. Equation 3.1 was used to calculate the sample size requirement based on the higher value of the travel expenditure of the "before" and "after" periods, i.e., MEB and MEA. With $\sigma=1136.53$ for MEA, the minimum sample size required was obtained to be 124. Thus the 192 data units are adequate for subsequent analyses.

4.3 Determination of Critical Person Descriptor Variables

As expected in a study in which several variables are used to describe units of study, not all variables will be relevant in scheme of things. In some situations, two or more significant variables may be so correlated as to render their simultaneous consideration in the analysis superfluous. It is thus necessary to sieve out those variables that are considered just enough for the analysis at hand. In this work the selection of these critical descriptor variables was done by the use of analysis of variance to select the variables for which the variation within the categories is significantly less than the variations between the categories.

This exercise was carried out for the before and after fuel price increase situations. Eight person descriptors or descriptor variables were (age, sex, household status, marital status, employment status, income, car ownership, and travel constraint) used in the questionnaire. One of these (i.e., travel constraint) was discarded because many respondents (39 out of 192, i.e., 20.3 %) did not indicate anything relating to it in the questionnaire. The categories of the seven person descriptors are listed in Table 4.2

Of the remaining seven descriptor variables, two (Income and Car Ownership) proved significant descriptors of the respondents in relation to travel money expenditures in the "before" fuel price increase situation. In the "after" situation, three additional ones (i.e., Age, Marital Status and Household Status) proved significant. Work in this same setting by Haliru (1982) also recorded personal income, household status and car ownership as determinants of mode choice for the journey-to-work of civil servants.

TABLE 4.2 Person descriptors

Descriptors	Age (yrs)	Sex	Establishment Status	Household Status	Cars Owned	Marital Status	Income (Naira)
Categories	20-25	Female	Full-time	Daughter	0	Single	<1001
	26-30	Male	F.time/P.time	Son	1	Married	1001-2000
	31-40		Contract F.time	HNH	2+		2001-3000
	41-50			Wife			3001-4000
	51-60			Husband			4001-5000
							5001-6000
							6001-7000
							7001+

The raw data obtained from the questionnaires are presented in Appendices B to F as follows:

APPENDIX B. Raw Data: Socio-economic characteristics of respondents;

APPENDIX C. Raw Data: Mode choice of respondents;

APPENDIX D. Raw Data: Weekly trip rates of respondents;

APPENDIX E. Raw Data: Weekly travel money expenditures of respondents;

APPENDIX F. Raw Data: Monthly non-travel money expenditures of respondents.

The formulae for the statistical tests used in this work are put together in Appendix G. The details of the paired t-test of difference between "before" and "after" data are presented in Appendix H. The details of the ANOVA test results for the selection of the critical person descriptors are presented in Appendix I.

CHAPTER FIVE
ANALYTICAL PROCEDURES

5.1 Elasticity Calculations

Papacostas (1989) defines price elasticity as the relative change in the quantity demanded to the relative change in price. Expressed quantitatively, this is

$$e = \frac{(dq/q)}{(dp/p)} = \frac{dq}{dp} \cdot \frac{p}{q} \quad (5.1)$$

where q is quantity and p is price, dq and dp are the changes in quantity and price, respectively. Figure 5.1 shows the governing price-demand relationship.

However, this equation is not used directly, because much data are required to establish a demand curve or price-demand relationship more appropriately, causal demand models. Recourse is taken to measuring elasticity on the basis of "before-and-after" observations of both price and quantity. Elasticity is usually measured in three ways. The first referred to as line elasticity in Grey (1975) is expressed as ;

$$e = \frac{(q_2 - q_1)/q_1}{(p_2 - p_1)/p_1} \quad (5.2)$$

where subscripts 1 and 2 denote before and after values, respectively.

The use of this equation is considered the simplest approach and represents a situation in which a constant elasticity slope is obtained by drawing a line between two points, to give a linear demand curve. Papacostas (1989) refers to this elasticity measure as "shrinkage elasticity" obviously because the measure is shrunk to the initial values (or the "before" values) of quantity and price. A variant of this elasticity equation was used by DeJong (1981) in an energy policy change study. According Cervero (1982),

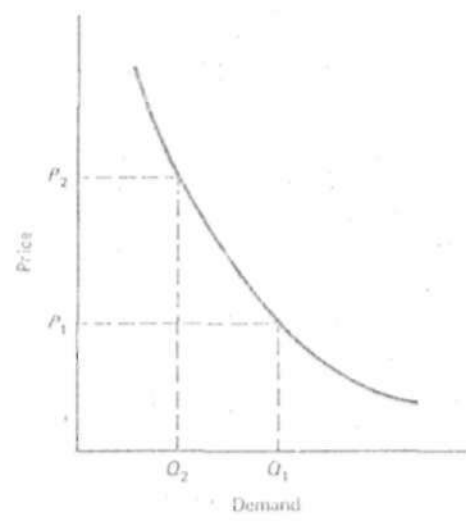


Figure 5.1 A typical price-demand curve.

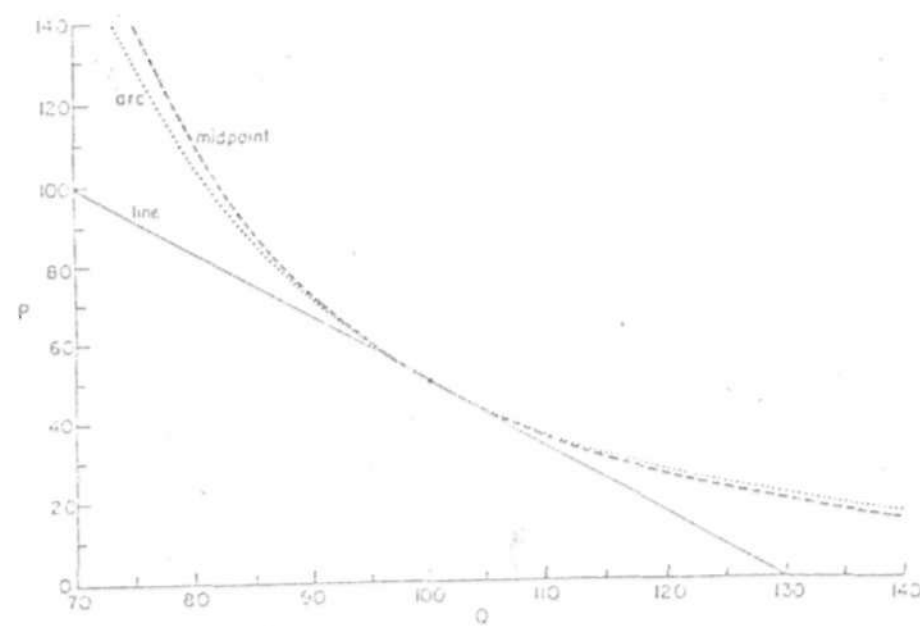


Figure 5.2 Demand relationships for alternative elasticity estimates (After Cervero (1982)).

intuitively, the linear demand curve representation seems inconsistent with the industry's prevailing view that public transport demand curve is not linear.

The second elasticity measure offered by Grey (1975) as "midpoint" elasticity moves nearer reality by representing the demand curve as a hyperbolic-type relationship between quantity and price. Grey expressed this elasticity as;

$$e_m = \frac{(q_2 - q_1) / (\frac{1}{2}(q_2 + q_1))}{(p_2 - p_1) / (\frac{1}{2}(p_2 + p_1))} \quad (5.3)$$

This elasticity is measured in relation to the average values of the "before" and "after" quantities and prices. This measure, which is referred to in Papacostas as midpoint (or linear) arc elasticity, was used by Dansker et al (1981) in their work on the impacts of motor-fuel supply in Massachusetts, in the United States of America.

The third elasticity measure is arc elasticity due Kemp (1974). It is expressed as;

$$e_{arc} = \frac{\log q_2 - \log q_1}{\log p_2 - \log p_1} \quad (5.4)$$

Figure 5.2 gives a comparison of the demand curves (arrived at by Cervero (1982 from a sensitivity analysis) based on the three measures. According to Grey, the major shortcoming of the arc elasticity (as with the midpoint elasticity) is that it does not touch the axes but is asymptotic to them, making it increasingly unreliable as the price changes being considered get bigger. Though he advanced a "theoretical" way of getting over this by just shifting the curve through some distance so that it meets the axes, his final appraisal of the approaches lead to the conclusion that the choice lies between the line elasticity and arc elasticity. In another vein, Papacostas, who refers to the arc elasticity as log-arc elasticity, explains that all three measures of elasticity (i.e., excluding Grey's modified arc elasticity) yield approximately equal values of elasticity when price changes

are small, but that the shrinkage ratio or line elasticity begins to deviate significantly from the other two when price changes are large. Thus for the present work, in which a price increase as large as 238.5% is involved, its use is considered inappropriate.

In adopting the log-arc elasticity for analysis, Cervero (1982) reported that past works (specifically those of Kemp (1974) and Donnelly (1975)) indicate that the log-arc elasticity measure describes reality better, with respect to transport fare changes (as can be occasioned by fuel price increase) and associated changes in ridership, and this is that ridership responses to fare increases is higher than from fare decreases. Thus, it is this log-arc elasticity measure that is adopted in this work. This log-arc elasticity formula has been used in a travel budget-related work by Downes and Emmerson (1985).

5.2 Segmentation of Population

Market segmentation is a way of identifying relatively homogeneous groups (in a population) to which can be targeted specific policy options or components to achieve optimum effect of the implementation of the policy concerned or for the purpose of studying the responses of the groups to changes in policy. According to Reichman (1976), the approach of market segmentation in the study of travel behaviour of social groups focuses on the varying needs of special groups in society. For example, he states that in this approach, the travel behaviour of the disadvantaged, such as the poor, the aged, or the disabled, is investigated with the aim of identifying potential ways of overcoming their mobility deprivation. Even for exercises like those of transit planning, Sobel and Alschuler (1980) have argued that market segments must be introduced into the alternative design steps. For this present work, segmentation was carried out to ascertain, among other things, whether the implementation of the energy policy change of October 1994, exemplified by petroleum products price increases, caused re-alignments in the transport market and hence shifts in the population groupings. It was also to facilitate the formulation of data-defined hypotheses for the study of the functional form and energy stability of travel expenditures.

Following from the modification in Chapter One of Foulkes and Robertson's (1981) definition of transport market, this aspect of the present work attempts, in part, to examine whether the demand side of the market can be segmented on the basis of travel money expenditure.

5.2.1 Theoretical Foundation of Transport Market Segmentation

The review of the literature in the area of segmentation is started with a consideration of the theoretical representation of the relationships that intervene in segmentation, as presented by Louvierre et al (1976). Market segmentation is defined by Louvierre et al as "the decomposition of consumer demand into independent behaviour groups." It is presumed that the demand groups, which are independent, have more within-group homogeneity with respect to some set of criteria (such as the socio-economic characteristics of income, sex, age) than between-group homogeneity (Frank et al, 1972).

The intervening sets in the presentation of Louvierre et al are;

- (i) {O} - travel choices (all modes, choices destinations choices, route choices), i.e., sets of opportunities;
- (ii) {D} - the set of behaviours or demand of consumers or demanders of the opportunities;
- (iii) {V} - the set of causal variables which cause {D} to assume some observed values with respect to the set {O};
- (iv) {A} - the sets of attributes of consumer groups, that "cause" differences in behaviour

In transport context, these sets can be seen as follows: {O} system supply; {D} travel demand; {V} policy changes; and {A} socio-economic characteristics of consumers or demanders of transportation or transport supply. According to Louvierre et al, and rightly too, any change in the variables representing the set {V} represents a change in the supply system or {O}. Thus {O} does not need to intervene directly in the

segmentation process or exercise. Louvierre et al also rightly noted that the change in the set $\{V\}$ affects $\{D\}$ and any change in $\{A\}$ affects $\{V\}$, and hence affects $\{D\}$. They stated also that the value of the elements in all these sets may change with respect to both space and time. This is how segmentation is a veritable tool for examining changes in travel behaviour over time and space or with respect to policy changes.

While Louvierre et al rightly relate $\{D\}$ to $\{V\}$ as the former being a function of the latter, i.e., $\{D\}=f(\{V\})$, their assertion that $\{V\}$ is a function of $\{A\}$, i.e., $\{V\}=f(\{A\})$, does not appear to the present researcher defensible. This assertion of theirs was made on their way to arriving at the correct assertion that $\{D\}$ is a function of $\{A\}$ via $\{V\}$, i.e., $\{D\}=f(g(\{A\}))$. It would appear more appropriate to think of $\{D\}$ as being dependent on $\{V\}$ and $\{A\}$ in their own rights directly, i.e., without considering the interdependence of $\{V\}$ and $\{A\}$. This being the case, what appears a more appropriate manner of expressing the relationship (if at all necessary) would be $\{D\}=f(\{V\},\{A\})$. However, this stage is not necessary in achieving the objective of segmentation, because it is the elements or variables of $\{D\}$ and $\{A\}$ that interact directly in the process of selecting the units of study (individuals or households) that should belong to specific groups or segments as a result of the relative homogeneity of their behaviours at a point in time or space. This can be expressed as $\{S\}=f(\{D\},\{A\})$, where $\{S\}$ is the set of homogenous groupings.

All these expressions are better seen as interactions and not necessarily mathematical equations, since as rightly pointed out by Louvierre et al, there is as yet no formal theory regarding the relational aspects of $\{A\}$.

5.2.2 Past Segmentation Procedures

Several approaches have been used in the literature for the segmentation of units of study. Tomlinson et al (1973) used principal component analysis to identify critical activities and went ahead to use analysis of variance (ANOVA) to investigate which of eight methods

of population classification (made up of five socio-economic characteristics and three locational characteristics in the setting studied) were most useful in generating groups with homogeneous time budgets. The ANOVA tests were both multivariate and univariate, and segmentation evaluation was based on associated Hotelling T^2 and Student t statistics. The normal equivalent to the χ^2 approximation of the criterion in the multivariate ANOVA was used as a comparative index of the usefulness of each system of grouping, with high values indicating good separation (into groups).

Oppenheim (1975) used factor analysis to construct few (six actually) criteria to describe the personal characteristics and travel behaviour of observation or study units. The factor analysis results were then used in a cluster analysis to form groups of urban residents with similar personal and environmental characteristics within the sample population on the basis of the proximity in a six-dimensional euclidean space where the coordinates were the scores (factor scores) of the residents on the criteria. A χ^2 test applied to contingency table was used finally in evaluating the segmentation groups for travel behaviour type and for urban resident types.

Factor analysis found favour again by Ochojna and Macbriar (1976) who used it to select the most significant person descriptors, and went ahead to segment the study units by using two-dimensional category analysis, with trip rate as segmentation basis. An amalgamation exercise was finally carried out through the use of the t-test of difference of means for adjacent cells or segments to arrive at a smaller number of segments.

Dunbar (1977), after a careful choice of critical variables, used a three dimensional category analysis to segment his units of study into twelve segments.

In another segmentation exercise, this time Stopher (1977), Pearson correlation analysis was used in selecting the socio-economic characteristics of the study units that are

Recker and Schuler (1982), in a perception study, used cluster analysis to segment units of observation into relatively homogeneous subgroups, along the dimensions of the descriptor variables (which in this case were determinant of stated intentions). The clustering procedure, unlike those used usually in standard computer statistical packages, was an iterative search to determine the number of clusters. The segmentation evaluation was based on what they called a pseudo F-ratio test, in which was employed the criterion of the ratio of the total between group variance divided by its degrees of freedom to the pooled within-group variance divided by its degrees of freedom.

From this review, it is seen that the analytical procedures used in these works varied significantly from each other in terms of the degree of rigour in the analyses and evaluation of the segmentation results, though specific analytical tools like, category analysis, factor analysis, principal component analysis, discriminant analysis, and cluster analysis, featured commonly in them. It is evident that apart from the availability of the analytical tools to the investigators, the exercises were fashioned to suit the problems at hand, as has been advocated by Neale and Hutchinson (1981).

Category analysis was not considered for this present work because of the high number of cells that usually arise when cross-classification is based on more than two critical descriptor variables (each having many categories) and the possibility of having cells with sparse observations or no observations at all. Although statistical (Rengaraju and Satyakumar, 1994) and probaility (Rengaraju and Satyakumar, 1995) procedures have been developed to overcome the problem of zero or sparse observation cells, the problem of the high number of cells still remains, and is compounded by the rather subjective manner in which the large number of cells or segments has to be reduced in a conventional segmentation exercise. This is because, according to Rengaraju and Satyakumar (1994), there is no goodness-of-fit measure of performance of the category analysis exercise. Factor analysis was not considered because of the subjectivity in the interpretation of the criteria for describing and selecting the critical person descriptors where it is used for identifying or

confirming them. Where it is used for obtaining latent factors or factor scores which are further used in a conventional cluster analysis for the segmentation of the study units, the argument against it, according to Goldberger (1974), is that the units of study are no longer described in the original variables measured in this "exploratory" factor analysis. In explaining why factor analysis is not favoured for use by economists, he in fact described factor analysis model as "a model in which all observables are treated as mere indicators of anonymous factors, and in which variables and parameters are freely redefined ex post facto," thereby breaking the "chains of causation and well-defined (if not necessarily well-measured) variables." Principal component analysis and discriminant analysis were also not considered for reasons not too different for those advanced for factor analysis.

5.2.3 Adopted Segmentation Procedure

The procedure adopted in this work has resulted from a careful selection of the tools that were considered necessary for the present exercise based on simplicity and directness of application. The procedure, which was applied to both the "before" and "after" energy policy change situations after the selection of the critical descriptor variables, is as follows:

(1) Use of cluster analysis to cluster units, based on travel money expenditure and the final selection of critical descriptor variables, into between N1 and N2 segmentation plans, where N1 is the least number of categories in the selected descriptor variables, and N2 the highest number of categories or the highest desirable number of segmentation groups established on the basis of normality considerations. The K-MEANS cluster algorithm as detailed in Hartigan (1975) and as packaged in SYSTAT for Apple Macintosh Computers was used for this exercise. The K-MEANS clustering algorithm essentially involves the minimization of the discordance between data observations or units (respondents in this case) and their partition into K number of clusters. It was chosen for this work for its directness and because of the availability of a computer package for its application. The algorithm of this approach of cluster analysis is presented in Appendix J.

(2) Choosing of the cluster plans for which the critical descriptor variables used are all significant (at the chosen level) for further evaluation. If only one plan meets this requirement, then the exercise ends and that plan is chosen. If not, the exercise continues to step (3).

(3) Selection of the cluster plans whose pairwise correlations are closest to those recorded for the sample. This step is to ensure that the adopted cluster plan has the characteristics of the overall sample, or that the identity of a respondent remains even if clustered in some way into a group.

More rigorous analyses have been used by Friedman and Rubin (1967), Nicholaidis et al (1977), and Neale and Hutchinson (1981). The rigours that these procedures entail are not considered warranted. Tardiff (1979) has reported that using simple statistical tests achieves the same results as using rigorous analyses like discriminant analysis and others.

5.3 Adopted Regression Modelling Approach

The approach that was adopted in this work for estimating the functional relationship between travel expenditure and available money is the Box and Cox (1964) transformation approach. This approach was adopted in order to allow the data evolve the most appropriate functional form as far as the limit of the modelling exercise carried out is concerned. According to Box and Cox, in regression studies, it is sometimes necessary to take an entirely empirical approach to the choice of a relation. To the present author this becomes more so when there are no standard laws that relate the response and regressor variables concerned to each other. In estimating a relationship between the variables in this kind of situation, a transformation is applied to the variables "in order to make a more efficient and valid analysis," in the words of Box and Cox.

The Box-Cox transformation regression has been used very much in the field of econometrics. It has also found use in transportation related issues. Examples are the

works of Zarembka (1968), Wang et al (1981), Hensher and Johnson (1979), Johnson (1979), and Gaudry and Willis (1978).

A linear model of the form

$$Y_i = \alpha + \beta X_i + \varepsilon_i \quad (5.5)$$

is written as a generalized Box-Cox model as;

$$Y_i^{(\lambda)} = \alpha + \beta X_i + \varepsilon_i \quad (5.6)$$

where $Y_i^{(\lambda)}$ is transformed as;

$$\begin{aligned} Y_i^{(\lambda)} &= \frac{Y_i^\lambda - 1}{\lambda} & \lambda \neq 0 \\ &= \ln Y_i & \lambda = 0 \end{aligned} \quad (5.7)$$

Extension of the Box-Cox model to include the transformation of the independent variable has been used by others (for example Zarembka, (1968, 1974); Kmenta (1971); Savin and White (1978); Hensher and Johnson (1979); Wang et al (1981)), Judge et al (1988), and Johnston (1991). The presentation from here on assumes this extension, but with the stochastic relationship (Johnson, 1979) between Y and X as;

$$Y_i^{(\lambda_1)} = \alpha + \beta X_i^{(\lambda_2)} + \varepsilon_i \quad (5.8)$$

where $Y_i^{(\lambda_1)}$ and $X_i^{(\lambda_2)}$ are transformed to appear in the model as;

$$\frac{Y_i^{\lambda_1} - 1}{\lambda_1} = \alpha + \beta \frac{X_i^{\lambda_2} - 1}{\lambda_2} + \varepsilon_i \quad (5.9)$$

Estimation with the Box-Cox transformation entails formulating the log likelihood function of equation 5.9, proceeding in the steps that follow.

From change-of-variable theorem (Kmenta, 1986)

$$f(Y_i) = \left| \frac{de_i}{dY_i} \right| f(e_i) \quad (5.10)$$

From equation 5.9, the error term is obtained as;

$$e_i = \frac{Y_i^{\lambda_1} - 1}{\lambda_1} - \alpha - \beta \left(\frac{X_i^{\lambda_2} - 1}{\lambda_2} \right) \quad (5.11)$$

$$\therefore \frac{de_i}{dY_i} = Y_i^{\lambda_1 - 1} \quad (5.12)$$

Substituting this back into equation 5.10, what is obtained is

$$f(Y_i) = Y_i^{\lambda_1 - 1} \left| \left(\frac{Y_i^{\lambda_1} - 1}{\lambda_1} \right) - \alpha - \beta \left(\frac{X_i^{\lambda_2} - 1}{\lambda_2} \right) \right| \quad (5.13)$$

Since the Y's are normal and uncorrelated (the basic assumptions in Box-Cox transformation regression), they are independent (Kmenta, 1986) Thus, the likelihood function can be presented as;

$$l = f(Y_1)f(Y_2)...f(Y_n) \quad (5.14)$$

The rigours in working with this equation is avoided by taken the logarithm since the parameters which maximize l are the same as those which maximize its logarithm (Kmenta, 1986). The log-likelihood takes the form

$$L = \ln l = \sum_{i=1}^n \ln f(Y_i) \quad (5.15)$$

Since $Y_i^{(\lambda_1)}$ is normally distributed with mean $(\alpha + \beta X_i^{(\lambda_2)})$ and variance σ^2 , the formula of the normal distribution can be used to obtain

$$L = (\lambda_1 - 1) \sum_{i=1}^n \ln Y_i - \frac{n}{2} (2\pi) - \frac{n}{2} \ln \sigma^2 - \frac{1}{2\sigma^2} \sum_{i=1}^n \left(\frac{Y_i^{\lambda_1} - 1}{\lambda_1} - \alpha - \beta \frac{X_i^{\lambda_2} - 1}{\lambda_2} \right)^2 \quad (5.16)$$

Differentiating equation (5.16) with respect to σ^2 , equating this result to zero, and rearranging and indicating parameters to be estimated appropriately (e.g. with $\hat{\cdot}$ on top), gives;

$$\frac{n}{2} = \frac{1}{2\hat{\sigma}^2} \sum_{i=1}^n \left(\frac{Y_i^{\lambda_1} - 1}{\lambda_1} - \hat{\alpha} - \hat{\beta} \frac{X_i^{\lambda_2} - 1}{\lambda_2} \right)^2 \quad (5.17)$$

Substituting this into equation (5.16) the maximized likelihood comes out, except for a constant, as;

$$L_{\max}(\lambda) = -\frac{n}{2} \ln \hat{\sigma}^2 + (\lambda_1 - 1) \sum_{i=1}^n \ln Y_i \quad (5.18)$$

Operating on equation (5.17) appropriately, it is seen that $\hat{\sigma}^2$ is related to the residual sum of squares, RSS, as;

$$\hat{\sigma}^2 = \frac{\sum_{i=1}^n \left[\left(\frac{Y_i^{\lambda_1} - 1}{\lambda_1} \right) - \hat{\alpha} - \hat{\beta} \left(\frac{X_i^{\lambda_2} - 1}{\lambda_2} \right) \right]^2}{n} = \frac{RSS}{n} \quad (5.19)$$

A gross correlation effect has been proved by Bickel and Doksum (1981) to attend the original Box-Cox transformation. To overcome this, Box and Cox (1982)

recommended using what was referred to in Box and Cox (1964) as normalized transformation in the form;

$$\begin{aligned} Y^{(\lambda)} &= \frac{Y^\lambda - 1}{\lambda \bar{Y}^{\lambda-1}} & \lambda \neq 0 \\ &= \bar{Y} \ln Y & \lambda = 0 \end{aligned} \quad (5.20)$$

where $\bar{Y}$ is the geometric mean of the untransformed variable, Y_i . This standardized variate (Box and Cox, 1964) is the form stated for use in Montgomery and Peck (1992) and is the one adopted for this work.

Working with the standardized variate (i.e., equation 5.20) makes the application of the transformation more direct, since according to Box and Cox (1964), the maximum likelihood estimate, $L_{\max}(\lambda)$ is obtained by minimizing the residual sum of squares, RSS, with respect to λ . Thus it is expected that $L_{\max}(\lambda)$, the minimum residual sum of squares and hence the maximum values of the coefficient of determination, R^2 and the F-ratio from the analysis of variance will coincide. In addition, the $L_{\max}(\lambda)$ reduces to ;

$$L_{\max}(\lambda) = -\frac{n}{2} \ln \hat{\sigma}^2(\lambda) \quad (5.21)$$

Before a value of λ is adopted from the analysis a statistical test is carried out to determine if it is significantly different from zero or unity. This is done by establishing the confidence region of λ by estimating an approximate $100(1-\alpha)\%$ confidence region by operating on;

$$L_{\max}(\hat{\lambda}) - L_{\max}(\lambda)(0.5\chi^2(\alpha)) \quad (5.22)$$

At the 95% confidence level on which this work is based, for one independent component in λ equation (5.22) translates to;

$$L_{\max}(\hat{\lambda}) - L_{\max}(\lambda)(1.92) \quad (5.23)$$

Leech (1975) has suggested a generalization that includes testing also if λ is statistically different from -1 as is done for 0 and 1. This generalization which gives a wider horizon for the testing of the value of λ is what is adopted in this work.

The interpretation of this approximate confidence region test is that if the interval contains $\lambda=1$, it is suggestive that no transformation is required. If the interval contains $\lambda=0$, it suggests that a logarithmic transformation is what is required. If neither is contained or if both are contained in the interval, the value of λ corresponding to the maximum value of $L_{\max}(\lambda)$ is adopted. For the case of $\lambda=-1$, it means that an inverse transformation is what is required.

5.4 Evaluation of Work

5.4.1 Preliminary Analyses

The hypothesis of change in life style is based on the assumption that if changes occur in pairwise correlation between the key variable (travel money expenditure) and the critical descriptor variables, changes would also have occurred in life style. A change in the number of descriptor variables will also indicate a change in life style. Positive results for both criteria also indicate that a change has occurred in the transport market segmentation. If, in addition to these, significant shifts or changes occur in the pattern of travel expenditures, then the hypothesis that travel budget is not definable in the short-term or with respect to energy policy change in Nigeria can be expected to be proved in the functional form stability testing stage.

5.4.2 Functional Form Estimation and Stability Testing Framework

Functional Form Estimation : It is necessary to evaluate the candidate models (selected in the first instance from their overall significance, i.e., F- test, and significance of coefficients, i.e., t- test) against homoscedasticity of residuals. Autocorrelation was

not considered because data are not longitudinal or time series. Collinearity has no meaning in a single independent variable situation. Moreover, the Box-Cox transformation regression takes care of this even in a multiple regression situation.

According to Zarembka (1974), while normality may not always be violated when the Box-Cox transformation is used, errors are almost always heteroscedastic, as had earlier been reported by Draper and Cox (1969), who showed that the transformation regression can still be useful even when no power transformation can produce normality exactly. With this, it was not considered necessary to test for the models' robustness to non-normality of residuals. Zarembka recommended that for any particular problem it is important to ascertain the robustness of estimates of λ to heteroscedasticity of errors, and went further to develop a procedure for estimating the Box-Cox model under heteroscedasticity.

The evaluation against homoscedasticity of errors was carried out using the Bartlett's χ^2 test for homogeneity of variance. As described in Intriligator (1978), the Bartlett's test entails testing the hypothesis that there is no difference in the variances, $\hat{S}_j^2$, of suitably chosen p ($j=1,2,3,\dots,p$) subsamples. The statistic, Q/I , calculated in the process is distributed as χ^2 with $p-1$ degrees of freedom. Q and I are obtained as;

$$Q = n \log \sum_{j=1}^p \frac{n_j}{n} \hat{S}_j^2 - \sum_{j=1}^p n_j \log \hat{S}_j^2 \quad (5.24)$$

$$I = 1 + \frac{1}{3(p-1)} \sum_{j=1}^p \left(\frac{1}{n_j} - \frac{1}{n} \right) \quad (5.25)$$

where n_j is the number of observations in the j th subsample and $n (= \sum n_j)$ is the total number of observations.

The models that do not violate this assumption of homoscedasticity of errors are adopted in the "before" and "after" cases for stability testing. In the event that violation of homoscedasticity renders stability testing inappropriate, the affected model is re-estimated under heteroscedasticity of errors, using one of Zarembka's (1974) two procedures, before proceeding to test for stability. In the Zarembka's procedure adopted in this work for obtaining a consistent estimate of λ under heteroscedasticity of errors, which is basically a graphical one, the value of $\hat{\lambda}$, say $\hat{\lambda}(h)$, at which the slope of the plot of the maximized log-likelihood function (i.e. equation 5.21) equals

$$\frac{dL_{\max}(\lambda)}{d\lambda} = (1 - \lambda - h)n \frac{\text{var}(\ln Y)}{\frac{1}{2} + (1 - \lambda - h)^2 \text{var}(\ln Y)} \quad (5.26)$$

is sought, conditional upon a belief about the degree of heteroscedasticity, i.e., with an apriori knowledge of the value of h , the degree of heteroscedasticity.

Zarembka developed the expression from which it is possible to obtain a value for h as;

$$[\text{var}(Y_i)]^{1/2} = \sqrt{c} [E(Y_i)]^h \quad (5.27)$$

Interchanging sides, squaring and taking logarithms in equation 5.27, and substituting other notations, what is obtained is;

$$b = g + ha \quad (5.28)$$

where $g = \ln c$, $a = 2 \ln [E(Y_i)]$ and $b = \ln [\text{var}(Y_i)]$. Dividing the data into suitable subsamples for which a and b can be estimated, a regression of b on a gives h as coefficient of a .

A procedure for estimating the Box-Cox transformation regression under heteroscedasticity of errors was also proposed by Gaudry and Dagenais (1979). The apriori knowledge of the degree of heteroscedasticity implicit in Zarembka's procedure makes it more appealing than the Gaudry-Dagenais procedure. An opportunity is given for initially testing for heteroscedasticity before proceeding to estimate under heteroscedasticity if homoscedasticity of errors is violated.

Stability Testing Framework: The assignment here was not necessarily finding the functional form that was the most significant (in terms of F-test results and high coefficients of determination, R^2) and robust to heteroscedasticity of residuals, but also stable with respect to the energy policy change. Thus, testing for the stability of candidate models was considered an important step.

According to Savin and White (1978), the regression coefficients in the Box-Cox model are not of particular interest (when comparing models) since they apply to the transformed variables and not the original variables. It is thus inappropriate to compare the estimated model coefficients with different λ values. What they recommend is the comparison of the estimated elasticities for the different models. This is supported by Gaudry and Willis (1979), who consider the variation in demand elasticities computed for models of different functional forms to be probably the most critical criterion for distinguishing the properties of one model from another.

In terms of the original variables, Zarembka (1968) expresses the elasticity of a given regressor, X_k , ($k=1, \dots, N$) evaluated at the sample means as:

$$E_k = \beta_k (\bar{X}_k / \bar{Y})^\lambda \quad (5.29)$$

for the case in which the Box-Cox transformation is applied to both the regressor and the response variables equally. This has been used, for example, by Savin and White (1978)

and Wang et al (1981). It follows from equation (5.29) that for different λ values for the regressor and response variables, say λ_1 and λ_2 , respectively, the elasticity of the regressor variable, Y , with respect to the response variable, X_k , is

$$E_k = \beta_k (\bar{X}_k^{\lambda_2} / \bar{Y}^{\lambda_1}) \quad (5.30)$$

The requirements for stability of functional form for a pair of models were put together for use in this work as;

- (1) equal number of parameters or coefficients in the models,
- (2) equal values of λ for the models,
- (3) equal elasticities.

5.5 Selection of Variables for Regression Modelling

The regression experimental approach adopted in this work gets more support when it is considered that there is as yet no universally accepted nomenclature for the variable that represents "available money" as the independent variable in the travel expenditure-available money model. The presentation in the functional form review section reveals that disposable income, DI, total expenditure, TE, and income, have been used by different workers as available money. Since income did not seem to vary during the period of the data collection period (because of the delay in the implementation of the salary increase that was to cushion the effect of the sudden and high fuel price increase), it is considered unsuitable for use in this work. Thus, the choice is to be made between disposable income and total expenditure.

Total expenditure is seen here as a measure of "true" income-related purchasing power of the individual while disposable income is a measure of his "declared" income-related purchasing power. This is in recognition of the fact that some respondents may have been more truthful in stating TE than in stating income. Moreover, only a range of values of income were required to be indicated in the questionnaire while actual values

were stated for travel and non-travel expenditures, which together make up TE. In other words, TE is taken here to account for undeclared income, and may more appropriately represent money available than DI would. DI is taken as a measure of the individual's ability to expend money on transport given that income has been truthfully declared.

While total expenditure clearly has universal definition as expenditure on all items and activities including travel activity, disposable income seems as varied as "money available" itself. For example, Bonsall and Champenowne (1976), Heraty (1980), and Golob et al (1981) used disposable income without defining it. Bonsall and Champenowne preferred to use it because they considered that a rise in such incomes would, other things being equal, lead to increased petrol consumption (a major component of travel money expenditure). Eastman and Pickering (1981) and Maunder (1985) defined disposable income as income less expenditure on housing, fuel and food. It was taken by Modgridge (1977) as equivalent to total expenditure, while Downes and Emerson (1985) simply substituted "total money available" for it, as also used in Golob et al (1981). In presenting an alternative approach to Modgridge's definition of it, Charlesworth (1978) thought of it as that left from total income after deducting tax plus National Insurance and the expenditure on essentials, while he regarded essentials as shelter, food and warmth. He expressed what he called obvious difficulties about this definition, such as that what may be regarded as essentials by some people will not be so regarded by others. In order to avoid confusion in terminology, he referred to this his definition of disposable income as "uncommitted income."

While expenditure on fuel for house heating might not be appropriate in a tropical country like Nigeria, expenditures on utilities are usually separate from that for rent or housing. Thus what are taken to constitute what may be called compulsory expenditures in a typical Nigerian setting are those for housing, food, and utilities. Thus, disposable income in this work is defined as total income (i.e., income from all sources) less expenditures on housing, food, and utilities.

If travel money expenditure is denoted by ME, the experimentation is to determine the more appropriate of the functional forms that relate ME to TE and ME to DI. Specifically, if B and A appended to the variables to denote the "before" and "after" periods, then $MEB=f(TEB)$ is to be compared with $MEA=f(TEA)$ in one set of functional form estimation and stability test, and $MEB=f(DIB)$ with $MEA=f(DIA)$ in a second set. The model specifications estimated in this work are presented in Table 5.1.

TABLE 5.1. Models' specifications

Model No.	Model
1	$MEB^{(\lambda)} = \alpha_1 + \beta_1 DIB$
2	$MEA^{(\lambda)} = \alpha_2 + \beta_2 DIA$
3	$MEB^{(\lambda)} = \alpha_3 + \beta_3 TEB$
4	$MEA^{(\lambda)} = \alpha_4 + \beta_4 TEA$
5	$MEB = \alpha_5 + \beta_5 DIB^{(\lambda)}$
6	$MEA = \alpha_6 + \beta_6 DIA^{(\lambda)}$
7	$MEB = \alpha_7 + \beta_7 TEB^{(\lambda)}$
8	$MEA = \alpha_8 + \beta_8 TEA^{(\lambda)}$
9	$MEB^{(\lambda)} = \alpha_9 + \beta_9 DIB^{(\lambda)}$
10	$MEB^{(\lambda)} = \alpha_{10} + \beta_{10} DIA^{(\lambda)}$
11	$MEB^{(\lambda)} = \alpha_{11} + \beta_{11} TEB^{(\lambda)}$
12	$MEB^{(\lambda)} = \alpha_{12} + \beta_{12} TEA^{(\lambda)}$

The assignment is thus not necessarily finding the functional that is most significant (in terms of overall model and parameter significance through F- and Student's t- tests, respectively) and unbiased (in terms of being robust to heteroscedasticity of residuals) but also stable over the "before" and "after" periods.

CHAPTER SIX

RESULTS AND DISCUSSIONS

6.1 Preliminary Results

6.1.1 Sample Description

The sample is described with respect to income distribution, whose plot is shown in Figure 6.1. The data have been truncated at ₦7001+ monthly income because of the small number of observations in the income groups above this level.

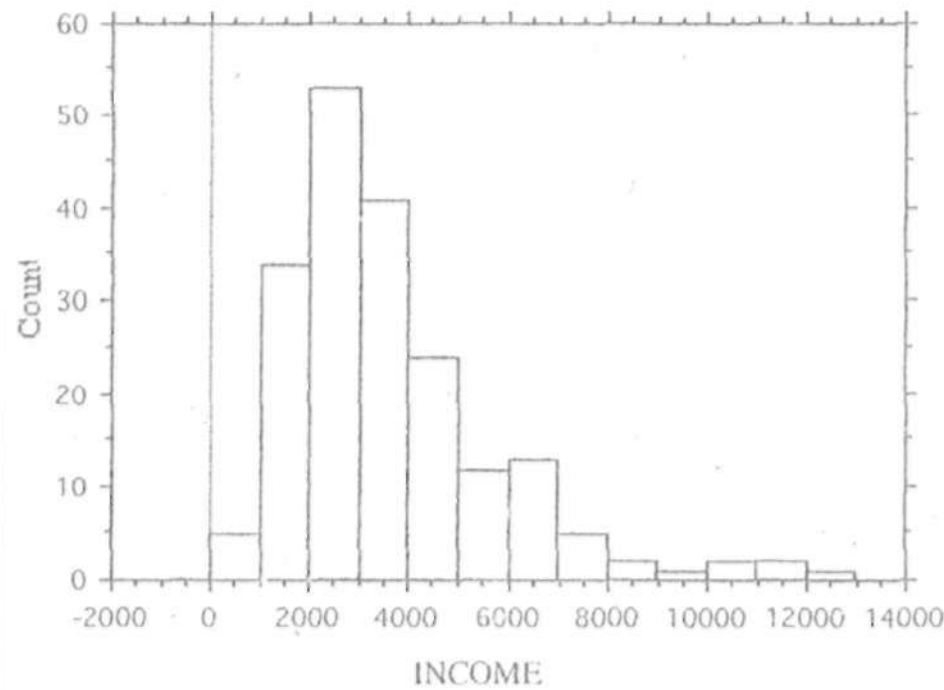


Figure 6.1. Income distribution of respondents

The distribution exhibited by the data is similar to those reported in Fouracre and Maunder (1987) for Indian city households, and by Ojumu (1975) for a Nigerian setting. Although no attempt was made to develop a model for this distribution, the pattern exhibited suggests that the lognormal distribution is a worthwhile hypothesis for it. The lognormal distribution finds common usage in the modelling of income. MacDonald and Ransom (1979) considered it along with some other distributions in an income distribution functional form estimation exercise.

6.1.2 Relationships Between Person Descriptors

One pragmatic way of checking how well data collected have adequately represented reality is to examine the magnitudes and signs of the pairwise correlation coefficients between the population characteristics, to see if they are in agreement with intuition or are counter-intuitive. The pairwise correlation coefficients between the variables are presented in Table 6.1. Based on the t-test, the underlined values in the Table are not significant at the 5% level.

The clearest indications that the data adequately represent reality come from the correct signs of the values, in addition to significant and high correlation exhibited in cases like HSTA and MSTA, CARS and INC, AGE and MSTA, and AGE and HSTA (Table 6.1). All these pairs are positively, significantly and highly correlated as the cases should be. For the cases of the money variables, adequate representation of reality is also indicated. For example, the expenditures and disposable incomes are correctly (with respect to sign), significantly and highly correlated with income.

TABLE 6.1. Pairwise correlation coefficients

	AGE	CAR	INC	MSTA	HSTA	MEB	DIB	TEB	MEA	DIA	TEA
AGE	1.000										
CAR	0.425	1.000									
INC	0.302	0.487	1.000								
MSTA	0.542	0.269	0.172	1.000							
HSTA	0.567	0.268	0.233	0.898	1.000						
MEB	<u>0.138</u>	0.472	0.349	<u>0.130</u>	<u>0.068</u>	1.000					
DIB	0.150	0.240	0.780	<u>-0.001</u>	<u>0.028</u>	0.265	1.000				
TEB	0.228	0.497	0.609	0.231	0.261	0.453	<u>0.103</u>	1.000			
MEA	0.365	0.746	0.453	0.225	0.199	0.686	0.298	0.498	1.000		
DIA	<u>0.031</u>	<u>0.108</u>	0.615	<u>-0.072</u>	<u>-0.072</u>	0.181	0.872	<u>0.012</u>	0.145	1.000	
TEA	0.292	0.545	0.585	0.252	0.274	0.395	<u>0.129</u>	0.918	0.568	<u>-0.050</u>	1.000

Underlined values are not significant at the 5% level.

What is to be noted in relation to the analyses and discussions to follow is the drastic change in the values of the correlation coefficients between the person descriptors

and the expenditure variables (increases) and disposable income variables (decreases), on the one hand, and between the money variables (expenditures and incomes) on the other hand. Without going into detailed discussions at this stage, it is worth stating that these are indications of changes that may have occurred in life-style or respondents, following the energy policy change.

6.2 Data Trends

6.2.1 Mode Change Characteristics

Data for the mode change characteristics are presented in Table 6.2. The data, which are percentage changes in mode usage by the respondents, include for all respondents and for car-available respondents.

TABLE 6.2. Mode choice changes (percentage change from and to modes indicated)

Type of Change	Trip categories			Full-time work trips	All trips
	Subsistence	Maintenance	Leisure		
Overall change	20.3	16.3	19.1	20.8	18.4
Change to walk mode	36.8	36.2	52.9	52.5	40.3
Car to other modes	25.0	23.4	17.6	17.5	22.6
Stopped	0.4	1.0	7.3	0.0	2.4

It is seen from the Table that while there does not seem to be any definable trend followed by the overall mode change and mode change from motorised modes to walk mode for subsistence through maintenance to leisure trips, the highest values of changes are recorded for the change to walk mode. These are followed by the values for changes from private car mode to other modes. For this particular mode change, the average level of change, i.e., for all trips, is just under 25% (22.6%). This is to say that private car trips reduced by a little less than a quarter of the "before" fuel price trip rate or that about a quarter of the trips that used to be made by using the private car mode were now made by other modes (including the walk mode) following the fuel price increase. This level of reduction in private car trips is not considered high enough to match the level of increase in the price of fuel.

Of particular interest, at least to the question of life style change, are the very high values recorded for the change from motorised modes to the walk mode for all trips. This averaged at 40.03%. The values are equal at about 53% for leisure trip category and full-time work trips (the most regular of all trips). This high level of mode change in these trips seems to confirm life style changes, based on the hypothesis posited by Wolff and Clark (1982) that the choice to change transport mode for making regular trips may involve a substantial change in life style. For many people, trips in the leisure trip category (e.g., recreational trips) can be said to be as regular as work trips. That the mode change characteristics for work trips and leisure trip category are similar, as results in this work suggest (as clearly shown in Table 6.2), indicates that classifying leisure trips as regular is not inappropriate.

While the life style change related to work trip mode mode choice change may mean affected individuals going to early in order to wake up early to set out for work early to trek to work, that related to leisure trip for such as recreation may mean change of destination such that the recreational demand can be satisfied within walking distance of home or other trip origin. Such destination change may involve change in taste or, in the extreme, complete change in recreational type.

6.2.2 Trip Rates

The results of the trip rate estimations for both periods are presented in Table 6.3. The percentage changes in trip rates are presented in Table 6.4. Generally, trip rates reduced after the fuel price increase, with the most reductions being made in leisure trips across all income groups. The lowest income group had the greatest reduction in leisure trips. Going up the income ladder, a decline occurs in the relative reduction, apart from the N5001-N6000 income group.

As expected, little reductions were made for subsistence trips, because of the work trips component of this trip category (see percentage changes in trip rates on Table 6.4).

TABLE 6.3. Average weekly trip rates before and after fuel price increase

Income group (Naira)	All trips		Subsistence trips		Maintenance trips		Leisure trips	
	Before	After	Before	After	Before	After	Before	After
<1001	44.40	36.00	10.80	10.40	24.00	21.60	9.60	4.00
1001-2000	36.92	31.04	15.50	14.38	14.91	12.78	6.51	3.88
2001-3000	38.58	30.91	19.25	16.58	14.06	10.55	7.06	4.12
3001-4000	41.92	31.06	17.54	14.63	14.02	10.83	10.36	5.60
4001-5000	43.31	34.13	19.33	15.98	15.20	13.05	8.78	5.40
5001-6000	48.66	38.57	19.16	16.67	18.70	16.50	10.80	5.40
6001-7000	65.96	54.36	24.46	19.02	28.84	26.00	12.66	9.34
7001+	45.82	38.10	23.18	19.00	11.00	10.37	11.64	8.73
Overall average	42.60	33.98	17.08	15.87	17.59	15.68	8.81	5.04

TABLE 6.4 Percentage changes in trip rates by income levels.

Income group (Naira)	Trip rates by purpose			
	All trips	Subsistence	Maintenance	Leisure
<1001	-18.92	-3.70	-12.50	-58.33
1001-2000	-15.93	-7.23	-14.20	-40.40
2001-3000	-19.88	-13.87	-24.96	-41.64
3001-4000	-25.91	-16.59	-22.75	-45.95
4001-5000	-21.20	-17.33	-14.14	-37.59
5001-6000	-20.74	-13.00	-11.76	-50.00
6001-7000	-17.59	-22.24	-9.85	-26.22
7001+	-16.85	-18.03	-5.73	-25.00
Overall average	-20.23	-7.08	-10.86	-46.54

However, despite the decline in trip rates across the board, the general trend of positive correlation of trip rate with income is unchanged, as can be seen in Figure 6.2. The lowest income group appears to have made more trips than the two next income groups of low income earners, in the both the before and after fuel price periods. The lowest income group incurred less expenditure on travel than the other two low income

groups in the "after" period because most of their trips (lowest income group) were made by the cheapest mode, the walk mode.

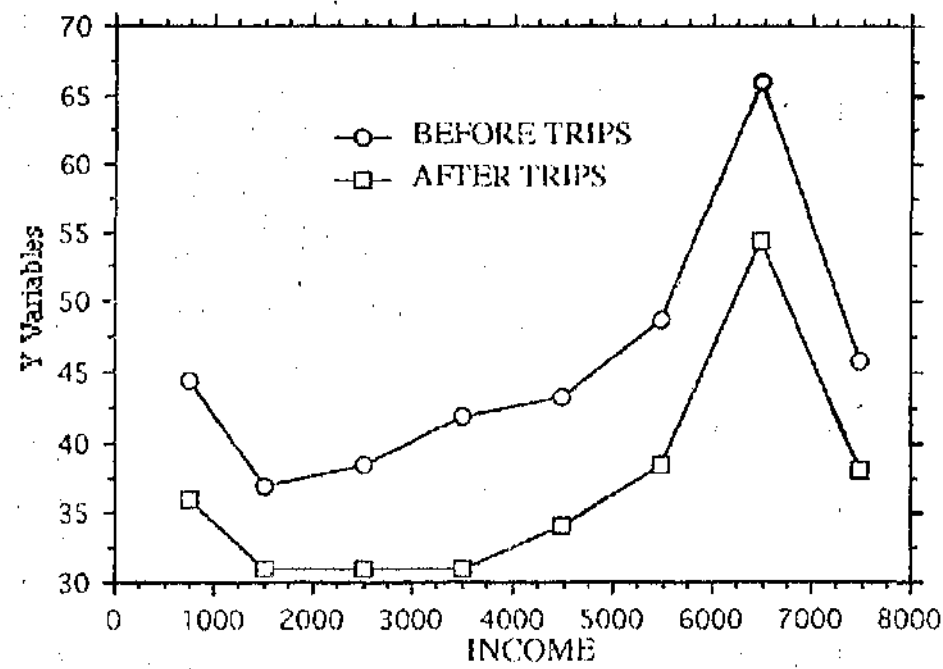


Figure 6.2 Variation of trip rates with monthly income.

For maintenance trips, had the percentage changes being plotted, a curve skewed to the side of the high income earners would have resulted. The low absolute values of these trips and the correspondingly low percentage reductions in them for this income group suggest that empirical evidence in this work has confirmed the general belief that people in this group have such as shopping and school-run trips made for them by others.

6.2.3 Travel Expenditures

The summary statistics for travel expenditures, total expenditures, and disposable incomes are presented in Table 6.5. The variations of travel expenditure with income are plotted in Figure 6.3a, while the variation of travel expenditure with disposable income and with total expenditure are plotted in Figure 6.3b. The variations with income of

travel expenditure as proportion of income, disposable income, and total expenditure are as in Figures 6.4. The percentage changes in the variables are presented in Table 6.6.

TABLE 6.5 Average values for money variables by socio-economic levels

Socio-economic variable	Levels	DIB	MEB	TEB	DIA	MEA	TEA
Age	20-25	1523.13	408.13	2635.63	1316.88	649.38	4058.13
	21-30	1899.00	467.49	2838.69	1025.18	732.05	4994.21
	31-40	1964.51	521.63	3420.97	1117.49	1049.40	6090.48
	41-50	2394.00	726.94	5309.12	1282.52	1929.61	9678.00
	51-60	2622.50	448.63	3058.63	1241.25	2005.00	6801.88
Car ownership	0	1686.59	390.98	2817.00	992.82	549.03	4852.42
	1	2755.15	752.24	4280.04	1585.82	2209.66	8148.67
	2+	2158.89	1221.97	9442.67	681.11	3061.44	1654.56
Income(N)	<1001	447.40	356.00	1277.00	307.40	304.00	1577.00
	1001-2000	671.97	375.85	2226.79	306.47	712.62	4036.44
	2001-3000	1284.28	409.74	2870.51	585.42	747.52	5316.66
	3001-4000	2065.65	580.43	3111.23	1225.68	1060.63	5530.15
	4001-5000	2370.50	587.00	4335.54	1225.96	1497.58	7836.21
	5001-6000	3801.36	681.55	3752.91	2220.00	1631.55	7079.09
	6001-7000	3629.92	790.07	6367.15	2288.46	2492.15	11415.15
	7001+	5431.08	922.33	7847.67	3748.33	2106.67	12977.50
Marital status	Single	2018.16	430.24	2505.76	1312.50	713.60	4348.80
	Married	2013.65	569.75	3913.20	1091.26	1293.52	7047.49
Household status	Daughter	1591.89	686.67	2367.00	960.78	908.89	4011.44
	Son	2053.43	491.86	2069.14	1749.50	645.00	3135.50
	NHM/Others	2141.96	312.82	2778.41	1203.15	684.07	5090.37
	Housewife	1901.86	563.69	3090.76	1173.45	1232.17	6070.00
	Husband	2042.34	571.30	4124.27	1070.17	1309.27	7298.31

Underlined "after" values are not significantly different from the "before" values at the 5% level. Paired two-sample t-test for means conducted for only INCOME levels.

Generally, from Tables 6.5 and 6.6, it is seen that travel expenditure increases with income both in the "before" and "after" periods. The same trend is also exhibited by disposable income and total expenditure. However, the trends of travel money expenditure in relation to other social economic descriptors do not seem as clear cut as it

is with income. These will be discussed immediately after an indepth discussion of income-related trends.

TABLE 6.6. Percentage changes in money variables.

Socio-economic variables	Levels	No. of units	Percentage changes		
			DI	ME	TE
Age	20-25	16	-13.54	59.11	53.97
	26-30	39	-46.01	56.59	75.93
	31-40	96	-43.12	101.18	78.03
	41-50	33	-46.43	165.44	82.29
	51-60	8	-52.67	346.92	122.38
Car ownership	0	128	-58.92	40.42	72.25
	1	55	-42.44	193.74	90.39
	2+	9	-67.66	150.53	75.20
Income	<1001	5	-3.13	-14.61	23.49
	1001-2000	34	-54.39	89.60	81.27
	2001-3000	53	-54.42	82.44	85.22
	3001-4000	40	-40.66	82.73	77.75
	4001-5000	24	-48.28	155.12	80.74
	5001-6000	11	-41.60	139.39	88.63
	6001-7000	13	-36.96	215.23	79.28
	7001+	12	-30.98	128.41	65.37
Marital status	Single	50	-34.97	65.86	73.55
	Married	142	-45.81	127.03	80.10
Household status	Daughter	9	-39.65	32.36	69.47
	Son	14	-14.80	31.13	51.54
	HNH/Others	27	-43.83	118.67	83.21
	Housewife	29	-38.30	118.59	96.39
	Husband	113	-47.60	229.17	76.62

From Figure 6.4, it is seen as hypothesized that the ratios of travel expenditure to income, disposable income, and total expenditure, bear inverse relationships with income, in the "before" and "after" periods. As posited that much higher expenditures as proportions of income and disposable income will be expected as result of the constraining effect of the fuel price than in normal times, much higher values than those

reviewed in the literature were recorded in this work as can be seen in Figure 4. On the average, the values for travel expenditure as proportion of income were recorded as 17.4% and 33.9% in the "before" and "after" periods, respectively, while they were recorded as 26.5 % and 99.4 % for travel expenditure as proportion of disposable income in the "before" and "after" periods, respectively. While the value of 99.4% seems outrageous for travel expenditure as proportion of disposable income, it suggests that many engaged in part-time or supplementary work (especially in the "after" period) to earn "undeclared" extra incomes, to be able to accommodate other expenditures, which also increased. These undeclared extra incomes are reflected in the much higher values of total expenditure in the "after" period than in the "before" period (Table 6.5), and the very low difference between 17.1% and 18.6% recorded as average values of travel expenditure as proportion of total expenditure in the "before" and "after" periods. It may thus be inferred that for people in developing country settings (as the respondents used in this work are), total expenditure is a more appropriate variable for quantifying economic status or purchasing power (or more appropriately, available money) of an individual than is income or disposable income.

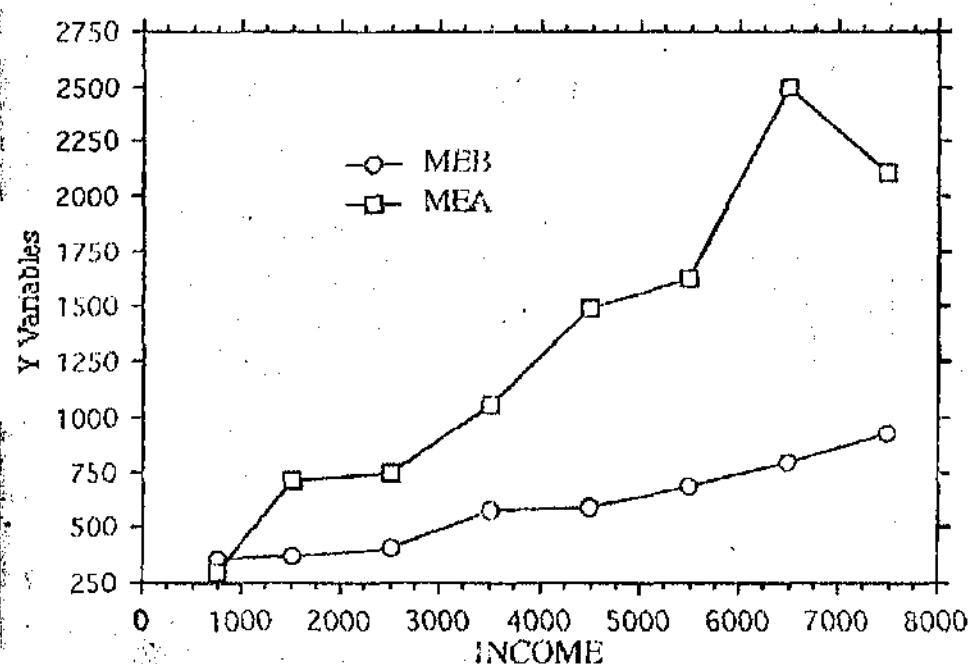


Figure 6.3a. Variation of monthly travel expenditure with monthly income.

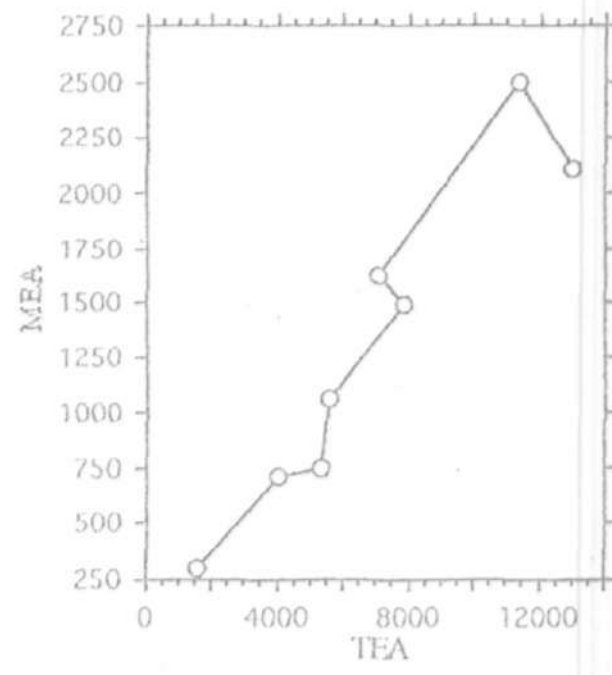
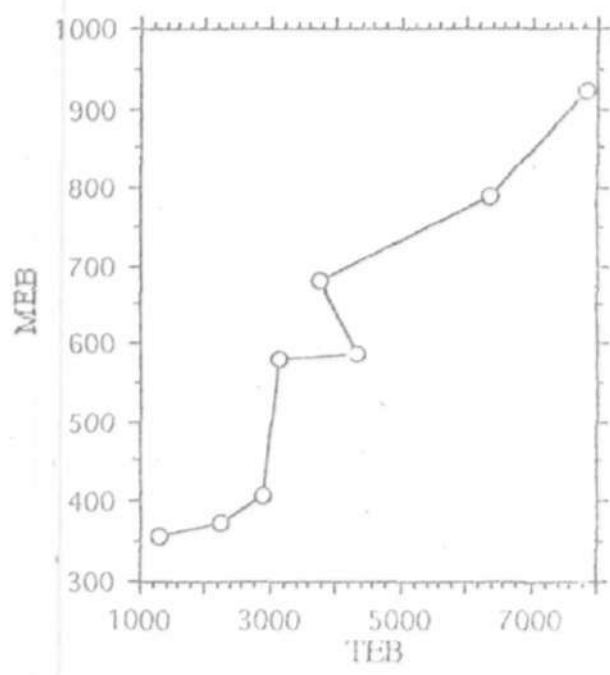
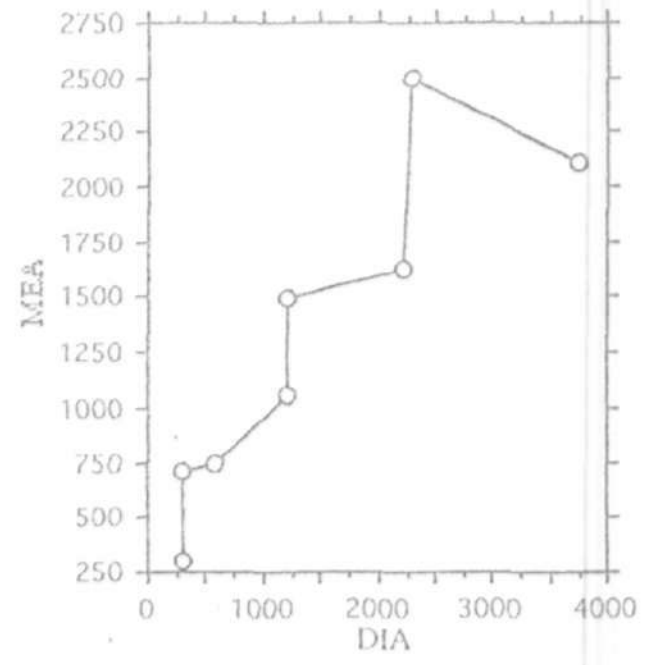
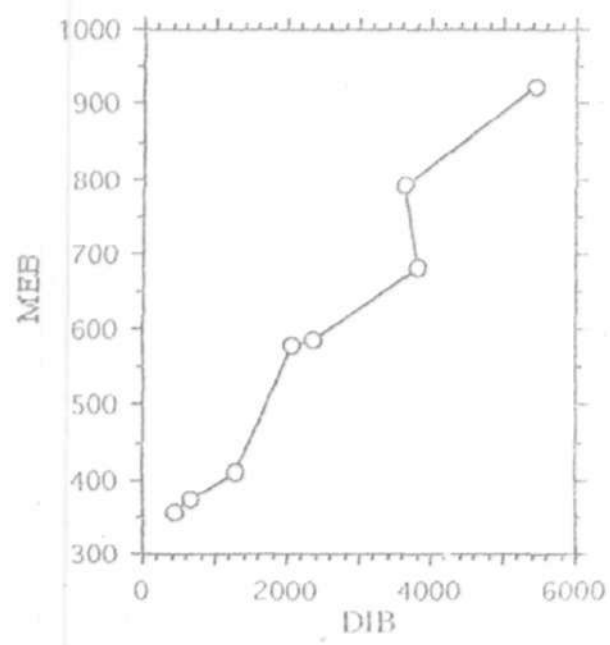


Figure 6.3b. Variation of travel expenditure with disposable income and total expenditure.

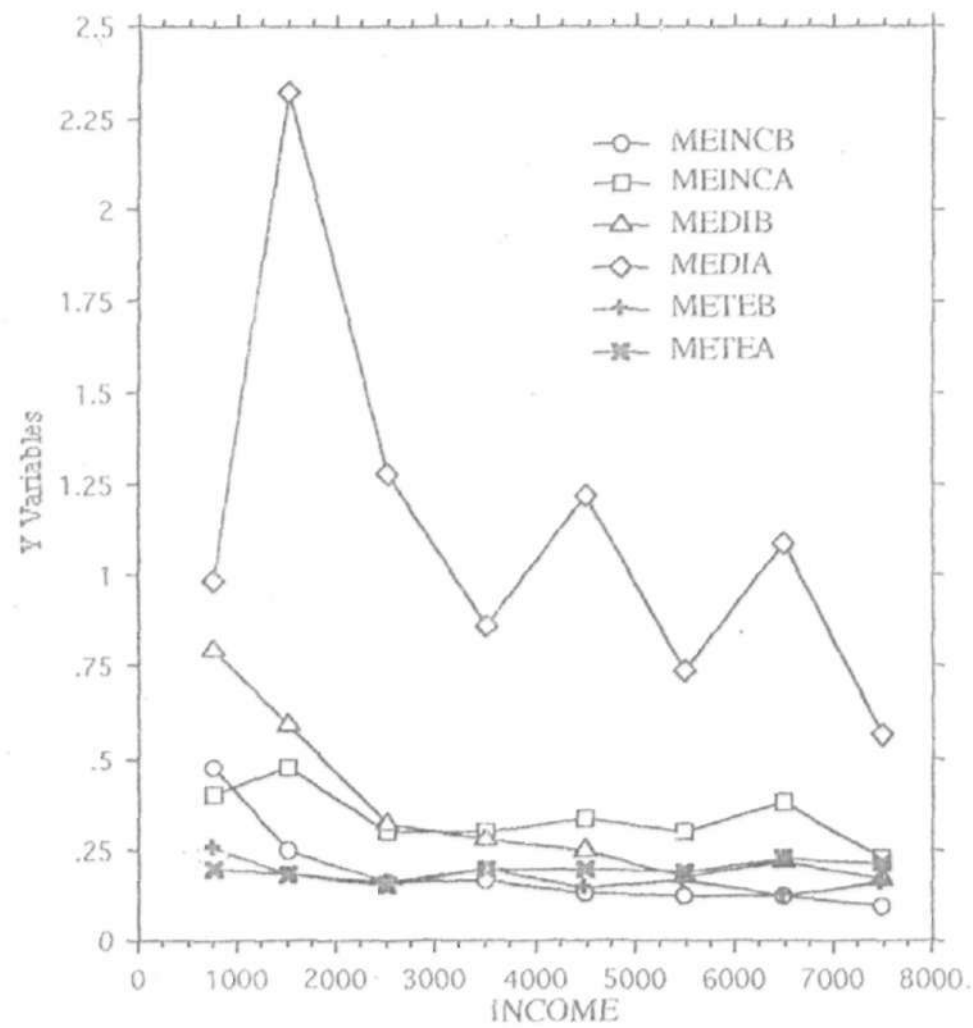


Figure 6.4. Variation of monthly expenditure ratios with monthly income.

The import of these trends is that the travel expenditure burden of the average individual increased following the fuel price increase. His disposable income reduced because of the increase that has occurred in his expenditure on essential items and services (food, housing, and utilities). With increases in both travel expenditure and essential expenditure and also in expenditure on other items and services, his total expenditure has also increased. It is clear, as has been said by Zahavi and Talvitie (1980), that travel expenditure is related to the prices of other goods in the economy.

The divergence of the "before" and the "after" plots in Figures 6.3a and 6.3b suggests that a functional form that is to be developed may not be stable across the before-after period (i.e., with respect to energy policy change) as hypothesised. This will also mean that short-term temporal stability of functional form may not be supported by the data used.

The specific effects of the fuel price increase on travel expenditures are now discussed in relation to the socio-economic characteristics of the respondents, as reflected in the pairwise correlation coefficients in Table 6.1 and the data in Table 6.5. For income, a significantly positive correlation, as expected, is established with travel expenditure in both periods, but becoming more correlated in the after period. Car ownership is also significantly positively correlated with travel expenditure, also as expected. In fact, car ownership has proved to be the most critical factor that affects travel expenditure, becoming strongly so in the after period. Age only became relevant in the scheme of things after the fuel price increase. Older, and richer people (age and income are positively correlated as can be seen in the Table) now spend more money on travel. Both marital status and household status became also relevant after the fuel price increase. Both are very highly correlated with each other (which is intuitively correct), thus discussing one is same as discussing the other. The meaning of the results here is that married people became separated from single people in terms of travel behaviour only after the fuel price increase, or that the fuel price increase had the effect of distinguishing the married and unmarried people in terms of travel. Since, both marital status and household status are positively and significantly correlated with income, it can be said that income is remotely affecting travel expenditure through these variables. Married people or people high up in the household ladder having more money available to them form the pooling together of family resources. This, coupled with the positive correlation between available money (measured either as income or disposable income) and travel expenditure, translates to higher propensity to make trips and hence higher expenditure on trip making or travel.

6.3 Transport Market Segmentation Shifts

The details of the shifts in the segmentation of the respondents are presented in Table 6.7. While in the "before" case the respondents were

Table 6.7. Details of population segmentation shifts

"Before" Segments	"After" Segments				Totals
	1	2	3	4	
1	92*	-	-	-	92
2	-	12*	-	12	24
3	-	-	5*	-	5
4	-	1	3	3*	7
5	33	15	-	5	53
6	5	-	-	6	11
Totals	130	28	8	26	192

* Number of respondents that remained in segment.

clustered into six segments, many got re-aligned in the "after" situation, to result in four segments. This proves the hypothesis that energy policy has an influence on transport market segmentation. The asterisks in the table indicate the number of respondents that did not re-align as a result of the policy change. These are more in the low income group, who changed mode to cheaper ones to maintain low expenditure levels.

The group averages for the relevant variables for the different segments are presented in Tables 6.6a and 6.6b for the "before" and the "after" fuel price increase periods, respectively. While in the before case the respondents were clustered into six segments, they were clustered into four segments in the after case. This proves the hypothesis that transport market can be segmented on the basis of travel expenditure. Also proven is the hypothesis that energy policy has an influence on transport market segmentation.

It is to be noted that there has been a complete re-arrangement in the groupings. No one group or segment retained the same number of respondents or the same

characteristics, such as average group travel expenditure, average group disposable income, average group income, or average group car motorisation (compare Tables 6.8a and 6.8b). This translates into a complete re-alignment in the society. It is thus evident that changes in life-style of individuals have occurred, and this is apparently due to the significant reduction in disposable income that attended the fuel price increase.

TABLE 6.8a. Summary statistics (group averages) for "before" segmentation.

Segment	No. of units	AGE	CARMOT	INCOME	MEB	DIB	TEB
1	92	32.50	0.163	2035.33	394.30	1012.51	2546.01
2	24	39.17	0.708	6041.67	740.33	3708.50	5168.96
3	5	43.00	1.400	11300.00	1086.00	5200.60	11492.80
4	7	37.86	0.857	8071.43	805.43	5595.71	5244.00
5	53	33.96	0.358	3858.49	392.13	2202.93	3285.09
6	11	33.64	0.818	3954.55	1502.00	2069.36	4944.73

TABLE 6.8b. Summary statistics (group averages) for "after" segmentation.

Segment	No. of units	AGE	CARMOT	INCOME	MEA	DIA	TEA
1	130	32.54	0.208	2463.46	774.02	703.93	4858.41
2	28	34.39	0.250	5214.29	621.43	2068.21	6268.29
3	8	40.60	1.250	10375.00	2238.75	3435.00	15491.25
4	26	41.15	1.115	5538.46	3208.73	1680.12	10144.00

The significant and intuitive correlation of travel expenditure with the socio-economic variables used in this work and their influence on the segmentation of the respondents are a confirmation of the hypothesis that travel expenditures are influenced by some socio-economic variables usually used in travel demand studies.

The details of the clustering exercise and the allocation of the respondents to the segments in the segmentation plans are presented in Appendix K.

6.4 Elasticities

The results of the elasticity calculations for travel expenditures are presented in Table 6.9, according to income level. The table also includes fuel price elasticity of trip rates. Generally, the results show that all the variables are inelastic to the fuel price increase. This translates to saying that the effects of the fuel price increase have not really been severe. It is thinkable that had the price been kept at the ₦15.00 it originally rose to on the 1st of October 1994 before it was brought down to ₦11.00 effective from 4th. of the same month, an elastic response would have followed the price change.

TABLE 6.9. Fuel price elasticities of expenditures, disposable incomes, and trip rates.

Income group (Naira)	Money variables				All trips	Trip rates by purpose		
	ME	TE	EE	DI		Subsist	M'nance	Leisure
<1001	-0.130	0.173	0.409	-0.308	-0.172	-0.031	-0.110	-0.718
1001-2000	0.525	0.488	0.420	-0.644	-0.142	-0.015	-0.126	-0.424
2001-3000	0.493	0.506	0.492	-0.644	-0.182	-0.122	-0.236	-0.442
3001-4000	0.494	0.472	0.435	-0.428	-0.273	-0.149	-0.212	-0.505
4001-5000	0.768	0.485	0.417	-0.541	-0.195	-0.156	-0.125	-0.387
5001-6000	0.716	0.520	0.540	-0.441	-0.191	-0.114	-0.103	-0.569
6001-7000	0.942	0.479	0.353	-0.378	-0.159	-0.206	-0.085	-0.249
7001+	0.667	0.413	0.366	-0.304	-0.151	-0.163	-0.048	-0.236
Overall average	0.625	0.477	0.426	-0.461	-0.185	-0.060	-0.094	-0.458

For fuel price elasticities of essential expenditures and disposable incomes, it is seen that the middle income groups have been affected the more. If this is related to trip rates, it is seen that these groups have not had appreciable changes in travel habits. For total expenditure, apart from the lowest income group, elasticity seems invariant with income, standing at around 0.480. What this may indicate is that people in this lowest income group are more able to get around hard times, at least with respect to trip making, than the higher paid people. The reason for this may be that poor respondents' relatively constraint trip frequency and probable economic constraints on mode choice mean that their life-style may be based on obtaining necessities that permit little monthly or seasonal variation (Stearns, 1976).

TABLE 6.10. Elasticity apportionment by socio-economic levels.

Socio-economic variables	Levels	No. of units	Elasticities		
			DI	ME	TE
Age	20-25	16	-0.114	0.381	0.354
	26-30	39	-0.506	0.367	0.463
	31-40	96	-0.463	0.573	0.473
	41-50	33	-0.512	0.801	0.492
	51-60	8	-0.614	1.238*	0.656
Car ownership	0	128	-0.435	0.278	0.446
	1	55	-0.453	0.883	0.528
	2+	9	-0.926	0.753	0.460
Income	<1001	5	-0.308	-0.130	0.173
	1001-2000	34	-0.644	0.525	0.488
	2001-3000	53	-0.644	0.493	0.506
	3001-4000	40	-0.428	0.494	0.472
	4001-5000	24	-0.541	0.768	0.485
	5001-6000	11	-0.441	0.716	0.520
	6001-7000	13	-0.378	0.942	0.479
	7001+	12	-0.304	0.677	0.413
Marital status	Single	50	-0.353	0.415	0.452
	Married	142	-0.502	0.672	0.486
Household status	Daughter	9	-0.414	0.230	0.433
	Son	14	-0.131	0.222	0.341
	HNM/Others	27	-0.473	0.642	0.497
	Housewife	29	-0.396	0.641	0.554
	Husband	113	-0.530	0.680	0.468

* The only elastic responsiveness recorded in the study.

For the case of fuel price elasticity of travel expenditure, the results are generally in accordance with intuition, with the exception again for the lowest income group. The counterintuitive negative sign recorded for this group of people means is due to the fact that their travel expenditures reduced after the fuel price increase. For this to have happened, both trip rate changes (reduction) and mode changes (to cheaper modes) should have occurred. These are, in fact, what happened with this group of respondents. All respondents in this group were non-car owners, and hence public transport captive trip makers, who had to reduce their public transport trips in order to save on disposable

income usage on travel. Incidentally, fuel price elasticity of disposable income varied the least for this group of respondents. As was shown under the section on mode choice changes, many respondents changed modes to cheaper ones, with many (especially in the middle and low income groups) resorting to the walk mode. Coupled with the complete change in the population segmentation recorded and discussed earlier, it can now be safely put that the hypothesis of life-style change following the October 1994 fuel price increase in Nigeria is proven in this work.

The middle and more especially the high income earners have responded more to the fuel price increase, with an overall elasticity of almost unity being recorded for the N6001-N7000 income group. These two groups contain people who are car owners or have cars available to them, and who make the most leisure trips (see Table 6.3). Leisure trips have had to be drastically reduced in the "after" period across the board in order to accommodate the fuel price change. From the discussion so far, it can be said, as posited by Stearns (1976), that elasticities are apportioned by income level.

The discussion above on elasticity has been with respect to only the levels of income. Elasticities are now discussed in relation to the levels of the other critical descriptor variables (data presented in Table 6.10) to confirm or otherwise the hypothesis of apportionment of elasticity by the levels of the variables. An examination of Table 6.10 reveals that while somewhat linear trends are exhibited by the variables for such as AGE, INCOME, AND MARITAL STATUS, and not too definable trends in others like HOUSEHOLD STATUS and CAR OWNERSHIP, it is only in a few cases like disposable income for HOUSEHOLD STATUS and total expenditure for INCOME and HOUSEHOLD STATUS that elasticities seem invariant with the levels of the socio-economic variables concerned. On the whole, empirical evidence in this work has confirmed the hypothesis that elasticities are apportioned not only by income level but by to the levels of the several of the socio-economic variables usually considered in travel demand analyses. Age, income, car ownership, and marital status have proved

particularly relevant in the scheme of things in this work. It is to be noted that it is only for AGE that the clearest trends were exhibited. It is also only for AGE that an elastic responsiveness was recorded, i.e. 1.238 for travel expenditure for the oldest age group.

Since on the average and in the majority of the socio-economic levels the results have been that of non-responsiveness of travel behaviour to the fuel price increase, it can be said that data available have proved otherwise the hypothesis that travel behaviour is elastic to energy policy change in Nigeria.

It is worth noting that elasticities are low because they are short-term elasticities. According to DeJong (1981), short-term elasticities are expected to be lower in absolute terms than medium-term (and by extension, long-term) elasticities of demand because people have had more time to react to the price changes.

6.5 Evaluation Against Private Car Usage Reduction Objective

Data calculated for the assessment of the responsiveness of travel behaviour by car owners to the fuel price increase are presented in Table 6.11. It is seen that though the percentage changes

TABLE 6.11. Average weekly trip rates for car-available respondents

Income group (Naira)	Number of units	All trips		Change (%)	Elasticity
		Before	After		
<1001	-	-	-	-	-
1001-2000	5	36.67	26.80	-29.10	-0.282
2001-3000	9	39.97	27.90	-30.05	-0.293
3001-4000	14	55.29	38.80	-29.82	-0.290
4001-5000	13	45.91	32.37	-27.31	-0.262
5001-6000	5	38.13	23.73	-37.77	-0.389
6001-7000	9	77.86	63.50	-18.44	-0.167
7001+	9	51.03	40.94	-19.77	-0.181
Overall average		51.01	37.83	-25.84	-0.245

and elasticities are generally higher than those recorded for all respondents (compare data in Table 6.11 with those in Table 6.4), the values are still not so high, especially for the elasticities. With this highly inelastic responsiveness of the demand for travel by car owners, it can be said that had the objective been to reduce car travel and hence conserve energy, the energy policy change would pass for a futile exercise, because the change in fuel price has not resulted in an elastic response in trip making by car owners.

6.6 Implications of Foregoing Results for Functional Form Modelling and Stability Testing

The main object of the foregoing discussions on the effects of the energy policy change on travel behaviour of individuals has been, as mentioned in Chapter One, to provide appropriate pedestal for explaining the results of the main assignment of regression modelling and stability testing of travel expenditures in relation to the energy policy change.

The trends in the discussions so far clearly indicate that the hypothesis of unstable functional form may be proven, even though it is to be realised that even when trip rates and travel expenditures are significantly different in the before and after situations, it is still possible that a stable functional form evolves. In fact, three things that are likely to happen even with significant changes in travel behaviour are; (1) functional forms are significant in both cases but not stable (the hypothesis being tested), (2) functional forms are significant in both cases but stable, and (3) functional forms not significant in either or both cases, in which case no grounds for testing stability is established.

However, the support for case 1 are obtained from an examination of the significance of the difference of the pairwise correlation between the critical person descriptor variables and travel money expenditure in the before and after situations was carried out, and a pictorial inspection of the plots of (i) the independent variables(disposable income and total expenditure) with income, and (ii) the independent

variables with the dependent variable (travel money expenditure). The evaluation of the results of these examinations were based on the following reasoning; (i) if correlation is significant and trends are dissimilar, then case 1 is expected to be proven; (ii) if pairwise correlation is significant and trends are similar, then case 2 is expected to be proven, without prejudice, however, to the fact that non-significant linear correlation may not lead to non-significant Box-Cox transformation regression relationships (the basis of the functional form and energy stability investigation); (iii) it was considered, however, safer to expect that a highly non-significant correlation and dissimilar trends may lead to case 3.

Based on this exposition, the examination results suggest that case 1 might be proven in the functional form estimation and stability testing stage of this research on travel expenditures. A hint on this had been given during the discussion on travel expenditure trends.

6.7 Functional Form Modelling and Stability Test Results

6.7.1 Estimation and Evaluation of Models

Typical results of the Box-Cox transformation regression exercise carried out in this work are presented in Table 6.12. The results are for model 1, estimated for λ values of 2.50 down to -1.00. The plots of $L_{\max}(\lambda)$ against λ for each model specification are as shown in Figure 6.5. The $L_{\max}(\hat{\lambda})$ and the corresponding $\hat{\lambda}$ are obtained from these plots. Values in brackets are Student's t-test statistic for the regression parameters.

For the case of the data in Table 6.12, the $L_{\max}(\hat{\lambda})$ was obtained at $\lambda = 1.00$. From Figure 6.5a, it is seen that apart from λ being somewhat dead-centred on 1.00, the 95% confidence interval (indicated by the hatched horizontal line with arrows at the ends) does not include 0. $\lambda = 1.00$ was thus adopted for this functional form. What this means is that MEB is linearly related to DIB, since $\lambda = 1.00$ indicates no transformation is

required. For this model, both the model constant term and coefficient of DIB are significantly different from zero at the 5% level.

TABLE 6.12 Typical Box-Cox regression results (For $MEB(\lambda) = \alpha + \beta DIB$)

λ	RSS	$L_{max}(\lambda)$	R^2	F	Constant	DIB
2.50	29920.593	-32.907	0.932	81.717	-32.692(-0.849)	0.140(9.040)
2.25	23656.211	-31.979	0.941	95.403	-10.062(-0.248)	0.135(9.767)
2.00	18984.317	-31.088	0.948	110.488	23.573(0.649)	0.130(10.511)
1.75	15639.059	-30.312	0.954	125.536	64.913(1.970)	0.125(11.204)
1.50	13410.231	-29.697	0.958	138.022	118.404(3.880)	0.122(11.748)
1.25	12133.526	-29.297	0.960	144.878	191.941(6.612)	0.119(12.037)
1.00	11682.812	-29.146	0.960	143.980	300.877(10.562)	0.116(11.999)
0.75	11964.049	-29.241	0.958	135.558	478.421(16.596)	0.114(11.643)
0.50	12910.579	-29.545	0.953	122.050	805.390(26.895)	0.112(11.048)
0.25	14479.553	-30.004	0.947	106.550	1503.380(47.405)	0.112(10.322)
0.00	16649.324	-30.563	0.938	91.429	3250.264(95.577)	0.110(9.562)
-0.25	19417.677	-31.178	0.929	77.945	8318.732(226.513)	0.110(8.829)
-0.50	22800.798	-31.820	0.917	66.507	24896.770(625.609)	0.110(8.155)
-0.75	26832.922	-32.472	0.905	57.050	84135.654(0.19E+04)	0.111(7.533)
-1.00	31566.615	-33.122	0.892	49.322	309486.246(0.66E+04)	0.112(7.023)

The summary results for the adopted models for the twelve specifications are presented in Table 6.13. It is seen that all the models are statistically significant and hence represent predictable trends in their own rights. The results for models 11 and 12 are presented only for completeness. They did not behave satisfactorily as expected in a Box-Cox transformation regression in which $L_{max}(\lambda)$, R^2 and F values are expected to reach their peaks at around the same value of λ . This same experience was recorded recently by the same researcher (Osula, 1998b) for the same type of specification, i.e., equal transformation for both regressor and response variables. As was concluded in that work, the data used (in this case, MEB and TEB, and MEA and TEA) do not support the Box-Cox transformation regression where the power transformation is applied equally to both regressor and response variables. This inference is more confidently made here because satisfactory results were recorded for equal transformation

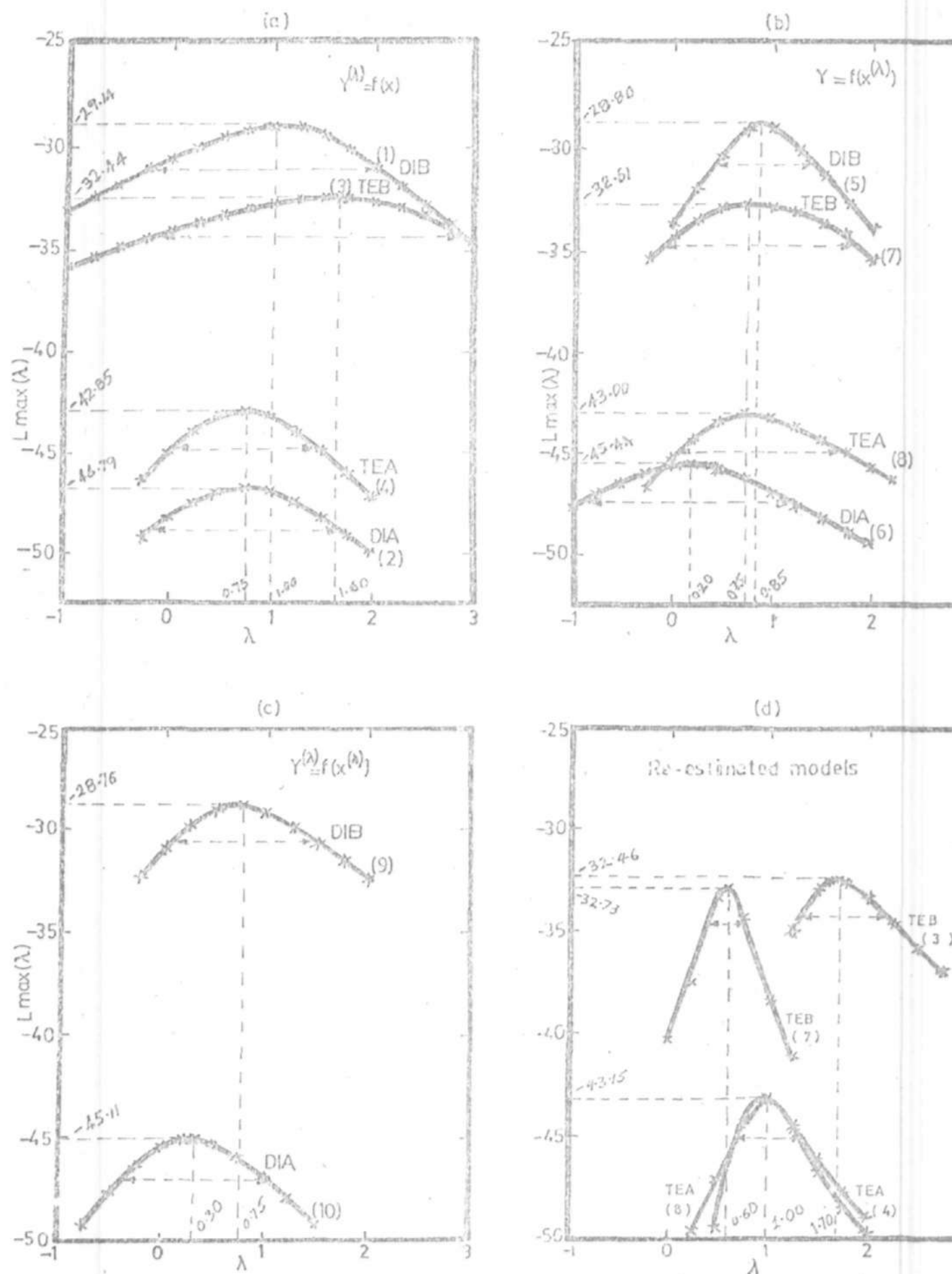


Figure 6.5. Trends for Box-Cox regression exercise (models in brackets).

in other cases in this work (MEB and DIB, and MEA and DIA), as have been recorded also in other transport-related works by such as Zarembka (1968), Savin and White (1978), Hensher and Johnson (1979), and Wang et al (1981). These two models (11 and 12) are not considered further in the analysis.

TABLE 6.13 Summary of results of models' estimation

Eqn. No.	Dependent Variable	λ	$L_{\max}(\lambda)$	R^2	F	Constant	Independent variable	Elasticity
1	MEB(λ)	1.00	-29.146	0.960	143.98	300.877	0.116DIB	0.438
2	MEB(λ)	0.75	-46.785	0.741	17.13	847.461	0.523DIA	0.090
3	MEB(λ)	1.00	-32.730	0.902	55.22	232.935	0.089TEB	0.592
4	MEB(λ)	1.00	-43.150	0.901	54.70	2.423	0.189TEA	1.050
5	MEB	1.00	-29.146	0.960	143.98	301.993	0.116DIB(λ)	0.438
6	MEA	0.20	-45.438	0.825	28.26	-1468.694	0.687DIA(λ)	0.002
7	MEB	0.75	-32.607	0.905	57.12	121.606	0.094TEB(λ)	0.081
8	MEA	1.00	-43.150	0.901	54.70	3.612	0.189TEA(λ)	1.050
9	MEB(λ)	1.00	-29.146	0.960	143.98	300.993	0.116DIB(λ)	0.438
10	MEB(λ)	0.30	-45.114	0.830	29.27	1149.751	0.668DIA(λ)	0.005
11	MEB(λ)	1.00	-32.730	0.902	55.22	233.024	0.089TEB(λ)	0.592
12	MEB(λ)	0.00	-40.727	0.948	109.34	-1997.066	0.189TEA(λ)	0.189

Models 3, 4, 7, and 8 recorded non-significant constant terms. This suggests that models forced through zero might give superior fit in these cases. The models were, thus, re-estimated forced through zero.

Schleselman (1971) showed that though the Box-Cox transformation (as originally developed in equation 5.4) leaves the analysis of variance unchanged, it does not do so when the model contains no constant term. This is to say that the Box-Cox transformation as originally proposed in equation 5.7 is not usable when the model is to be forced through zero. Zarembka (1974) reported having recorded "nonsensical results" while estimating models with no constant term with the original transformation. Schleselman proposed alternative transformations for use in estimating "no constant term" models. He suggested a general formula as follows:

$$Y^{(\lambda)} = \frac{Y^\lambda - C^\lambda}{\lambda} \quad \lambda \neq 0 \quad (6.1)$$

$$\log(Y / C) \quad \lambda = 0$$

where C can be sample average, sample geometric mean, and sample median. The procedure proposed by Schlesselman was not used because, according to him, while leaving the analysis of variance unchanged it has the disadvantage of making the form of the transformation partially dependent upon the sample values. A similarity that is noted between this and the Box-Cox transformation with the standardized variate (i.e., equation 5.20) is the scaling about the mean. Thus the Box-Cox transformation with the standardized variate invariably takes care of regression modelling in the case of no constant term. In fact, experience by the present researcher shows that using the standardized variate allows estimating models without constant term satisfactorily. Thus the Box-Cox transformation used in the earlier estimation (i.e., for models with constant terms) was also used in the "no constant term" model estimation. The results of the models' re-estimation are presented in Table 6.14. It is seen from this table, that the resulting models compare well in terms of RSS, with the models having constant terms.

TABLE 6.14 Summary of re-estimated models.

Model	Dependent variable	λ	$L_{\max}(\lambda)$	R ²	F	Coefficient	Elasticity
3	MEB ^(λ)	1.50	-32.922	0.985	394.00	0.103TEB	0.030
4	MEA ^(λ)	1.00	-42.365	0.983	346.94	0.189TEA	1.050
7	MEB	0.75	-34.393	0.991	660.67	0.115TEB ^(λ)	0.099
8	MEA	1.00	-42.365	0.983	346.94	0.189TEA ^(λ)	1.050

From the evaluation of the models against heteroscedasticity of errors using the Bartlett's Chi square test for constancy of variance, all the ten models were found to be robust to heteroscedasticity of errors. The details of the results of this test are presented in Appendix I. The test statistic recorded ranges from 0.009 to 1.17, compared with the critical Chi square statistic of 3.841 for one degree of freedom at the 5% level. At this

stage it can be said that the hypothesis that a predictable functional form is estimable for travel expenditures for a Nigerian setting is proven in this work.

6.7.2 Testing of Stability of Models

Table 6.15 presents the summary of how the appropriate model pairs fared in the stability test. Based on the criteria set out for the test, all model pairs failed to meet the stability requirements. Thus, as hypothesized, travel money expenditure functional forms are not stable with respect to energy policy change in Nigeria.

Since it was stated that the "before-and-after" scenario considered in this work also passes for a short-term period, it can also be inferred that short-term stability for travel money expenditures have not been established in this work.

TABLE 6.15 Stability test results for adopted models

Models compared	Basis of comparison of models			Remark
	Parameters	λ values	Elasticity	
1 and 2	Equal	Not equal	Not equal	Failed test
3 and 4	Equal	Not equal	Not equal	Failed test
5 and 6	Equal	Not equal	Not equal	Failed test
7 and 8	Equal	Not equal	Not equal	Failed test
9 and 10	Equal	Not equal	Not equal	Failed test

What has happened can be explained on the significant changes that have taken place in the travel behaviour of the respondents, in their general life styles, as well as in the segmentation of the population.

6.7.3 Functional Forms Selected for the "Before" and "After" Periods

Though stability of functional form has not been established in this work, it was still necessary to select a functional form for each period. This selection was based on the highest $L_{\max}(\hat{\lambda})$ value for each period since this corresponds to the least RSS and hence residual mean square. According to Montgomery and Peck (1992), residual mean

square is a reasonable measure of overall quality of model fit when considering models with constant term and models with no constant term, because occasionally R^2 for the latter is higher than for the former even though its residual mean square may be higher. This is because R^2 for the "no constant term" model is computed using uncorrelated sum of squares.

Based on this criterion, model 1 (or 5 or 9, since the power transformation is 1.00 for all three cases) is adopted for the "before" period. This model involved using MEB as dependent variable and DIB as the independent variable with a constant term present. For the "after" period, it is model 4 (or 8, both forced through zero) that is adopted. This model involved using MEA as the dependent variable and TEA as the independent variable. The import of this is that while it is disposable income that was operative in the "before" period, it is total expenditure that has become operative in the "after" period.

6.8 Implications of Results

On a general note, the elasticity values show that the a percentage change in fuel price has not generated equal or higher level of responsiveness based on all the variables used, except for the oldest age group for which a value of 346.92% was recorded (see Table 6.6) The closest value to this of 215.23% barely compares with the 238.5% increase in fuel price. While this translates to saying that the energy policy change has not been severe or adverse, an average reduction of about 43% in an individual's disposable income, and an average increase of about 114% in his travel expenditure burden are by no means insignificant in austere times. With regard to travel budget-based travel demand modelling, the effect of the energy policy change has not also been in the positive direction for the Nigerian setting. The implications of these for policy, public transport service, and transportation planning are discussed below.

6.8.1 Implications for Energy Policy Formulation and Implementation

Two usual policy objectives of increasing fuel price are to conserve energy and reduce air pollution, by increasing the cost of private car travel in relation to public transport travel, and hence reduce private car usage. The highly inelastic responsiveness of trip rates by car owning individuals to the fuel price increase makes this policy change a futile exercise in the Nigerian context. The direct implication of this for policy is that it may be necessary for future contemplation of energy policy formulation to ascertain in the first instance where the public interest lies so as to more appropriately identify the component of energy policy to implement and not adversely and unduly increase travel and other expenditure burdens on the individual. This becomes more relevant when it is realised that the main purpose of increasing fuel price in Nigeria seems only to be withdrawal or reduction of petroleum subsidy.

6.8.2 Implications for Public Transport Operation

For public transport operation, the reduction in trip rates may have serious implications not only for the operators but also for the patrons. This is because continued decline in patronage without increase in fares may mean declining revenue to the operator and hence the possible lowering of level and quality of service offered in making his service available to the trip maker. Operators have been known to resort to overloading their vehicles to the terrible inconvenience of the patrons. Others have reduced the extent of their coverage of the city in order to increase revenue. This reduced city coverage has the effect of lowering public transport accessibility in the city.

6.8.3 Implication for Public Transportation Policy

This work has shown that while elasticities are apportioned by the levels of several socio-economic variables, age seems to be the most relevant socio-economic variable with respect to travel money expenditures. Only respondents still in employment and who all happen to be less than 60 years of age were considered in this work. Based on the positive trend exhibited between elasticity and age, it is thinkable that the effect would be

more adverse on retired and more elderly people, especially those who never had any meaningful employments in their younger years. This points to the need to evolve energy cum transportation policies that will ensure preferential treatment for the elderly in the society.

6.8.4 Implications for Transportation Planning

What can be said of the findings of the main investigation of this work is that though negative with respect to the definition of travel budget in the Nigerian context, outright rejection of the UMOT model for the Nigerian setting is considered premature and hence not advised at this stage of the investigation on travel expenditures. Work has been only on a short-term reaction of respondents and not on long-term reactions. Long-term reactions usually have more relevance in the scheme of things because by then, according DeJong (1981), people would have had more time to react. Moreover, it is encouraging that predictable trends have been established in the "before" and "after" energy policy change periods, an implication of which is that at any point in time, a predictable trend is definable for travel expenditures in Nigeria.

CHAPTER SEVEN

SUMMARY, CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH

7.1 Summary

The effort in this research work has been to investigate if a predictable functional form can be developed for travel money expenditures in developing countries, using a Nigerian city as a case study. The effort also included testing whether a functional form so established is stable with respect to energy policy change. The October 1994 fuel price increase in Nigeria provided the opportunity to collect data for this work, which has been conceived to address the long standing call by Kirby (1981) to examine the energy policy sensitiveness of travel expenditures, as well as investigate if the UMOF model due to Zahavi (1979a, 1979b, 1979c, 1982) can be employed for urban travel demand estimation in Nigeria.

As a prelude to the main assignment of estimating and testing the energy stability of travel money expenditure functional form, an analysis of the data, collected through the use of questionnaires and activity diaries, was carried out to examine the trends of the travel behaviour (typified by trip rates and travel money expenditures) of the respondents, before and after the fuel price increase. This was to facilitate the explanation of the outcome of the functional form estimation and stability testing exercise.

While several of the research questions raised have been positively answered and all but one of the hypotheses put forward proven, several gaps that need to be filled have been identified. The former are stated as conclusions below while the latter are presented as directions for further research.

7.2 Conclusions

From the investigation carried out in this work the following conclusions are made;

- (1) The October 1994 fuel price increase in Nigeria has significantly affected urban travel behaviour of individuals. Trip rates reduced while travel expenditures increased. However, the established negative correlation between travel expenditure-disposable income ratio and income remained unchanged. Travel money expenditure increased on the average by 114.18%.
- (2) The least reduction of 7.08% in trip rate was recorded for subsistence trips (apparently because of the relatively inelastic work trip component) and the highest value of 46.54% was recorded for leisure trips. The lower reductions in subsistence trips is because a major component of these trips is the rather inelastic work trip. The drastic reduction in leisure trips suggests that the reducing effect of the fuel price increase on disposable income may have caused respondents to change to more a reflective, less socialising, and desirably, less extravagant life-style.
- (3) Appreciable changes occurred in mode choice, with an average value of 40.30% change being made from motorised modes to the walk mode. The highest mode change of 52.9% was recorded for leisure trips, with values for maintenance and subsistence trips standing at 36.8% and 36.2 %, respectively.
- (4) Segmentation of individuals in Nigeria can be made on the basis of the interaction between travel money expenditure and some socio-economic characteristics of individuals. The socio-economic characteristics that have proved influential for segmentation in this work are age, car ownership, income, marital status, and household status. Income and car ownership were influential in both the before and after fuel price increase situations, with car ownership having the most influence in both situations. While the respondents were grouped into six segments in the before period, they were grouped into four segments in the after period. This shift in population segmentation is apparently due to similarities in some cases and dissimilarities in others in the re-

alignment of individuals or groups of individuals in accommodating the increase in cost of travel in relation to personal incomes.

(5) The elasticities of travel expenditures with respect to fuel price were, in general, below unity. Specifically, -0.185, -0.060, -0.094, and -0.458 were recorded as average values for all trips, subsistence trips, maintenance trips, and leisure trips, respectively. It stood at 0.625 for travel money expenditure. Thus from the government's point of view, the energy policy change has not produced adverse effects on travel expenditure and trip rate. The same goes for expenditures on essential items and services and other non-travel activities.

(6) Elasticities are apportioned not only by income level but also by the levels of other socio-economic factor that are usually considered in travel demand studies. Age, car ownership, income, and marital status have proved particularly relevant in this present work. The respondents in the oldest age bracket seem to have felt the pinch much more than others. It is only for this socio-economic group that an elastic responsiveness value of 1.283 of travel expenditures to the energy policy change was recorded.

(7) In relation to the usual energy conservation objective of increasing fuel price to reduce private car usage, the highly inelastic responsiveness of trip rates by car owning individuals to the fuel price increase makes this policy change a futile exercise in the Nigerian context.

(8) As hypothesized, a significant relationship or functional form is definable between travel money expenditures and money available in Nigeria. Though the functional form that evolved in both periods were similar being simple linear regression models, the relationship has, however, not been proved to be stable with respect to energy policy changes and over a short-term period. This is explained on the significant changes that have taken place in the travel behaviour of the respondents, in their general life styles, as well as in the segmentation of the population. Thus "travel budget" is as yet, not usable as a term for travel expenditures in Nigeria.

(9) Of disposable income and travel expenditure, the former has proved to be more appropriate for use as "available money" for the estimation of travel expenditure-available

money relationship in the "before" period, while total expenditure has proved more appropriate in the "after" period..

(10) One implication of the findings in this work for travel demand modelling in Nigeria is that there is as yet no basis for the use of the UMOT in Nigerian settings.

(11) The direct implication of the findings in this work for policy is that it may be necessary for future contemplation of energy policy change to ascertain in the first instance where the public interest lies so as to more appropriately identify the component of energy policy to implement and not adversely and unduly increase travel and other expenditure burdens on the individual. For example, the clear and positive correlation of elasticity with age and the fact that it is for the oldest age group that an elastic response was recorded point to the need to evolve energy and transportation policies that will ensure preferential treatment for the elderly in the society.³

7.3 Directions for Further Research

Financial constraints have placed serious limitations on data collection in this work. Thus the contributions made in this work are by no means exhaustive but modest. Regarding, therefore, the continuing efforts towards evolving an appropriate pedestal for incorporating travel expenditure as a variable in travel demand modelling approaches for developing countries, the following are suggested as further works:

(1) Even if sample size was statistically adequate based on the data used, more data are required in this setting or in other settings in Nigeria to test the hypotheses drawn from this work.

(2) A refinement in the area of car trips is required. Car-related trips have been discussed here as "trips made by car owners" which is not necessarily the same as car trips. This has had to be so because data relating to trips made by mode were not useful, as filled in the questionnaires, compared with those on trips made by purpose.

(3) The elasticities measured in this work are short-term elasticities because of the short time interval between the "before" and the "after" periods. A better appreciation of the responsiveness of travel demand to the fuel price increase will be gotten if medium-term

and long-term elasticities are used in the assessment. According to DeJong (1981), short-term elasticities are expected to be lower in absolute terms than medium-term (and hence long-term) price elasticities of demand because people would have had more time to react to the price change. For example, Bonsall and Champenowne (1976) estimated elastic responses in the long term and inelastic short-term responses in a simulation study of the elasticities of the demand for petrol.

(4) The question of the probable existence of saturation level of travel expenditure has been raised by Goodwin (1981) and discussed positively by Kirby (1981). It is probable that this will exist for groups or segments of people in Nigeria. If this is the case, it may be necessary to investigate which is more appropriate of saturation level and average value of travel expenditure in describing population groups and in probably, modelling travel demand, based on the UMOT concept or any other concept.

(5) If saturation level of travel expenditure exists, it is also probable that the concept of extreme values can be defined for travel expenditures. Extreme values are common parameters in reliability studies. Investigations in this direction require a lot more data than used in this work, if groups of individuals of similar expenditure patterns are to be the units of study.

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APPENDIX A
SAMPLE QUESTIONNAIRE/ACTIVITY DIARY BOOKLET

DEPARTMENT OF CIVIL ENGINEERING
AHMADU BELLO UNIVERSITY, ZARIA

SURVEY QUESTIONNAIRE FOR A COMPREHENSIVE TRANSPORTATION SURVEY

INTRODUCTION

The purpose of this questionnaire is to collect data and information on the daily trip making habits of individuals in urban centres in Nigeria, before and after fuel price increases. Data and information collected are to be used in studying the effects of energy policy changes (fuel price changes) on the trip making habits of individuals, the ultimate purpose being to evolve policy-sensitive transportation planning methodologies that are rational and appropriate for Nigeria, and that will help in meeting the ever growing demand for mobility, as well as ease urban traffic congestion problems that currently plague Nigerian cities.

Your co-operation in making this effort a success is highly solicited. Please complete the questionnaire truthfully and carefully. For some of the information required, observations of your travel habits may need to be made for a period of about one week. For such information as travel time components (walking time, waiting time for public transport, and actual trip time in the vehicle), it will be necessary to make actual travel time measurements, i.e., noting the time (in minutes) consumed while you are engaged in any of travel activities. For trips made by the "walk" mode, the actual trip time is time spent walking on public road, track or footpath outside the premises from which the trips originated and ended.

Information supplied will be used for research only, and will not be traced to respondent. So, feel free in completing the questionnaire.

Thank you very much in advance for your co-operation in responding to this questionnaire.

INSTRUCTIONS Fill-in the required information where no boxes are provided, i.e., where dotted lines appear. Tick (✓) or cross (X) the appropriate box where boxes are provided with information. Fill-in the required information in an appropriate empty box where boxes are empty but have prompting information accompanying them.

OPTIONAL DAILY ACTIVITY DIARIES ARE PROVIDED FOR 7 DAYS FOR MAKING ACTUAL RECORDS OF YOUR DAILY TRAVEL ACTIVITIES TO SUPPORT THE INFORMATION SUPPLIED IN THE QUESTIONNAIRE.

PART A: PERSONAL DETAILS AND SOCIO-ECONOMIC CHARACTERISTICS

1. Profession : 2. Sex : ☐ Male ☐ Female 3. City :

4. Age (years) : ☐ 16-20 ☐ 21-25 ☐ 26-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ Above 60

5. Nature of work : ☐ Administrative ☐ Professional ☐ Teaching ☐ Secretarial ☐ Clerical ☐ Messenger
☐ OTHERS (STATE)

6a. Level of Education : ☐ No formal education ☐ Primary ☐ Secondary ☐ Tertiary ☐ NDE

b. Years of formal education : ☐ Less than 9 ☐ 9-14 ☐ 15-20 ☐ Above 20

7. Marital status : ☐ Single ☐ Married ☐ Separated ☐ Divorced ☐ Widowed ☐ Cohabite

8. Position in household : ☐ Husband ☐ Wife ☐ Son ☐ Daughter ☐ Other relative ☐ Family head
☐ Household head but not married

9a. If a vehicle owner, how many vehicles in working condition? ☐ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 & above

b. If not a vehicle owner, is a vehicle available to you always? (Note: Motorcycle is a vehicle) ☐ YES ☐ NO

10. Employment status (A full-time worker may also have a part-time job) :

☐ Full-time ☐ Part-time ☐ Retired contract ☐ Retired part-time ☐ Contract full-time

PART C: INDIVIDUAL TRAVEL EXPENDITURE PATTERN

18. If you make trips by public transport for any of the following purposes, state (1) the time (minutes) you spend waiting for the vehicle to arrive; (2) the time (minutes) you spend in the vehicle for the trip; (3) the amount (in Naira) you used to spend for the trip before fuel price increase; (4) the amount (in Naira) you now spend after the fuel price increase.

	Full-time work	Part-time work	Farm	Shopping	Recreation	Worship	Social visit	School run	Business
1. Waiting time									
2. Trip time									
3. Money (Before)									
4. Money (After)									

19. If you walk to your place of boarding public transport vehicle for any of the following trip purposes, state the time (minutes) you spend, on the average, walking.

	Full-time work	Part-time work	Farm	Shopping	Recreation	Worship	Social visit	School run	Business
Time									

20. If after alighting from a vehicle (public or private transport) you have to walk to the final destination associated with any of the following trip purposes, state your average walking time (minutes), and the distance (metres) over which you walk.

	Full-time work	Part-time work	Farm	Shopping	Recreation	Worship	Social visit	School run	Business
Time									
Distance									

21. If a vehicle owner, state your expenditure (in Naira) as follows:

	Weekly fuel	Monthly on vehicle maintenance
Before fuel price increase		
After fuel price increase		

22. Which of the following determines the number of trips you make?

[TIME] [MONEY] [TIME & MONEY]

PART D: INDIVIDUAL EXPENDITURE PATTERN ON NON-TRAVEL ACTIVITIES

23. State your average daily time expenditure (in hours), before and after the fuel price increase, on any of the following activities that you are normally engaged in.

	Sleeping	House chores	Eating	Full-time work	Part-time work	Farming	Shopping	Recreation	Worship	Social visit	School run	Business
Before												
After												

24. State your average monthly expenditure, in Naira, before and after the fuel price increase, on any of the following items that you normally spend money on. Do not fill the "Rent" column (1) if you are not a tenant, or (2) if as a tenant, your rent is deducted from source (i.e., your rent is deducted from your salary before being paid to you.)

	Rent	Feeding & insurance	Clothing, education & health	Telephone electricity	Recreation	Extended family	Alimony & loan repayment	Other non- travel activities
Before								
After								

DATE OF COMPLETION OF THIS QUESTIONNAIRE:

PART C: INDIVIDUAL TRAVEL EXPENDITURE PATTERN

18. If you make trips by public transport for any of the following purposes, state (1) the time (minutes) you spend waiting for the vehicle to arrive; (2) the time (minutes) you spend in the vehicle for the trip; (3) the amount (in Naira) you used to spend for the trip before fuel price increase; (4) the amount (in Naira) you now spend after the fuel price increase.

	Full-time work	Part-time work	Farm	Shopping	Recreation	Worship	Social visit	School run	Business
1. Waiting time									
2. Trip time									
3. Money (Before)									
4. Money (After)									

19. If you walk to your place of boarding public transport vehicle for any of the following trip purposes, state the time (minutes) you spend, on the average, walking.

	Full-time work	Part-time work	Farm	Shopping	Recreation	Worship	Social visit	School run	Business
Time									

20. If after alighting from a vehicle (public or private transport) you have to walk to the final destination associated with any of the following trip purposes, state your average walking time (minutes), and the distance (metres) over which you walk.

	Full-time work	Part-time work	Farm	Shopping	Recreation	Worship	Social visit	School run	Business
Time									
Distance									

21. If a vehicle owner, state your expenditure (in Naira) as follows:

	Weekly on fuel	Monthly on vehicle maintenance
Before fuel price increase		
After fuel price increase		

22. Which of the following determines the number of trips you make?

☐ TIME ☐ MONEY ☐ TIME & MONEY

PART D: INDIVIDUAL EXPENDITURE PATTERN ON NON-TRAVEL ACTIVITIES

23. State your average daily time expenditure (in hours), before and after the fuel price increase, on any the following activities that you are normally engaged in.

	Sleeping	House chores	Eating	Full-time work	Part-time work	Farming	Shopping	Recreation	Wor- ship	Social visit	Sch- ool run	Busi- ness
Before												
After												

24. State your average monthly expenditure, in Naira, before and after the fuel price increase, on any of the following items that you normally spend money on. Do not fill the "Rent" column (1) if you are not a tenant, or (2) if as a tenant, your rent is deducted from source (i.e., your rent is deducted from your salary before being paid to you.)

	Rent	Feeding & insurance	Clothing, education, & health	Telephone, electricity	Recreation	Extended family	Alimony & loan repayment	Other non- travel activities
Before								
After								

DATE OF COMPLETION OF THIS QUESTIONNAIRE:

DAY: WEDNESDAY		DATE: 2/11/94											
CODES TO BE USED		TRAVEL ACTIVITY NO. 1					TRAVEL ACTIVITY NO. 2						
ORIGIN & DESTINATION		Origin & time of leaving	Mode & time of departure	Arrival time of mode	Mode trip cost	Mode trip distance	Destination & time of arrival	Origin & time of leaving	Mode & time of departure	Arrival time of mode	Mode trip cost	Mode trip distance	Destination & time of arrival
Home	D0												
Office	D1												
Shopping centre (Market)	D2												
School	D3												
Recreation centre	D4	12mnt-3am											
House of worship	D5	5am-6am											
Farm	D6	6am-7am											
Relation's/Friend's	D7	7am-8am											
Intermediate (Bus stop, Taxi stop, Railway station, Boatyard or Ferry station, etc.)	D8	8am-9am											
Others (Bank, Clinic, Post Office, etc.)	D9	9am-10am											
		10am-11am											
		11am-12nn											
		12nn-1pm											
		1pm-2pm											
		2pm-3pm											
		3pm-4pm											
		4pm-5pm											
		5pm-6pm											
		6pm-7pm											
		7pm-8pm											
		8pm-9pm											
		9pm-10pm											
		10pm-11pm											
		11pm-12mnt											
MODE OF TRANSPORT													
Walk	M0												
Free ride	M1												
Own bicycle	M2												
Own motorcycle	M3												
Own car	M4												
Official vehicle	M5												
Motorcycle	M6												
Taxi	M7												
Minibus	M8												
Bus	M9												
Train	M10												
Ferry/Boat	M11												
Others	M12												
TRIP DISTANCE (Km)													
Less than 1	L0												
1.1 - 2	L1												
2.1 - 5	L2												
5.1 - 10	L3												
10.1 - 15	L4												
15.1 - 20	L5												
20.1 - 30	L6												
Over 30	L7												
TIME & MONEY SPENT													
The actual clock time													
and the actual amount of money (in Naira) spent should be stated.													

DAY : THURSDAY		DATE :											
CODES TO BE USED		TRAVEL ACTIVITY NO. 1				TRAVEL ACTIVITY NO. 2							
ORIGIN & DESTINATION		Origin & time of leaving.	Mode & time of departure	Arrival time of mode	Mode trip cost	Mode trip distance	Destination & time of arrival	Origin & time of leaving.	Mode & time of departure	Arrival time of mode	Mode trip cost	Mode trip distance	Destination & time of arrival
Home	D0												
Office	D1												
Shopping centre (Market)	D2												
School	D3												
Recreation centre	D4	12mid-5am											
House of worship	D5	5am-6am											
Farm	D6	6am-7am											
Relation's/Friend's	D7	7am-8am											
Intermediate (Bus stop, (Taxi stop, Railway station, Boatyard or Ferry station, etc.)	D8	8am-9am											
Others (Bank, Clinic, Post Office, etc.)	D9	9am-10am											
		10am-11am											
		11am-12nn											
		12nn-1pm											
		1pm-2pm											
		2pm-3pm											
		3pm-4pm											
MODE OF TRANSPORT													
Walk	M0	4pm-5pm											
Free ride	M1	5pm-6pm											
Own bicycle	M2	6pm-7pm											
Own motorcycle	M3	7pm-8pm											
Own car	M4	8pm-9pm											
Official vehicle	M5	9pm-10pm											
Motorcycle	M6	10pm-11pm											
Taxi	M7	11pm-12mid											
Minibus	M8												
Bus	M9	12mid-5am											
Train	M10	5am-6am											
Ferry/Boat	M11	6am-7am											
Others	M12	7am-8am											
		8am-9am											
		9am-10am											
TRIP DISTANCE (Km)		10am-11am											
Less than 1	L0	11am-12nn											
1.1 - 2	L1	12nn-1pm											
2.1 - 5	L2	1pm-2pm											
5.1 - 10	L3	2pm-3pm											
10.1 - 15	L4	3pm-4pm											
15.1 - 20	L5	4pm-5pm											
20.1 - 30	L6	5pm-6pm											
Over 30	L7	6pm-7pm											
		7pm-8pm											
TIME & MONEY SPENT		8pm-9pm											
The actual clock time and the actual amount of money (in Naira) spent should be stated.		9pm-10pm											
		10pm-11pm											
		11pm-12mid											

CODES TO BE USED		DAY : SATURDAY		DATE :									
		TRAVEL ACTIVITY NO. 1				TRAVEL ACTIVITY NO. 2							
		Origin & time of leaving.	Mode & time of departure	Arrival time of mode	Mode trip cost	Mode trip distance	Destination & time of arrival	Origin & time of leaving.	Mode & time of departure	Arrival time of mode	Mode trip cost	Mode trip distance	Destination & time of arrival
ORIGIN & DESTINATION													
Home	D0												
Office	D1												
Shopping centre (Market)	D2												
School	D3												
Recreation centre	D4	12mnt-5am											
House of worship	D5	5am-6am											
Farm	D6	6am-7am											
Relation's/Friend's	D7	7am-8am											
Intermediate (Bus stop, (Taxi stop, Railway station, Boatyard or Ferry station, etc.)	D8	8am-9am											
Others (Bank, Clinic, Post Office, etc.)	D9	9am-10am											
		10am-11am											
		11am-12nn											
		12nn-1pm											
		1pm-2pm											
		2pm-3pm											
		3pm-4pm											
MODE OF TRANSPORT													
Walk	M0	4pm-5pm											
Free ride	M1	5pm-6pm											
Own bicycle	M2	6pm-7pm											
Own motorcycle	M3	7pm-8pm											
Own car	M4	8pm-9pm											
Official vehicle	M5	9pm-10pm											
Motorcycle	M6	10pm-11pm											
Taxi	M7	11pm-12mnt											
Minibus	M8												
Bus	M9	DAY : SUNDAY											
Train	M10	DATE :											
Ferry/Boat	M11	12mnt-5am											
Others'	M12	5am-6am											
		6am-7am											
		7am-8am											
		8am-9am											
		9am-10am											
		10am-11am											
		11am-12nn											
		12nn-1pm											
		1pm-2pm											
		2pm-3pm											
		3pm-4pm											
		4pm-5pm											
		5pm-6pm											
		6pm-7pm											
		7pm-8pm											
		8pm-9pm											
		9pm-10pm											
		10pm-11pm											
		11pm-12mnt											
TRIP DISTANCE (Km)													
Less than 1	L0												
1.1 - 2	L1												
2.1 - 5	L2												
5.1 - 10	L3												
10.1 - 15	L4												
15.1 - 20	L5												
20.1 - 30	L6												
Over 30	L7												
TIME & MONEY SPENT													
The actual clock time and the actual amount of money (in Naira) spent should be stated.													

APPENDIX B

RAW DATA: RESPONDENTS' SOCIO-ECONOMIC CHARACTERISTICS

TABLE B1. Socio-economic characteristics of respondents.

S/N	Sex	Marital status	Household status	Employment status	Constraint	Cars owned	Income (Naira)	Age (years)
1	F	MD	WF	FT	-	0	750.00	35.0
2	M	MD	HB	FT	-	0	750.00	27.5
3	F	SG	DT	FT	TM	0	750.00	22.5
4	F	SG	DT	FT	TM	0	750.00	22.5
5	M	SG	HNM	FT	T	0	750.00	22.5
6	M	MD	HB	FT	M	0	1500.00	35.0
7	M	MD	HB	FT	-	0	1500.00	45.0
8	M	MD	HB	FT	TM	0	1500.00	35.0
9	M	SG	SN	FT	TM	0	1500.00	27.5
10	M	MD	HB	FT	TM	0	1500.00	35.0
11	F	MD	WF	FT	TM	0	1500.00	27.5
12	M	MD	HB	FT	-	0	1500.00	35.0
13	F	SG	DT	FT	TM	0	1500.00	27.5
14	F	SG	OR	FT	TM	0	1500.00	27.5
15	M	MD	HB	FT	TM	1	1500.00	22.5
16	M	MD	HB	FT	M	0	1500.00	35.0
17	F	MD	WF	FT	TM	0	1500.00	35.0
18	F	MD	WF	FT	-	0	1500.00	35.0
19	M	MD	HB	FT	TM	0	1500.00	35.0
20	F	SG	HNM	FT	TM	0	1500.00	35.0
21	M	MD	HB	FT	TM	0	1500.00	55.0
22	F	MD	WF	FT	M	0	1500.00	27.5
23	M	SG	SN	CFT	TM	0	1500.00	22.5
24	M	MD	HB	FT	TM	0	1500.00	35.0
25	F	MD	WF	FT	-	0	1500.00	27.5
26	M	MD	HB	FT	TM	0	1500.00	45.0
27	M	SG	HNM	FT	M	0	1500.00	45.0
28	F	MD	WF	FT	TM	1	1500.00	35.0
29	M	MD	HB	FT	TM	0	1500.00	45.0
30	M	SG	SN	FT	T	0	1500.00	22.5
31	M	MD	HB	FT	-	1	1500.00	45.0
32	M	SG	SN	FT	TM	0	1500.00	27.5
33	F	MD	WF	FT	TM	0	1500.00	35.0
34	F	MD	WF	FT	TM	0	1500.00	22.5
35	M	SG	HNM	FT	M	0	1500.00	22.5
36	M	SG	HNM	FT	TM	0	1500.00	27.5
37	M	MD	HB	FT	M	0	1500.00	35.0
38	M	MD	HB	FT	T	1	1500.00	45.0
39	M	MD	HB	FT	TM	1	1500.00	35.0
40	M	MD	HB	FT	-	0	2500.00	35.0
41	M	MD	HB	FT	M	0	2500.00	27.5
42	M	MD	HB	FT	T	0	2500.00	35.0
43	M	MD	HB	FT	TM	0	2500.00	35.0
44	M	MD	HB	FT	-	0	2500.00	45.0
45	F	SG	DT	FT	M	0	2500.00	27.5
46	M	MD	HB	FT	TM	0	2500.00	35.0
47	F	MD	WF	FT	TM	0	2500.00	35.0
48	M	SG	SN	FT	TM	1	2500.00	27.5
49	F	MD	WF	FT	TM	0	2500.00	35.0
50	M	MD	HB	FT	-	0	2500.00	35.0

TABLE B1 cont'd

S/N	Sex	Marital status	Household status	Employment status	Constraint	Cars owned	Income (Naira)	Age (years)
51	F	SG	DT	FT	-	0	2500.00	27.5
52	F	SG	HNH	FT	TM	0	2500.00	27.5
53	F	MD	WF	FT	-	0	2500.00	35.0
54	M	SG	HNH	FT	TM	0	2500.00	27.5
55	M	SG	HNH	CFT	TM	0	2500.00	22.5
56	M	MD	HB	FT	TM	0	2500.00	35.0
57	F	SG	HNH	FT	TM	0	2500.00	35.0
58	M	MD	HB	FT	-	0	2500.00	45.0
59	F	MD	WF	FT	-	0	2500.00	35.0
60	M	MD	HB	FT	TM	0	2500.00	35.0
61	M	SG	HNH	FT	TM	1	2500.00	35.0
62	M	MD	HB	FT	-	0	2500.00	35.0
63	M	MD	HB	FT	TM	0	2500.00	35.0
64	M	SG	SN	FT	TM	0	2500.00	22.5
65	M	MD	HB	FT	TM	0	2500.00	35.0
66	M	MD	HB	FT	TM	1	2500.00	45.0
67	F	MD	WF	FT	-	0	2500.00	35.0
68	M	SG	HNH	FT	TM	0	2500.00	27.5
69	M	SG	SN	FT	TM	0	2500.00	27.5
70	M	SG	SN	FT	TM	0	2500.00	27.5
71	M	SG	HNH	FT	TM	0	2500.00	27.5
72	F	MD	WF	FT	-	0	2500.00	35.0
73	M	MD	HB	FT	TM	1	2500.00	45.0
74	M	MD	HB	FT	-	0	2500.00	35.0
75	M	MD	HB	FT	TM	0	2500.00	35.0
76	M	MD	HB	FT	TM	0	2500.00	35.0
77	M	MD	HB	FT	T	0	2500.00	35.0
78	M	MD	HB	FT	TM	0	2500.00	35.0
79	F	MD	WF	FT	TM	1	2500.00	35.0
80	M	MD	HB	FT	TM	0	2500.00	35.0
81	M	MD	HB	FT	TM	0	2500.00	35.0
82	M	MD	HB	FT	M	0	2500.00	35.0
83	M	MD	HB	FT	TM	0	2500.00	27.5
84	M	SG	HNH	FT	TM	0	2500.00	35.0
85	M	MD	HB	FT	M	0	2500.00	35.0
86	M	MD	HB	FT	-	2	2500.00	35.0
87	M	MD	HB	FT	M	0	2500.00	35.0
88	M	MD	HB	FT	-	0	2500.00	35.0
89	M	MD	HB	FT	-	0	2500.00	35.0
90	F	MD	WF	FT	-	2	2500.00	27.5
91	M	MD	HB	FT	-	0	2500.00	35.0
92	M	MD	HB	FT	T	1	2500.00	45.0
93	M	MD	HB	FT	T	0	3500.00	45.0
94	M	SG	SN	FT	-	0	3500.00	35.0
95	M	MD	HB	FT	TM	0	3500.00	35.0
96	M	MD	HB	FT	-	0	3500.00	35.0
97	M	MD	HB	FT	TM	1	3500.00	35.0
98	M	MD	HB	FT	TM	1	3500.00	35.0
99	M	MD	HB	FT	M	0	3500.00	35.0
100	F	SG	DT	FT	TM	0	3500.00	27.5
101	F	SG	DT	FT	TM	0	3500.00	35.0
102	F	MD	WF	FT	-	0	3500.00	35.0
103	M	MD	HB	FT	TM	1	3500.00	35.0
104	M	SG	SN	FT	-	0	3500.00	35.0

TABLE B1 cont'd

S/N	Sex	Marital status	Household status	Employment status	Constraint	Cars owned	Income (Naira)	Age (years)
105	M	MD	HB	FT	M	0	3500.00	35.0
106	M	SG	HNM	FT	-	0	3500.00	27.5
107	M	SG	HNM	FT	M	0	3500.00	27.5
108	F	MD	WF	FT	TM	0	3500.00	35.0
109	M	MD	HB	FT	TM	1	3500.00	55.0
110	M	SG	SN	FT	TM	0	3500.00	22.5
111	M	MD	HB	FT	TM	1	3500.00	35.0
112	M	MD	HB	FT	-	0	3500.00	35.0
113	M	MD	HB	FT	-	0	3500.00	27.5
114	M	MD	HB	FT	M	0	3500.00	35.0
115	F	MD	WF	FT	M	0	3500.00	27.5
116	M	SG	HNM	FT	TM	0	3500.00	27.5
117	F	MD	WF	FT	-	1	3500.00	27.5
118	F	SG	DT	FTPT	TM	0	3500.00	22.5
119	M	SG	HNM	FT	TM	1	3500.00	35.0
120	M	SG	HNM	CFT	TM	1	3500.00	55.0
121	M	MD	HB	FT	TM	1	3500.00	35.0
122	M	SG	HNM	FT	-	0	3500.00	27.5
123	F	MD	WF	FT	TM	0	3500.00	22.5
124	M	MD	HB	FT	TM	1	3500.00	35.0
125	M	MD	HB	FT	M	1	3500.00	45.0
126	F	MD	WF	FT	M	1	3500.00	45.0
127	M	MD	HB	FT	M	1	3500.00	35.0
128	M	MD	HB	FT	-	0	3500.00	35.0
129	M	MD	HB	FT	TM	0	3500.00	35.0
130	M	MD	HB	FT	TM	0	3500.00	45.0
131	M	SG	SN	FT	TM	0	3500.00	22.5
132	M	MD	HB	FT	TM	1	3500.00	27.5
133	M	MD	HB	FT	TM	0	4500.00	35.0
134	M	SG	SN	FT	TM	0	4500.00	27.5
135	M	SG	HNM	FT	TM	0	4500.00	22.5
136	M	SG	HNM	FT	M	0	4500.00	27.5
137	M	MD	HB	FT	M	0	4500.00	35.0
138	M	MD	HB	FT	TM	1	4500.00	35.0
139	F	MD	WF	FT	T	1	4500.00	55.0
140	M	MD	HB	FT	TM	1	4500.00	45.0
141	M	SG	HNM	FT	TM	0	4500.00	27.5
142	M	MD	HB	FT	M	1	4500.00	35.0
143	M	SG	HNM	FT	M	0	4500.00	27.5
144	F	MD	WF	FT	M	1	4500.00	35.0
145	M	MD	HB	FT	M	1	4500.00	55.0
146	M	MD	HB	FT	TM	1	4500.00	35.0
147	M	MD	HB	FT	M	2	4500.00	45.0
148	M	MD	HB	FT	TM	1	4500.00	35.0
149	M	SG	SN	FT	M	0	4500.00	22.5
150	M	MD	HB	FT	-	0	4500.00	35.0
151	M	SG	HNM	FT	M	0	4500.00	27.5
152	M	MD	HB	FT	TM	2	4500.00	45.0
153	M	MD	HB	FT	TM	1	4500.00	45.0
154	M	MD	HB	FTPT	M	1	4500.00	35.0
155	M	MD	HB	CFT	TM	0	4500.00	35.0
156	M	MD	HB	FT	TM	0	4500.00	35.0
157	M	MD	HB	FT	TM	1	5500.00	45.0
158	M	MD	HB	FT	TM	1	5500.00	45.0

APPENDIX C

RAW DATA: RESPONDENTS' MODE CHOICE CHARACTERISTICS

TABLE C1. Mode choice characteristics of respondents, by trip purpose

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECR/TION		WORSHIP		SOCIAL VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
1	M10	M10	-	-	-	-	M10	M10	-	-	M0	-	M10	M10	-	-	-	-
2	M7	M10	-	-	-	-	M7	M0	-	-	M0	M0	M10	M10	-	-	-	-
3	M0	M0	-	-	-	-	M0	M0	-	-	M0	M0	M10	M10	-	-	-	-
4	M0	M0	-	-	-	-	M8	M7	-	-	M0	M0	M7	M8	-	-	-	-
5	M0	M0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	M9	M9	-	-	-	-	M9	M9	-	-	M8	M9	-	-	-	-	-	-
7	M9	M9	-	-	-	-	M9	M9	-	-	M10	M10	-	-	M9	M10	-	-
8	M0	M0	-	-	-	-	M8	M8	-	-	M0	M0	-	-	-	-	-	-
9	M0	M0	-	-	-	-	M7	M8	-	-	M8	M8	-	-	-	-	-	-
10	M7	M7	-	-	-	-	M7	M0	-	-	M7	M7	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	M0	M0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	M8/9	M8/9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	M0/10	M0/10	-	-	-	-	M0/10	M0/10	-	-	M0/10	M0/10	-	-	-	-	-	-
16	M0	M0	-	-	-	-	M9	M9	-	-	M0	M0	-	-	-	-	-	-
17	M9	M9	-	-	-	-	M0	M0	-	-	M0	M0	-	-	-	-	-	-
18	M0	M0	-	-	-	-	M0	M0	-	-	M0	M0	-	-	-	-	-	-
19	M7	M7	-	-	-	-	M7	M7	-	-	M0	M0	-	-	-	-	-	-
20	M8	M8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	M8	M8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	M9	M9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	M2	M2	-	-	-	-	M2	M2	-	-	M2	M2	-	-	-	-	-	-
24	M2	M2	-	-	-	-	M2	M2	-	-	M2	M2	-	-	-	-	-	-
25	M0	M0	-	-	-	-	M0/9	M0/9	-	-	M0/9	M0/9	-	-	-	-	-	-
26	M0/9	M0/9	-	-	-	-	M4	M4	-	-	M4	M4	-	-	-	-	-	-
27	M4	M4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C1 cont'd

S/N	PT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOCIAL VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
29	M6	M6	-	-	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	-	-	-	-
30	M2	M0	M9	M9	-	-	M9	M9	-	-	M9	M10	MS	M10	M0	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	M7	M07	-	-	-	-	-	-	-	-	MS	M9	-	-	-	-	-	-
33	M1	M09	-	-	-	-	M17	M9	-	-	M10	M10	-	-	-	-	-	-
34	MS	M0	-	-	-	-	MS	M7	-	-	M0	M0	MS	M08	M0	-	-	-
35	M0	M0	-	-	-	-	M0	M0	-	-	M0	M0	M0	M0	-	-	-	-
36	M2	M2	-	-	-	-	-	M13	-	-	M0	M0	-	-	-	-	-	-
37	M9	M13	-	-	-	-	M9	M13	-	-	M13	M13	MS	MS	-	-	-	-
38	M3	M3	-	-	-	-	-	M3	-	-	M4	M4	MS	MS	-	-	-	-
39	M4	M4	-	-	-	-	M4	M4	-	-	-	-	-	-	-	-	-	-
40	M0	M0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	M10	M0	M0	M0	-	-	-	-	-	-	M0	M0	M0/10	M0/10	M0	M0/10	M0/10	M0/10
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	M0	M0	-	-	-	-	-	M0	-	-	M0	M0	M0	M0	-	-	-	-
44	MS	MS	-	-	-	-	-	-	-	-	M0	M0	M0	M0	-	-	-	-
45	M10	M10	-	-	-	-	-	-	-	-	M0	M0	-	-	-	-	-	-
46	M3	M3	M3	M3	-	-	M3	M3	-	-	M3	M3	MS	MS	-	-	-	-
47	MS	M0	-	-	-	-	MS	MS	-	-	MS	MS	-	-	-	-	-	-
48	M3	M1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	M7/9	M7/9	-	-	-	-	M7	M7	-	-	M7	M7	-	-	-	-	-	-
50	MS	MS	-	-	-	-	MS	MS	-	-	MS	MS	-	-	-	-	-	-
51	M0	M0	-	-	-	-	M7	M7	-	-	MS	MS	M10	M10	M10	-	-	-
52	MS	MS	-	-	-	-	MS	MS	-	-	MS	MS	MS	MS	-	-	-	-
53	MS	MS	-	-	-	-	MS	MS	-	-	MS	MS	-	-	-	-	-	-
54	M1	M0	-	-	-	-	MS	M10	-	-	M0	M0	M1	M0	M10	-	-	-
55	M0	M0	-	-	-	-	M1	M1	-	-	M1	M1	M1	M1	-	-	-	-
56	M9	M9	-	-	-	-	M9	M9	-	-	M9	M9	-	-	-	-	-	-
57	M9	M9	-	-	-	-	MS	MS	-	-	-	-	M9	M9	-	-	-	-
58	M9	M0	-	-	-	-	MS	MS	-	-	M0	M0	M9	M9	-	-	-	-
59	MS	MS	-	-	-	-	MS	MS	-	-	MS	MS	-	-	-	-	-	-
60	M7	M7	-	-	-	-	M7	M7	-	-	M9	M9	-	-	-	-	-	-

TABLE C1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECREATION		WORSHIP		SOCIAL VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
61	M4	M4	-	-	-	-	M4	M4	M4	-	M1	-	M1	-	-	-	-	-
62	M1	M1	-	-	M9	M9	M8	M8	-	-	M0	M0/9/0	M0/9/0	M0/1	-	-	-	-
63	M0/9/0	M0/9/0	-	-	-	-	M0/9/0	M0/9/0	-	-	M1	M1	M1	M0/1	M0/8	-	-	-
64	M1/10/8	M0/6	-	-	M0	M0	M0	M0	-	-	M1	M1	M10	M10/8	-	-	-	-
65	M8	M7	-	-	-	-	-	-	-	-	M1	M1	M110	-	-	-	-	-
66	M4	M0	-	-	M4	M0	M4	M0	-	-	M0	M0	M4	-	-	M4	M6	-
67	M10	M10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68	M0	M0	-	-	-	-	M0	M9	-	-	M7	M7	M7	-	-	-	-	-
69	M0/9	M0/6	-	-	-	-	-	-	-	-	M0	M0	M0	-	-	-	-	-
70	M9	M6	-	-	-	-	M8	M0	M9	M0	M0	M0	M9	-	-	-	-	-
71	M0	M0	-	-	-	-	M8	M10	-	-	M0	M0	M0	-	-	-	-	-
72	M10	M10	-	-	M0	M0	M10	M10	-	-	M0	M0	M10	-	-	-	-	-
73	M3	M3	-	-	M3	M3	-	-	-	-	M3	M3	-	-	-	-	-	-
74	M0	M0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	M7	M7	-	-	-	-	-	-	-	-	M7	M7	M7	-	-	-	-	-
76	M10	M10	-	-	-	-	M7	M7	M7	M0	M10	M10	M0	M0	-	-	-	-
77	M8/9/0	M8/9/0	-	-	-	-	M10	M10	-	-	-	-	-	-	-	-	-	-
78	M7	M0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
79	M0	M0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	M10	M10	-	-	-	-	M4	M4	-	-	M4	M4	M0	M9	M10	M4	M4	-
81	M8	M8	-	-	-	-	M10	M10	-	-	-	-	-	-	-	-	-	-
82	M7	M7	-	-	M9	M9	-	-	-	-	M9	M9	M0	-	-	-	-	-
83	M0	M0	-	-	-	-	M7/9	M0	-	-	M7	M7	M7	-	-	-	-	-
84	M0	M0	-	-	-	-	-	-	-	-	M0/9	M0/9	M0	-	-	-	-	-
85	M0	M0	-	-	-	-	M0	M0	-	-	M0	M0	M0	-	-	-	-	-
86	M4	M4	-	-	M4	M4	M4	M4	-	-	M0	M0	M4	-	-	-	-	-
87	M0	M0	-	-	M0	M0	M0	M0	-	-	M4	M4	M4	-	-	-	-	-
88	M0	M0	-	-	M7	M0	M0	M0	-	-	M0	M0	M8	-	-	-	-	-
89	M0	M0	-	-	-	-	-	-	-	-	M8	M8	M8	M1	M0	-	-	-
90	M4	M4	-	-	-	-	M4	M4	-	-	M4	M4	M4	-	-	M4	M4	-
91	M0	M0	-	-	-	-	M7	M7	-	-	M0	M0	M0	-	-	M0	M0	-
92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECR'TION		WORSHIP		SOCIAL VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
93	M10	M10	-	-	-	-	M10	-	M10	-	M10	M10	M10	-	-	-	-	-
94	M8	M10	-	-	-	-	M10	M10	M10	-	M8	M10	M10	-	-	-	-	-
95	M7	M7	-	-	-	-	M10	-	M10	-	M7	M10	M10	-	-	-	-	-
96	M10	M10	-	-	-	-	M10	-	M10	-	M10	M10	M10	-	-	-	-	-
97	M4	M4	-	-	-	M4	M4	-	M10	-	M4	M4	M4	M4	-	-	-	-
98	M10	M10	-	-	-	-	M4	-	M10	-	M10	M4	M4	M4	-	-	-	-
99	M8	M8	M10	M10	-	-	M8	M8	M10	M10	M10	M10	M10	M10	M4	M4	M4	M4
100	M8	M8	M8	M8	-	-	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8
101	M10	M10	-	-	-	-	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10
102	M8	M8	-	-	-	-	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8
103	M4	M4	-	-	-	M4	M4	-	M4	-	M4	M4	M4	M4	M4	M4	M4	M4
104	M8	M8	M8	M8	-	-	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8
105	M3	M3	-	-	-	M3	M3	-	M3	-	M3	M3	M3	M3	M3	M3	M3	M3
106	M9	M9	-	-	-	-	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9
107	M7	M7	-	-	-	-	M7	M7	M7	M7	M7	M7	M7	M7	M7	M7	M7	M7
108	M1/7	M1/0	-	-	-	-	M1/0	M1/0	M1/0	M1/0	M1/0	M1/0	M1/0	M1/0	M1/0	M1/0	M1/0	M1/0
109	M4	M4	-	-	-	M4	M4	-	M4	-	M4	M4	M4	M4	M4	M4	M4	M4
110	M10	M10	-	-	-	-	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10
111	M4	M4	-	-	-	-	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4
112	M9	M9	-	-	-	-	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9
113	M9	M9	-	-	-	-	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9	M9
114	M9/6	M9/6/1	-	-	-	-	M9/6	M9/6/1	M9/6	M9/6/1	M9/6	M9/6/1	M9/6	M9/6/1	M9/6	M9/6/1	M9/6	M9/6/1
115	M10	M10	-	-	-	-	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10
116	M10	M10	-	-	-	-	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10
117	M4	M4	-	-	-	-	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4
118	M1	M1	-	-	-	-	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
119	M4	M4	-	-	-	-	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4
120	M4	M4	-	-	-	-	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4
121	M3	M3	-	-	-	-	M3	M3	M3	M3	M3	M3	M3	M3	M3	M3	M3	M3
122	M7	M7	-	-	-	-	M7	M7	M7	M7	M7	M7	M7	M7	M7	M7	M7	M7
123	M1	M1	-	-	-	-	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
124	M4	M4	-	-	-	-	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4

TABLE C1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOCIAL VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
125	M4/8	M4/8	-	-	-	-	M0/4	M0/4/7	M4/7	M4/7	M4/7	M4/7	M4/7	M4/7	-	-	-	-
126	M4	M0	-	-	M4	M4	M4	M4	-	-	M4	M4	M4	M0	M4	-	-	-
127	M4	M4	-	-	M4	M4	M4	M4	-	-	M4	M4	-	-	-	-	-	-
128	M0	M0	-	-	M8	M8	M8	M8	M0	M0	M0	M0	M8	M8	-	-	-	-
129	M0	M0	-	-	-	-	-	-	-	-	M0	M0	M8	M8	-	-	-	-
130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
131	M9	M9	-	-	-	-	-	-	M0	M0	M0	M0	-	-	-	-	-	-
132	M4	M4	-	-	-	-	M4	-	-	-	M4	M4	-	-	-	-	-	-
133	M7	M8	-	-	-	-	-	-	-	-	M0	M0	M8	M8	M4	-	-	-
134	M0	M0	-	-	-	-	M10	M10	M10	M10	M10	M10	-	-	-	-	-	-
135	M8	M8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
136	M0	M0	-	-	-	-	M9	-	-	-	M0	M0	M9	M9	-	-	-	-
137	M0	M0	-	-	-	-	-	-	-	-	M0	M0	M0	M0	-	-	-	-
138	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
139	M4	M4	-	-	-	-	M4	M4	-	-	M4	M4	-	-	-	-	-	-
140	M4	M3	-	-	M4	M4	M4	M3	M4	M3	M4	M3	M4	M3	M4	M3	-	-
141	M1/2	M0/1/2	-	-	-	-	M8/9	M8/9	M0/8	M0/8	M0/1	M0/1	M0/1	M0/1	M0	M0	-	-
142	M4	M4	-	-	-	-	M4	M4	-	-	M4	M4	M4	M4	M4	M4	-	-
143	M10	M10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
144	M4	M4	-	-	-	-	-	-	-	-	M4	M4	M4	M4	M4	M4	-	-
145	M4	M4	-	-	-	-	-	-	-	-	M4	M4	M4	M4	M4	M4	-	-
146	M4	M4	-	-	-	-	M4	M4/8	-	-	M4	M4	M4	M4	M4	M4	-	-
147	M4	M4	-	-	-	-	M4	M4	-	-	M4	M4	-	-	M4	M4	-	-
148	M0/1/4	M0/1/4	-	-	-	-	M4	M3	M3	M3	M4	M4	M4	M4	-	-	-	-
149	M10	M10	-	-	-	-	M0/1/4	M0/1/4	-	-	M0/1/4	M0/1/4	-	-	-	-	-	-
150	M5	M5	-	-	-	-	M4	M4	M4	M4	M0	M0	M4	M4	-	-	-	-
151	M0	M0	-	-	-	-	M10	M10	-	-	M0	M0	M5	M5	-	-	-	-
152	M3	M3	-	-	-	-	M3	M3	-	-	-	-	M5	M5	-	-	-	-
153	M5	M5	-	-	-	-	M5	M5	M5	M5	-	-	-	-	-	-	-	-
154	M4	M4	-	-	-	-	M4	M4	-	-	-	-	-	-	-	-	-	-
155	M10	M10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
156	M0	M0	-	-	-	-	-	-	M9	M9	M8	M8	M9	M9	-	-	-	-

TABLE C1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOCIAL VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
157	M4	M4	-	-	-	-	M4	M4	-	M0	M4	M4	M4	M4	-	M10	-	A
158	M4	M10	-	-	M0	-	M4	M10/4	M0	M0	M10	M10	M10	M10	M4	M4	-	M10
159	M8	M0	-	-	-	-	M10	M0	M0	M0	M0	M8	M0	M0	-	-	-	-
160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
161	M2	M2	-	-	M2	-	M2	M2	M0	M0	M0	M0	M0	M0	M2	M2	-	-
162	M0	M0	-	-	M0	-	M0	-	-	-	M0	M8	M8	M8	-	-	-	-
163	M8	M8	-	-	-	-	M8	M8	-	-	M8	M8	M8	M8	-	-	-	-
164	M0	M0	-	-	-	-	M9	M9	-	-	M0	M9	M9	M9	-	-	-	-
165	M4	M4	-	-	-	-	M4	M4	M4	M0	M4	M4	M0	M0	-	-	-	-
166	M0/4	M0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
167	M0	M0	-	-	-	-	-	-	-	-	M0	M0	M0	M0	-	-	-	-
168	M4	M4	-	-	-	-	M4	M4	M4	M4	-	M4	M4	M4	M4	M4	-	M4
169	M4	M4	-	-	-	-	M4	M4	M4	M4	M4	M4	M4	M4	-	-	-	-
170	M0	M0	-	-	-	-	-	-	-	-	-	M8	M8	M8	-	-	-	-
171	M4	M5	-	-	M0	-	M4	M9	M9/7	M9/7	M4	M4	M4	M4	M5	M5	-	-
172	M9	M5	-	-	-	-	M4	M4	M4	M4	M9/7	M9/7	M9/7	M9/7	M0	M0	-	-
173	M4	M4	-	-	-	-	M4	M4	M4	M4	M0	M0	M0	M0	-	M4	M4	M4
174	M4	M4	-	-	-	-	M4	M4	M4	M4	M4	M4	M4	M4	-	M4	M4	M4
175	M0	M0	-	-	-	-	M8	M8	M10	M10	M0	M10/8	M10/8	M10/8	-	-	-	-
176	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
177	M9	M9	-	-	-	-	M9	M9	-	-	M9	M9	-	-	-	-	-	-
178	M4	M4	-	-	M4	-	M4	M4	M4	M4	M4	M4	M4	M4	M4	M4	-	M4
179	M5	M5	-	-	-	-	-	M5	M5	-	-	-	-	-	-	-	-	-
180	M4	M4	-	-	-	-	-	-	-	-	M4	M4	M4	M4	-	-	-	-
181	M0	M0	-	-	-	-	M9	M9	-	-	M4	M4	M4	M4	M0	M0	-	-
182	M4	M4	-	-	-	-	M4	M4	-	-	M4	M4	M4	M4	-	-	-	-
183	M3	M3	-	-	M0	-	M8	M9	M9	M9	M9	M3	M9	M9	-	M3	M3	M3
184	M0	M0	-	-	-	-	M4	M4	-	-	M4	M4	M4	M4	-	-	-	-
185	M4	M4	-	-	-	-	M4	M4	-	-	M4	M4	M4	M4	-	-	-	-
186	M4	M10	-	-	-	-	-	-	-	-	-	M7	M4	M4	-	-	-	-
187	M6	M6	-	-	-	-	M4/1	M4/1	M4/1	M4/1	M4/1	M4/1	M4/1	M4/1	-	-	-	-
188	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE C1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOCIAL VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
189	M4	M4	-	-	-	-	M4	M4	M4	M4	M0	M0	M4	M4	M8	M4	M4	M4
190	M4	M4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M4	M4
191	M0	M0	-	-	-	-	-	-	-	-	M0	M0	-	-	-	M8	M8	M8
192	M5	M5	-	-	-	-	-	-	-	-	-	-	M4	M4	-	M5	M5	M5
193	M4	M4	-	-	M4	M4	-	-	-	-	M4	M4	M4	M4	M4	-	-	-
194	M0	M0/1	-	-	M10	M10	M8/10	M10	-	-	M0	M0	M8/10	M10	M0/1	M8/10	M10	M10
195	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Observations 193, 194, and 195 are the outliers in the data set.

B Before period. A After period.

Legend for modes

- M0 Walk
 M1 Free ride
 M2 Own bicycle
 M3 Own motorcycle
 M4 Own car
 M5 Official car
 M6 Official bus
 M7 Motorcycle public transport
 M8 Taxi
 M9 Minibus
 M10 Bus

APPENDIX D

RAW DATA: RESPONDENTS' WEEKLY TRIP RATES

TABLE D1. Weekly trip rates of respondents, by trip purpose.

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1	14	0	0	0	0	0	2	6	0	0	2	10	6	0	0	0	0	0
2	10	0	0	0	0	0	6	12	0	0	10	14	12	0	0	0	0	0
3	10	0	0	0	0	0	2	2	0	0	14	20	20	0	0	0	0	0
4	10	0	0	0	0	0	4	4	0	0	70	10	4	0	0	0	0	0
5	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	10	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	0
7	10	0	0	0	0	0	2	4	0	0	0	4	0	0	0	0	0	0
8	10	0	0	0	0	0	4	4	0	0	2	0	4	8	6	0	0	0
9	14	0	0	0	0	0	4	4	0	0	70	0	0	10	0	0	0	0
10	12	0	0	0	0	0	2	6	0	0	2	0	0	0	0	0	0	0
11	14*	0	0	0	0	0	4	8	0	0	14	0	0	0	0	0	0	0
12	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	10*	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
15	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	20	8	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0
17	12	0	0	0	2	4	2	4	0	0	14	4	4	0	0	0	0	0
18	10	0	0	0	0	0	2	2	0	0	2	2	2	0	0	0	0	0
19	28	0	0	0	0	0	10	10	10	10	16	10	6	0	10	0	0	0
20	10	0	0	0	0	0	2	6	0	0	10	4	4	0	20	0	0	0
21	10	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0
22	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	20	0	0	0	12	0	2	2	14	0	2	4	4	2	0	0	0	0
25	12	0	0	0	0	0	4	2	0	0	8	2	0	0	10	0	0	0
26	10	0	0	0	0	0	0	0	0	0	4	0	14	0	0	0	0	0
27	10	0	0	0	0	0	2	2	24	24	4	4	14	0	0	0	0	0

TABLE D1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
28	40	20	0	0	0	0	4	2	0	0	28	16	8	2	0	0	0	0
29	10	10	0	0	0	0	6	6	4	6	6	6	6	6	0	0	0	0
30	10	10*	0	0	0	0	4	2	0	0	4	4	6	2	10	0	0	0
31	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	10	10	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0
33	10	10	0	0	0	0	10	6	0	0	10	4	6	0	0	0	0	0
34	12	12	0	0	0	0	16	4	2	2	2	4	10	0	2	0	0	0
35	40	40	0	0	0	0	4	4	0	0	14	14	24	6	0	0	0	0
36	28	28	0	0	0	0	0	0	0	0	48	48	0	0	0	0	0	0
37	10	10	0	0	0	0	2	0	0	0	2	2	2	0	0	0	0	0
38	10	10	0	0	0	0	0	0	14	14	2	0	2	0	0	0	0	0
39	14	4	0	0	0	0	4	4	0	0	2	8	2	0	0	0	0	0
40	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	20*	30*	0	0	0	0	0	0	0	0	18	14	4	2	18	0	28	26
42	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	24	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	18	18	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0
47	20	20	0	0	0	0	4	4	0	0	66	2	6	0	0	0	0	0
48	28	28	0	0	0	0	0	2	0	0	4	0	0	0	0	0	0	0
49	10	10	0	0	0	0	2	0	0	0	10	10	0	0	0	0	0	0
50	10	10	0	0	0	0	2	2	0	0	2	2	0	0	0	0	0	0
51	12	12	0	0	0	0	20	12	0	0	8	6	4	4	0	0	0	0
52	12	12	0	0	0	0	4	4	0	0	2	2	2	2	0	0	0	0
53	12	12	0	0	0	0	16	6	32	12	16	4	22	8	0	0	0	0
54	20	20	0	0	0	0	4	4	22	10	2	4	44	32	0	0	0	0
55	10	10	0	0	0	0	4	4	0	0	4	2	0	0	0	0	0	0
56	10	10	0	0	0	0	4	4	0	0	4	4	0	4	0	0	0	0
57	10	10	0	0	0	0	0	0	4	0	0	0	4	4	0	0	0	0
58	10	4	0	0	0	0	0	0	0	0	2	2	8	4	0	0	0	0

TABLE D1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECR'TION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
59	24	24	0	0	0	0	4	4	0	0	6	4	12	2	0	0	0	0
60	10	6	0	0	0	0	2	10	0	0	10	10	0	0	0	0	0	0
61	20	10	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
62	14	14	0	0	14	0	14	14	0	0	14	14	14	14	0	0	0	0
63	10	10	0	0	0	0	4	12	0	0	12	12	4	4	10	0	0	0
64	10	10	0	0	0	0	0	70	0	0	70	10	26	20	10	0	0	0
65	26*	26*	0	0	0	0	0	12	0	0	12	10	10	0	0	0	0	0
66	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	40	40	0	0	0	0	2	2	0	0	2	4	4	4	0	0	0	0
69	14	10	0	0	0	0	14	14	0	0	14	10	10	10	0	0	0	0
70	10	10	0	0	0	0	2	2	0	0	2	2	2	2	0	0	0	0
71	10	10	0	0	0	0	2	2	0	0	2	2	2	2	0	0	0	0
72	10	10	0	0	0	0	2	2	0	0	2	2	2	2	0	0	0	0
73	12	12	0	0	0	0	2	2	0	0	2	2	2	2	0	0	0	0
74	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	16	16	0	0	0	0	8	10	0	0	10	10	4	4	10	0	0	0
76	24	24	0	0	0	0	12	6	0	0	6	6	0	0	0	0	0	0
77	14	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	14	14	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0
79	10	10	0	0	0	0	4	2	0	0	2	2	2	2	10	2	10	2
80	14	14	0	0	0	0	4	10	0	0	10	10	6	6	0	0	0	0
81	10	10	0	0	0	0	0	0	0	0	0	0	6	6	0	0	0	0
82	12	10	0	0	0	0	2	8	0	0	8	8	6	6	0	0	0	0
83	10	10	0	0	0	0	0	10	0	0	10	14	6	6	0	0	0	0
84	10	10	0	0	0	0	2	8	0	0	8	8	2	2	0	0	0	0
85	50	50	0	0	0	0	2	14	0	0	14	14	2	2	0	0	0	0
86	10	10	0	0	0	0	0	4	0	0	4	4	4	4	0	0	0	0
87	10	10	0	0	0	0	2	0	0	0	2	2	2	2	0	0	0	0
88	10	10	0	0	0	0	2	2	0	0	2	2	4	4	0	0	0	0
89	10	10	0	0	0	0	2	2	0	0	2	2	14	14	0	0	0	0

TABLE D1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECREATION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
90	36	26	0	0	0	0	2	2	0	0	8	8	4	4	10	10	0	0
91	24	24	0	0	0	0	6	6	0	0	48	48	0	0	20	20	0	0
92	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	20	16	0	0	0	0	0	0	0	0	14	14	16	14	0	0	0	0
94	10	10	0	0	0	0	2	2	0	0	2	2	14	14	0	0	0	0
95	12	12	0	0	0	0	2	2	0	0	0	0	4	4	0	0	0	0
96	10	10	0	0	0	0	2	2	0	0	2	2	8	8	0	0	0	0
97	20	20	0	0	0	0	2	2	0	0	16	16	4	4	10	10	0	0
98	22	22	10	10	2	0	2	2	0	0	2	2	2	2	22	22	2	12
99	10	6	6	2	0	0	6	2	6	6	2	2	8	8	10	10	0	0
100	24	24	0	0	0	0	4	4	0	0	2	2	2	2	0	0	0	0
101	10	10	0	0	0	0	4	4	0	0	2	2	4	4	0	0	0	0
102	10	10	0	0	0	0	4	4	0	0	2	2	4	4	0	0	0	0
103	10*	10*	0	0	0	0	4	4	0	0	2	2	4	4	0	0	0	0
104	10	10	10	10	0	12	4	2	0	0	6	6	14	14	0	0	0	0
105	10	10	0	0	0	0	2	2	0	0	2	2	4	4	0	0	0	0
106	20	20	0	0	0	0	2	2	0	0	2	2	6	6	0	0	0	0
107	12	12	0	0	0	0	4	4	0	0	2	2	0	0	0	0	0	0
108	18	18	0	0	0	0	4	4	0	0	6	6	0	0	10	10	0	0
109	34	12	0	0	12	0	10	2	2	2	2	2	6	4	0	0	0	0
110	10	10	0	0	0	0	2	2	0	0	2	2	4	4	0	0	0	0
111	12	12	0	0	0	0	2	2	0	0	2	2	0	0	10	10	0	0
112	12	12	0	0	0	0	2	2	0	0	6	6	0	0	0	0	0	0
113	10	10	0	0	0	0	2	2	0	0	0	0	14	14	0	0	0	0
114	10	10	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
115	24	24	0	0	0	0	4	4	0	0	6	6	6	6	0	0	0	0
116	10	10	0	0	0	0	2	2	0	0	2	2	4	4	0	0	0	0
117	14	12	0	0	0	0	6	6	0	0	2	2	10	10	0	0	0	0
118	12	12	20	6	0	0	16	4	0	6	10	10	30	10	0	0	0	0
119	20	20	0	0	0	0	2	2	0	0	2	2	2	2	0	0	0	0
120	12	4	0	0	0	0	10	2	0	0	0	0	30	4	0	0	0	0

TABLE D1 cont'd

S/N	FI. WORK		PT. WORK		FARM		SHOPPING		RECREATION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
121	10	10	0	0	0	0	12	4	14	4	16	8	18	8	10	10	0	0
122	18	18	0	0	0	0	2	4	4	2	2	2	6	6	0	0	0	0
123	10	10	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
124	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125	22	10	0	0	0	0	18	4	6	18	16	4	8	4	0	0	0	0
126	10	10	0	0	0	0	12	0	0	10	10	0	6	2	10	10	0	0
127	22	22	0	0	0	0	12	0	0	4	4	0	6	0	0	0	0	0
128	26	16	0	0	0	0	2	14	14	2	2	2	4	0	0	0	0	0
129	12	10	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
130	10*	10*	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
131	10	10	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0
132	10	10	0	0	0	0	6	0	4	0	70	16	0	0	2	0	0	0
133	14	14	0	0	0	0	0	0	0	0	14	70	0	0	0	0	0	0
134	10	10	0	0	0	0	4	0	0	4	4	14	4	0	0	0	0	0
135	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	12	12	0	0	0	0	14	0	0	0	10	0	8	4	0	0	0	0
137	18	18	0	18	0	0	0	0	0	0	70	0	4	0	0	0	0	0
138	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139	10	10	0	0	0	0	2	2	2	0	14	14	14	0	20	20	14	14
140	10	10	0	14	0	0	2	2	0	0	14	14	14	0	12	12	0	0
141	10	10	0	0	0	0	6	12	12	6	6	6	2	2	10	18	0	0
142	20	20	0	0	0	0	4	2	0	0	2	2	0	0	0	0	0	0
143	20	20	0	0	0	0	0	0	0	0	4	0	10	2	20	0	0	0
144	20	20	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
145	10	10	0	0	0	0	2	0	0	0	2	0	0	0	20	20	0	0
146	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
147	48	22	0	0	0	0	24	8	14	4	6	4	14	8	0	0	0	0
148	10	10	0	0	0	0	2	2	0	4	4	4	0	0	0	0	0	0
149	10	10	0	0	0	0	0	0	12	4	2	2	0	8	0	0	0	0
150	28	28	0	0	0	0	0	0	18	16	0	16	14	4	0	0	0	0
151	12	12	0	0	0	0	2	2	0	0	2	2	4	4	0	0	0	0

TABLE D1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
152	20	12	0	0	0	14	8	0	0	0	0	0	0	0	0	0	0	0
153	10	10	0	0	0	2	2	14	0	0	0	0	0	0	0	0	0	0
154	24	12	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0
155	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	24	12	5	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
157	10	10	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
158	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
159	10	10	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0
160	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	25	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162	28	28	10	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
163	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
164	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165	22	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
167	12	12	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
168	20	20	20	20	0	10	0	0	0	0	0	0	0	0	0	0	0	0
169	30	20	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0
170	10	10	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0
171	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
173	28	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
174	22	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
177	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
178	24	24	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0
179	14	14	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0
180	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	10	10	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
182	36	36	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0

TABLE D1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
183	10	8	0	0	8	8	10	8	6	6	6	6	18	0	0	0	0	0
184	24	12	0	0	0	12	12	0	0	14	14	0	0	0	0	0	0	0
185	12	12	6	6	0	2	2	0	0	2	2	4	4	0	0	0	0	0
186	14	10	0	0	0	0	0	0	0	0	0	8	8	0	0	0	0	0
187	20	20	0	0	0	2	2	20	12	2	2	4	2	0	0	0	0	0
188	10*	10*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
189	26	18	0	0	0	4	2	0	0	4	2	22	16	8	4	8	2	2
190	10	10	0	0	0	0	0	0	0	4	4	6	4	0	0	24	2	2
191	12	12	0	0	0	0	0	0	0	12	12	0	0	0	0	12	12	12
192	30	22	0	0	0	10	8	4	2	4	4	32	20	4	4	12	6	6
193	40	40	0	0	2	0	0	0	0	2	2	2	2	40	40	0	0	0
194	10	10	0	0	2	4	4	8	0	2	2	0	0	0	0	30	6	6
195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Observations 193, 194, and 195 are the outliers in the data set.

B Before period. A After period.

* 10 one-way trips assumed for full-time work trips for respondents who did not fill the trip rate portion of the questionnaire. However, these respondents were not considered in the averaging of trip rates for the income groups for other trip purposes.

APPENDIX E

RAW DATA: RESPONDENTS' WEEKLY TRAVEL MONEY EXPENDITURES

TABLE E1. Weekly travel money expenditures of respondents, by trip purpose (Naira).

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECREATION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
1	70	120	0	0	0	0	30	20	0	10	0	30	20	0	0	0	0	0
2	50	0	0	0	0	0	60	0	0	0	0	60	60	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	100	80	0	0	0	0	0
4	0	0	0	0	0	0	20	40	0	0	0	50	40	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	50	200	0	0	0	0	20	40	0	20	80	0	0	0	0	0	0	0
7	50	200	0	0	0	0	20	40	0	0	0	20	0	40	120	0	0	0
8	70	0	0	0	0	0	20	40	0	10	20	0	0	50	40	0	0	0
9	0	0	0	0	0	0	60	20	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	24	28	0	6	4	49	0	0	0	0	0	0
11	42	90	0	0	0	0	30	0	0	49	14	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0	0
14	100	165	0	10	20	0	10	20	0	25	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	80	200	0	0	0	0	20	30	0	70	0	6	10	0	0	0	0	0
17	0	0	0	0	0	0	20	40	0	0	0	20	40	0	0	0	0	0
18	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	50	100	0	0	0	0	30	20	0	0	0	20	20	0	0	0	0	0
21	50	100	0	0	0	0	0	0	0	0	0	0	0	50	100	0	0	0
22	100	120	0	0	0	0	0	0	0	0	0	0	0	100	120	0	0	0
23	110	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	48	80	0	0	0	0	0	0	0
27	50	100	0	0	0	0	10	20	140	20	40	70	140	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE E1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
29	30	50	0	0	12	60	30	60	20	30	60	60	120	0	0	0	0	0
30	0	0	0	0	0	0	16	20	0	20	40	30	20	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	30	100	0	0	0	0	0	0	0	20	60	0	0	0	0	0	0	0
33	0	50	0	0	0	0	15	30	0	15	20	12	0	0	0	0	0	0
34	60	0	0	0	0	0	40	0	40	0	0	50	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0
37	50	100	0	0	0	0	20	0	0	20	0	20	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	100	0	0	0	0	0	0	0	0	0	0	8	10	0	0	140	390	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	63	0
44	72	240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	240	240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	200	0	0	0	0	0	40	30	0	20	30	30	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	20	50	0	0	0	0	0	10	0	10	50	0	0	0	0	0	0	0
50	50	100	0	0	0	0	6	10	0	10	10	0	0	0	0	0	0	0
51	0	0	0	0	0	0	100	120	0	40	60	20	40	0	0	0	0	0
52	36	60	0	0	0	0	12	20	0	6	10	6	10	0	0	0	0	0
53	36	60	0	0	0	0	20	40	0	10	20	0	0	0	0	0	0	0
54	0	0	0	0	0	0	80	90	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	30	30	0	0	0	0	20	40	0	12	20	0	0	0	0	0	0	0
57	20	50	0	0	0	0	0	0	20	0	0	8	20	0	0	0	0	0
58	30	0	0	0	0	0	0	0	0	0	0	24	20	0	0	0	0	0
59	96	240	0	0	0	0	20	60	0	24	150	60	0	0	0	0	0	0
60	50	60	0	0	0	0	10	20	0	70	0	0	0	0	0	0	0	0

TABLE E1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECREATION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	420	0	140	0	0	0	0	0	0	0	0	0	0
63	100	200	0	0	0	0	20	40	0	0	0	0	20	40	0	0	0	0
64	100	150	0	0	0	0	0	0	0	0	0	0	0	0	50	150	0	0
65	130	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	100	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	20	0	0	0	20	0	28	40	0	0	0	0
69	140	200	0	0	0	0	0	0	0	0	0	0	50	20	0	0	0	0
70	100	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0
72	50	100	0	0	0	0	20	40	0	0	0	0	40	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	32	112	0	0	0	0	160	56	12	0	20	0	8	0	0	0	0	0
76	120	140	0	0	0	0	60	120	0	42	90	0	0	0	0	0	0	0
77	56	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	42	0	0	0	0	0	0	0	0	0	0	0	0	0	30	90	0	0
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	75	0	0
80	50	75	0	0	0	0	8	15	0	0	0	0	0	0	0	0	0	0
81	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	60	100	0	0	0	120	0	0	0	20	120	0	30	0	0	0	0	0
83	0	0	0	0	0	40	18	0	0	50	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0
88	0	0	0	0	0	60	0	0	20	0	0	0	42	70	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	30	60	0	0	0	0	0	0	0	0	0	0

TABLE E1 cont'd

S/N	FT. WORK		FT. WORK		FARM		SHOPPING		RECRITION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	100	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	50	100	0	0	0	0	28	0	0	0	0	0	56	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	30	60	12	10	0	0	0	0	0	0	0	0	20	40	40	0	0	0
100	240	480	0	0	0	0	20	80	0	20	0	20	40	20	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0	0	0	12	20	0	0	0	0
102	50	50	0	0	0	0	20	0	0	10	0	20	20	20	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
104	150	150	150	0	0	0	30	0	0	0	0	20	60	40	0	0	0	0
105	0	0	0	0	0	0	20	0	0	0	0	20	20	20	0	0	0	0
106	100	0	0	0	0	0	10	0	0	0	0	20	0	0	0	0	0	0
107	36	120	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0
108	45	0	0	0	0	0	0	0	0	0	0	0	12	40	0	0	0	0
109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112	60	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
113	30	50	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
114	50	50	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
116	50	0	0	0	0	0	40	0	20	0	0	0	30	20	0	20	0	20
117	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
118	0	50	78	60	0	0	0	0	60	0	50	0	300	200	0	0	0	0
119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	0	150	0	0	0	0	120	0	28	0	56	0	60	60	90	170	0	0
122	72	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0
123	0	0	0	0	0	0	60	0	0	0	0	0	60	0	0	0	0	0
124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE E1 cont'd

S/N	PT. WORK		PT. WORK		FARM		SHOPPING		RECREATION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
128	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133	140	210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135	60	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
142	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
143	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
149	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
152	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
153	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
154	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155	16	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	0	0	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE E1 cont'd

S/N	FT. WORK		PT. WORK		FARM		SHOPPING		RECREATION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
159	20	50	0	0	0	0	80	0	0	0	0	0	0	180	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162	0	0	50	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0
163	50	100	0	0	0	0	10	10	0	0	10	0	20	60	0	0	0	0
164	0	0	0	0	0	0	0	0	0	0	0	0	20	20	0	0	0	0
165	0	0	0	0	0	0	0	0	0	0	0	0	10	20	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
169	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
172	72	0	0	0	0	0	12	20	36	60	20	0	36	60	0	0	0	0
173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	12	20	20	40	0	0	20	20	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
177	30	50	0	0	0	0	8	10	0	0	24	40	0	0	0	0	0	0
178	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
179	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	24	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
182	0	0	0	0	0	0	16	20	0	0	20	0	0	0	0	0	0	0
183	0	0	0	0	0	0	40	100	30	60	60	0	0	180	0	0	0	0
184	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0
185	0	0	0	0	0	0	0	10	0	0	70	0	0	0	0	0	0	0
186	0	50	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0
187	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE E1 cont'd

S/N	FL. WORK		PT. WORK		FARM		SHOPPING		RECREATION		WORSHIP		SOC. VISIT		SCH. RUN		BUSINESS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
188	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
189	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	165
193	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Observations 193, 194, and 195 are the outliers in the data set.

Car owning respondents have zeros as entries for all trip purposes in the Table. Travel expenditures for them are made up of fuel expenditures and vehicle maintenance costs.

B Before period. A After period.

APPENDIX F

RAW DATA: RESPONDENTS' MONTHLY NON-TRAVEL MONEY EXPENDITURES

TABLE F1. Monthly non-transport expenditures of respondents (Naira).

S/N	RENT		FEEDING		CLOTHING		UTILITY		RECRITION		EXT. FAM		LOAN		OTHERS	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1	0	0	50	50	370	370	80	80	0	0	0	0	0	0	0	0
2	0	0	450	980	150	395	0	0	0	0	180	290	0	0	0	0
3	0	0	600	800	900	1400	0	0	0	0	0	0	0	0	200	500
4	0	0	0	0	700	1000	0	0	0	0	0	0	0	0	300	500
5	0	0	0	0	500	700	0	0	0	0	0	0	0	0	0	0
6	0	0	500	1000	700	1000	0	0	0	0	0	0	0	0	300	500
7	500	1000	700	1000	0	0	0	0	0	0	0	0	0	0	300	500
8	0	0	1500	2000	0	0	0	0	300	0	0	0	0	0	0	0
9	0	0	600	850	1500	2000	15	30	0	0	0	0	0	0	0	0
10	100	180	390	700	200	500	0	0	50	0	0	0	0	0	0	0
11	300	500	700	900	1000	1500	0	0	0	0	0	0	0	0	0	0
12	1000	1000	1500	2500	500	1500	0	0	0	0	300	500	297	297	0	0
13	0	0	350	800	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	720	1500	600	1200	0	0	0	0	300	100	0	0	400	800
15	0	0	1000	2500	200	600	150	450	0	0	0	0	0	0	0	0
16	80	80	300	1300	500	2000	0	0	0	0	400	1200	0	0	250	1000
17	500	500	0	0	1000	1500	130	250	0	0	0	0	0	0	0	0
18	100	200	2500	4000	1500	3000	200	400	0	0	500	1000	600	600	0	0
19	100	200	250	400	150	250	80	150	120	0	0	0	0	0	210	420
20	50	120	0	0	500	1000	0	0	0	0	100	200	0	0	0	0
21	75	125	1000	1500	600	800	0	0	400	0	200	300	200	200	100	150
22	0	0	300	600	500	900	0	0	30	0	0	0	0	0	0	0
23	0	0	800	1000	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	600	1500	350	700	40	40	300	0	100	150	0	0	0	0
25	60	150	700	1300	1000	1600	0	0	500	0	0	0	1000	1000	0	0
26	0	0	2000	2500	1000	1500	40	40	0	0	1000	2000	0	0	0	0
27	0	0	1200	1600	300	150	25	25	150	0	200	350	0	0	0	0
28	0	0	1000	3500	100	700	20	73	0	0	100	500	0	0	0	0

APPENDIX F

RAW DATA: RESPONDENTS' MONTHLY NON-TRAVEL MONEY EXPENDITURES

TABLE F1. Monthly non-transport expenditures of respondents (Naira).

S/N	RENT		FEEDING		CLOTHING		UTILITY		RECREATION		EXT. FAM		LOAN		OTHERS	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1	0	0	50	50	370	370	80	80	0	0	0	0	0	0	0	0
2	0	0	450	450	150	395	0	0	0	0	180	290	0	0	0	0
3	0	0	600	600	900	1400	0	0	0	0	0	0	0	0	200	500
4	0	0	0	0	700	1000	0	0	0	0	0	0	0	0	300	500
5	0	0	0	0	500	700	0	0	0	0	0	0	0	0	0	0
6	0	0	500	1000	1000	1000	0	0	0	0	0	0	0	0	300	500
7	500	1000	700	1000	0	0	0	0	0	0	0	0	0	0	300	500
8	0	0	1500	2000	0	0	0	0	150	300	0	0	0	0	0	0
9	0	0	600	850	1500	2000	15	30	0	0	0	0	0	0	0	0
10	100	180	390	700	200	500	0	0	15	50	0	0	0	0	0	0
11	300	500	700	900	1000	1500	0	0	0	0	0	0	0	0	0	0
12	1000	1000	1500	2500	500	1500	0	0	0	0	300	500	297	297	0	0
13	0	0	350	800	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	720	1500	600	1200	0	0	0	0	300	100	0	0	400	800
15	0	0	1000	2500	200	600	150	450	0	0	0	0	0	0	0	0
16	80	80	300	1300	500	2000	0	0	0	0	400	1200	0	0	250	1000
17	500	500	0	0	1000	1500	130	250	0	0	0	0	0	0	0	0
18	100	200	2500	4000	1500	3000	200	400	0	0	500	1000	600	600	0	0
19	100	200	250	400	150	250	80	150	0	0	0	0	0	0	0	0
20	50	120	0	0	500	1000	0	0	80	120	0	0	0	0	210	420
21	75	125	1000	1500	600	800	0	0	0	0	100	200	200	200	100	150
22	0	0	300	600	500	900	0	0	200	400	200	300	0	0	0	0
23	0	0	800	1000	0	0	0	0	20	30	0	0	0	0	0	0
24	0	0	600	1500	350	700	40	40	100	300	100	150	0	0	0	0
25	60	150	700	1300	1000	1600	0	0	1000	500	0	0	1000	1000	0	0
26	0	0	2000	2500	1000	1500	40	40	0	0	1000	2000	0	0	0	0
27	0	0	1200	1600	300	150	25	25	400	150	200	350	0	0	0	0
28	0	0	1000	3500	100	700	20	73	0	0	100	500	0	0	0	0

TABLE F1 cont'd

S/N	RENT		FEEDING		CLOTHING		UTILITY		RECR'TION		EXT. FAM'Y		LOAN		OTHERS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
29	100	250	500	1500	200	750	0	0	0	0	200	600	0	0	0	0
30	300	300	2500	3200	500	700	180	310	0	0	0	0	0	0	500	900
31	300	450	600	950	700	950	75	150	0	0	0	0	0	0	0	0
32	0	0	0	0	500	4000	40	120	0	0	600	600	0	0	0	0
33	0	0	700	1000	200	350	0	0	0	0	200	300	0	0	0	0
34	0	0	300	500	500	2500	750	900	0	400	200	500	0	100	200	500
35	200	400	300	500	0	0	20	20	0	0	700	700	0	0	150	250
36	0	0	400	1000	0	0	0	0	0	0	400	1000	0	0	0	0
37	0	0	1000	2500	500	1000	50	150	0	0	800	1000	0	0	300	700
38	300	450	500	700	0	0	0	0	100	0	700	1000	0	0	0	0
39	0	0	3000	3000	1000	1000	200	200	0	0	0	0	0	0	0	0
40	280	380	2000	2500	500	1000	0	0	0	0	500	1000	0	0	0	0
41	70	400	1400	2500	600	1500	20	80	0	0	500	1000	0	0	0	0
42	800	800	1500	1500	650	650	0	0	0	0	0	0	0	0	0	0
43	150	480	800	1500	2000	4500	15	67	200	0	300	500	0	0	0	0
44	800	900	1200	2000	500	1000	100	200	0	0	0	0	0	0	500	1000
45	150	400	700	2100	1000	4000	50	80	800	0	0	0	0	0	300	650
46	0	0	600	1500	1000	2500	0	0	0	0	0	0	0	0	0	0
47	200	500	0	0	600	3000	0	0	0	0	0	0	0	0	0	0
48	0	0	1000	1600	600	1000	0	0	0	0	0	0	0	0	300	600
49	200	350	1700	4500	1000	3500	120	150	0	0	500	1000	0	0	0	0
50	140	300	800	1400	200	600	25	60	0	0	0	0	0	0	0	0
51	400	600	600	1200	0	0	320	500	100	200	0	0	0	0	0	0
52	250	400	800	1200	300	750	75	140	0	0	0	0	0	0	0	0
53	120	300	800	1200	500	800	80	140	0	0	0	0	0	0	0	0
54	0	0	1200	2500	200	500	0	0	0	0	0	0	0	0	300	600
55	100	250	400	700	300	400	70	90	200	0	1000	3000	0	0	0	0
56	0	0	1000	1800	500	1000	15	30	0	1200	200	2000	0	500	0	0
57	0	0	1000	2000	0	0	0	0	0	0	0	0	0	0	0	0
58	400	600	700	900	200	500	0	0	0	0	0	0	0	0	0	0
59	450	450	500	2000	700	1000	0	0	0	0	150	1500	0	1500	0	0
60	0	0	1500	2000	300	300	0	0	0	0	400	0	0	0	0	0

TABLE F1 cont'd

S/N	RENT		FEEDING		CLOTHING		UTILITY		RECREATION		EXT. FAM'Y		LOAN		OTHERS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
93	200	300	3000	4000	500	600	200	300	0	0	0	0	0	0	600	800
94	60	120	700	1400	200	150	0	0	50	150	0	0	0	0	0	0
95	100	200	600	900	500	700	0	0	100	200	0	0	0	0	0	0
96	60	135	500	2000	300	1500	30	90	0	0	200	500	0	0	0	0
97	0	0	1500	3000	100	400	0	0	0	0	300	1000	0	0	0	0
98	0	0	1000	3000	300	600	40	60	0	0	500	800	0	0	0	0
99	450	900	1200	3000	600	1400	30	100	100	500	400	1000	0	0	1000	2000
100	100	200	1000	1500	500	800	50	100	0	0	0	0	0	0	200	500
101	333	583	0	0	0	0	0	0	500	500	1000	1000	0	0	0	0
102	200	450	800	1400	600	950	120	350	0	0	100	320	0	0	0	0
103	400	833	2000	3000	600	1000	150	150	0	0	0	0	0	0	0	0
104	0	0	667	667	0	0	0	0	0	0	400	400	0	0	0	0
105	0	0	1000	2000	200	400	20	20	200	200	200	300	200	400	400	600
106	0	0	1300	1800	250	500	30	65	100	50	500	800	0	0	0	0
107	0	0	2000	4300	0	0	0	0	700	100	0	0	0	0	0	0
108	0	0	1000	3000	500	0	0	0	0	0	1000	2000	0	0	0	0
109	0	0	1000	4000	100	400	50	100	100	250	100	200	0	0	0	0
110	0	0	2000	1500	0	0	0	0	0	0	0	0	0	0	0	0
111	400	450	500	2000	200	300	10	50	0	0	300	0	210	210	0	0
112	240	450	1000	1500	300	250	40	40	300	100	1200	900	0	0	0	0
113	466	900	2000	5000	1000	2000	0	0	0	0	500	1000	0	0	0	0
114	150	600	800	2500	2000	3000	6	40	0	0	0	0	0	0	0	0
115	300	400	1000	1700	1000	2000	0	0	400	1000	0	0	0	0	0	0
116	0	0	1200	1600	700	1000	0	0	0	0	250	500	0	0	200	500
117	0	0	2000	3000	0	0	1000	0	0	0	0	0	0	0	0	0
118	0	0	700	1500	800	1300	80	120	20	40	500	700	0	0	400	600
119	0	0	500	3000	200	1000	0	0	0	0	0	0	0	0	0	0
120	0	0	1000	1800	200	500	300	400	0	0	0	0	0	0	0	0
121	0	0	300	650	400	580	20	40	10	20	200	350	1100	1100	350	400
122	450	450	800	1300	600	600	50	100	45	10	1000	1800	0	0	0	0
123	150	150	200	200	0	0	0	0	0	0	500	100	0	0	0	0
124	0	0	1000	1000	300	200	80	80	0	0	0	0	0	0	20	20

TABLE F1 cont'd

S/N	RENT		FEEDING		CLOTHING		UTILITY		RECREATION		EXT. FAM'Y		LOAN		OTHERS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
93	200	300	3000	4000	500	600	200	300	0	0	0	0	0	0	600	800
94	60	120	700	1400	200	150	0	0	50	150	0	0	0	0	0	0
95	100	200	600	900	500	700	0	0	100	200	0	0	0	0	0	0
96	60	135	500	2000	300	1500	30	90	0	0	200	500	0	0	0	0
97	0	0	1500	3000	100	400	0	0	0	0	300	1000	0	0	0	0
98	0	0	1000	3000	300	600	40	60	0	0	500	800	0	0	0	0
99	450	900	1200	3000	600	1400	30	100	100	500	400	1000	0	0	1000	2000
100	100	200	1000	1500	500	800	50	100	0	0	0	0	0	0	200	500
101	333	583	0	0	0	0	0	0	500	500	1000	1000	0	0	0	0
102	200	450	800	1400	600	950	120	350	0	0	100	320	0	0	0	0
103	400	833	2000	3000	600	1000	150	150	0	0	0	0	0	0	0	0
104	0	0	667	667	0	0	0	0	0	0	400	400	0	0	0	0
105	0	0	1000	2000	200	400	20	20	200	200	200	300	200	400	400	600
106	0	0	1300	1800	250	500	30	65	100	50	500	800	0	0	0	0
107	0	0	2000	4300	0	0	0	0	700	100	0	0	0	0	0	0
108	0	0	1000	3000	500	0	0	0	0	0	1000	2000	0	0	0	0
109	0	0	1000	4000	100	400	50	100	100	250	100	200	0	0	0	0
110	0	0	2000	1500	0	0	0	0	0	0	0	0	0	0	0	0
111	400	450	500	2000	200	300	10	50	0	0	300	900	210	210	0	0
112	240	450	1000	1500	300	250	40	40	300	100	1200	900	0	0	0	0
113	466	900	2000	5000	1000	2000	0	0	0	0	500	1000	0	0	0	0
114	150	600	800	2500	2000	3000	6	40	0	0	0	0	0	0	0	0
115	300	400	1000	1700	1000	2000	0	0	400	1000	0	0	0	0	0	0
116	0	0	1200	1600	700	1000	0	0	0	0	250	500	0	0	200	500
117	0	0	2000	3000	0	0	1000	1000	0	0	0	0	0	0	0	0
118	0	0	700	1500	800	1300	80	120	20	40	500	700	0	0	400	600
119	0	0	500	3000	200	1000	0	0	0	0	0	0	0	0	0	0
120	0	0	1000	1800	200	500	300	400	0	0	0	0	0	0	0	0
121	0	0	300	650	400	580	20	40	10	20	200	350	1100	1100	350	400
122	450	450	800	1300	600	600	50	100	10	10	1000	1800	0	0	0	0
123	150	150	200	200	0	0	0	0	0	0	500	100	0	0	0	0
124	0	0	1000	1000	300	200	80	80	0	0	0	0	0	0	20	20

TABLE F1 cont'd

S/N	RENT		FEEDING		CLOTHING		UTILITY		RECRITION		EXT. FAM'Y		LOAN		OTHERS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
125	160	500	750	2500	250	700	40	160	0	0	150	200	0	200	0	0
126	0	0	2500	4000	2000	4500	500	1050	50	100	0	0	0	0	0	0
127	1500	1500	2000	3700	500	800	0	0	0	0	250	200	0	200	0	0
128	250	500	500	2400	2400	4900	75	198	50	150	1400	2800	0	0	0	0
129	350	650	2000	3000	0	0	0	0	0	0	0	0	0	0	0	0
130	417	1000	1500	5000	500	0	0	0	300	0	500	300	0	0	0	0
131	0	0	300	600	1000	1000	0	0	0	0	0	0	0	0	0	0
132	833	1250	3000	5000	0	0	0	0	0	0	2000	3000	2000	2000	500	1500
133	70	160	500	1500	800	2400	100	400	0	0	400	750	0	0	50	250
134	0	0	1000	1500	500	500	0	0	100	100	500	500	0	0	0	0
135	500	750	4000	6000	2500	4000	500	700	1000	2000	2000	3000	0	600	2500	5000
136	100	300	1000	3500	1000	3000	0	0	0	0	400	800	200	0	0	0
137	208	417	2500	3000	417	750	200	200	0	0	0	0	0	0	0	0
138	1070	1070	2000	5000	0	0	0	0	0	0	500	300	0	0	250	150
139	0	0	1000	2000	2000	4000	750	1200	0	0	500	1000	0	0	500	1000
140	0	0	2000	4000	200	400	60	100	0	0	2000	4000	0	0	0	0
141	0	0	1000	1800	800	1500	0	0	0	0	300	500	130	130	1000	1300
142	0	0	2000	3000	1000	1500	70	70	0	0	1000	1000	0	0	0	0
143	120	150	1000	2000	500	1000	80	80	0	0	0	0	0	0	0	0
144	0	0	1500	3000	2000	4000	100	250	0	0	0	0	0	0	0	0
145	0	0	2500	4000	500	750	60	100	0	0	0	0	0	0	0	0
146	0	0	1500	2500	500	500	0	0	0	0	1000	1000	0	0	500	500
147	0	0	3000	4500	0	0	500	750	0	0	0	0	0	0	0	0
148	0	0	1100	2000	0	0	300	300	0	0	1000	1000	0	0	0	0
149	0	0	200	500	0	0	0	0	0	0	700	0	0	0	500	500
150	1000	1000	3000	3000	1000	1000	500	500	0	0	500	500	0	0	0	0
151	100	200	1000	1500	0	0	0	0	0	0	0	0	0	0	0	0
152	0	0	5000	7000	0	0	100	100	0	0	0	0	1500	1500	0	0
153	600	600	1500	3000	1000	2000	300	450	500	2000	500	1000	0	0	0	0
154	1600	1600	1000	3000	400	1000	100	300	500	100	300	800	0	800	0	0
155	625	1250	850	2000	630	2350	95	250	0	0	500	2100	0	0	0	0
156	200	600	2000	3500	0	0	100	200	0	0	500	1000	0	0	0	0

TABLE F1 cont'd

S/N	RENT		FEEDING		CLOTHING		UTILITY		RECRITION		EXT. FAM'Y		LOAN		OTHERS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
157	500	1500	1000	2000	1000	1800	200	200	200	0	500	0	0	0	0	0
158	0	0	1500	3000	2000	3000	0	0	500	200	1000	0	0	0	0	0
159	200	400	1000	2750	333	750	0	0	300	140	417	0	0	300	0	150
160	0	0	800	2000	1000	1500	0	0	300	500	700	400	1000	200	400	400
161	75	120	1000	3000	200	300	10	50	80	100	100	0	0	50	180	180
162	0	0	2000	4000	500	1500	0	0	0	0	2000	0	0	0	0	0
163	400	550	800	1400	250	480	200	320	0	0	220	0	0	0	0	0
164	200	400	2000	3000	500	600	100	100	500	500	0	0	0	0	0	0
165	0	0	2000	5000	1000	3000	40	80	500	200	100	0	0	0	0	0
166	0	0	3000	3000	0	0	0	0	0	0	600	0	0	0	0	0
167	200	450	1500	3000	0	0	0	50	0	0	500	0	0	0	0	2000
168	500	1000	2000	3500	0	0	0	0	0	0	5500	0	0	0	0	0
169	0	0	2500	4000	2000	1500	100	300	300	150	100	0	0	300	0	600
170	125	250	2000	2000	250	583	0	0	0	0	4000	0	0	0	0	0
171	0	0	1000	2000	1000	2000	0	0	0	0	1000	0	0	0	0	0
172	1200	1200	1000	2500	0	0	40	40	0	0	0	466	466	0	0	0
173	0	0	3000	3000	1800	4000	50	250	0	0	1000	0	0	500	0	1000
174	0	0	8000	10000	5000	8000	2000	3000	500	2000	2000	0	0	0	0	0
175	600	700	2000	3000	1000	2000	33	63	200	300	2000	0	0	0	0	0
176	0	0	6000	8000	2000	4000	0	0	0	0	600	0	0	0	0	0
177	580	830	1700	2800	500	700	600	1000	0	0	500	0	0	0	0	0
178	0	0	833	1667	200	500	2000	2500	0	0	2000	0	0	0	0	0
179	0	0	2000	4000	500	800	200	400	50	100	200	0	0	0	0	0
180	0	0	1500	3000	500	1000	150	250	200	500	1000	0	0	0	0	0
181	500	500	3000	3600	600	800	200	400	0	0	0	0	0	500	900	900
182	1000	1000	3000	3000	1000	1000	0	0	0	0	0	0	0	0	0	0
183	1000	1500	1000	2500	2750	4830	0	0	500	550	3000	0	0	0	0	0
184	0	0	0	0	400	800	0	0	0	0	0	0	0	0	0	0
185	400	600	1200	2600	1000	1000	300	450	200	400	1000	0	0	0	0	0
186	530	850	1500	2500	800	1200	0	0	0	0	0	0	0	400	600	600
187	200	500	1500	2700	500	800	2000	1500	1000	600	1200	890	890	0	0	0
188	0	0	5000	10000	2500	3500	1500	2000	0	0	1000	500	500	1000	1000	1000

TABLE F1 cont'd

S/N	RENT		FEEDING		CLOTHING		UTILITY		RECREATION		EXT. FAM'Y		LOAN		OTHERS	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
189	0	0	4800	5700	1200	1800	530	720	0	0	500	800	0	0	1900	2000
190	0	0	10000	15000	2500	5000	0	0	200	500	1000	5000	0	0	1000	5000
191	600	600	1500	3000	0	0	1200	2500	0	0	0	0	0	0	0	0
192	1667	2500	4000	6000	1667	2000	500	800	1000	2000	2000	3000	0	0	2500	5000
193	0	0	3000	5000	300	200	50	50	0	0	0	0	0	0	500	600
194	300	600	1200	1600	800	1200	120	200	0	0	800	1400	0	0	0	0
195	0	0	2000	4000	0	0	500	1100	0	0	0	0	0	0	0	0

Observations 193, 194, and 195 are the outliers in the data set.

B Before period. A After period.

APPENDIX G

FORMULAE AND TEST STATISTICS USED

I. ANOVA

TABLE G1. One-way ANOVA (Analysis of variance) table.

Source of variation	Sum of squares	Degrees of freedom	Mean square	Variance ratio, F
Between columns	$SS_B = \sum (\hat{X} - \bar{X})^2$	$m-1$	$MS_B = SS_B / (m-1)$	MS_B / MS_W
Within columns	$SS_W = \sum (X - \hat{X})^2$	$n-m$	$MS_W = SS_W / (n-m)$	
Total	$SS_T = \sum (X - \bar{X})^2$	$n-1$		

In the table, X is the criterion variable, which in this work was travel money expenditure, $\bar{X}$ is the mean value of X over all the observations or units of study, $\hat{X}$ is the mean for each column or category considered, n is number of observations, m is number of columns or categories in the descriptor variable.

2. Paired two sample t-test of mean difference.

According to Miller and Freund (1987), the conventional two-sample t-test of difference of means is not applicable where samples are not independent such as in a "before and after" kind of data. For this case, what are used are the signed differences of the paired data and the test is whether these differences belong to a random sample from a population whose mean is equal to a certain figure, usually zero. For small samples (size less than or equal to 30), the t-test is used, while it is the z-test that is used for large sample.

The test statistic for each sample type and the associated hypotheses and rejection criterion are as below;

$$\text{Small sample test statistic: } t = (\bar{X} - \mu_0) / (S / \sqrt{n}) \quad (G1)$$

$$\text{Large sample test statistic: } z = (\bar{X} - \mu_0) / (\sigma / \sqrt{n}) \quad (G2)$$

Null hypothesis: $H_0: \mu=0$ (where μ is the mean of the population difference sampled)

Alternative hypothesis: $H_1: \mu \neq 0$

Criterion: Reject the null hypothesis if $|t| > |t_{\alpha/2, n-1}|$ in the small sample test, and $|z| > z_{\alpha/2}$ which at $\alpha = 5\%$ is 1.960, where α is the level of significance.

3. Pairwise correlation coefficient, r , between two variables, Y and X, is:

$$r = \frac{\sum (Y_i - \bar{Y})(X_i - \bar{X})}{[\sum (Y_i - \bar{Y})^2 \sum (X_i - \bar{X})^2]^{1/2}} \quad (G3)$$

The summation is over the number, n , of observations. The Student's t-test for significance of pairwise correlation coefficient is:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad (G4)$$

which follows the t-distribution with $n-2$ degree of freedom if the null hypothesis is true, i.e., if $H_0: \rho=0$ is true. The alternative hypothesis is $H_1: \rho \neq 0$. The null hypothesis is rejected if $|t| = |t_{\alpha/2, n-2}|$.

4. Regression coefficient of determination, R^2 , and F ratio for regression analysis of variance or test of significance.

For constant term model:

$$R^2 = \frac{\sum (\hat{Y}_i - \bar{Y})^2}{\sum (Y_i - \hat{Y}_i)^2} \quad (G5)$$

i.e., regression sum of squares divided by total sum of squares, where Y_i is the i th observed dependent variable, $\bar{Y}$ is the mean of the observed dependent variables, and $\hat{Y}_i$ is regression estimate of the dependent variable. The associated standard error of estimate, SE, is

$$SE = \sqrt{\frac{\sum (\hat{Y}_i - \bar{Y})^2}{n - m - 1}} \quad (G6)$$

where m is the number of independent variables in the model, while the 1 that appears in the denominator stands for the constant term. The summation is over the number, n , of the observations used in estimating the model. The F-ratio test of significance of model is estimated as:

$$F = \frac{R^2}{1 - R^2} \frac{n - m - 1}{m} \quad (G7)$$

For no-constant term model:

The corresponding for regression coefficient of determination, standard error of estimate, and variance ratio test of significance of model, respectively, are:

$$R_0^2 = \frac{\sum \hat{Y}_i^2}{\sum Y_i^2} \quad (G8)$$

$$SE = \sqrt{\frac{\sum (\hat{Y}_i - \bar{Y})^2}{n - m}} \quad (G9)$$

$$F = \frac{R_0^2}{1 - R_0^2} \frac{n - m}{m} \quad (G10)$$

APPENDIX H
DETAILS OF PAIRED t-TEST

TABLE H1. Results of paired t-test of difference between means of MEB and MEA

Income group	n	$\bar{x}$	s or σ	t-test	$t_{0.025, n-1}$ or $Z_{0.025}$	Remarks
<1000	5	-52.00	134.82	-0.086	-2.776	H ₀ not rejected.
1001-2000	34	339.76	503.09	3.938	1.960	H ₀ rejected.
2001-3000	53	349.47	484.97	5.247	1.960	H ₀ rejected.
3001-4000	40	519.03	826.61	3.971	1.960	H ₀ rejected.
4001-5000	24	909.46	990.42	4.738	2.069	H ₀ rejected.
5001-6000	11	950.00	1288.21	2.446	2.228	H ₀ rejected.
6001-7000	13	1702.08	1256.29	4.885	2.179	H ₀ rejected.
7001+	12	1210.00	971.17	4.316	2.201	H ₀ rejected.

H₀ not rejected: Difference not significant. H₀ rejected: Difference significant.

TABLE H2. Results of paired t-test of difference between means of DIB and DIA

Income group	n	$\bar{x}$	s or σ	t-test	$t_{0.025, n-1}$ or $Z_{0.025}$	Remarks
<1000	5	-196.00	195.61	-2.241	-2.776	H ₀ not rejected.
1001-2000	34	-349.18	276.93	-7.352	-1.960	H ₀ rejected.
2001-3000	53	-732.83	468.50	-11.388	-1.960	H ₀ rejected.
3001-4000	40	-847.48	827.94	-6.474	-1.960	H ₀ rejected.
4001-5000	24	-1161.21	719.08	-7.911	-2.069	H ₀ rejected.
5001-6000	11	-1581.36	744.55	-7.044	-2.228	H ₀ rejected.
6001-7000	13	-1272.23	961.62	-4.770	-2.179	H ₀ rejected.
7001+	12	-1516.08	1054.38	-4.981	-2.201	H ₀ rejected.

TABLE H3. Results of paired t-test of difference between means of TEB and TEA

Income group	n	$\bar{x}$	s or σ	t-test	$t_{0.025, n-1}$ or $Z_{0.025}$	Remarks
<1000	5	300.00	234.20	2.867	2.776	H_0 rejected.
1001-2000	34	1814.94	1203.71	8.792	1.960	H_0 rejected.
2001-3000	53	2342.49	2239.11	7.616	1.960	H_0 rejected.
3001-4000	40	2716.33	1897.79	9.081	1.960	H_0 rejected.
4001-5000	24	3447.71	2180.50	7.746	2.069	H_0 rejected.
5001-6000	11	3326.18	2001.86	5.511	2.228	H_0 rejected.
6001-7000	13	4884.08	2915.04	6.041	2.179	H_0 rejected.
7001+	12	5132.58	4678.54	3.800	2.201	H_0 rejected.

APPENDIX I

ANOVA DETAILS FOR SELECTION OF CRITICAL PERSON

DESCRIPTORS

TABLE 11a. ANOVA details for selection of person descriptors for "before" case

Descriptor variable	Source of variation	Amount of variation	D.f.	Estimated variance	F-ratio	Critical F
Income	Bt. col. means	4882322.14	7	697474.59	3.42	2.01
	Within col. means	37504603.61	184	203839.37		
	Total	42386925.75	191			
Car Own.	Bt. col. means	9497442.16	2	4748721.08	27.29	3.00
	Within col. means	32889483.59	189	174018.43		
	Total	42386925.75	191			
Age	Bt. col. means	1727394.01	4	431848.50	1.99	2.37
	Within col. means	40659531.74	187	217430.65		
	Total	42386925.75	191			
Marital status	Bt. col. means	719727.00	1	719727.00	3.28	3.84
	Within col. means	41667198.75	190	219301.05		
	Total	42386925.75	191			
Household status	Bt. col. means	1738204.03	4	434551.01	2.00	2.37
	Within col. means	40648721.72	187	217372.84		
	Total	42386925.75	191			
Employment status	Bt. col. means	536351.57	2	268175.79	1.21	3.00
	Within col. means	41850574.18	189	221431.61		
	Total	42386925.75	191			
Sex	Bt. col. means	64402.06	1	64402.06	0.29	3.84
	Within col. means	42322523.69	190	222750.13		
	Total	42386925.75	191			

TABLE 11b. ANOVA details for selection of person descriptors for "after" case

Descriptor variable	Source of variation	Amount of variation	D.f.	Estimated variance	F-ratio	Critical F
Income	Bt. col. means	58827214.10	7	8403887.73	8.23	2.01
	Within col. means	187888004.26	184	1021130.46		
	Total	246715218.36	191			
Car Own.	Bt. col. means	140850102.15	2	70429551.08	125.75	3.00
	Within col. means	105856116.21	189	560085.27		
	Total	246715218.36	191			
Age	Bt. col. means	37721261.93	4	9430315.84	8.43	2.37
	Within col. means	208993956.43	187	1117614.74		
	Total	246715218.36	191			
Marital status	Bt. col. means	12436360.24	1	12436360.24	10.09	3.84
	Within col. means	233278858.12	190	1233046.62		
	Total	246715218.36	191			
Household status	Bt. col. means	13006480.82	4	3251620.20	2.60	2.37
	Within col. means	233708737.54	187	1249779.35		
	Total	246715218.36	191			
Employment status	Bt. col. means	1018020.00	2	509010.00	0.39	3.00
	Within col. means	245697198.36	189	1299985.18		
	Total	246715218.36	191			
Sex	Bt. col. means	80354.23	1	80354.23	0.06	3.84
	Within col. means	246634864.13	190	1298078.23		
	Total	246715218.36	191			

APPENDIX J

K-MEANS ALGORITHM

In K-Means clustering, a data set of M observations ($I=1,2,3,\dots,M$) of N variables ($J=1,2,3,\dots,N$) is partitioned into K clusters such that (1) the partition $P(M,M)$ is composed of K clusters ($L=1,2,3,\dots,K$) and (2) each of the M observations lies in just one of the K clusters. Essentially, the algorithm involves the minimization of the discordance between the units or observations and their partition into the K clusters (Hartigan, 1975).

If the mean of the J th variable over the cases in the L th cluster is denoted by $B(L,J)$, and the cases in the cluster by $N(L)$, the distance between the I th observation (or a unit in the sample being clustered) and the cluster (i.e., the L th cluster) is expressed as,

$$D(I,L) = (\sum_{J=1}^N \{A(I,J) - B(L,J)\}^2)^{1/2} \quad (J1)$$

where $A(I,J)$ is the value of the I th case of the J th variable. The summation of the square of this distance over the data set is the error of the partition. It is expressed as;

$$e[P(M,K)] = \sum_{I=1}^M \{D[I, L(I)]\}^2 \quad (J2)$$

where $L(I)$ is the cluster containing the I th case. $D[I, L(I)]^2$, which is the same thing as $D(I,L)$, is more appropriately called the euclidean distance between I and the cluster mean of the cluster containing I .

Having decided on the number of clusters, K , for the particular partitioning assignment at hand, the observations or units are arranged into each cluster of the K clusters by moving units from one cluster to another and calculating the error, $e[P(M,K)]$, for each arrangement. The search for an appropriate partition or cluster pattern ends when no movement of units between clusters reduces the error.

The steps in this search process as outlined in Hartigan (1975) are;

Step 1. Choose a cluster number, $K (L=1,2,\dots,K)$ and arrange the units into the clusters. Compute the means of each variable for each cluster, $B(L,J) (1 \leq L \leq K, 1 \leq J \leq N)$, and the initial partition error, $e[P(M,K)]$.

Step 2. For the first observation or unit, compute for every cluster, L , the expression

$$\frac{N(L)D(L,L)^2}{N(L)+1} - \frac{N[L(1)]D[L,L(1)]^2}{N[L(1)]-1} \quad (J3)$$

as "the increase in error in transferring the first unit from $L(1)$ to which it belongs at present, to cluster L . If the minimum of this quantity over all $L \neq L(1)$ is negative, transfer the first case from cluster $L(1)$ to this minimal L , adjust the cluster means of $L(1)$ and the minimal L , and add the increase in error (which is negative) to $e[P(M,K)]$."

Step 3. For the l th case ($2 \leq l \leq M$), repeat Step 2.

Step 4. If no unit can be moved between clusters, then stop. Otherwise, go back to Step 2.

APPENDIX K

DETAILS OF K-MEANS CLUSTERING EXERCISE

TABLE K1. Pairwise correlation coefficient comparison for the cluster plans tested

Period	Correlation coefficient	Sample value	Number of segments in cluster plan ¹					
			3	4	5	6	7	8
Before	r _{CARS-MEB}	0.472	1.00	0.999	0.998	0.695 ²	0.857	0.851
	r _{INCOME-MEB}	0.349	1.00	0.995	0.991	0.360 ²	0.601	0.494
After	r _{CARS-MEA}	0.746	0.890	0.909 ²	0.898	0.910	0.915	0.890
	r _{INCOME-MEA}	0.453	0.782	0.474 ²	0.455	0.425	0.386	0.216
	r _{MSTATUS-MEA}	0.225	0.995	0.991	0.921 ³	0.919 ³	0.906 ³	0.426 ³
	r _{HSTATUS-MEA}	0.199	0.991	0.850	0.764	0.754	0.766	0.287
	r _{AGE-MEA}	0.365	0.995	0.953	0.949	0.925	0.931	0.900

¹ Correlation coefficients for cluster plans with two segments were all 1.00.

² Closest value to sample value where all variables are significant at the 5% level.

³ Variable not significant at the 5% level in the analysis of variance for the cluster plan

TABLE K2. K-MEANS clustering ANOVA results for the adopted segmentation plans

Period	Variable	Between sum of squares	D.f. ¹	Within sum of squares	D.f. ¹	F-ratio	Probability
Before	CARS	15.850	5	47.395	186	12.441	0.000
	INCOME ²	0.809624E+09	5	0.568363E+08	186	529.909	0.000
	MEB	0.162305E+08	5	0.261564E+08	186	23.083	0.000
After	CARS	24.440	3	38.796	188	39.491	0.000
	INCOME ²	0.705771E+09	3	0.160690E+09	188	275.240	0.000
	MSTATUS	1.736	3	35.243	188	3.087	0.028
	HSTATUS	16.341	3	255.653	188	4.006	0.009
	AGE	1884.510	3	12103.407	188	9.830	0.000
	MEA	0.145869E+09	3	0.100846E+09	188	90.645	0.000

¹ Degrees of freedom.

² Based on actual incomes and not truncated incomes.

TABLE K3. Allocation of respondents to segments

S/N	B	A	S/N	B	A	S/N	B	A	S/N	B	A	S/N	B	A	S/N	B	A
1	1	1	33	5	2	65	1	1	97	6	4	129	5	1	161	1	1
2	1	1	34	1	1	66	5	1	98	5	1	130	5	1	162	1	1
3	1	1	35	1	1	67	1	1	99	5	1	131	5	1	163	5	2
4	1	1	36	1	1	68	5	1	100	1	1	132	6	1	164	5	2
5	1	1	37	1	1	69	2	2	101	5	1	133	5	2	165	5	1
6	1	1	38	1	1	70	5	1	102	1	1	134	5	2	166	2	4
7	1	1	39	1	1	71	1	1	103	1	1	135	5	2	167	2	2
8	1	1	40	1	1	72	1	1	104	6	1	136	5	2	168	2	4
9	1	1	41	1	1	73	6	4	105	1	1	137	5	2	169	1	1
10	1	1	42	1	1	74	5	1	106	5	2	138	5	4	170	1	1
11	1	1	43	1	1	75	1	1	107	5	1	139	5	4	171	5	1
12	1	1	44	1	1	76	1	1	108	1	1	140	5	4	172	2	2
13	1	1	45	1	1	77	1	1	109	5	1	141	5	1	173	2	4
14	1	1	46	1	2	78	5	1	110	1	1	142	5	1	174	2	4
15	1	1	47	1	1	79	5	2	111	4	4	143	1	1	175	2	2
16	6	1	48	1	1	80	1	1	112	1	1	144	1	1	176	2	4
17	1	1	49	1	1	81	1	1	113	1	1	145	1	1	177	2	2
18	1	1	50	2	2	82	2	2	114	5	1	146	5	2	178	2	4
19	1	1	51	1	1	83	5	1	115	5	1	147	1	1	179	2	4
20	1	1	52	4	3	84	2	2	116	5	1	148	1	1	180	2	4
21	6	4	53	5	1	85	5	1	117	5	1	149	1	1	181	4	2
22	1	1	54	1	1	86	1	1	118	6	1	150	5	1	182	1	1
23	1	1	55	2	4	87	1	1	119	1	1	151	5	1	183	4	4
24	1	1	56	6	1	88	1	1	120	1	1	152	5	2	184	4	4
25	1	1	57	1	1	89	1	1	121	1	1	153	6	4	185	1	1
26	1	1	58	1	1	90	1	1	122	1	1	154	5	4	186	4	3
27	1	1	59	5	4	91	1	1	123	1	1	155	5	2	187	4	3
28	6	1	60	1	1	92	1	1	124	2	2	156	5	2	188	3	3
29	1	1	61	1	1	93	5	1	125	1	1	157	2	4	189	3	3
30	1	1	62	1	1	94	5	1	126	2	2	158	2	4	190	3	3
31	1	1	63	5	2	95	5	1	127	5	1	159	2	2	191	3	3
32	5	1	64	2	4	96	5	1	128	5	1	160	6	4	192	3	3

B: "Before" segment number (1 to 6 segments);

A: "After" segment number (1 to 4 segments).

=: Demarcation between succeeding income groups (8 income groups).

APPENDIX L

DETAILS OF HETEROSCEDASTICITY TESTS

TABLE L1. Model residuals by income groups and Bartlett's χ^2 test details (Critical $\chi^2=3.841$)

Model number	1	2	3	4	5	6	7	8	9	10
Residuals by income group										
<1001	2.24	-704.23	30.47	4.95	2.22	-163.22	52.55	6.14	2.22	-474.90
1001-2000	-3.98	-295.12	-45.92	-50.27	-6.30	246.35	-49.45	-50.08	-3.98	293.78
2001-3000	-41.11	-406.11	-81.19	-257.32	-41.11	-110.91	-86.24	-257.13	-41.11	-7.85
3001-4000	33.94	-427.86	52.69	15.43	38.94	-312.27	59.69	15.62	38.94	-135.39
4001-5000	10.14	8.94	-58.05	16.54	10.14	124.51	-49.39	16.73	10.14	260.87
5001-6000	-61.28	-376.97	101.40	253.60	-61.28	-213.73	98.29	293.79	-61.28	-114.48
6001-7000	67.13	447.82	-17.72	334.69	67.13	621.18	-12.44	334.88	67.13	419
7001+	-9.55	-701.17	18.78	-346.08	-9.55	-204.36	11.99	-346.27	-9.55	-285.72
Bartlett's χ^2 test details										
S ₁	26.66	150.63	54.59	109.98	28.47	205.09	63.38	110.15	28.39	275.65
S ₂	45.95	429.49	58.79	264.40	45.95	339.85	54.34	272.15	45.95	282.37
Q	0.48	1.64	0.01	1.19	0.38	0.43	0.04	1.26	0.39	0.05
I	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
χ^2	0.44	1.51	0.01	1.10	0.36	0.39	0.04	1.17	0.36	0.05