UTILITY PAYMENT PLAN CHOICE: EFFECT ON HOUSEHOLD NATURAL GAS CONSUMPTION AND COST

By

LORI E. WORTHINGTON

Bachelor of Science

Cameron University

Lawton, Oklahoma

1989

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
July, 1991

UTILITY PAYMENT PLAN CHOICE: EFFECT

ON HOUSEHOLD NATURAL GAS

CONSUMPTION AND COST

Thesis Approved:

Sue E. Williams

Thesis Adviser

Gong-soog Hong

Richard Dodder

Norman N. Durham

Dean of the Graduate College

PREFACE

This study was possible due to the assistance of many people. First of all, I would like to thank those who provided financial assistance to myself or to the project from which this study came: the College of Home Economics, the University Center for Energy Research, and the Gladys T. Logue Graduate Fellowship. Appreciation is also extended to the Oklahoma Natural Gas Company and the county assessors' offices for their assistance in providing data for this project.

Sincere thanks is also given to all those who provided leadership and guidance throughout the course of my graduate work. First of all, I would like to thank the members of my graduate committee: to Dr. Gong-Soog Hong, thanks is extended for her encouraging words, her willingness to share her time and knowledge, and most of all for her role as a mentor; to Dr. Richard Dodder, thanks are given for the enthusiasm and patience he showed while teaching statistics; and to my major advisor, Dr. Sue Williams, I would like to say thank you for her guidance, her professional advice, and most of all for not loosing her wonderful sense of humor. Thanks also goes to Dr. Margaret Weber. Although not on my committee, she willingly helped in any way that was asked. I would also like to thank Dr. Mikkiyoung Ha for her time and assistance in the analysis and interpretation of the data. A very special thank you goes to Jamie Girard, my very good friend and colleague. Her support and friendship were invaluable. I also thank Lynda Dillwith for sharing her word processing expertise. Lynda's willingness to help and her unending patience insured the success of this study.

This acknowledgement would not be complete without thanking my friends and my family. To my friends and most of all my roommates, thanks is given for their friendship, encouraging words, and most of all for understanding when I was "too busy" for them. Last, but not least, I would like to thank my family for their love, support, and for the value of education that they instilled in me at a very young age. Their undying faith in me and my abilities encouraged me to strive towards and achieve my goal of obtaining a Master's degree.

TABLE OF CONTENTS

Chapter	Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Statement of the Problem

For several decades before 1970, natural gas and electric utilities were in the enviable position of watching their costs and rates decrease while their profits increased. This was the direct result of increased economics of scale, technological advances, and the availability of oil that was relatively cheap. During these prosperous times, the utilities, the regulators, and the customers became content; thus they were unprepared to deal with the soon to be energy crisis (Henderson, 1979).

The Arab oil embargo of 1973-74, subsequent price increases by OPEC, a major economic recession, and continuous increases in consumer energy demand had a detrimental effect on America's energy situation. Between the years of 1969 to 1974, the price for natural gas as well as for fuel oil, electricity, and gasoline increased more than any other item on the consumer price index, with the exception of food. During this time, the sharp increases in utility rates, especially during the unusually cold winters of 1976-77 and 1977-78, have come to symbolize the economic dimensions of the energy crisis in America (Henderson, 1979).

As America entered and progressed through the decade of the eighties, anxieties concerning it's energy supplies seemed to diminish. As oil prices dropped, a false sense of security evolved. It appeared that apathy replaced the desire for a strong, aggressive national energy policy (Routh, 1989).

In 1989, it was confirmed that America was continuing to consume more energy per capita than any other nation. America was using increasing amounts of energy while it's oil production was at an all time low. Foreign imports had once again begun to climb rapidly (Committee on Energy and Commerce, 1989).

After considering America's sharply rising consumption rate, the question that arose was whether or not these trends were likely to continue, making the United States increasingly dependent on foreign oil. This is of particular concern since most of the known oil reserves are heavily concentrated in the Middle East. It has been estimated that approximately 53 percent of the world's remaining oil reserves are located in this area.

In 1989, a government report stated, that while the United States is less vulnerable today than it was a decade ago, unexpected developments in the Middle East could have an unfavorable impact in the decade to come (Committee on Energy and Commerce, 1989). In fact, during early 1991, this prediction became an alarming truth. The conflict in the Persian Gulf, which evolved into a full scale war, vividly illustrated the seriousness of America's dependence on such an unstable area. It is thought that America may once again realize the need for a strong aggressive national energy policy.

The first step towards achieving long-term energy security is to validly assess the problem (Sweet and Hexter, 1987). In 1989, it was estimated that America's sharp rise in energy consumption was costing consumers about $30 billion per year in higher energy bills (Committee on Energy and Commerce, 1989). According to Prindle and Reid (1988), energy costs were second only to rent or mortgage payments for consumers of all income levels. Therefore, the high cost of energy has an impact on all consumers, but it has an extremely detrimental effect on low and fixed income consumers. Families whose incomes fall below the poverty threshold spend an average of more than one third of their income for energy costs (Prindle and Reid, 1988). Norgaard and Jensen (1985), stated that between the years of 1974 to 1983, wages in the 50 states and the District of Columbia rose 196% while the cost of natural gas rose 425% and the cost of electricity rose 230%. Since low income residents spend a large amount of their income on such costs, this disproportionate rise in costs had a drastic effect on this group as a whole.

Henderson (1979), identified utility bills as the most continuous and essential cost which faces low income households. In 1987, Brown stated that "the inability of low income households to meet their gas and electric bills poses, in human terms, the most compelling issue facing state utility regulators" (p.9). Therefore, consumer advocates, state agencies, legislators, and utility representatives have lobbied for utility reform and billing procedures which address the issue of fairly and equitably distributing energy from the utilities to all consumers (Routh, 1989).

In 1985, the Oklahoma Corporation Commission ruled that the utility companies in Oklahoma must offer their customers the option of averaging their utility bills over the time period of one year (Oklahoma Corporation Commission, 1985). Because of this ruling, the billing option known as the average monthly payment plan (AMP plan) was developed. This billing process is also known as budget billing or levelized billing. These terms are used synonymously throughout the literature. This billing process mathematically divides the utility customer's total yearly cost into 12 equal bills or payments. This policy was developed to benefit low and fixed income customers. The system evolved because it appeared that the major problem of many disadvantaged consumers was the fluctuation of their utility bills during high energy usage months (McDermott, Guldmann, Pfister, & Kumari, 1980).

Due to the implementation of many AMP plans, McDermott et al. (1980) prepared an in-depth report for the United States Department of Energy. This report dealt with the use of budget billing for both natural gas and electric utilities. One of the main recommendations made by the study was that further consideration should be given to the AMP plan's effect on energy consumption. It was concluded that the budget billing plan misguides consumers by providing them with a muted price signal. In the long run, it was thought that this muted price signal may have actually caused the consumer to use more energy. This increased consumption translated to increased costs (McDermott et al., 1980).

In a study conducted by the Lincoln Electric Service, it was found that not only did the muted price signals have a negative effect on consumers, but they also had a negative effect on the conservation of energy (Lincoln Electric Service (LES), 1976). Norgaard and Jensen (1985) state that conservation requires an understanding of what motivates individuals to minimize utility costs. In a market economy, price allocates services. Individuals respond to the price signals and avenues that bypass the price signal promote waste. The conclusion of the LES study (1976) was that "budget billing should not be approved for implementation for the Lincoln Electric System" (p.5). The concept of budget billing is against the intended purpose of seasonal rates (LES, 1976).

Relatively few studies have investigated the consumption and cost differences between AMP and non-AMP customers. Furthermore, there appears to be a definite void in the literature concerning natural gas consumers. An exploratory study conducted by Routh (1989) which involved electric utility data, concluded that consumers using the AMP plan consume and pay more for electricity than do consumers not on the AMP plan. The findings from the Routh (1989) study suggest that in the long run, AMP consumers will pay significantly more for their utility services. This increased cost could be detrimental to those the AMP plan was designed to benefit: low and fixed income consumers. The findings not only suggest that the AMP plan is detrimental to consumers but increased consumption can be detrimental to society as well (Routh, 1989). As the preceding literature has illustrated, America is seriously becoming dependent of foreign oil. It is imperative that America change it's consumption patterns. Public policies should be encouraging increased conservation, not increased consumption.

Henderson (1979), suggested that advocates of the poor should differentiate strategies by fuel type. Utility decision making about gas, electricity and other fuel types differentially affect the poor. The strategies devised by advocates should be sensitive to the differences in types of utilities and the equity issues they raise (Henderson, 1979). This recommendation as well as the findings from the

Routh (1989) study suggest that there is a need to evaluate the natural gas customers using the AMP plan. It is felt that such an evaluation could be conducted by replicating the study done by Routh (1989). Such a replication would use natural gas consumers instead of electrical energy consumers.

The AMP plan was enacted without prior research of similiar programs or review of studies which had been conducted (Routh, 1989). Since that time, what little research that has been done suggests that the AMP plan is not fulfilling it's intended purpose. It has become apparent that a study should be conducted using data from natural gas AMP consumers. It is necessary that research determine whether or not the AMP plan is detrimental to the financial well-being of low and fixed income consumers. Conducting a replicated study using natural gas consumers may support the findings of the Routh (1989) study which would warrant a restructuring of the AMP policy. If findings are not supported, a call for further research is needed.

Purpose of the Study

The purpose of this study is to assess the effect of payment plan choice interacting with specific housing characteristics, household income, and residential location on total and seasonal household natural gas consumption and cost. This study and it's specific components will be a replication of the study conducted by Routh (1989). Specific objectives of this analysis included:

1. Identify effect of payment plan choice, specific housing characteristics, household income, and residential location on total household natural gas consumption and cost.

2. Identify effect of payment plan choice, specific housing characteristics, household income, and residential location on seasonal household natural gas consumption and cost.

3. Develop a model for the effect of payment plan choice, specific housing characteristics, household income, and residential location on household natural gas consumption and cost.

Assumptions

For this study it was assumed that:

1. The sample was representative of customers who participated in the AMP plan and those who did not use the AMP plan within an Oklahoma natural gas utility company.

2. Data acquired from property assessment records were representative of specific housing characteristics.

3. Appraised property values were an accurate proxy for household income levels.

4. The price variable was treated as a constant since consumption between consumers who do and do not participate

in the AMP plan does not vary when considering seasonal changes and price structure variations.

Limitations

The following limitations are acknowledged for this study:

1. The sample was limited to Oklahoma customers of an Oklahoma natural gas utility company which serves a large portion of Oklahoma.

2. Contact with customers was prohibited by the utility company. Thus, the effect of behavior and attitudes were not included in the estimation equation. Additionally, information about appliance ownership and use was also not available.

3. Reference to thermal efficiency of the dwellings was also restricted due to the lack of accurate information from residential energy audits.

4. Due to the fact that complete data were not available for all the observations, the number of the observations that fell out of the stepwise regression analysis had the potential of being fairly large. For the stepwise regression, the number of observations that were complete was 197.

5. For this study, it would useful to be able to compare the consumption patterns of the AMP consumers before and after they began using the AMP plan; however, these data

were not available. Therefore, it was not possible to conduct such a comparative analysis.

Definitions of Terms

The following definitions will be used in this study:

AMP consumers (Averagers): Those utility customers who have elected to use the average monthly payment plan.

Average monthly payment plan (AMP): The mathematical process of evenly dividing a natural gas utility customer's yearly total natural gas cost over 12 monthly billing periods (McDermott, et al., 1980).

Household: Consists of an individual or individuals who reside in a dwelling.

Household natural gas cost: The dollar charge assessed by the natural gas utility company for MCF consumption and service. In other words, the cost represented by the monthly utility bill.

MCF (Million Cubic Feet): The unit of measurement for the consumption of natural gas. One MCF is equal to 1,000 cubic feet.

Non-AMP customers: Those natural utility customers who have chosen not to use the AMP plan. Their monthly natural gas bills have reflected actual consumption and charge for the billing period.

Property appraised value: The value of land and improvements (i.e., home and other structures) as assessed by county governments.

Tenure: Term used to refer to the date when the consumer moved into their present home.

CHAPTER II

LITERATURE REVIEW

Introduction

Prior to the energy crisis of the seventies, research concerning energy was limited. During this pre-embargo era, Americans were experiencing prosperous times. Concerns about energy were virtually non-existent. However, as the energy crisis evolved, interest in energy research soared and the amount of published energy research became abundant. This literature review will focus on the various aspects of energy research related to the present study. Specific emphasis will be placed on natural gas as a household fuel source and on the average monthly payment plan. Energy demand expenditure patterns, and consumption factors will also be included.

Consumer Energy Expenditures

Although America is no longer experiencing an energy crisis as it did in the seventies, increasing energy costs have become a major concern for many residential utility customers (Everett & Malko, 1977). As previously stated energy costs are second only to rent or mortgage payments for consumers of all income levels (Prindle & Reid, 1988). Energy rates have never returned to their pre-embargo level. In fact, cost has continued to increase along with consumption levels. Americans are consuming more energy than ever before and this increase in use translates to consumers paying about $30 billion more in energy bills each year (Committee on Energy and Commerce, 1989).

Energy assistance emerged as a pressing national concern during the seventies and has not been out of the spotlight since (Sweet & Hexter, 1987). This is due to the fact that America's low-income households have been under increasing pressure as they try to pay for their utility costs. These costs continue to account for an increasing proportion of the low income household's financial resources. In the aggregate, direct household energy costs rise into the millions of dollars. For the average household, costs are relatively small compared to income; however, for low income households the burden created by energy costs is not minor (Everett & Malko, 1977).

A 100 percent increase in the price of energy would reduce the real income of the average American household by 9.9 percent. In contrast it would reduce the real income of the poorest decile by 34 percent and the wealthiest decile by 5 percent. The real income effects among the poor are about seven times those seen among the rich. It has been estimated that low-income households pay between 22 and 36 percent of their incomes for energy (Sweet & Hexter, 1987).

Serious disparities between energy and income continuously plague this nation's poor; therefore, low income households divert larger percentages of their disposable income away from basic necessities such as food and medicine so that they can pay their utility bill (Rhodes, 1980). Cullen, Johnson, & Sommers (1983), refer to this situation as the "eat or heat" dilemma.

The Consumer Expenditure Survey of 1986 reported that households spent an average of 1,646 dollars for housing costs such as utilities, fuel, and public services. In relation to total household expenditures, this amount had risen from 28.7 percent of total household expenditures in 1979 to 30.3 percent in (Bureau of Labor Statistics, 1988).

As predicted by Brazzel and Hunter (1979), the impact of rising energy costs has been more substantial than for middle or high income households. It has become starkly apparent that energy policies at all levels must take into account the fact that incomes for many of America's households will continue to lag behind inflation, an important component of which is utility costs (Sweet & Hexter, 1987). In response to this alarming situation new and effective solutions must be found to alleviate America's growing problem of fuel poverty (Rhodes, 1980).

Consumer Search Behavior

In economic theory, the decision to consume a good is usually the result of a search. Consumers engage in search behavior so that they may take advantage of the best price available for the good they wish to purchase. Consumers will engage in search until the marginal benefit equals the marginal cost of the search. However, in the case of unique goods the cost of search is typically so expensive that consumers take advantage of goods offered locally (Stigler, 1961). In the case of natural gas, search behavior does not typically take place due to the uniqueness of the utility market. Utilities, such as natural gas, are typically provided by only one service company for a designated area. Consumers usually do not have any choice as to where they will purchase their fuel. This means that they have no reason to search, because they have no choice as to where they may purchase their natural gas supply. Due to the uniqueness of the utility market, consumers do not make consumption decisions in the same manner as they do for other economic goods.

Consumer Energy Consumption and Conservation

The interrelated topics of consumer energy consumption and conservation are ones that have been the focus of numerous research efforts (Bauer & Badenhop, 1984). Basically, there are two approaches to analyze the influences on energy consumption. One consists of economic demand functions which were derived from the combination of classical demand theory, household income, price of energy, and energy use as a function of the price of the energy source being considered. The second is an analysis using multiple regression to analyze various demographic, climatic, and economic factors (Baxter, Feldman, Schinnar, and Wirtshafter, 1986).

When the quantity demanded or the level of consumption of energy is considered, the fact that Americans are consuming increasing amounts of energy often emerges. Van Raaij and Verhallen (1982) addressed this issue by asking, "Why do not all consumers behave in a more energy-conscious way?" (p.40). First, it was suggested that one possible answer is that energy conservation is not viewed as a problem which concerns them personally (Van Raaij & Verhallen, 1982). In another article by these researchers it was stated that consumers will only act according to their attitudes when they perceive themselves to be personally responsible for energy problems, and when they perceive that their personal contribution to conservation is effective (Verhallen & Van Raaij, 1981). Another study concluded that people are more likely to accept conservatory policies if they understand that energy resources are not infinite and that each individual is responsible for his or her energy consumption (Morrison, Gladhart, Zuiches, Keith, Keefe, & Long, 1978). A second possible answer to the question was that the social environment in which the consumer resides does not induce energy-conscious behavior. A third proposed answer was that the feedback information derived from the energy bills came too late to make people aware that they were practicing energy wasting behavior. Another proposed answer was that most consumers are not aware of the costs of many household behaviors. A fifth answer dealt with the person's home. Many homes and heating systems are not energy efficient; therefore, consumers may have little control over their energy consumption. It was also suggested that many consumers are selfish in that they refuse to give up the comfort they derive from high home temperatures (Morrison, Gladhart, Zuiches, Keith, Keefe, & Long, 1978). Van Raaij and Verhallen's (1982) final answer was that energy conservation requires some degree of extra effort. Many people may not be willing to add the responsibility of energy conservation to their list of important concerns.

It also appears that income status is linked to conservation. It has been concluded that low-income consumers do not usually adopt new conservation practices due to the fact that they cannot easily reduce their energy usage any further (Newman & Day, 1975; Cunningham & Joseph, 1978). On the other end of the income bracket, conservation does not take place due to the fact that high income consumers are unwilling to reduce their energy usage. It appears that the middle income sector of society is the group most likely to adopt energy conservation practices (Cunningham & Joseph, 1978).

As it has already been stated, sources of domestic energy are not expected to increase; therefore, conservation must become an important issue in the United States (Karns & Khera, 1983). Decreased consumption does not necessarily mean decreased standard of living. In 1979, Stobaugh and Yergin estimated that the United States could use 30 to 40 percent less energy and still maintain it's current standard of living.

Price

In traditional economic theory, price serves as a signal which provides information on the cost of consumption. In a competitive market, this price is determined where price equals the marginal cost of production (McDermott et al., 1980; Gwartney & Stroup, 1987). Energy prices are a very important factor in the utility industry. The law of demand states that the quantity demanded of a product is inversely related to it's price (Gwartney & Stroup, 1987). Based on this theory, pricing systems, like those used for public utilities, have been devised as a means of signaling the consumer. As conservation became an important issue many different types of pricing systems were proposed as a way of placing higher price rates on increasing levels of consumption. The ultimate goal of these price systems was to coerce consumers into beginning to make intelligent economic decisions concerning their energy consumption (Blocker, 1983).

Feedback Mechanism

Ultimately, price is a feedback mechanism which provides the customer the information needed to make consumption decisions (McDermott et al., 1980; Van Raaij & Verhallen, 1982). Given this important fact, policy makers must be concerned that prices do not become distorted from the true value they are intended to represent. If prices become distorted to the extent that they underrepresent costs, more energy will be used than is economically efficient. On the other hand, if prices overstate costs, then energy consumption will fall below an economically efficient level (McDermott et al., 1980). Prices must not be overlooked in energy reform, it has been found that household energy consumption may be significantly influenced by the price of the energy source (Gladhart, 1984).

Elasticity

The extent to which a change in price affects the quantity of energy demanded is expressed in terms of price elasticity. Gwartney and Stroup (1987) stated that "price elasticity of demand indicates the degree of consumer response to variation in price" (p. 379).

The precise distinction between demand being elastic or inelastic is determined by calculating the elasticity coefficient. This calculation is done by dividing the percent change in quantity demanded by the percent change in price:

$$\varepsilon = \frac{\Delta \% Q d}{\Delta \% P} \qquad (1)$$

If the coefficient is greater than the absolute value of 1 then demand is considered elastic; however, if the coefficient is less than the absolute value of 1 the demand is inelastic. If the coefficient is 1 then the demand is referred to as unitary elastic (Gwartney & Stroup, 1987). Traditionally, normal goods, such as food, tend to be price inelastic. In other words, the rate at which these items was demanded did not decrease as quickly as the price increased. On the other hand, luxury items, such as fine jewelry, tend to be price elastic (Williams, 1984).

Economists, as well as other professionals, have estimated the price elasticity of demand for numerous goods (Gwartney & Stroup, 1987). In the case of utility policies this is thought to be very important. Estimates of price elasticity often prove to be extremely beneficial when formulating utility policies (Henson, 1984). For example, if the price elasticity of demand for energy is elastic then a price increase would result in reduced consumption; therefore, a price increase could be used by utility policy makers to encourage conservation. On the other hand, if the demand for energy is inelastic a price increase would do little to encourage conservation (Williams, 1984). Reliable estimates of the price elasticity of demand can be used to avoid making serious energy policy errors (Henson, 1984).

It has been suggested by at least two studies that households with differing levels of income may react to price changes of energy in various ways. It was considered that the low income consumers are affected adversely by increases in energy rates. These households cannot easily adjust their consumption due to the fact that it has been found that low income households cannot reduce their energy use any further; therefore, increases in price cause these households to respond by foregoing other necessities or by depriving themselves of comfort (Newman & Day, 1975; Cunningham & Joseph, 1978). One specific study concluded that households with an annual income of 5000 dollars or less are the least price sensitive income group (Cunningham & Joseph, 1978). On the other end of the income spectrum, it was found that the wealthy are also not responsive to price. These high income families tend to adjust so that they can continue to purchase the same amount of energy. The middle income bracket of families tend to be the group which exhibits the highest rate of price responsiveness (Newman & Day, 1975; Cunningham & Joseph, 1978).

Routh (1989) concluded from these two studies that the time frame in which the influences on consumption were noted was very important. Initial changes due to a price increase during a short length of time could be minimal due to the fact that housing structures and appliances were fixed. "Thus, results could indicate that households may not be sensitive toward price as measured by change in quantity demanded" (Routh, 1989, p. 26).

In the literature which analyzed the price elasticity of demand, Routh (1989) found that for electricity, the price elasticity coefficient was quite small in value. It was then concluded that for household electricity, the demand would most likely be inelastic (Routh, 1989).

For natural gas, Barnes, Gillingham and Hagemann (1982) found an overall short run price elasticity of demand of -.0682. Thus, it was concluded that the short run price elasticity of demand for natural gas was inelastic. For income elasticity of demand, MacAvoy (1983) made an estimate of .65.

These results indicate that the effect of a one percent change in price on the quantity of natural gas consumed is relatively close to the effect of a one percent change in income. The relevance of the two intervening variables - price and income - is largely dependent upon on the size of the changes in the percentages for price and income for the study group during the study time period (Williams, 1984).

Household Energy Consumption Factors

A common question in energy research often concerns the factors that are necessary to conduct a meaningful research study (McDermott et al., 1980). Due to the uncertainty and the limited sets of variables used in many of the previous studies, conclusions concerning household energy factors have often been inconsistent; therefore, it is still very important that household and housing characteristics be evaluated as to their relation to household energy consumption (Ritchie, McDougall & Claxton, 1981).

Size of House

House size, which can be measured several ways, is a factor that numerous studies have linked to energy usage (Morrison, 1975; Morrison et al., 1978; Ritchie et al., 1981; Van Raaij & Verhallen, 1982; Routh, 1989). One measurement that has been significantly linked to energy usage is the number of rooms in a house. In 1975, Morrison found that the number of rooms in a house explained a significant portion of the variation found for energy consumption; furthermore, in 1978 Morrison et al. again drew the conclusion that the number of rooms in a house significantly affected energy consumption. In 1981, it was found by Ritchie et al. that families occupying larger homes were consuming significantly larger amounts of energy. Throughout the literature, the size of the house, measured by the number of rooms, was found to be positively related to energy consumption of all energy forms (Routh, 1989).

Another proxy variable that researchers often use to represent house size is the number of bedrooms and bathrooms in a housing structure. The Sierra Pacific Power Company (1979) found that for winter gas consumption, the number of bedrooms and bathrooms were a significant predictor.

However, the question as to how accurately the number of bedrooms represents house size has been raised. For instance, two houses with the same number of bedrooms could have significantly different square footages. In such a situation, how accurate would such a measure be (Routh, 1989)?

Actual square footage can also be used as a predictor of household energy consumption; however, few studies do so (Routh, 1989). As with much of the literature there appears to be a void concerning this subject for natural gas; however, the Routh (1989) study which used electricity, found that square footage was a positive predictor of energy consumption.

Age of House

In their book, Sweet and Hexter (1987) concluded that home heating was directly related to the age of the house. Older homes in this country are generally less energy-efficient than are newer ones (Sweet & Hexter, 1987). Lower amounts of energy are consumed per unit of floor space in newly built dwellings as compared to older ones (Committee on Energy and Commerce, 1989). This improved efficiency is primarily due to the fact that as time progresses, technological advances strive to improve all things, including energy efficient materials used in homes.

Physical Condition

Numerous studies have concluded that the physical condition of a house has a positive effect on energy consumption (Newman & Day, 1975; Verhallen & Van Raaij, 1981; Van Raaij & Verhallen, 1982; Sweet and Hexter, 1987). Verhallen and Van Raaij (1981) addressed the topic of physical condition numerous times in their research. They concluded that home improvement and retrofitting had a substantial effect on energy consumption. Homes with superior insulation were found to have the tendency to use substantially lower amounts of natural gas. This finding was especially true during the winter months (Verhallen & Van Raaij, 1981).

Routh (1989) found that little research had appropriately illustrated how physical condition could effect a household's energy consumption. It has since been concluded that this void in research continues, especially for the fuel source of natural gas.

Income

As the literature was reviewed, one household demographic characteristic that consistently appeared to have an effect on energy consumption was household income (Newman & Day, 1975; Everett & Malko, 1977; Hogan & Paolucci, 1979; McDougall, Claxton, Ritchie, & Anderson, 1981; Van Raaij & Verhallen, 1982; Sweet & Hexter, 1987;).

As referenced earlier, Newman & Day (1975) concluded that low income households use the lowest amount of energy possible. They typically cannot conserve energy due to the fact that the majority of their energy consumption is for non-discretionary purposes (Van Raaij & Verhallen, 1982). Generally, as the middle and upper income households purchase housing they tend to choose newer more energy efficient dwellings; thus, the older less efficient housing filters down to the poor. Such housing does not lend itself well to energy conservation (Van Raaij & Verhallen, 1982; Sweet & Hexter, 1987). Although the more efficient sector of the population tends to live in fairly energy efficient dwellings, these homes are usually larger; therefore, the use of energy is still greater than that of the poor. It was found that the more affluent spend about 40 percent more on natural gas used for heating (Van Raaij & Verhallen, 1982). Newman and Day (1975) as well as Morrison et al. (1978) concluded that as family income increased so did the amount of energy which was consumed. Newman and Day (1975) also found that for natural gas usage, the higher income families tended to consume 40 percent more energy than their less affluent counterparts. Cunningham and Lopreato (1977) recommended that conservation efforts be focused on the higher income bracket of society.

In a Canadian study, income was found to be the most significant variable in the given set of demographic variables. In this particular study, family income continuously proved to be the most significant variable even when included with other variables. Furthermore, Gladhart (1984) found that as family income increased by 1000 dollars energy consumption also increased by about 70,000 to 1.6 million BTUs.

As with the Routh (1989) study, most of the literature which was reviewed consistently found that household income was a significant factor concerning energy conservation. McDermott et al. (1980) specifically stated that family income should be considered when conducting energy consumption research. It was also stated that such a variable should either be quantified or at the very least represented by a reasonable proxy variable (McDermott et al., 1980).

Location of Residence

Location of the residence is another demographic variable which could contribute to household energy usage. However, few studies have analyzed whether or not location significantly affects energy usage. In 1987 the Energy Information Administration (EIA) confirmed that urban and rural households differed in their energy consumption patterns. When compared on their average energy usage, urban households consumed more energy on the average than did the rural households (EIA, 1987). The fact that a household is either rural or urban may have an affect on the type of utility service to which the household has access.

A study which analyzed electricity usage, concluded that rural residents used more electricity than did urban residents because the rural households were more dependent upon electricity for water heating, space heating, and cooking (Ruffin & Weinstein, 1979). Although this study did not consider natural gas usage, it would appear that location might also effect usage rates, due to the fact that three energy uses stated by Ruffin & Weinstein (1979), water heating, cooking, and space heating, could utilize natural gas as a fuel source. This is particularly true in Oklahoma.

Location is a demographic variable that has been considered in relatively few studies, but the significance for this variable should not be overlooked. Additional information concerning this variable, especially for the fuel source of natural gas, would be useful to future energy research (Routh, 1989).

Average Monthly Payment Plan

The impact of rising energy costs over the past two decades caused considerable concern among utility companies, policymakers, and even the consumers themselves. This concern sparked a period of utility reform which produced various solutions to the energy crisis of rising utility bills. One such policy which was developed was the AMP plan. The original intent of this payment plan was to reduce the impact or financial strain high utility payments place on low and fixed income households. It was thought that by evenly distributing a household's energy cost over twelve months budgeting would become easier and energy costs more manageable (McDermott et al., 1980). The Oklahoma Corporation Commission first approved the use of the AMP plan on September 26, 1976 (Routh, 1989) and in January of 1985, the Oklahoma Corporation Commission ruled that each utility company should offer it's residential consumers the option of participating in some type of an AMP plan. The ruling required that each utility submit a proposed plan to the commission; therefore, variations exist between utility companies (Oklahoma Corporation Commission, 1985). The remainder of this literature review will focus on the AMP plan in general as well as on the AMP plan in use at Oklahoma Natural Gas Co.

Calculation

Given the objective that the AMP plan was developed to help reduce the impact of widely fluctuating utility bills, the customer's past energy consumption is usually the basis for the calculated average monthly payment. Most AMP plans use the last twelve month's energy consumption to determine a 12 month estimate for total yearly consumption. This yearly amount is then divided by 12 to yield an average amount. The following equation illustrates this calculation process:

Monthly Payment Plan = 12 preceding month's billing/12 (McDermott et al., 1980). (2)

The Oklahoma gas utility being reviewed uses this method for their calculation of a customer's historic consumption (L. Harmon, personal communication, February 27, 1991).

Billing Practices

A very important component in the AMP plan is the manner in which payments are readjusted after a certain length of time. McDermott et al. (1980) stated that there are two basic methods used to limit the extent of under or over payments. The first method is to recalculate the customer's historic consumption at various time intervals. These time intervals vary from once a month to once a year. This procedure allows for adjustments upward or downward so that present consumption habits can be reflected in the billing plan. The length of time between adjustment intervals is thought to have a substantial effect on a consumer's consumption habits. The shorter the time frame, the more accurately the customer's average payment will reflect current energy consumption patterns; therefore, appropriate price signals are sent (McDermott et al., 1980).

A second method which is sometimes used to balance the customer's payment plan is the use of an adjustment month. During such a month, any credit or debit must be paid either to the customer or to the utility. This debit or credit balance can be handled various ways. Some utilities handle the over or under payment situation on a strictly cash payment basis; therefore, any credit or debit balance is paid in cash at the end of the budget period. Other utilities use a running credit procedure. This procedure handles the overpayment by applying the resulting credit balance to the customer's bill until it is exhausted or by amortizing the payments over the next billing period's time frame. Under payments or debit balances are handled in a similar manner. They are either paid in cash over the next two months or are amortized over the next billing period (McDermott et al., 1980).

In some cases, the customer may be given an option of choosing which method will be used. McDermott et al. (1980) stated that a particularly equitable solution is one that allows customers to avoid overpayment by paying only the amount used if it is less than the budgeted amount. On the contrary, a debit balance would either be paid in cash or amortized if extremely large (McDermott et al., 1980).

Readjustment calculations should be handled in a manner which is equitable to both the customer and the utility. It is obvious that the various methods discussed are not equally advantageous to the customer and the utility. Methods which benefit only the utility must not be tolerated. One such example is the method which handles credit balances by using amortization or by applying the credit to future bills. This method allows the utility to keep the customer's money; thus, resembling an interest free loan. If the AMP plan is to fulfill it's goal of benefitting low and fixed income consumers, then detrimental practices must not be used (McDermott et al., 1980).

The Oklahoma Natural Gas Co. readjusts it's customers' payment plans on a yearly basis. Each year during the anniversary month in which the customer first enrolled in the AMP plan, the customer's account is balanced. During this balancing procedure the amount actually paid is compared to what is actually owed. If the customer has a debit balance, the amount owed to the gas company is amortized over the next year's billing cycle; thus increasing the customer's monthly bill. If the customer's account has a credit balance then the amount owed to the customer is amortized over the next year's billing cycle; thus, decreasing the customer's monthly payment (L. Harmon, personal communication, February 27, 1991). It would appear that this readjustment procedure is more beneficial to the utility than to the customer. It appears to be what McDermott et al. (1980) referred to as resembling an interest free loan.

The method of amortizing the amount the customer owes to the utility company further distorts the relationship between the amount of energy used and the amount of the utility bill. It further removes energy use from consumer decision making; thus the utility bill is not useful as a feedback mechanism.

Economic theory and empirical findings have emphasized time and time again the importance of information and feedback in relation to energy consumption (Routh, 1989). The monthly bill received by an energy consumer is the source of such information; therefore, much concern is expressed concerning the format of the bills received by the budget billing customers. If efficient consumption is to be encouraged, then the bills that are sent to the AMP customers should not only state the budget payment but also the actual cost of the energy which was consumed. The bill should give the customer a running balance on the status of the account so that the customer can become aware of the difference between the levelized payment and the actual cost. Another form of information which would be beneficial to the consumer would be comparative data. Data such as this could either compare the customer's present usage to the previous month's usage or could compare it to the same month's usage from the previous year. This information would be helpful in that it would allow the consumers to realistically analyze their consumption patterns (McDermott et al., 1980).

The bills received by the AMP customers of the Oklahoma Natural Gas Company state the customer's monthly average payment as well as the actual amount that was used. It also states the actual cost of the natural gas which was used and reflects the customer's current account balance (L. Harmon, personal communication, February, 1991).

If consumers are to react in an energy conscious manner, they must be furnished with and use accurate billing information. Misguided billing practices, which do not provide consumers with accurate information, go against all goals of energy reform targeted at low and fixed income consumers (McDermott et al., 1980).

One point that, that must not be overlooked is that it is likely that some customers may not use billing information even if it is given in an accurate easy to read manner. This type of consumer might respond to a monetary cue; thus, it is important that the AMP plan not distort the price cue.

Impact of AMP

One final area that warrants consideration is the projected impact of the AMP plan on consumers and their consumption decisions. In a report to the United States Department of Energy, McDermott et al. (1980) concluded that the AMP plan mutes the price signal; therefore, overconsumption occurs. This conclusion is consistent with the findings from the Routh (1989) study which stated that participation in the AMP plan tended to cause consumers to increase their demand for electricity; thus, increasing energy costs. In the long run, increased utility costs could prove to be detrimental to those the AMP plan was originally designed to benefit: low and fixed income consumers (Routh, 1989). This increased consumption also has serious implications for society as a whole, in that it contributes to the growing problem of dependence on foreign oil. The literature from the Lincoln Electrical Service (1976) specifically states that the AMP plan has a negative impact on the conservation of energy.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to assess the effect of payment plan choice interacting with specific housing characteristics, household income, and residential location on total and seasonal household natural gas consumption and cost. Data in this replicated study were collected and analyzed according to this purpose.

Sample

The data set which will be used consists of a five percent random sample of AMP customers from Oklahoma Natural Gas Company's central Oklahoma service area. This sample was composed of 300 households. An equal number (300 households) of the non-AMP customers was also chosen by random sampling so that the total number of households was 600. After the random sample was selected, it became necessary to eliminate some of the customers due to the following problems:

1. Incomplete utility cost and usage records.
2. Inability of meter location to be translated into a legal description.

3. Meter was for a mobile home or for a commercial property.

Of the 600 customers, the final sample size which will be utilized was 569. Of these, 298 were non-AMP customers and 271 were AMP customers. Complete cost and consumption data were available for these 569 customers. Of these 569, property tax information was available for 469 records. Due to the fact that data, such as property tax information, were not available for all of the customers, specific components of the analysis could cause the sample size to vary.

Methodology

This project is classified as an explanatory study due to the fact that the relationship between payment plan choice, specific housing characteristics, household income, location of residence, and household natural gas consumption and cost will be explored by using a non-experimental design. Explanatory research is the discovery and reporting of relationships among different aspects of the phenomena under study (Babbie, 1989). The preceding literature review provided justification for the variables which were selected. The relationship of the selected variables was conceptualized into a model based on previous literature and the results of the study being replicated (See Figure 1). The data source, which has already been discussed, yielded the variables which will be used to fulfill the objectives.

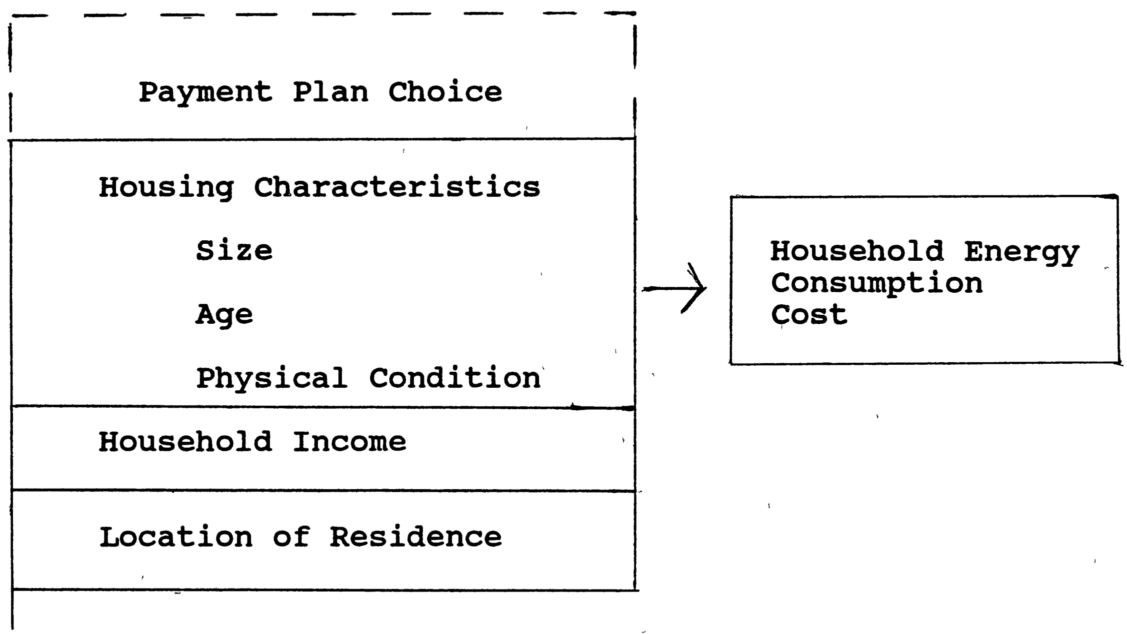


Figure 1. Conceptual Model of Influences on Household Energy Consumption and Cost

This study is a modified replication of the study conducted by Routh (1989) entitled Average Monthly Payment Plan: Effect on Household Energy Consumption and Cost. Routh's study used electrical energy consumers; however, the present study used natural gas consumers. Replication is suggested as a practice in social research to guard against over-generalization. It is also suggested that it be used as a way to strengthen the validity of the findings. Best (1981), states that replication is a way to challenge or verify the conclusions of a previous study. Replication is done using different subjects, at a different time, in a different setting (Best, 1981). Replication is a standard procedure in the field of physical science; however, social scientists often overlook this important research method (Babbie, 1989). In the case of this specific study, replication is necessary not only to reinforce the generalizability and validity of past and present findings but also to differentiate among fuel types. Henderson (1979) specifically states that energy research should be differentiated by fuel types.

This study was referred to as a modified replication, due to the fact that since the Routh (1989) study was conducted it has become evident that there were modifications that could be made to the study. Specifically, for the collinearity test, this study used a more advanced objective statistical analysis than did Routh (1989). Although modifications were made, they were not such that they jeopardized the replication process, if anything, they strengthened it.

Pre-Test

To determine if a replication of the Routh (1989) study using natural gas consumers was warranted, a pre-test was conducted using the data collected from the Oklahoma Natural Gas Company. The objective of the pre-test was to determine whether or not the natural gas AMP and non-AMP consumers differed natural gas consumption and cost. If these two groups were shown to not differ, then this study would not be worthwhile.

The data set which was used for the pre-test was previously described in chapter III. The AMP and the non-AMP data were analyzed for differences using t-test procedures. The t-test assessed differences between mean amounts of natural gas used and between the cost of the natural gas used. It was also used to assess the differences between the two groups, AMP and non-AMP, for selected household and housing characteristics. The variables used were payment plan choice, household income, square footage of house, year house was built, and tenure. Tenure refers to the year in which the customer moved into the house.

Dependent Variable

Total and seasonal household natural gas consumption and cost were the dependent variables. The monthly natural gas consumption was measured in million cubic feet (MCF), while the monthly costs were measured in dollars. These costs were actually reflected on the gas bills of the non-AMP customers; however, the AMP customers received bills reflecting their averaged charges. The AMP customers' costs were recorded as the actual charges they would have received had they not been participating in the AMP plan. The actual monthly costs for the AMP and the non-AMP customers were utilized rather than the averaged charges.

Total consumption and cost were divided into seasonal values: winter and summer. By assessing a mean for each variable from the months of October to March, winter season consumption and costs were determined. Likewise, by determining the mean values of consumption and cost for the months of May thru September, summer usage and cost were determined (Williams, Weber, Routh, 1988).

Energy consumption and cost were both included in the equation because cost is not a consistent linear function of consumption. Natural gas is priced using a declining rate structure. Such a pricing structure, differs from the price structures used for many other consumer goods and services. Thus, consumption and cost were not considered in a traditional economic context. For utility research, such as this study, consumption and cost must be analyzed seperately.

Independent Variable

The independent variables of this study, which were chosen to represent specific housing characteristics, were age of house, house size, and physical condition. Payment plan choice, household income, and location of residence were also be included in the analysis as independent variables.

Square footage of the house was entered as the actual square feet of the living space. Areas such as garages, porches, and storage areas were excluded. The age of the house was recorded as the year in which the construction of the house was completed.

The variable referred to as physical condition was a comparison of the present physical condition with a new physical condition. This comparison was expressed in a percentage. Each of the counties' field appraisers assigned this percentage according to a structure's physical depreciation. The structures were also graded according to maintenance and condition of exterior and interior walls, doors, windows, and roofs (Routh, 1989). The lower the physical condition percentage, the greater the deterioration of the structure. A larger percentage translated to a higher structural maintenance.

The variable of payment plan choice was established as a dichotomous variable. Each household in this study either participated in the AMP plan or did not participate in the AMP plan.

Household income for each customer was represented by a proxy variable equal to the combination of the dollar amounts of land valuation and of total improvements. The appraised values of land and improvements were obtained from county tax records. These values were calculated by each county's tax assessor. The values represent approximate market values of the properties. The use of appraised value of house and land as a household income proxy has been documented in previous economic literature (Howe & Linaweaver, 1967; Grima, 1973; Danielson, 1979; Jones & Morris, 1984; Routh, 1989).

Location of residence, which was also a dichotomous variable, was classified as either rural or urban. The meter readings which were located in counties outside the Standard Metropolitan Statistical Area (SMSA) as established by the U.S. Bureau of Census (1980), were categorized as rural. The addresses which were located in counties inside the SMSA were labeled as urban (U.S. Bureau of Census, 1980).

Data Collection

Although the collection of consumption data directly from utility companies is quite costly and time consuming, McDougall et al. (1981) stated that it was the foundation for future energy research. Thus, this study like the one being replicated, used this data collection method. The data on the monthly costs and consumption levels were obtained during 1989. This utility data were furnished for a sixteen month period from October 1987 to January 1989.

Appraised property values, square footage data, age of house, and physical condition were collected from the county assessment records during 1989. This data were collected by contacting the various county assessors' offices by mail or by actual visits.

The utility company requested that contact not be made with the customers; therefore, a secondary source was used to obtain household data. This secondary data source was county assessment records. Appraised property value, square footage, age of house, and physical condition data were obtained from these records. Besides the fact that these county records provided information otherwise unavailable, it is thought that secondary data sources are advantageous because they provide data at a faster and less expensive rate than do original surveys (Babbie, 1989).

The county assessment records in Oklahoma are maintained by the county assessors. These records are listed by the legal description for the residential, commercial, and industrial properties within each county. Appraised values of land and improvements have been calculated using the notations of each county's field appraisers. These appraisers visit property sites and note improvements, list dwelling characteristics, and rate structures according to established criteria (Routh, 1989).

The fact that several pieces of information such as age, square footage, and physical condition of the structure could be obtained about each individual property was an advantage to using property assessment records. On the contrary, a disadvantage is that these records were often found to be inconsistent from county to county. Many of the counties collected extensive information concerning the interior and exterior structural characteristics and appliance stocks, while others only collected information concerning the exterior of the household. These inconsistencies posed a challenge in obtaining consistent and sufficient data to be used in the analysis (Routh, 1989).

Analysis

The monthly cost and consumption data were coded and records which were incomplete were eliminated. Data obtained from the county property assessment records were coded and then merged with the monthly consumption and cost data. Coded as continuous value data were monthly natural gas consumption and cost, age of house, square footage, household income proxy, and physical condition. Payment plan choice and location of the residence were represented by data on the nominal level.

To achieve the established objectives and to analyze data for model development, multiple regression with stepwise techniques was utilized. This specific statistical technique was used due to the fact that it had the capacity to offer a fuller explanation of the dependent variable. Furthermore, it has the capability of incorporating several independent variables into the equation and the effects of each influence could be precisely determined. It has been proclaimed that interaction effects exist when an influence of a particular variable is affected by a value of an additional independent variable (Lewis-Beck, 1980). This statement along with information from Neter, Wasserman, & Kutner (1983) led to the development of an equation which was designed to determine the impact of independent variables whose effect on the dependent variable could interact with other variables as cross product or interaction terms. Routh (1989) stated that previous research was the basis for the justification of the hypothesized interactions. This statement was made due to the fact that it could be concluded that energy consumption could be affected by household and structural characteristics. These effects could have the capability to increase the magnitude of the final analysis (Routh, 1989).

Household natural gas consumption and cost will be predicted using a multiple stepwise regression technique that employs the best set of independent variables which resulted from a stepwise procedure (Neuter et al., 1983). It was thought that by sequentially selecting variables which greatly augment the explained variance at each step, redundant variables would be deleted from the proposed equation (Chatelain, 1981). This analysis was valuable in the situation where numerous variables could have contributed to the dependent variable (Routh, 1989).

The effect of the independent variables interacting with payment plan choice on total and seasonal natural gas consumption and cost was assessed using the following equation:

$$Y_i = b_0 + b_1\text{PLAN} + b_2\text{SIZE} + b_3(\text{PLAN SIZE}) + b_4\text{AGE} + b_5(\text{PLAN AGE}) + b_6\text{CONDITION} + b_7(\text{PLAN CONDITION}) + b_8\text{INCOME} + b_9(\text{PLAN INCOME}) + b_{10}\text{LOCATION} + b_{11}(\text{PLAN LOCATION}) + e \quad (3)$$

where as i= 1, 2, 3, and 4

Y_1 = Total household natural gas consumption

Y_2 = Seasonal household natural gas consumption

Y_3 = Total household natural gas cost

Y_4 = Seasonal household natural gas cost

b_0 = Intercept

PLAN = Payment Plan Choice

SIZE = Square Footage of Residence

AGE = House age

CONDITION = Physical Condition of the Structure

INCOME = Appraised Property Value as a Proxy Variable for Household Income

LOCATION = Location of Residence

e = Error term

This equation was also utilized to assess the effect of the independent variables on seasonal household natural gas consumption and on total and seasonal natural gas cost. The findings from this analysis were used to finalize the conceptual model development process.

CHAPTER IV

RESULTS

Introduction

The purpose of this study was to replicate the study done by Routh (1989) using natural gas consumers. The first two objectives dealt with identifying the effect of payment plan choice, specific housing characteristics, household income, and residential location on total and seasonal household natural gas consumption and cost. The third objective was to develop a model which conceptualized the effect of payment plan choice, specific housing characteristics, household income, and residential location on household natural gas consumption and cost. To achieve these objectives, ordinary least squares (OLS) regression with stepwise techniques was utilized. From the results of the regression, modifications were made concerning the proposed concept model.

Characteristics of the Sample

To determine if statistically different amounts of natural gas were used by the AMP and non-AMP consumers, a pre-test was conducted in a manner similar to that done by Routh (1989). For both the AMP and the non-AMP natural gas customers, means were calculated for the independent and the dependent variables and then analyzed using a t-test procedure. Results from this analysis are presented in Table I. The average house size for the AMP consumers was 1471.227 square feet while the average size for the non-AMP consumers was 1445.75; therefore, there was no significant difference found for house size between the two groups.

Concerning the variable age of house, on the average the AMP homes were built in 1957. For the non-AMP consumers the average year of construction for their homes was 1961. When analyzed using a t-test procedure, the average age of the homes for both groups, AMP and non-AMP, were not significantly different.

No significant difference occurred between the AMP and the non-AMP consumers when average land valuation was compared. For the AMP group, the average valuation was $11238.48 and for the non-AMP group, the average was $11254.50.

Total improvements were also assessed and evaluated. The AMP consumers exhibited an average improvement value of $41,757.88, while the non-AMP consumers had an average improvement value of $42,419.85. When analyzed using t-test procedures, no significant difference was found between the two groups.

For the variable of tenure, which was translated as when the consumer moved into the house, the AMP consumers had an average tenure date of approximately 1980. The non-

AMP households had an average tenure date of approximately 1982. When statistically analyzed, it was found that the AMP consumers had lived in their current house significantly longer than had the non-AMP consumers.

Concerning the physical condition of the homes in which the sample lived, the AMP consumers had an average improvement percentage of 73.35 while the non-AMP group had an average percentage of 76.58. These improvement percentages were found to not be significantly different.

Natural Gas Consumption and Cost

For the sample, means were also calculated and analyzed using a t-test for natural gas consumption and cost. The results of these analysis are reported in Table II. For Winter consumption, the AMP households used an average of 82.09 MCF while the non-AMP households used an average of 70.55 MCF. For the cost of the natural gas used in the winter, the AMP consumers paid an average of $346.44 while the non-AMP consumers paid an average of $305.74. For both winter cost and consumption, it was found that the AMP households used and paid significantly more for natural gas than did the non-AMP households.

For the variable of summer consumption, the AMP household used an average of 15.94 MCF, while the non-AMP households used an average amount of 16 MCF. For the amount of gas used in the summer, the AMP households paid an

TABLE I

T-TEST RESULTS FOR AMP AND NON-AMP HOUSEHOLDS

Variable	AMP	NON-AMP	t	P-Value
Square footage	1471.27	1445.75	-.425[c]	.671
Year built	1957.21	1960.54	1.822	.069
Land valuation ($)	11238.48	11254.50	.021	.983
Total improvements ($)	41757.88	42419.85	.287[c]	.983
Tenure	80.37	82.30	2.664	.009*
Physical Condition ($)	73.35	76.58	1.538	.126

* $p<.05$

[c] = unequal variance

average of \$93.72 while the non-AMP households paid and average of \$85.19. For the cost and consumption of natural gas in the summer, it was found that the two groups, AMP and non-AMP, did not differ significantly.

Means were also calculated and assessed for total cost and consumption. For the total amount of natural gas used, the AMP households used an average of 149.45 MCF while the non-AMP households used 132.43 MCF. When considering the cost difference, AMP households paid an average of \$652.98 while the non-AMP households paid an average of \$582.35. For both variables, total cost and total consumption, the AMP consumers used and paid significantly more than did the non-AMP households.

Regression Analysis

The effect of the predictor variables on household natural gas consumption and cost was evaluated using two analytical steps: (a) determination of the "best" combination of predictor variables with stepwise regression procedures and (b) assessment of the reduced set of statistically significant variables with multiple regression analysis.

To select the "best" set of predictors, the stepwise procedure known as the "maximum R^2 stepwise technique" was utilized. At each step, this technique chose the next single variable which in combination with previously selected variables maximized the coefficient of multiple

TABLE II

T-TEST RESULTS FOR AMP AND NON-AMP HOUSEHOLDS

	AMP	Non-AMP	t	P-Value
Winter Consumption (MCF)	82.09	70.55	-4.074*	.0001
Summer Consumption (MCF)	15.94	16.00	.026*	.979
Total Consumption (MCF)	149.45	132.43	-2.480*	.014
Winter Cost ($)	346.44	305.74	-3.074*	.002
Summer Cost ($)	93.72	85.19	-1.861	.063
Total Cost ($)	652.98	582.35	-3.041*	.003

* $p<.05$

^{c} = unequal variance

determination (R^2). R^2 was defined as a measurement of the proportionate reduction of total variation in a dependent variable associated with use of the selected set of predictor variables (Neter et al., 1983). Within the stepwise procedure, the combinations of the variables were evaluated at each step using the criterion of maximizing R^2 to the fullest extent, regardless of the variables selected in the previous steps. For this particular analysis, the collection of the variables was more important than the individual predictors (Routh, 1989).

The model used for the regression analysis procedure which was derived from the maximum R^2 stepwise technique was selected based on three criteria: 1) statistical significance ($\alpha = .1$), 2) maximizing R^2, and 3) decreasing mean squared error. Of all the possible combinations of predictor variables, a model was chosen if the set of predictors met all three of these criteria.

The mean squared error (MSE) criterion was met if the model exhibited the lowest MSE when compared to the previous model sets. Mean squared error (MSE) was defined as a measure of the bias and of the sampling variation (Neter et al., 1983). It was thought that a minimal MSE was desirable to the degree to which the predicted or the expected levels of the dependent variables deviated from the observable level of the dependent variable on the average (Neter et al., 1983).

Once the "best" set of predictors was chosen, the model was then analyzed using Ordinary Least Square (OLS) regression. OLS regression identified the effect of the predictor variables on household natural gas consumption and cost by providing an unbiased efficient parametric estimate (Routh, 1989).

The third step in the analytical process was to regress the predictor variables which were statistically significant in the reduced model. OLS regression was again used to analyze the variables for the final model. This analysis yielded the final models which were composed of independent variables which were concluded to be the best predictors of household natural gas consumption and cost.

A problem that often occurs in multiple regression is that a regressor is nearly a linear combination of the other regressors in the model. This is referred to as intercorrelation or collinearity. Collinearity is problematic in that it causes the estimates to be unstable and it also causes high standard errors (SAS Institute Inc., 1988).

More specifically, it can severely limit the size of R^2 and can make determination of the importance of a given predictor difficult because the effects of the predictors are confounded due to high correlation among the variables (Stevens, 1986). Due to shared explanation power, collinearity can also result in variables which are unable to indicate statistical significance (Bieber, 1988).

Routh used Pearson Product-Moment Correlation to determine the association existing between all the variables. Two of the independent variables, physical condition and age of house, were highly correlated above the .8 level. Routh (1989) remedied this correlation by deleting the variable of age from the analysis. This deletion was based on recommendations found in the literature. Using a subjective procedure, physical condition was determined to be the better predictor variable; therefore, it was included and age was deleted (Routh, 1989).

For the present study, a more objective approach to assessing collinearity was readily available; therefore, the independent variables were not analyzed and deleted in the manner used by Routh (1989). The method used to assess collinearity was the Collin option available in the SAS program. This approach, which was done on the final regression model, was formulated based on the recommendations of Belsey, Kuh, & Welsch (1980).

When checking for collinearity using the Collin option, a collinearity problem exists when a variable which is associated with a high condition index (30+) contributes strongly (50% or more) to the variance of two or more variables (Belsey et al., 1980; SAS Institute Inc., 1988). For the present study, it was found that collinearity was not a problem between any of the variables included in the final models. The results of the Collin collinearity tests are reported in the Appendix in Table IX thru Table XIV.

Like the Routh (1989) study interaction terms were used to describe the linear relationship between the independent and the dependent variables. Using interaction terms allowed for the differing linear contributions from each of the independent variables in describing the effect on seasonal and total natural gas consumption and cost (Routh, 1989).

If the interaction term or the PLAN variable was included in the regression model, it indicated that participation in the AMP plan either affected the constant level of consumption or cost, otherwise known as the intercept, or influenced the rate of consumption or cost associated with the specific predictor variable (Routh, 1989).

If the variable PLAN was significant in the final regression model, then it would be interpreted as a change in the constant level of consumption or cost; thus, the intercept would be summed with the PLAN variable coefficient. Such a calculation would yield a different constant level of consumption for the AMP consumers (Routh, 1989).

If the predictor variable and the respective interaction term were found to be statistically significant in the final regression model, then the interpretation would be that there was a change in the rate of consumption or cost for the AMP households. The coefficients of each of the predictors plus the interaction term coefficient would be summed to indicate the AMP households rate of cost or consumption (Routh, 1989).

When using a stepwise regression procedure, all observations with incomplete information will be excluded from the analysis. For this particular study, only 197 of the 569 observations had complete information for all of the independent variables. Due to the fact that the number of observations which dropped out was potentially larger than the number which stayed in, it was thought that analysis should determine whether or not the observations which had complete data differed from those observations which did not have complete responses. This analysis was not done in the Routh (1989) study, but it was thought that it was a worthwhile addition to the present study. This analysis did not effect the replication, it added additional information which would strengthen the conclusions of the present study.

To achieve this goal, a t-test procedure was used to compare the observations with complete data to the observations with incomplete data. This statistical procedure was used on all six of the independent variables. The results of the t-tests showed that for the variables of averaging, age of house, and location, no significant differences were found between the complete and the incomplete observations. For the variables house size, physical condition, and income, there were significant differences. For house size, the incomplete observations were found to have significantly larger homes and higher incomes than did the complete observations. For the variables physical condition, the incomplete observations were found to live in homes of poorer condition than the observations with complete data.

Effect of AMP Plan

Winter Natural Gas Consumption

The set of variables which were descriptive of the effect on winter natural gas usage are presented in Table III. The chosen set of variables from the stepwise technique explained 15 percent of the variation for winter natural gas usage. In step 4, the interaction term plan*location entered into the "best" set of predictors at a level that was not significant; however, when entered in step 5, this variable was significant. Therefore, the interaction term of plan*location was included in the reduced model.

In the reduced model, income, age, plan*location, and location were analyzed and were found to explain 19.6 percent of the variability. The variable of location was found to not be significant; therefore, it was excluded from the final model.

In the final model, income, age, and plan*location were all found to be significant predictors of winter usage and they explained 19.1 percent of the variability. The

TABLE III

MULTIPLE REGRESSION RESULTS FOR
WINTER NATURAL GAS CONSUMPTION

Predictor	Stepwise Model R^2	Stepwise Model MSE	Stepwise F^a	Step	Reduced Beta	Reduced t	Final Beta	Final t
Income	.089	722.269	19.12***	1	.001	9.505***	.001	9.699***
Age	.119	702.387	6.52*	2	-.456	-5.005***	-.464	-5.076***
Plan*Size	.141	687.945	5.07*	3				
Plan*Location	.150	684.735	1.90ns	4	.145	2.547#	14.337	1.964#
Location	.150	684.468	3.21#	5[b]	-10.081	-1.618ns		
Intercept					944.369		956.759	
R^2					.196		.191	
Adjusted R^2					.188		.185	
F-ratio					25.054***		32.405***	
MSE					900.333		903.869	

a: entrance level significance
b: variable plan*size removed
ns: not significant

*** $p<.001$
** $p<.01$
* $p<.05$
# $p<.1$

significance of the interaction term suggested that the effects on winter consumption were different between the AMP and the non-AMP consumers. From this analysis, the following equation was derived for non-AMP households:

$$\text{Winter MCF} = 956.759 + .001\ (\text{INCOME}) + {}^{-}.464\ (\text{AGE}) \tag{4}$$

Due to the fact that the interaction term plan*location was found to be significant, the following equation for AMP households was derived:

$$\text{Winter MCF} = 956.759 + .001\ (\text{INCOME}) + {}^{-}.464\ (\text{AGE}) + 14.337\ (\text{LOCATION}) \tag{5}$$

For winter natural gas consumption, income was found to be a positive predictor for both the non-AMP and the AMP households. The age of the house was found to be a negative predictor; thus, as the year the house was built decreased, the amount of natural gas consumed increased (i.e., older homes used more natural gas). For the AMP households the location of the house in an urban area was also found to be a positive predictor of natural gas consumption.

Winter Natural Gas Cost

Presented in Table IV are the results from the maximum R^2 stepwise procedure as well as the ordinary least squares regression analysis. For winter natural gas cost, the "best" set of predictors which explained 14 percent of the variance was composed of the variables income, age of house, and the interaction term plan*size.

TABLE IV

MULTIPLE REGRESSION RESULTS FOR
WINTER NATURAL GAS COST

	Stepwise				Reduced		Final	
Predictor	Model R^2	Model MSE	F^a	Step	Beta	t	Beta	t
Income	.084	9749.412	17.91***	1	.362	6.829***	.362	6.829***
Age	.117	9450.423	7.17**	2	-.176	-3.423***	-.176	-3.423***
Plan*Size	.140	9245.048	5.31*	3	.095	1.994*	.095	1.994*
Intercept					3141.357		3141.357	
R^2					.132		.132	
Adjusted R^2					.125		.125	
F-ratio					20.830***		20.830***	
MSE					20298.831		20298.831	

a: entrance level significance
ns: not significant

***p<.001
**p<.01
*p<.05
#p<.1

The reduced model, composed of the variables of income, age, and plan*size, explained 13.2 percent of the variance. All of the predictors included in the reduced model were statistically significant; therefore, the final model was identical to the reduced model. From the results of the OLS regression, equation 5 was devised for non-AMP households:

$$\text{Winter cost} = 3141.357 + .362\ (\text{INCOME}) + {}^{-}.176\ (\text{AGE}) \quad (6)$$

In the final model, the interaction term of plan*size was statistically significant. This finding indicated that AMP households' winter natural gas costs were influenced by an additional factor. Equation 6 illustrates the results for the AMP households winter natural gas costs:

$$\text{Winter Cost} = 3141.357 + .002\ (\text{INCOME}) + {}^{-}1.495\ (\text{AGE}) + .017\ (\text{SIZE}) \quad (7)$$

The findings for winter natural gas cost implied that for both AMP and non-AMP consumers, the income proxy was a positive predictor of winter cost; therefore, for every dollar increase in the income proxy, it was found that winter natural gas cost would increase by .002 cents. The age of the house was found to have a negative effect on winter cost. Natural gas cost was shown to increase by $1.50 for each year the house aged. For the AMP households, it was found that an additional variable was a significantly positive predictor of winter natural gas cost: size of house. As the size of a house increased by one square foot, it was found that the natural gas cost for winter would increase by .017 cents.

Summer Natural Gas Consumption

For summer natural gas consumption, the income proxy variable and the interaction term plan*size composed the "best" set of predictors. These two predictors explained 7 percent of the variability and the results of the analysis are presented in Table V.

For the reduced model, analysis revealed that only one of the variables, income, was a significant predictor for summer natural gas consumption. Therefore, the final model was composed of only one predictor variable which explained one percent of the variability. From the final model, the following equation was derived for both AMP and non-AMP households:

$$\text{Summer MCF} = 11.574 + .0001\ (\text{INCOME}) \qquad (8)$$

For both households, AMP and non-AMP, the findings suggest that for every one dollar increase in the income proxy, summer natural gas consumption would increase by .0001 MCF. Therefore, it can be concluded that for summer natural gas consumption, the income proxy was a weak, but positive predictor.

Summer Natural Gas Cost

From the stepwise procedure, it was determined that the "best" set of predictors for summer natural gas cost was

TABLE V

MULTIPLE REGRESSION RESULTS FOR SUMMER NATURAL GAS CONSUMPTION

	Stepwise				Reduced		Final	
Predictor	Model R^2	Model MSE	F^a	Step	Beta	t	Beta	t
Income	.047	103.045	9.58**	1	.104	2.174*	.099	2.153*
Plan*Size	.070	101.098	4.75*	2	-.021	-.438ns		
Intercept						11.900		11.574
R^2						.010		.010
Adjusted R^2						.006		.008
F-ratio						2.365#		4.636*
MSE						598.933		591.998

a: entrance level significance
ns: not significant

***p<.001
**p<.01
*p<.05
#p<.1

TABLE VI

MULTIPLE REGRESSION RESULTS FOR
SUMMER NATURAL GAS COST

Predictor	Stepwise Model R^2	Model MSE	F^a	Step	Reduced Beta	t	Final Beta	t
Income	.052	1550.651	10.78^{**}	1	.170	3.540^{***}	.190	4.171^{***}
Plan*Size	.078	1516.826	5.35^{*}	2	.055	1.159^{ns}		
Location	.091	1503.217	$2.76^{\#}$	3	-.026	$-.562^{ns}$		
Intercept					72.751		72.843	
R^2					.0393		.036	
Adjusted R^2					.0330		.0339	
F-ratio					6.255^{***}		17.398^{***}	
MSE					1954.251		1941.065	

a: entrance level significance
ns: not significant

$^{***}p<.001$
$^{**}p<.01$
$^{*}p<.05$
$^{\#}p<.1$

composed of income, plan*size, and location. Together, these three variables explained 9.1 percent of the variability for summer cost.

When these three variables were regressed, it was found that like summer natural gas consumption, summer natural gas cost had only one statistically significant predictor: income. For the final model, the income proxy was the single predictor for summer natural gas cost and it explained 3.6 percent of the variability. From the regression analysis of the final model, Equation 8 was derived for both AMP and non-AMP households:

$$\text{Summer Cost} = 72.843 + .0003\ (\text{INCOME}) \qquad (9)$$

From this equation, it can be concluded that a one dollar increase in the income proxy can be expected to lead to a .0003 cent increase in summer natural gas cost.

Total Natural Gas Consumption

The combination of variables which met the MSE criterion for predicting total natural gas consumption are listed in Table VII. Together, these predictor variables explained 15.6 percent of the variation in total MCF usage. The variable house size, entered into the stepwise technique at step four and was not significant; however, when included in step five it was significant. Therefore, it was a component of the "best" set of predictors and was included in the regression models.

TABLE VII

MULTIPLE REGRESSION RESULTS FOR
TOTAL NATURAL GAS CONSUMPTION

Predictor	Stepwise Model R^2	Stepwise Model MSE	Stepwise F^a	Step	Reduced Beta	Reduced t	Final Beta	Final t
Income	.086	2279.655	18.26^{***}	1	.250	2.579^{*}	.250	2.579^{*}
Plan	.124	2195.906	8.44^{**}	2	.198	3.208^{**}	.198	3.208^{**}
Age	.139	2169.460	$3.36^{\#}$	3				
Size	.150	2151.577	2.60^{ns}	4	.238	3.097^{**}	.238	3.097^{**}
Condition	.152	2147.443	$3.12^{\#}$	5^b	-.196	-2.348^{*}	-.196	-2.348^{*}
Intercept					122.277		122.277	
R^2					.179		.179	
Adjusted R^2					.164		.164	
F-ratio					11.999^{***}		11.999^{***}	
MSE					2156.462		2156.462	

a: entrance level significance
b: variable age removed
ns: not significant

$^{***}p<.001$
$^{**}p<.01$
$^{*}p<.05$
$^{\#}p<.1$

In the reduced model, the variables of income, payment plan, house size, and physical condition explained 17.9 percent of the variance in total natural gas usage. Due to the fact that all the variables in the reduced model were statistically significant, the final model for total natural gas consumption was identical to the reduced model.

From the regression model, Equation 9 was derived for non-AMP households:

$$\text{Total MCF} = 122.277 + .0001\ (\text{INCOME}) + .008\ (\text{SIZE}) + {}^{-}.647\ (\text{CONDITION}) \quad (10)$$

For both types of households, AMP and non-AMP, it was found that as the income proxy increased by one dollar, consumption of natural gas would also increase by .0001 MCF. As the size of the house increased one square foot, consumption was found to increase by .008 MCF; therefore, it was concluded that both size of house and income were positive predictors of natural gas consumption. On the other hand, physical condition of the house was found to be a negative predictor. It was shown that as the physical condition of the house deteriorated by 1 percent, total natural gas usage increased by .647 MCF.

For the AMP households, the constant level of consumption was greater than that of the non-AMP households. Therefore, it was concluded that payment plan choice had a significant effect on total natural gas consumption.

Total Natural Gas Cost

For total natural gas cost, the "best" set of predictor variables selected was composed of the variables of income and physical condition and the interaction term of plan*size. For these three predictors, it was found that 11.5 percent of the variance was explained. The results are shown in Table VIII.

These three variables all proved to be statistically significant in the reduced model; thus, the final model was identical in nature. From the regression analysis, which utilized the final model, Equation 10 was derived for non-AMP households:

$$\text{Total Cost} = 649.541 + .003\ (\text{INCOME}) + {}^{-}2.58\ (\text{CONDITION}) \qquad (11)$$

For the AMP households, the addition of the interaction term which was significant, yielded the equation 11.

$$\text{Total Cost} = 649.541 + .003\ (\text{INCOME}) + {}^{-}2.58\ (\text{CONDITION}) + .057\ (\text{SIZE}) \qquad (12)$$

For both AMP and non-AMP households, the income proxy was found to be a positive predictor of total natural gas cost. As the income proxy rose one dollar, total cost was found to increase by .003 cents. For the predictor variable physical condition, a negative effect was established. It was concluded that as physical condition increased by one percent, total cost was found to decrease by .21 cents.

For the AMP households, it was discovered that in addition to income and physical condition, the size of the

TABLE VIII

MULTIPLE REGRESSION RESULTS FOR
TOTAL NATURAL GAS COST

Predictor	Stepwise Model R^2	Stepwise Model MSE	Stepwise F^a	Stepwise Step	Reduced Beta	Reduced t	Final Beta	Final t
House Size	.065	33572.884	13.55***	1				
Plan	.092	32755.696	5.86*	2				
Income	.098	32546.214	14.67***	3[c]	.333	3.859***	.333	3.859***
Plan*Size	.099	32511.212	7.431**	4[d]	.234	3.682***	.234	3.682***
Condition	.115	32103.599	3.46#	5	-.208	-2.432*	-.208	-2.432*
Intercept					649.541		649.541	
R^2					.1353		.1353	
Adjusted R^2					.1236		.1236	
F-ratio					11.529***		11.529***	
MSE					32230.840		32230.840	

a: entrance level significance
b: variable house size removed
c: variable plan removed
ns: not significant

***p<.001
**p<.01
*p<.05
#p<.1

house was also a predictor of total cost. The effect shown by the variable size of house for AMP consumers was positive in that it was found that as the size of the house increased by one square foot, total natural gas cost was found to increase by .057 cents.

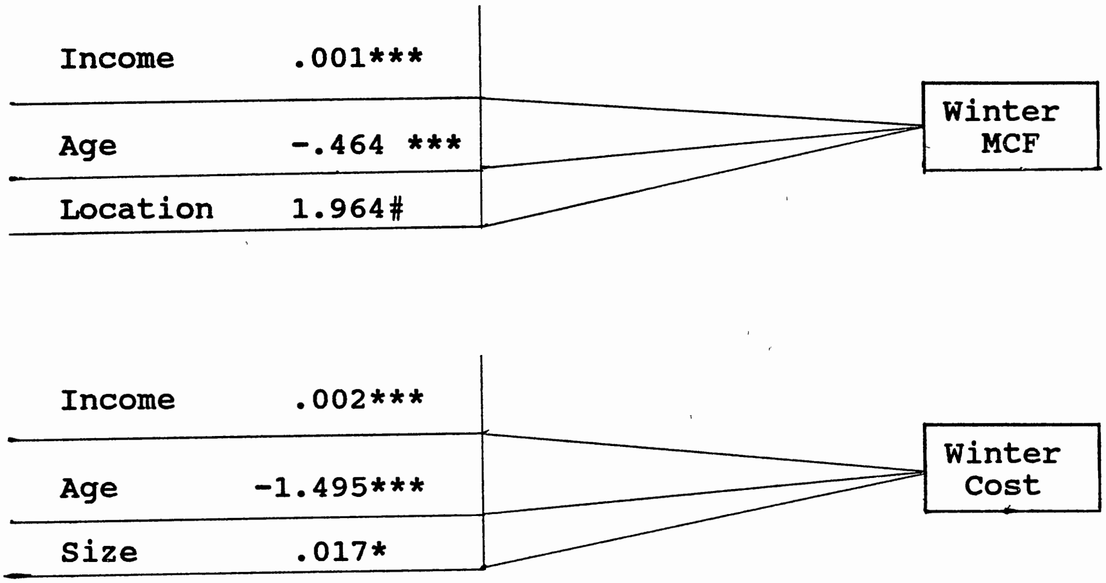
Model Development

As with the Routh (1989) study, the third objective was to develop a model which would be representative of the interaction between payment plan choice with specific housing characteristics, household income, and residential location. To meet this objective, the results from the OLS regression analysis were used to construct visual models which illustrated the significant influences on winter, summer, and total natural gas consumption and cost.

In chapter III of this study, a conceptual model was proposed; however, it was found that all the dependent variables could not be explained by one single illustration. Thus, each dependent variable was explained with a separate model.

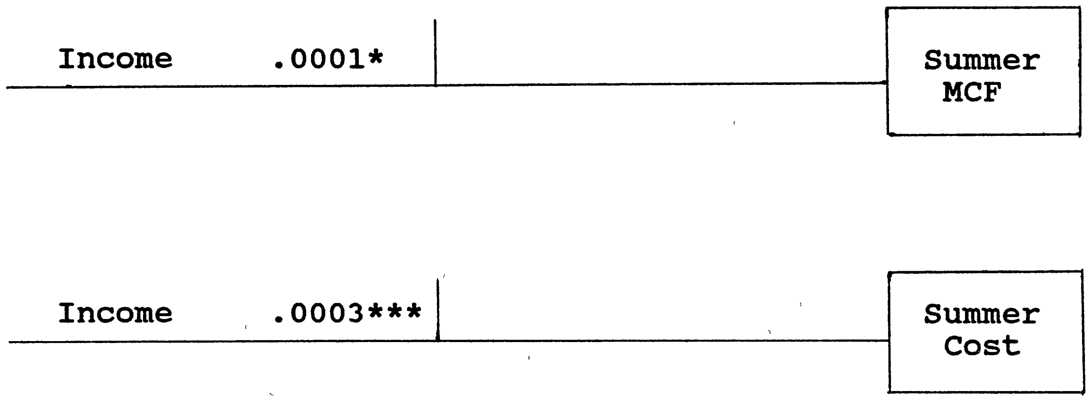
Winter Consumption and Cost

For winter consumption and cost, income and age were both found to be predictors; however, the magnitude at which these predictors affected each of the dependents variables was different. The models for winter consumption and cost differed in that location was a predictor for consumption



***p<.0001
**p<.001
*p<.05
#p<.1

Figure 2. Tested Model of Winter Natural Gas Consumption and Cost for AMP Households



***p<.0001
**p<.001
*p<.05
#p<.1

Figure 3. Tested Model of Summer Natural Gas Consumption and Cost for AMP Households

and age of the house was found to a predictor for winter natural gas cost (see Figure 2).

Summer Consumption and Cost

Summer natural gas consumption and cost were both found to only be influenced by one predictor variable: income. However, the magnitude or the level at which this variable influenced summer natural gas cost and consumption differed for each of the dependent variables (see Figure 3).

Total Consumption and Cost

For total consumption and cost, the models derived from the regression analysis differed in composition. For total natural gas consumption, income, size of house, and physical condition of house all had a significant influence. It was also found, that for total consumption, participation in the AMP plan significantly influenced the total amount of natural gas consumed.

For total natural gas cost, the model differed from that drawn for total consumption in that payment plan was not a significant predictor. Thus, payment plan significantly increased total MCF use but not total natural gas cost. It was also found that although the two models both had three predictor variables in common, the magnitude of influence for each of the independent variables differed for each of the dependent variables (see Figure 4).

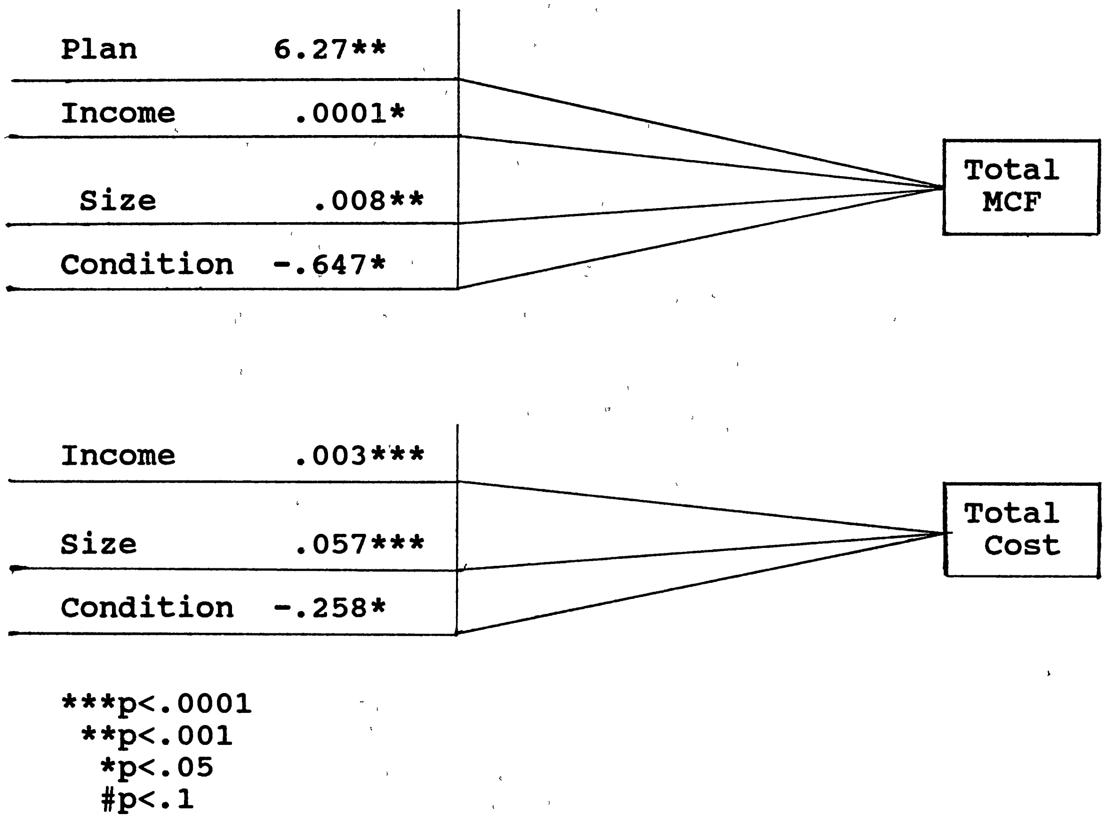


Figure 4. Tested Model of Total Natural Gas Consumption and Cost for AMP Households

Summary

To meet the objectives of this study, Ordinary least squares regression with stepwise techniques was utilized. Based on the findings from the analysis, models illustrating the effects of the independent variables on the dependent variables were drawn.

Winter consumption and cost was found to be influenced by income, age of house and size of house. Summer consumption and cost was found to only be influenced by income. For total consumption and cost, income, size of house, and physical condition of the house were all found to predictors. For total natural gas usage, payment plan was also found to be a significant predictor of natural gas use. Total natural gas consumption was the only dependent variable which was found to be influenced by the variable of payment plan choice. Throughout the analysis, income was the only variable which was found to be a predictor for all the dependent variables.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

One of the most compelling issues facing state utility regulators is the inability of many households to meet their natural gas and electric bills (Brown, 1987). Thus, consumer advocates from all facets of society have lobbied for major utility reform. In answer to such lobbying efforts, the Average Monthly Payment Plan (AMP) policy was developed. In 1985, the Oklahoma Corporation Commission ruled that the utility companies of Oklahoma must offer their customers the option of averaging their utility bills.

The problem with the AMP policy is that it was enacted with little or no prior research. Since it's implementation, limited research has suggested that the AMP plan is not fulfilling it's intended purpose. It has also been strongly suggested that utility policy should be differentiated by fuel type. However, current AMP policies fail to consider fuel source (Henderson, 1979).

Based on the findings from Routh (1989) and Henderson (1979) it was felt that a study should be conducted replicating the research methods of Routh (1989), but using data from a natural gas company.

Objectives of the Study

The specific purpose of this study was to assess the effect of payment plan choice interacting with specific housing characteristics, household income, and residential location on total and seasonal household natural gas consumption and cost. The objectives were to identify the effect of payment plan choice, specific housing characteristics, household income, and residential location on total and seasonal natural gas consumption and cost. It was also the objective of this study to develop a model for the effect of payment plan choice, specific housing characteristics, household income, and residential location on household natural gas consumption and cost.

Summary and Conclusions

The sample for this study was composed of 600 households which were randomly selected from the customer accounts of the Oklahoma Natural Gas Company. Monthly consumption and cost data were provided by the utility company, while specific housing and household characteristics were obtained from county property records.

Sample Characteristics

Both the AMP and the non-AMP consumers lived in homes which were similar in age, size, and physical condition. For the variables of land valuation and total improvements, which were used as an income proxy, the two groups, AMP and non-AMP showed no significant differences. The only significant difference between the AMP and the non-AMP consumers was that the non-AMP consumers had lived in their present homes longer than had the AMP consumers. For the most part, the characteristics of the sample for this study showed that the AMP and the non-AMP consumers were very similar demographically.

Analysis of winter consumption and cost as well as total consumption and cost revealed that the AMP consumers used significantly more natural gas; thus paying more than did the non-AMP consumers. For the summer months, the AMP and the non-AMP consumers did not differ significantly in their natural gas consumption or cost. These findings differ from the Routh (1989) study in that Routh found that the AMP consumers used significantly greater amounts of electricity year round. These differing findings were as expected since natural gas and electricity differ in seasonal use patterns. Electricity is often a household's predominate energy source on a year round basis; however, natural gas can be predominantly used as an energy source for heating purposes. Thus, it was expected that for natural gas customers, there would be no significant difference between the AMP and the non-AMP consumers in the summer months.

As with the Routh (1989) study, it was found that both the AMP and the non-AMP consumers were similar demographically; however, the AMP households used significantly greater amounts of energy. Thus, the findings based on the characteristics of this sample, reinforced the previous conclusion that the AMP plan may provide the consumer with a false or muted price signal.

Effect of the AMP Plan

Results of the regression model revealed that summer, winter, and total consumption and cost all had differing predictors; thus it was found that for each dependent variable a separate model had to be developed.

For summer natural gas cost and consumption, income was found to be the only predictor; however, the level at which income influenced each, summer consumption and cost, was of a different magnitude. For the summer months it was found that households with the highest incomes would be expected to consume and pay the most for natural gas. The finding for summer differed from those found by Routh (1989) in that Routh also found that payment plan, physical condition of home, and the size of home were predictors of summer electricity use. These results were as expected when considering the seasonal usage patterns of these two energy types. As previously discussed, natural gas is used primarily for heating purposes. Thus, in the summer a household's use for natural gas would either be non-existent or would be for tasks such as cooking or heating water. On the other hand, electricity is used a great deal in the summer for air-conditioning, which is a high energy user.

Thus, many households have very high electricity bills in the summer. Since gas is not used as a heating source in the summer, variables such as the age of the house or physical condition were not expected to be predictors. It seems reasonable that if natural gas is not being used for heating, the consumption behavior of the consumer would not be impacted by the AMP plan because the magnitude of use would be much lower.

For the winter season, it was found that natural gas consumption was impacted by the income of the household the age of the house, and the location of the house. The model for winter natural gas cost differed from the model for winter consumption in that it was impacted by the size of the house instead of the location of the house.

Based on the literature, it was expected that the age of the house would have a negative effect on natural gas use and cost. It has been suggested in the literature that the newer the home, the more likely it is to be total electric; thus, the older the home, the more likely it is to use natural gas for heating and other household purposes (Jafee, Houston, & Olshavsky, 1982). This statement is consistent with the findings from the present study and from the Routh (1989) study. Routh (1989) found that the newer the home the higher it's electricity usage.

Size of house influenced the total cost of natural gas for all households. As the size of the home increases, it is reasonable to believe that it would take more energy to provide heat; thus resulting in higher utility bills. This finding is consistent with energy literature.

Location of the household in an urban area was found to be a positive predictor for winter consumption. This finding is consistent with the literature. Households in urban locations generally have access to electricity and natural gas, while rural residents usually only have access to electricity (Ruffin & Weinstein, 1979). If rural residents do not have as great an access to natural gas, then it is expected that their consumption of natural gas during the winter months would be significantly lower than households located in urban areas.

When compared to the findings for the Routh (1989) study, the major difference between models for winter were that natural gas consumption and cost were found to be predicted by the age of the home while electricity consumption and cost were found to be predicted by the condition of the home. This difference probably occurs due to the fact that Routh (1989) found a high degree of collinearity between age and condition; thus, condition was found to be the better predictor so age was deleted.

For total consumption and cost, the models both found that income and size were positive predictors while physical condition was a negative predictor. Thus, consumers living in the largest homes with the highest incomes were found to use the largest amounts of natural gas. As the condition of the home deteriorated, it was expected that natural gas use and cost would also increase a significant amount.

The difference between these two models was that for total consumption, payment plan was found to be a significant predictor of natural gas use. This was the only dependent variable which was found to be impacted by the payment plan variable. This is in direct contrast to the findings of the Routh (1989) study which used electricity consumers. Routh (1989) found that payment plan significantly influenced all the dependent variables: winter cost and consumption, summer cost and consumption, and total cost and consumption.

The fact that the AMP plan was found to have a positive effect on the AMP consumer's consumption supports Routh's (1989) and McDermott et al. (1980) conclusion that the AMP plan provides the consumers with a false or muted price cue. Thus, the AMP plan is not meeting it's intended purpose.

Based on the fact that total cost is a function of total consumption, it was expected that each would be predicted by identical variables; however, this was not the case for total natural gas consumption and cost. This finding was thought to have occurred due to the fact that natural gas utilities use a declining block rate structure to assess charges for the amount of gas used. In such a rate structure, as the amount of energy increases, the cost per unit (MCF) declines. It is also relevant to realize that as use increases the amount of the discount given increases. Thus, if payment plan influences a natural gas customer to consume a greater amount of natural gas, it might not necessarily cause that customer to pay a significantly greater amount in fuel bills due to the nature of the declining block rate structure in use. The use of a block rate structure can be used as an explanation for the differences seen among all the models developed for natural gas consumption and cost.

Utility bill averaging and declining block rate structure have serious implications for energy consumption. These two policies do not encourage conservation, but encourage consumption. The AMP plan mutes the price cue so consumption is increased while the declining blockrate structure encourages consumption by "rewarding" large energy users. Alone, each of these energy policies have serious implication, but together, the seriousness of the problem is magnified.

Among all the models developed, the income proxy was the only independent variable which was found to have an influence on all the dependent variables. The fact that the income proxy was a positive predictor of natural gas usage and cost throughout this study was an expected finding; however, based on the literature, it was expected that the income proxy would be a stronger positive predictor. Through out the literature, it has been found that as income increases, energy use will also increase, which is consistent with the findings of this study.

When the findings from the present study are compared to those of Routh (1989), it became apparent that natural gas consumption was not influenced by the proposed variables in the same manner as was electricity. It is thought that one of the main reasons that this difference occurred was due to the differing seasonal usage of these two energy sources. Natural gas is mainly used in the winter season for heating purposes. While electricity is often used year round for heating, cooling, and numerous other household purposes; thus, it was expected that natural gas would be influenced by fewer variables than would electricity.

It was also concluded that differences were seen between the two studies due to the behavioral differences of natural gas and electric consumers. Natural gas is primarily used for heating, cooking, and/or heating water. Electricity can be used for all these tasks but can also be used for numerous other household purposes, such as lighting. Bodily comfort was thought to be the cause of part of the behavioral differences. Consumers might use other methods such as clothing modification to keep warm, but resort to thermostat changes to keep cool. Therefore, natural gas consumers are less likely to be influenced by a muted price cue than are electricity consumers who are using electricity to stay cool. Differences were also thought to have occurred due to the fact that since electricity is used for more household purposes, it's consumers would be more likely to "overuse" due to the effects of the AMP plan (i.e., muted price cue). Excluding heating, natural gas is not used for household purposes which are easily conserved. Most people do not worry about the amount of natural gas they are using to cook or to heat water due to the fact that these uses are considered to be necessary to everyday life.

Differences observed between the present study and the Routh (1989) study may have also been the result of the differing manner in which electricity and natural gas are measured. Electricity is measured in kilowatt hours (KWH) while natural gas is measured in million cubic feet (MCF). To supply one therm or 100,000 btu's of heat, it takes 156.3 MCF of natural gas while it only takes 29.3 KWH of electricity to provide the same amount of energy (Jones & Harp, 1981). Thus, mathematical analysis for the two fuel sources could vary considerably.

Policy Implications

When the results from the Routh (1989) study are compared to the present study, the most apparent policy implication that appears is in support of Henderson's (1979) statement that utility policymakers should differentiate their strategies by fuel type. Routh (1989) found that the AMP plan significantly affected electricity consumption and cost. The present study found that for natural gas, the AMP plan only had a significant effect on total consumption. The contrast between the two studies, suggests that the AMP plan affects electricity consumers differently than it does natural gas consumers. This difference suggests that the current AMP policy needs to be restructured to address each fuel type in a separate policy.

Although it was found that the AMP plan only had a significant effect on total consumption, the AMP plan could still be somewhat detrimental to the natural gas customer. In the pre-test, it was shown that the AMP consumers used and paid significantly more for natural gas. Even though the regression analysis did not show that the AMP plan had a significant effect on the total cost as it did for total consumption, it is thought that future utility price increases could change this finding. If the AMP consumers are using more than the non-AMP consumers, then it would be expected that they would also be paying more. The reason that total cost may not be significantly affected was thought to be the result of the declining block rate structure used by natural gas utilities. If natural gas prices were to suddenly increase, then it is very likely that the AMP consumers who were found to be consuming significantly more natural gas would then be found to be affected by the AMP plan for total cost.

It has been suggested that, in the future, the block rate structure may be discontinued or reversed so that it is a progressive rate structure. The deletion or reversal of the block rate structure would change the relationship between price and consumption. Proving to be detrimental to those consumers on the AMP plan, since they consume more because their price cue is muted.

The fact that the AMP plan was found to significantly affect total consumption implies that the AMP plan encourages consumption of energy not conservation. It has been stated that America is rapidly becoming dependent on foreign oil imports. This is a serious situation, in that a world event such as the Persian Gulf Conflict, could place America in a vulnerable position for greatly needed fuel supplies (Committee on Energy and Commerce, 1989). If the goal of the United States as a whole is to encourage conservation, then the finding that the AMP plan has an effect on total consumption suggests that the AMP plan needs to be restructured so that conservation not consumption is encouraged.

The AMP plan was implemented to serve low and fixed income consumers who were negatively impacted by high and fluctuating utility bills. But, the fact that the AMP plan provides the consumer with a muted price cue, suggests that the plan is not meeting the goal of providing low and fixed income consumers with an advantageous method of managing their utility bills. As Routh (1989) suggested, policy makers should consider the possibility that while the AMP policy may be accomplishing the goal of providing consumers with a budgeting service, the costs of the plan may outweigh the benefits.

Since the AMP plan was implemented to meet the needs of low and fixed income consumers, it is important to consider the findings from the pre-test which suggested that the AMP and the non-AMP consumers were very similar demographically; however, the AMP consumers used and payed significantly more for natural gas. If the consumers choosing the AMP plan are not significantly different than those not using the plan, then the AMP policy is probably not helping those it was implemented to benefit.

In the future, policymakers need to carefully evaluate the predicted outcomes of proposed energy policy. They must reevaluate the AMP plan, and restructure it so that the policy is differentiated by fuel type. Since this study, like the Routh (1989) study, suggested that the AMP plan was not meeting the needs of low and fixed income consumers, it is important that new polices be developed to fill this alarming void. Until the current AMP policy is restructured, then AMP consumers should be alerted to the fact that they may be receiving a false or muted price cue. This would allow consumers to make informed and rational consumption decisions. Utility policymakers should use the results of the present study and the Routh (1989) study as justification for carefully reevaluating the AMP policy. It should now be apparent that utility policies should not be implemented without prior research. The policy makers of the future, should consider not only the consumers and the utility companies, but also the potential effect that the

AMP policy could have on America's energy demand and supplies.

The results from this study yielded very important utility policy implications. The following is a brief summary of these implications:

1. Restructuring of the AMP policy is warranted so that policy is differentiated by fuel source.

2. The AMP policy tends to encourage consumption. National and state utility policies should be reviewed in light of the importance of conservation to our state and nation. If conservation is a priority, then utility bill averaging should be carefully scrutinized as a policy contrary to conservation.

3. The present study found that the AMP plan had a positive effect on total consumption, but not total cost. However, substantial increases in price or deletion or reversal of the block rate structure could impact this finding. Future policy should make allowances for a potential changes in the price structure.

4. The AMP plan may be meeting the budgeting needs of consumers; however, the costs associated with this policy should be carefully reviewed. Future policy makers should carefully examine these claims and make the necessary adjustments so that the AMP policy is advantageous to those it was designed to benefit.

Recommendations

Energy costs continue to be one of the most troubling issues for low and fixed income consumers. With high energy costs and foreign dependency continuing to increase, energy research will continue to be an important research topic. With this in mind, the following are recommendations for further research:

1. To gain additional information concerning the effect of the AMP plan, a longitudinal study should be conducted that compares the consumer's natural gas or electric consumption before and after choosing to use the AMP plan.

2. If consumers are using the AMP plan as a budgeting device, then it is important to know if they are aware of the potential cost. Additional research is needed that would enlighten policy makers as to who is using the AMP plan and what their attitudes are towards their energy consumption while on the plan. If they are not aware of the potential costs, then it would be important for an educational program to be developed which educated the public as to the costs and benefits of the AMP plan.

3. The AMP plan was originally implemented as a way to aid the disadvantaged segment of society; however, this study as well as the Routh (1989) study suggest that the disadvantaged are not necessarily the group using the plan. Research which develops a demographic profile that more clearly identifies groups using the AMP plan should be done.

4. Since missing data were a problem in the present study, it is recommended that further studies make some type of adjustment to compensate for missing information. Three ways that further research could handle the missing data are:

A. If the incidences of missing variables are infrequent, then the observations with missing data could be deleted (Wozniak, 1991).

B. The missing values could be estimated based on prior knowledge such as a regression equation that predicts the missing value based on the values of nonmissing variables. If this method is used, then it must be noted that overfitting may occur (Wozniak, 1991).

C. Mean scores for each of the variables could also be substituted in for the missing values. If this method is used, then the fact that the correlations are artificially reduced should be recognized (Wozniak, 1991).

5. It is suggested that if the missing data is compensated for by using one of the suggested methods in recommendation 4, that analysis be conducted both with and without the missing data. The comparison of these results would allow the researcher to determine whether or not the results were similar.

BIBLIOGRAPHY

Babbie, E. (1989). The practice of social research (5th ed.). Belmont, CA: Wadsworth.

Barnes, R., Gillingham, R., Hageman, R. (1982) The short-run residential demand for natural gas. Energy Journal, 3(1), 59-72.

Bauer, J.W., & Badenhop, S.B. (1984). Residential energy research: Progress and potential. Home Economics Research Journal, 12(4), 550-562.

Baxter, L.W., Feldman, S.L., Schinnar, A.P., & Wirtshafter, R.M. (1986). An Efficiency analysis of household energy use. Energy Economics, 8(2), 62-73.

Belsey, D.A., Kuh, E., Welsch, R.E. (1980). Regression Diagnostics. Wiley: New York.

Best, J.W. (1981). Research in Education. Prentice-Hall: Englewood Cliffs, NJ.

Bieber, S.L. (1988). Multiple Regression and it's alternatives. The Social Science Journal, 20(4), 79-87.

Blocker, T.J. (1983). Residential energy rates: Conservation, cost, and comfort. The Social Science Journal, 20(4), 79-87.

Brazzel, J.M., & Hunter, L.J. (1979). Trends in energy expenditures by black households. The Review of Black Political Economy, 9, 276-299.

Brown, A.C. (1987). Percentage of income payment plans: Regulation meets social reality. Public Utilities Fortnightly, 119, 9-12.

Bureau of Labor Statistics. (1988). Consumer expenditure survey results from 1986. News (USDL: 88-175). Washington, DC: United States Department of Labor.

Chatelain, L.B. (1981). Residential energy consumption practices, weatherization features in dwellings and electrical energy consumption in rural and urban households in Utah. Unpublished doctoral dissertation, Florida State University, Tallahassee, FL.

Committee on Energy and Commerce. (1989). U.S. energy outlook (No. 101-14). Washington, DC: U.S. Government Printing Office.

Cullen, B.T., Johnson, J.H., Jr., & Sommers, L.M. (1983). Implications of electric utility rate reform legislation for low-income households in Oakland and Livingston Counties, Michigan. The Social Science Journal, 20(2), 88-97.

Cunningham, W.H. & Joseph, B. (1978). Energy conservation, price increases and payback periods. In H.K. Hunt (Ed.), Advances in Consumer Research, Vol. 5. (pp. 201-205). Association for Consumer Research.

Cunningham, W.H., & Lopreato, S.C. (1977). Energy use and conservation incentives. New York: Praeger.

Danielson, L.E. (1979). An analysis of residential demand for water using micro time-series data. Water Resources Research, 15(4), 763-767.

Energy Information Administration. (1987). Residential energy consumption survey: Consumption and expenditures (DOE/EIA-0321/2-84). Washington, DC: Government Printing Office.

Everett, C.T., & Malko, J.R. (1977). Measuring the impact of residential gas and electric rates. Public Utilities Fortnightly, 100(13), pp. 20-24.

Gladhart, P.M. (1984). Interactions of prices and household characteristics and residential energy conservation. Housing and Society, 11(3), 149-167.

Grima, A.P.L. (1973). The impact of policy variables on residential water demand and related investment requirements. Water Resource Bulletin, 9(4), 703-710.

Gwartney, J.D., & Stroup, R.L. (1987). Economics: Public and private choices. San Diego: Harcourt.

Henderson, L.J., Jr. (1979). Public utility regulations: The socioeconomic dimensions of reform. Review of Black Political Economy, 9, 260-275.

Henson, S.E. (1984). Electricity demand estimates under increasing block rates. Southern Economic Journal, 51, 147-156.

Hogan, M.J., & Paolucci, B. (1979). Energy conservation: Family values, household practices and contextual variables. Home Economics Research Journal, 7(4), 210-218.

Howe, C.W., & Linaweaver, F.P. (1967). The impact of price on residential water demand and its relation to system design and price structure. Water Resources Research, 3(1), 13-32.

Jaffee, B.L., Houston, D.A., & Olshavsky, R.W. (1982). Residential electricity demand in rural areas: The role of conservation actions, engineering factors and economic variables. The Journal of Consumer Affairs, 16(1), 137-151.

Jones, C.V. & Morris, F.R. (1984). Instrumental price estimates and residential water demand. Water Resources Research, 20(2), 197-202.

Jones, K. & Harp, S. (1981). The energy event: Fuel type and thermal efficiency: Major factors in home heating cost. Oklahoma Cooperative Extension.

Karns, D.A. & Khera, I.P. (1983). U.S. consumer attitudes and home-heating conservation behavior: A multiattribute longitudinal model. Journal of Economic Psychology, 4, 57-70.

Lewis-Beck, M.S. (1980). Applied regression: An introduction. In J.L. Sullivan (Ed.), Sage University Paper series: Quantitative Application in the Social Sciences (Series No. 07-022). Beverly Hills, CA: Sage Publications.

Lincoln Electric Service. (1976). Alternate rate structure study. Lincoln, NE.

MacAvoy, P.W. (1983). Energy Policies. New York: W.W. Norton.

McDermott, K.A., Guldmann, J.M., Pfister, K.A., & Kumari, K.V. (1980). Budget billing plans for electric and gas utilities: An analysis and some recommendations for change. Columbus, OH: The National Regulatory Research Institute.

McDougall, G.H.G., Claxton, J.D., Ritchie, J.R.B., & Anderson, C.D. (1981). Consumer energy research: A review. Journal of Consumer Research, 8, 343-354.

Morrison, B.M. (1975). Socio-physical factors affecting energy consumption in single family dwellings: An empirical test of a human eco-systems model (Doctoral dissertation, Michigan State University, 1975). Ann Arbor, MI: University Microfilms No. 76-5608.

Morrison, B.M., Gladhart, P.M., Zuiches, J.J., Keith, J.G., Keefe, D., & Long, B.K. (1978). Energy and families: The crisis and the response. Journal of Home Economics, 70(4), 18-21.

Neter, J., Wasserman, W., & Kutner, M.H. (1983). Applied linear regression models. Homewood, IL: Irwin.

Newman, D.K., & Day, D. (1975). The American energy consumer. Cambridge, MA: Ballinger.

Norgaard, R. & Jensen, I. (1985). Winter moratoriums on utility bills. Public Utilities Fortnightly, pp. 32-39.

Oklahoma Corporation Commission. (1985). Hearings: January 8, 1985, motions for reconsideration. (OCC Report Cause No. 27759/Order No. 274115) Oklahoma City, OK.

Prindle, W.R., & Reid, M.W. (1988). Preparing for the energy challenges of the 1990s. Washington, DC: The Alliance to Save Energy.

Rhodes, S.R. (1980, November). Energy assistance to low-income elderly and needy households: A cost effectiveness analysis in two states. Paper presented at the Thirty-Third Annual Scientific Meeting of the Gerontological Society of America, San Diego, CA.

Ritchie, J.R.B., McDougall, G.H.G., & Claxton, J.D. (1981). Complexities of household energy consumption and conservation. Journal of Consumer Research, 8, 233-242.

Routh, S. P. (1989). Utility payment plan choice: Effect on household electrical energy consumption and cost. Unpublished master's thesis, Oklahoma State University, Stillwater, OK.

Ruffin, M.D., & Weinstein, M.B. (1979). Energy in the farm home. Home Economics Research Journal, 8, 2-15.

SAS Institute Inc. (1988). SAS/STAT User's Guide (Release 6.03 ed.). SAS Institute Inc.: Cary, NC.

Sierra Pacific Power Co., (1979). Home energy survey: Electrical and gas analysis Report No. 4. Reno, NV: Author.

Stevens, J. (1986). Applied multivariate statistics for the social sciences. Hillsdale, NJ: Lawrence Erlbaum Associates.

Stigler, G.J. (1961). The economics of information. The Journal of Political Economy, 69(3), 213-225.

Stobaugh, R. & Yergin, D. (1979). Energy future. New York: Random House.

Sweet, D.C., & Hexter, K.W. (1987). Public utilities and the poor: Rights and responsibilities. New York: Praeger.

U.S. Bureau of Census. (1980). The 1980 census of the population: Characteristics of the population (Vol. 1). Washington, DC: Government Printing Office.

Van Raaij, W.F., & Verhallen, T.M. (1983). A behavioral model of residential energy use. Journal of Economic Psychology, 3(1), 39-63.

Verhallen, T.M. & Van Raaij, W.F. (1981). Household behavior and the use of natural gas for home heating. Journal of Consumer Research, 8, 253-257.

Williams, S.E. (1984). Energy education for limited resource Oklahomans: A policy evaluation. Unpublished doctoral dissertation, Oklahoma State University, Stillwater, OK.

Williams, S.E., Weber, M.J., & Routh, S.P. (1988). Impact of utility averaging on residential users (H.E. Research Project #275). Stillwater, OK: Oklahoma State University, College of Home Economics.

Wozniak, P.J. (1991, June). Research methodological and statistical analysis. Workshop conducted at Oklahoma State University, Stillwater, OK.

APPENDIX

COLLINEARITY DIAGNOSTICS

TABLE IX

COLLINEARITY DIAGNOSTICS FOR WINTER NATURAL GAS CONSUMPTION

Variable	Eigenvalue	Condition Number	Var Prop Intercept	Var Prop Age	Var Prop Income	Var Prop Plan*Location
Intercept	2.90187	1.00000	.0000	.0000	.0183	.0090
Age	.94919	1.74849	.0000	.0000	.0039	.9618
Income	.14891	4.41450	.0001	.0001	.7968	.0244
Plan*Location	.0000341	291.81286	.9999	.9999	.1810	.0049

TABLE X

COLLINEARITY DIAGNOSTICS FOR WINTER NATURAL GAS COST

Variable	Eigenvalue	Condition Number	Var Prop Intercept	Var Prop Plan*size	Var Prop Age	Var Prop Income
Intercept	3.44080	1.00000	.0000	.0272	.0000	.0122
Plan*Size	.40869	2.90158	.0000	.9379	.0000	.0134
Age	.15048	4.78187	.0001	.0159	.0001	.7731
Income	.0000336	320.01975	.9999	.0189	.9999	.2013

TABLE XI

COLLINEARITY DIAGNOSTICS FOR SUMMER NATURAL GAS CONSUMPTION

Variable	Eigenvalue	Condition Number	Var Prop Intercept	Var Prop Income
Intercept	1.87621	1.00000	.0619	.0619
Income	.12379	3.89306	.9381	.9381

TABLE XII

COLLINEARITY DIAGNOSTICS FOR SUMMER NATURAL GAS COST

Variable	Eigenvalue	Condition Number	Var Prop Intercept	Var Prop Income
Intercept	1.87621	1.00000	.0619	.0619
Income	.12379	3.89306	.9381	.9381

TABLE XIII

COLLINEARITY DIAGNOSTICS FOR TOTAL NATURAL GAS CONSUMPTION

Variable	Eigenvalue	Condition Number	Var Prop Intercept	Var Prop Plan	Var Prop Square Footage	Var Prop Physical Condition	Var Prop Income
Intercept	4.35190	1.00000	.0014	.0153	.0039	.0011	.0041
Plan	.45527	3.09174	.0004	.8586	.0054	.0016	.0182
Square Footage	.11701	6.09869	.0879	.0854	.0075	.0174	.3793
Physical Condition	.06350	8.27882	.0061	.0109	.9109	.0407	.1847
Income	.01232	18.79256	.9041	.0298	.0723	.9393	.4137

TABLE XIV

COLLINEARITY DIAGNOSTICS FOR TOTAL NATURAL GAS COST

Variable	Eigenvalue	Condition Number	Var Prop Intercept	Var Prop Plan*size	Var Prop Physical Condition	Var Prop Income
Intercept	3.39858	1.00000	.0027	.0287	.0018	.0089
Plan*Size	.46386	2.70680	.0033	.9391	.0034	.0167
Physical Condition	.12432	5.22850	.0876	.0028	.0087	.5828
Income	.01324	16.02430	.9063	.0293	.9861	.3916

VITA

Lori E. Worthington

Candidate for the Degree of

Master of Science

Thesis: UTILITY PAYMENT PLAN CHOICE: EFFECT ON HOUSEHOLD NATURAL GAS CONSUMPTION AND COST

Major Field: Housing, Interior Design and Consumer Studies

Area of Specialization: Consumer Studies

Biographical:

Personal Data: Born in Frederick, Oklahoma, November 5, 1966, the daughter of John and Janice Worthington.

Education: Graduated from Chattanooga High School, Chattanooga, Oklahoma in May 1985; received Bachelor of Science degree in Home Economics from Cameron University at Lawton, Oklahoma, in May 1989; completed requirements for the Master of Science degree at Oklahoma State University in July, 1991.

Professional Experience: Graduate assistant for Oklahoma State University Home Economics Cooperative Extension, August, 1989 - August, 1990. Graduate research assistant, Oklahoma State University, Department of Housing Interior Design and Consumer Studies, August, 1990 - June 1991.