AVERAGE MONTHLY PAYMENT (AMP) PLAN:
POLICY IMPLICATIONS FOR
ELDERLY HOUSEHOLDS

By

JAMIE S. GIRARD

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Thesis Approved:

Sue E. Williams

Gong Soog Hong

Joseph A. Weber

Thomas C. Collins
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

Statement of the Problem

The impact of the 1970s oil embargo was felt by many individuals, but the poor and near poor were the most adversely affected (Cullen, 1983). Energy assistance emerged as a pressing national issue. The resulting energy crisis forced individual consumers, consumer groups, and utility companies to develop creative alternatives to off-set high energy bills. Load-management, utility rate reform, weatherization, conservation strategies, and utility billing alternatives were among the many programs developed on state and federal levels to assist low-income and elderly households in managing their energy bills (Brown, 1987; Weld & Sweet, 1979). Many utility companies actively addressed the needs of their customers, especially those on low and fixed incomes, by helping them to improve the energy efficiency of their residence and to manage utility bills.

Little was known about the relationship between the poor and energy when energy management programs first began. The lack of knowledge and the lack of a carefully studied approach were barriers to the development of effective programs (Sweet & Hexter, 1987). Many of the programs enacted were 'piecemeal' attempts to create a low-income energy policy (Cullen, 1983).

The Average Monthly Payment (AMP) plan was one of the programs designed to assist disadvantaged households in managing and budgeting monthly utility bills. The Residential Energy Consumption Survey (1984, p. 9) defined a budget plan as "a plan under which the utility company or fuel dealer and household agree that the household will pay the same amount for fuel each month for a number of months." Utility bills were to be tabulated annually and then divided into twelve monthly payments. Each state utility regulatory agency and utility company determined the rules and regulations of the AMP plan.

A lengthy investigation of AMP plans was done for the Department of Energy in 1980 (McDermott, Guldmann, Pfister, Kumari, 1980). Natural gas and electric utilities who used these plans were included in the investigation. The investigation indicated that the budget billing plan was sending consumers muted price signals. It was speculated that this muted price signal may, in the long run, cause consumers to consume more energy thus increasing utility expenditures. This result would be contrary to the desired effect of the plan to benefit low and fixed income consumers. The study recommended that further research was needed regarding the

AMP plan's effect on energy consumption (McDermott et al., 1980).

Lincoln Electric Service (LES) conducted a study on the AMP plan and found that the muted price signals had a negative impact on consumers and that it also had a negative impact on energy conservation (Lincoln Electric Service, 1976). In a free market system individuals rely on price signals to help consumers make consumption decisions. If the price signal is muted consumers are not able to properly respond and therefore might increase consumption. The LES (1976) study recommended that the budget billing plan not be approved for use in the Lincoln Electric System. Previous studies' (Routh, 1989; Worthington, 1991) found that AMP plan consumers actually used more energy and paid more than those not on the plan.

The present study focuses on elderly consumers. There are unique factors that influenced the consumption patterns of older Americans, such as increased health concerns, medical costs, adequate housing, economic status, and the influence of geographic location (Iams, Wilhelm, & Zimmer, 1988). Elderly consumers on average spent a larger portion of their income on energy related housing costs (Iams et al., 1988; Vine, Barnes, Mills, & Ritschard, 1989; Kennedy, 1980). Individual's needs changed as they progress through life events such as empty nest, retirement, loss of spouse, and ill health. The success of adjustment to these events depends on a balance of time, money, and health (Sorce, Tyler, & Loomis, 1989). Many low-income and elderly consumers must reduce the amount spent on other necessities in order to pay increased home energy costs (Junk, Jones, & Kessel, 1988).

The problems of the poor as related to energy were multidimensional. They reflected housing problems, income problems, credit problems, legal problems, and energy problems (Sweet et al., 1987). The difficulty that fixed and low income consumers had coping with increased energy costs was a manifestation of a much broader income distribution problem (Pace, 1976). Energy assistance programs were developed through the efforts of a broad array of individuals and organizations. The Average Monthly Payment plan was enacted without prior research of programs or review of studies (Routh, 1989). Since that time little research had been conducted to assess the impact of AMP programs on consumers particularly elderly consumers.

Purpose of Study

This study will determine if the AMP billing plan is reaching the target group of low and fixed-income, elderly households and to determine the impact of chosen characteristics on payment plan choice and energy consumption. First a profile of elderly AMP consumers will be developed by examining household and housing characteristics. Further, selected household and housing characteristics along with household equipment, energy conservation behavior, and structural efficiency of elderly households selecting payment plan choice will be evaluated. Finally, the study will examine the impact these variables have had on elderly household energy consumption. This research has broad and practical implications for utility energy policy makers, family economics, and the individual consumer. Energy policies should be periodically evaluated to determine if they are continuing to be effective. With an increasing elderly population, this issue will be more critical in the 1990s.

Assumptions

For this study it was assumed that:

1. The sample was representative of elderly consumers who have participated in the AMP plan and those who did not use the AMP plan based on the 1987 Residential Energy Consumption Survey (RECS).

2. Data acquired from the 1987 RECS survey was representative of household characteristics, housing characteristics, household equipment, household energy conservation behavior, structural efficiency, and energy consumption of elderly households.

Limitations

The following limitations were acknowledged for this study:

1. Control of training/selection of interviewer, interview procedures, coding and/or keypunching of data, and general techniques of the survey were not available to the author.
2. Using an existing data set limited the variable selection to test the conceptual model.

Definitions

The following definitions were used in this study:

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

AMP plan (Average Monthly Payment Plan): The process of evenly distributing the total yearly utility costs or payments over 12 monthly billing periods.

Elderly Householder: Households with the head of household 60 years of age or older (RECS, 1987).

KWH (Kilowatt hours): The unit measurement of the consumption of electricity which was metered by a supply company during an accounting period. One KWH was the amount of electricity consumed by an appliance rated at 1000 watts when it was used for one hour (Kirk & Milson, 1982).

Non-AMP customers (Non-averagers): Those utility customers who have chosen <u>not</u> to use the average monthly payment plan. Their monthly utility bills reflect actual consumption and charge for the billing period.

Space Heating: All energy used to generate heat by space-heating equipment (RECS, 1987).

Structural Energy Efficiency: The thermal efficiency of a building.

Tenure: Term used to refer to whether a respondent rents or owns the residence in which they dwell.

Water Heating: "All energy used to heat water for hot running water, water heated at point sources (stoves, or auxiliary water-heating equipment), bathing, cleaning, and other non-cooking applications for water" (RECS, 1987, p. 143).

Objectives

This study focused on the unique needs of the elderly residential energy consumer. The goal of this study was to determine the implications of utility bill averaging on the elderly consumer and based on this information to develop energy policy recommendations that consider the elderly consumer's special needs. Specifically, the objectives of the study include:

1. To develop a profile of elderly AMP and Non-AMP consumers.
2. To determine the individual impact of household characteristics, housing characteristics, household equipment, household energy conservation behavior, structural energy

efficiency, and payment plan choice on energy consumption.

3. To determine the combined impact of household characteristics, housing characteristics, household equipment, household energy conservation behavior, structural energy efficiency, and payment plan choice on energy consumption while controlling for all other variables.
4. To determine the likelihood that household characteristics, housing characteristics, household equipment, household conservation behavior, structural energy efficiency, and energy consumption contribute to elderly consumer's payment plan choice.

The research proposes to focus on factors impacting energy consumption and payment plan choice of the residential elderly consumer. This study will first review existing literature that identifies the importance of household energy consumption research specifically related to elderly households. It will then state the methods used, report findings of the research, and make recommendations for future research.

CHAPTER II

LITERATURE REVIEW

Introduction

Schultz (1988) conducted a telephone survey to determine attitudes and behaviors of individuals toward energy conservation. Of the top six respondent concerns, three were related to energy: (1) cost of energy, (2) energy conservation, and (3) energy use in the home. The survey found that the level of concern for energy had declined since the late 1970s but had leveled out since 1985.

Energy assistance and weatherization programs for low-income households was a relatively new extension of the welfare system. In 1979, President Carter's decision to decontrol domestic oil prices intensified the poor's inability to respond to rising fuel costs. In 1970, home energy cost accounted for 9% of the entire income for low-income households and about 3% for the average American household. By 1984, low-income households allocated about 25% of their income for home energy costs, three to four times the portion paid by the average American household (Levitan, 1985). Programs were enacted to help low and fixed income households manage increasing energy expenditures. The following literature review addresses: characteristics of elderly households, elderly households and energy, price, economic theory, the Average Monthly Payment plan, household and housing factors, elasticity, home ownership status, household equipment, energy conservation behavior, and structural energy efficiency.

Elderly

Average life expectancy at birth has increased by 30 years during the past century. This growth depicts a greater increase than all past human history (America's Centenarians, 1988). In 1987, 12.2% of the United States population was 65 years of age and older. By 2010 it is projected that 13.9% of the population will be 65 and older. From 1940 to 1980 there was an 8.6% increase in white elderly men, a 42.9% increase in nonwhite elderly men, a 52.2% increase in white elderly women, and an 100.0% increase in nonwhite elderly women (Ross, Danziger, & Smolensky, 1987). In 1987 the mean income for those over the age of 65 was $20,333. Those persons aged 65 and older in poverty constituted 12.2% of the population in 1987 (Statistical Abstract, 1989). The elderly are an economically and socially diverse group. In the past the elderly were viewed as a sympathetic and vulnerable group. Although a portion of the elderly population's financial status has improved the elderly continue to represent a critical consumer group. The rate of poverty declined for those 65 and over from 20.3 percent in 1980 to 13.9 percent in 1988. Nelson (1982) stated that old age was the "great leveler of social class and status distinctions" (p. 86). The argument of grouping the elderly together based on income alone is no longer valid. Despite the increased affluence of many older Americans the total picture is not so positive. Over three million individuals over the age of 65 remain below the poverty level. This rate continued to be the highest poverty rate among all adult Americans. An equal percentage of older Americans have incomes just above the poverty threshold. Over one third of all older Americans have incomes near or below the poverty level (Moon, 1990). Viewing the aged as a homogeneous group, may result in the creation of one policy to meet their growing needs. A heterogeneous group, such as the elderly would not benefit from this type of policy making (Schulz, 1988).

Economic status is of great concern to the elderly. According to the life-cycle hypothesis of consumption, the rational family adopts a lifetime consumption plan that balances the satisfaction gained from acquiring additional financial assets against expenditures on current consumption across all life-cycle stages. To do this, they borrow during the early years of household formation, repay debts and save during peak earning years, and then dissave during retirement years. Dissaving should not be considered an inappropriate means of financial management. However, dissaving can be dangerous if it is done at rates that cannot support the household's life expectancy. Life cycle theory suggests that individuals will consume less and work more if they expect to live longer. Managing assets in the later years requires a reorganization of liquidation and portfolio adjustment in order to generate interest and dividend income. For many individuals a large portion of accumulated household assets reside in home equity. Financial management is especially important for households that are asset-rich and cash-poor (Hogarth, 1988; Chen & Jensen, 1985).

The elderly are a vulnerable group. By nearly three to one, older Americans used more health care services than any other age group. Programs such as Medicare, Medigap, and Medicaid provide well-needed assistance but out-of-pocket expenditures can often be unmanageable (Moon, 1990).

The life cycle income model indicates that as age increases, household income increases until retirement age (Chen, et al., 1985). Many transitions must be made upon retirement such as the adjustment to a somewhat altered economic environment. Upon retirement individuals can become more economically vulnerable. The option of replacing reduced resources by income from earnings is not as readily available as it is to other household types. One study (McConnel & Deljavan, 1983) found that medical care and energy related expenses appear to be major budgetary problems of retired households. Living on a fixed/low income can be a challenging situation, but as an elderly person this situation can be devastating. "If catastrophic illnesses or illnesses of long duration occur, there was a significant economic threat, even to the aged with good economic resources, because they had little opportunity to replace assets they had spent" (Waldo, Sonnefeld, McKusick, & Arnett, 1989, p. 27).

Elderly Households and Energy

Between the years of 1978 and 1981, the cost of residential electricity increased an average of 44%, piped gas increased 67%, and home heating oil rose 144%. Low-income consumers allocated 15% of their income for energy in contrast to 4% for the average household. "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 today" (Brown, 1987, p. 9).

Literature (Fritzche, 1981; & Dillman, Rosa, & Dillman, 1983) revealed that approximately two-thirds of all energy used in the United States was consumed by individual households. One-half of this amount was estimated to be direct consumption of electricity and fuel (Dillman et al., 1983). Increased costs for energy had become a burden for many Americans, but for the elderly individual living on a low, fixed income the problems were intensified. There were many elderly individuals that were not classified as poor but obviously needed assistance with energy related bills. These households lived primarily on limited or fixed incomes. Most had been active all their lives in the work force, paid off mortgages on their homes, and lived on Social Security and possibly a small pension or savings. The role increased energy costs played in creating a new class of low-income elderly consumers needs further exploration (Sweet et al., 1987).

The elderly tended to have fewer household members; therefore, they formed a greater proportion (20.8%) of the total households in the United States. About 21% of total residential energy used annually was by elderly households (Berry & Brown, 1988). According to one study (Iams et al., 1988) older Americans typically had fewer appliances and smaller households, but they generally paid a larger portion of their income for lighting, refrigeration, water heating, and cooling. Because the elderly were among those hardest hit by rising energy costs, some were being forced to divert dollars previously spent on other necessities in order to pay home energy costs. Rhodes (1980) used the term 'fuel poverty' to describe households that were unable to manage rising costs of residential utility bills. Often a majority of these individuals received fixed income benefits such as social security, pensions, and public assistance. These benefits failed to keep up with inflation and increased energy prices; therefore, these individuals lacked the financial ability to absorb the increased residential energy costs. As previously stated, a large portion of the elderly own their homes. Single family, detached dwellings typically required more energy to heat than apartment or row housing. Many of these residences lacked proper insulation, caulking, storm doors, and windows. Older Americans may be more reluctant to seek public assistance and often respond to increased bills by turning down the thermostat, closing off rooms, or reducing the amount spent on other necessities such as health care or food. These factors combined created extreme consequences for the elderly.

Another problem facing some elderly individuals regarding energy usage was hypothermia. Accidental hypothermia was defined as an inadvertent drop in the body's temperature to below 95 F. Research showed that people over the age of 75 are five times as likely to die from this condition than those individuals under the age of 75. Accidental hypothermia was the sixth leading cause of death among older Americans (Macey, 1989). Fluctuations in the weather can precipitate medical problems for the older person. Lack of exercise, poor eating habits, and susceptibility to viral infections made the aged prime candidates for hypothermia (Iams & Royce, 1985). Elderly who reported satisfaction with the current temperatures of their homes may be in danger because "they have become accustomed, or even expect to feel cold, because they have developed decreased sensitivity to the cold" (Pestle et al., 1985, p. 165). Inadequate heating had often been listed as a contributing factor of hypothermia. There was a need to sustain adequate thermal surroundings for the elderly individual because as a group they are particularly susceptible to accidental hypothermia (Macey, 1989). "The energy problem, therefore, for older people was not one of energy conservation, but rather, a need to use adequate energy to maintain their well-being" (Iams et al., 1985, p. 16). The concern of maintaining an adequate thermal environment for the elderly indicated that there was a need for current weatherization and energy programs.

As previously stated there were many unique factors surrounding the energy consumption patterns of the elderly. This study will investigate the relationship of household and housing characteristics, household equipment, conservation behavior and structural characteristics on energy consumption. According to Bailey (1986), sociodemographic variables that influence the reduction of energy are household income, age of head, education, and household size. Junk et al., (1988) identified some of the factors most often mentioned as contributors to lower home-energy costs for elderly households. They are: higher education levels, being young-old (60-74), having a higher income level, being a home-owner, living in a newer home, presence of four or more inches of ceiling insulation, presence of storm doors, storm windows, and weather stripping and/or caulking.

Economic Consumer Theory

Equity and efficiency are two basic objectives of economic theory. If these two concerns are not being upheld government regulation intercede. The issue of social equity is one that should be raised when utility policies are created and evaluated (Sweet et al., 1987). In a classic article by Stigler (1961) knowledge was defined as power. Information on price, quality and terms permitted the buyer to make efficient choices in the marketplace. The major problem of information was the ascertainment of market price. This was especially true regarding utility services. Prices often change with varying frequency unless a market is completely centralized. Price dispersion is the measure of ignorance in the market. If the dispersion of price quotations of sellers is at all large it would pay on average to canvass several sellers; however this is not possible with utility services.

When consumers decide to purchase a good or service it is typically the result of a search. Economic theory states that consumers will search until the marginal benefit equals the marginal cost of a search. Because a utility service is a unique good, consumers are unable to search due to the expense. Utility services are generally provided by one company in an area. There is little search for an alternative with the exception of fuel type or the decision to have no fuel provided. Due to the nature of unique goods consumers do not make the same consumption decisions regarding utility services as they do for other goods (Stigler, 1961).

Swagler (1979) defined a natural monopoly as instances where the fixed costs of providing a good were extremely large in relation to the marginal cost, so that the average cost declined over the relevant consumption range. This was the case regarding utility services (Swagler, 1979). A utility service was a unique good. With unique goods the efficiency of personal search for either buyers or sellers was extremely low (Stigler, 1961).

Energy Price

Price acted as a signal that provided information on consumption cost. When price and marginal cost of production were equal competitive market price would be set. The law of diminishing marginal return, a basic economic principle, stated that as consumption of a good increased, the marginal utility obtained from the consumption of one more unit of the good would eventually decline. As one more unit of energy was consumed, customers made purchases to a point where the benefit of consuming the last unit of energy was equal to the costs of the last unit consumed (Gwartney & Stroup, 1987). Energy rate makers encountered the problems of ensuring that: (1) prices charged reflected the actual costs and (2) the consumer had adequate ability to readily interpret the information. Limited knowledge of market economic conditions often hinder consumers in the decision making process.

Economic theory assumes that consumers are rational decision makers with perfect information. If perfect information does not exist the consumer was said to have behaved with bounded rationality. Bounded rationality contended that consumers were only able to receive, store, and process a limited amount of information. When faced with decision making they tended to simplify the problem and reduce alternatives. Consumers therefore made decisions with limited, or bounded information (Ramsey, 1985). Since price was the basic mechanism for providing information and since it was assumed to reflect true cost, whenever there was a change in price the consumer was immediately alerted and made the necessary adjustments regarding consumption. A change in price acted as a signal to consumers to change their consumption habits.

However, there were several considerations to be made in regard to public utility regulation. One was that the consumer was often unaware that the good being consumed (energy) was in continuous use. In order for a customer to understand the price signal that was included on the monthly utility bill, customers must know and understand their tariff structure, read their consumption figure from the bill, and apply this to their tariff to calculate price per unit of electricity. Research (McDermott et al., 1980; Sweet et al., 1987) has indicated that budget billing may contribute to misguiding consumers in that they receive a false price cue during those peak consumption periods. An examination of actual annual customer utility bills found that individuals receiving a high level of energy assistance had higher than average utility bills. Low or fixed income consumers have a low degree of control over their personal household energy consumption and how their energy consumption patterns compared with other income groups. These consumers are not as able to reduce fuel use or save money by switching to less expensive fuels because the energy used for household heating generally does not have a good substitute (Sweet et al., 1987).

Elasticity

Price elasticity is defined as the extent to which a change in price affects the quantity of energy demanded. The price elasticity of demand indicates the degree of consumer response to price variation (Gwartney et al., 1987).

An elasticity coefficient shows the exact difference between demand being elastic or inelastic. The calculation is done by dividing the percent change in quantity demanded by the percent change in price. When the coefficient is greater than the absolute value of 1 then demand is elastic. When the coefficient is less than the absolute value of 1 the demand is inelastic. Unitary elasticity occurs when the coefficient is equal to one. Typically, normal goods tend to be inelastic or not responsive to changes in price. Luxury or discretionary items tend to be elastic or very responsive to price changes (Gwartney, et al., 1987).

Identifying the price elasticity of various products can be helpful when formulating new or existing energy policies (Henson, 1984). For example, if the price elasticity of energy demanded was elastic, a price increase would provoke consumers to reduce energy consumption; thus, promoting energy conservation. If, however, energy was inelastic, an increase in price would not be a good conservation tool for policy makers (Williams, 1984).

Two studies (Newman & Day, 1975; Cunningham & Joseph, 1978) present two viewpoints about the effect price has on households with varying income levels. It was found that the two households least responsive to change in price of energy were: households with an annual income of $5000 or less and high income households. High income families tended to adjust expenditures so that they could continue to purchase the same amount of energy. Households most price sensitive were low income families who may not have the ability to reduce energy consumption any further.

Past research (Wilder & Willenborg, 1975; Roth, 1981; Kohler & Mitchell, 1984; Henson, 1984) have analyzed price elasticity of demand for electric household energy consumption. Price elasticity coefficients have ranged from -1.00 to -.06. These varying ranges can be attributed to inconsistencies in source of data, statistical analysis, and treatment of price variables. However, recent studies have indicated that the price elasticity coefficient was small in absolute value; therefore, price elasticity of demand for household electricity was expected to be inelastic (Routh, 1989).

Household Characteristics

Variables to be included in discussion of household characteristics are: family income, age of head of household, education of head of household, sex of household head, employment of household head, race of household head, and number of household members.

Income of a household has a direct impact upon energy affordability and possibly energy consumption level. During the inflationary period of the 1970s and 1980s, income lagged behind cost of living increases (Iams et al., 1988). Those groups of individuals with higher incomes typically made more energy consumption adjustments than did lower income groups (Bailey, 1986). Individuals with low incomes used energy mainly for essentials such as heating, lighting, and refrigeration (Henderson, 1988). Elderly individuals having an income of less than $10,000 a year consumed energy at a much higher rate than elderly consumers having higher incomes (Junk et al., 1988). Fritzche (1981) also found that energy use was related to family income. Junk et al., (1988) indicated that the lower income, less educated group spent on average 40 cents more per square foot for energy than does the higher income, higher educated home owners. Elderly households spent more of their budget proportionally on home energy costs, and their energy consumption was more sensitive to income changes than that of younger households (Macey, 1989). Just as low and fixed income consumers suffer when the prices of other goods increase they also suffer when energy prices increase. These individuals often had little or no control over energy consumption. This made it difficult for them to conserve in order to counter rising energy costs. Their incomes are less likely to increase as energy prices increase (Sweet et al., 1987).

Age, another sociodemographic factor, may influence energy usage. Ritchie et al., (1981) found that age was positively related to in-home energy consumption. Individuals aged 65 and older were more resistant to making changes in lifestyles. They often spent much of their time at home, and life's satisfactions were more directly affected by decreases in energy use (Smith, 1976). Ritchie et al., (1981) found that education did not provide significant incremental explanation for increased energy consumption.

Energy consumption research has limited information on the impact that race of householder has on energy consumption or budget billing participation. Most studies evaluating sociodemographic variables do not include race. However, Henderson (1988) provided a limited amount of information on nonwhite energy consumption. Nonwhites and the poor consume far less energy per capita than other communities and yet they spend more of their disposable income on energy related costs. Although all segments of the population are affected by energy shortages and price increases, there is a double impact felt in non-white communities. There is a gap in literature as to the effects of race on energy consumption or AMP participation. Future energy research should include race to determine if there are any such affects.

Housing Characteristics

Variables to be included in housing characteristics discussion are: age of home, number of rooms and bathrooms in home, year moved in to home, main home heating equipment, tenure, total square footage, and type of living quarters.

An estimated 70% of older Americans own their own homes (Iams et al., 1985). Approximately 47% of older Americans live in housing built prior to 1950, and over one-quarter of the total home owner population consists of elderly individuals. "Many of these homes are thirty to forty years old and lack adequate insulation and proper heating and cooling systems, in addition to having structural defects" (Iams et al., 1988, p. 16). Homes 40 or more years old consumed energy at twice the mean consumption rate. The type, age, and condition of the home was found to be directly related to amount of energy used in home. Low and fixed income individuals often live in older homes which are less energy- efficient and in poor structural condition (Sweet et al., 1987). Tenure was found to be a characteristic related to structural features. When comparing renters to home owners several factors were evident. The nature of renting gave rise to a split incentive; those who used the building's energy were not the same people who made the decisions about the building's level of energy efficiency. Renters who made indirect energy payments were not as likely to be aware of their level of energy usage or cost; therefore, the incentive to make adjustments or conserve decreased (Laquarta, 1987). A major portion of low income families were not helped because they tended to live in rented accommodations and often utility meters were operated from master meters. Renting households were almost three times more likely to have lower incomes or incomes below the federal poverty level. Tenants with higher incomes were reluctant to make improvements to buildings which they did not own (Coltrane, Archer, & Aronson, 1987).

Numerous studies (Morrison, 1975; Morrison, Gladhart, Zuiches, Keith, Keefe, & Long, 1978; Ritchie et al., 1981; Verhallen et al., 1982; Routh, 1989; Worthington, 1991) have linked size of house to energy usage. House size can be measured several ways - number of rooms in home or total square footage. Past research (Morrison, 1975; Morrison, et al., 1978;) found that a significant amount of variation for energy consumption was explained by the number of rooms in a house. Other research using total square footage came to the same conclusion - house size impacts energy consumption.

Household Equipment

The number of small and large appliances tended to increase as income increased (Smith, 1976). Typically, the elderly own fewer appliances than do other households (Claxton, Anderson, Ritchie, & McDougall, 1981, p. 71). A national survey revealed that people do not usually consider the amount of energy used by an appliance before a replacement was purchased. Typically price of the appliance, size of the appliance, and brand name would be considered before purchase. Generally individuals with higher education levels appeared to be more interested in the appliances energy use. A General Electric executive stated that, "The typical consumer just isn't interested in something that doesn't pay back the additional cost within 2 or 3 years" (Smith, 1976, p. 33). Changes that have been viewed as most important in regard to energy-using equipment in American homes have been: (a) increase in use of electricity in home heating, water heating, and cooking; (b) decrease in heating with oil; (c) growth in the degree of saturation of specific appliances; and (d) improved energy efficiency of new appliances. There had also been an increase in the use of secondary heating equipment such as wood stoves.

According to Meyers (1987) the average home had become more appliance intensive. Some of these appliances were more energy efficient, but the prevalence of some major energy-using appliances had increased. Those appliances included: frost-free refrigerators, freezers, clothes dryers, and dishwashers. The use of swimming pool pumps, hot tubs, color TV's, VCR's, microwave ovens, home computers, and other small devices had also increased, but this had not had a significant effect on energy consumption. It appeared that the major appliances in the average American home today were more energy-efficient than in 1970.

Total energy consumption values per household had decreased since the early 1970s. This decline was in part attributed to increased electrification of appliances and space heating. Research had indicated that reduced household size, improved efficiency of equipment, improved shell efficiency, increased wood use, and behavioral/ lifestyle changes had contributed to the drop in residential energy in the past 15 years. Present household equipment products were twice as efficient as past typical models in housing stock. For example, the average efficiency of new water heaters had increased about 5% since about 1972. The average air conditioner manufactured in the U.S. in 1986 was 33% more efficient than the typical model produced in 1972. Other improvements included the replacement of gas pilot lights with electric ignition, which resulted in a 45% decrease in overall gas use. Microwave ovens, were used in about 35% of households at present. They provide an energy-efficient means of cooking with electricity. Studies involved in comparison of food items cooked in microwave ovens showed that the use of microwaves reduced electricity consumption for cooking by 25-50% compared to a standard oven. The average clothes washer manufactured in 1981 consumed 32% less than those produced in 1971. An important factor to remember was that the user's behavior played an important role in energy consumption of all household equipment.

Several states had enacted minimum efficiency standards for residential appliances. In March 1987, federal law enacted national appliances efficiency standards. The rationale behind the standards were that by eliminating the production, purchase, and use of less efficient products, the marketplace moved closer to minimizing life cycle cost and societal benefits. Regulatory agencies, government agencies, and utilities had been and continue to take actions that directly effect efficiency of equipment and use at the residential sector. The National Appliance Energy Conservation Act (NAECA) was passed by Congress in 1986. This act had been developed by conservation advocates and industry representatives. It received support from appliance manufactures, utilities, consumer advocates, and environmental organizations. The standards enacted are minimum efficiency requirements that begin at the point of production. It had been estimated that by the year 2000, the standards will have reduced national electricity consumption by 51 Kwh/yr and peak summer demand by 21,000 Mega Watts (MW). Ritchie et al., (1981) suggested that appliance ownership showed no significant association with aggregate in-home energy consumption.

Advanced technologies promise to cause an even greater reduction in household energy equipment usage. The next generation of efficient residential equipment may involve more radical innovations in technology and product design. The adoption of these advancements will largely depend on the degree of promotion, attitudes of salesperson, the nature of purchase decision, consumer preferences, and the regulatory environment (Geller, 1988).

Energy Conservation Behavior

Two-thirds of all energy used in the United States is consumed by individual households. Half of this amount is direct fuel and electricity consumption (Dillman, et al., 1983). Various incentive programs have been created to encourage energy conservation. According to Blocker (1981) the majority of existing energy literature indicates that if an energy conservation policy is to be meaningful it must encourage conservation behavior among high income households that constitute high consumption levels. Blocker (1981) also argues with the price elasticity strategy that indicates that high energy prices promote conservation among all households.

Older Americans typically used energy less efficiently than the non-elderly population. Due to retirement, older citizens may be at lower income levels which often limits their participation in conservation programs. Physical limitations and economic difficulties may prevent some individuals from taking conservation actions. Many of the attitudes toward taking conservation actions were often a result of the savings mentality of older individuals. Although they may tend to be more frugal, they often do not understand the philosophy of 'spend-now-to-save-later' (Berry et al., 1988).

Verhallen et al., (1981) found that bedroom temperature while sleeping, home temperatures during absence from home, and home temperature while at home were factors that explained some of the variance of household energy consumption. Young households and elderly households tended to take fewer conservation actions than those in their middle years indicating the possibility of a curvilinear relationship (Berry et al., 1988). Inadequate attention has been given to elderly individuals problems regarding rising energy costs. Irregardless of income an elderly person may choose not to make an investment that may take years to pay for itself (Junk et al., 1988). Dillman et al., (1983) indicated that in response to higher energy prices the poor were more likely to have made 'lifestyle adjustments', while the wealthy were more likely to have invested in conservation practices (p. 314-315). Vine et al., (1989) found that window opening and closing was the primary method of controlling the thermal environment for the study's sample of elderly respondents. In conclusion, literature indicated that elderly households have different conservation and energy related needs and attitudes as compared with non-elderly households. Those needs should be separately addressed.

Structural Characteristics

Previous studies have concluded that the physical condition of a house has a positive effect on energy consumption (Newman, et al., 1975; Verhallen & Van Raiij, 1981; Sweet et al., 1987). Problems can occur among older structures. Many older dwellings had no insulation and had numerous structural defects. Brandt & Guthrie (1984) found that older homes were more likely than newer homes to lack insulation and to have structural defects. Studies (Newman et al., 1978, Iams et al., 1988) found that by adding insulation a considerable energy savings can result. Most of these homes are in great need of energy retrofitting; however, most occupants of these houses are people who can least afford to retrofit. These conditions result in extreme energy waste and high energy bills.

Bailey (1986) found that more adjustments were made by people with higher levels of education than by those people with less education. "The real 'energy crisis' had persisted for low income households who lacked the resources to compensate for rising energy bills" (Routh, 1989, p. 16). Structural measures most often taken by elderly consumers to conserve energy included double-paned or storm windows, caulking, weatherstripping, and storm doors (Junk et al., 1988). Structural characteristics were found to be more important than demographic factors in predicting energy consumption levels (Iams et al., 1988). Distinctive factors regarding energy demand of the elderly included the continued growing elderly population and the apparent inefficient use of energy; therefore, attention to the subject was warranted.

Average Monthly Payment Plan

There were basically three different approaches taken in providing energy assistance to the poor and low income. There are energy conservation/weatherization programs. Direct financial assistance was also used. Finally, rate relief or rate reform inn which the Average Monthly Payment (AMP) plan fits. Most of these programs were compensatory and did not address long-term changes (Sweet et al., 1987). As stated in Chapter I, this alternative billing procedure was offered to disadvantaged utility customers. The billing procedure has been recognized under a variety of titles: budget billing, levelized billing, and average monthly payment plan. The plan was designed to help low and fixed income consumers reduce the impact or financial strain of the high cost payments of monthly utility bills (McDermott et al., 1980).

Calculation

The AMP plan allowed a customer to pay a fixed amount each month rather than trying to manage fluctuating monthly utility bills. The typical method used to determine monthly payments used a historic twelve month period which was aggregated to determine a total consumption figure. This figure was then divided by twelve to provide an average bill that will cover the total billing period's consumption cost.

Billing Procedure

There are several ways that a company handles debit/credit accounts. One method was to use cash basis payment. All credit balances are paid to the customer at the end of the twelve month period; likewise, debit balances are paid to the utility company by the customer. One problem for consumers who used this procedure was the potentially large final payment at the end of the budget year. A second method, was the credit approach where all balances, debit/credit, are either subtracted or added to the next twelve monthly payments. A third method, was the combination of the first and this procedure can be favorable to the utility company. The credit balances were treated as credits over the long period, providing the utility company with a source of extra money. The debit balances were usually paid in cash by the customer which ensured the utility company that the costs would be paid by the end of the year.

The starting date played an important role in determining whether or not the billing period would begin during the peak or the off-peak period. An off- peak starting date allowed the collection of revenue by the utility company early in the year in excess of costs and services. Most utilities allowed the customer to start the billing plans at any time during the year. Some companies required their customers to start the plan in the late spring or summer months.

Utility companies have been left to create their own methods of calculations for billing procedures. Many utilities have differing methods of performing the budget billing calculations. Some of the methods have resulted in an undercollection of revenues while others have resulted in an overcollection of revenues, which was not beneficial to the consumer (McDermott, et al., 1980). The issue of providing the customer information about monthly consumption has been closely examined. As set by Oklahoma utility companies procedures, the AMP customer's monthly bill reflected the following: (a) previous balance (either debit or credit), (b) current monthly charges, (c) account total, and (d) the AMP payment (Routh, 1989). Many of the energy assistance programs benefit the non-poor as well.

Hypothetical Model

A hypothetical model has been formulated which suggests a relationship between household and housing characteristics, equipment, energy conservation behavior, and structural efficiency scores with payment plan choice and ultimately on energy consumption for elderly households. The objectives listed in Chapter I combined to create the hypothetical model (Figure 1).

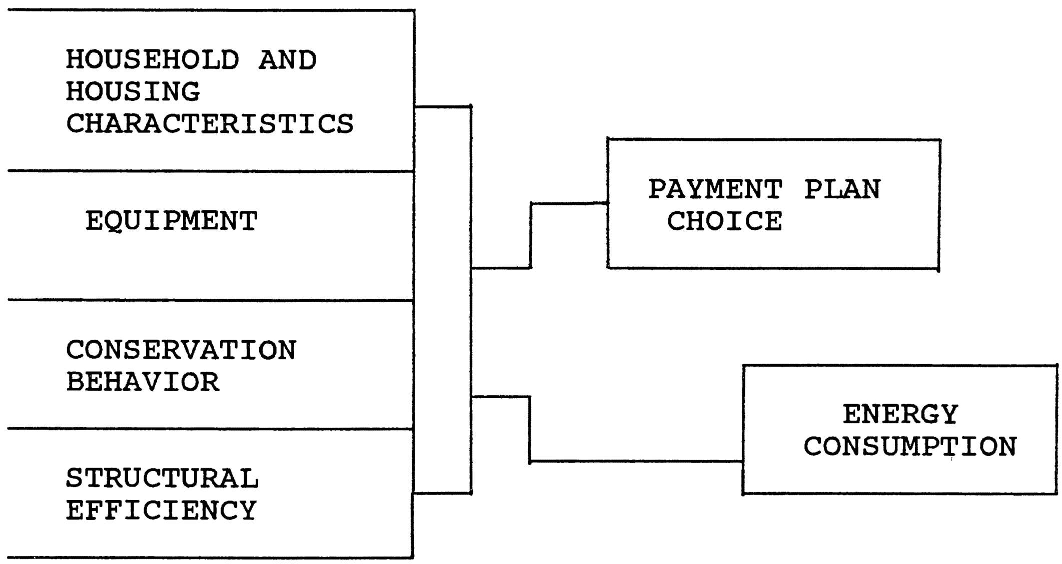


Figure 1. Hypothetical Model Showing Relationship Between Household and Housing Characteristics, Household Equipment, Household Behavior, Structural Efficiency, and Payment Plan Choice on Energy Consumption.

Summary

Schultz (1988) indicates that energy remains a concern for most American households. Yet, the level of political and social concern has wanned since the energy crises of the 1970s and early 1980s. Many energy weatherization and assistance programs were created and implemented to help the low and fixed income combat increasingly high energy costs. Some programs, such as the AMP plan, were implemented with little previous research conducted on the effectiveness of the program. The elderly are a heterogeneous group. While a portion of the elderly population's financial status has dramatically improved from previous generations, the elderly continue to represent a critical economic consumer group. Studies (Berry, et al., 1988; Dillman, et al., 1988; & Iams, et al., 1988) have indicated that on average, elderly consumers use less energy but pay a proportionately higher share of income.

Economic theory suggests that information about price, quality and terms allows consumers to make efficient purchasing decisions. Studies (McDermott, et al., 1980; Sweet, et al., 1987) have suggested that the AMP plan may send a false price cue to consumers thus increasing energy consumption.

Previous studies (Iams, et al., 1988; Junk et al., 1988; Fritzche, 1981; Sweet et al., 1988; Laquarta, 1987) suggested that household factors, housing factors, structural characteristics, household behavior, and household equipment impact energy consumption. Little research has been done to determine if the AMP policy is helping those it was originally designed to help. Further investigation is needed to determine the effectiveness of this policy.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to determine if the AMP billing plan is reaching the target group of low-income and elderly households. The research proposes to focus on the impact of utility payment plan choice on the elderly residential energy consumer and to determine the impact this plan has had on energy consumption patterns. Household characteristics, housing characteristics, household equipment, energy conservation behavior, and structural efficiency were examined in regard to payment plan choice and energy consumption.

According to the 1987 RECS survey, per household energy consumption was 100.8 million Btu in 1987. It was estimated that 54% of household energy used was for space heating, 23% for appliance use, 18% for water heating, and 5% for air conditioning. In addition to energy consumption data the RECS data provided housing and household characteristics. This information provided a clearer picture of the consumer who is taking advantage of the AMP plan. Knowing some of the household and housing characteristics of the respondents will indicate those consumers who tended to choose the AMP plan.

This study constituted descriptive research. Descriptive research systematically reports a situation factually and accurately. Researchers have not agreed on what constitutes descriptive research. According to Isaac & Michael (1981, p. 46), the purpose of descriptive research is to: "(1) collect detailed factual information that describes existing phenomena; (2) identify problems or justify current conditions and practices; (3) make comparisons and evaluations; and (4) determine what others are doing with similar problems or situations and benefit from the experience in making future plans and decisions."

A profile of AMP and Non-AMP elderly residential energy consumers was first developed. Then the research evaluated the individual and combined impact of household and housing characteristics, household behavior, household equipment, structural efficiency, and payment plan choice on energy consumption. Finally, it will report the findings of household and housing characteristics, household equipment, household conservation behavior, structural efficiency, and energy consumption in relation to payment plan choice.

Data

Data obtained from the 1987 Residential Energy Consumption Survey (RECS) were designed by the Energy

Information Administration (EIA). This survey was designed to provide information about energy consumption within the residential sector. The data from the 1987 RECS survey represents 90.5 million households throughout the United States and the District of Columbia. The 1987 RECS was the seventh survey in the series. The RECS survey, a national multistage probability sample, was conducted on a triennial basis. This probability sample included rotating groups of respondents and returning rotating groups of respondents. Data were collected from the fall of 1987 to the Spring of 1988. On the basis of the size of the Metropolitan Statistical Areas (MSA's), the 50 states and the District of Columbia were divided into 1,800 Primary Sampling Units (PSU's). All eligible occupied housing units, including single family homes, apartments, and mobile homes, were considered as the primary residence.

The RECS data were collected in two stages. The first stage included a personal interview which asked about household characteristics and obtained authorization to obtain household utility billing information. Personal interviews were conducted in the fall of 1987. The average length of the interview was 56 minutes with 85% of the interviews lasting between 30 and 75 minutes. The householder was interviewed regarding structural features of the house related to energy, such as insulation, doors, windows, heating and cooling systems, primary fuels used, household appliances, government assistance for heating expenditures, and demographic information. Following the interview, respondents were asked to sign an authorization form allowing the primary fuel supplier to release energy consumption data. There were a total of 293 interviewers. Forty-five percent, or 131 interviewers, had conducted interviews on a previous RECS survey. The remainder had been trained or had previous experience on other survey research organizations or with the United States Bureau of Census. Verifications of interviews were conducted by telephone on 20% of the personal interviews to ensure that they had been carried out as intended.

The second stage was a mail questionnaire asking household energy expenditure and consumption information from the household's energy supplier. The billing data covered a twelve month period from January 1987 through December 1987. Electricity, natural gas, fuel oil, kerosene, and LPG were the five fuels covered in the supplier survey. The initial fuel-supplier survey attempted to contact 1,025 companies. The procedures used to obtain data from the utility companies was as followed: (a) an initial letter from the Director of the Office of Energy Marketing and End Use was sent to the President or other official in the company, informing them of the purpose of the research and procedures involved (b) a contact by telephone was made to determine the name of the contact person (c) survey materials were mailed to the contact person (d) a follow-up telephone call was made a few days later (e) completed surveys were returned by mail and (f) a thank you letter was issued to the contact person for their cooperation. Fuel supplier records that covered too few months or records that were incomplete were labeled as non-useable.

Sample

The original sample consisted of 8,232 units, 225 of them either were not used for dwelling purposes or were not habitable. Of the 8,007 remaining units, 824 were ineligible for this study because the occupants were not primary residence of the units. Personal interviews were conducted at 5,856 of the 7,183 eligible units. An 81.5% response rate occurred. Out of the 1,327 households that had not participated in the personal interview phase of the study, mail questionnaires were sent to 1,153 households. A 32.4% response rate occurred among the mail questionnaires that were sent. Sample selection was based on (a) population estimates of counties and equivalent units taken from the 1980 Census, (b) Metropolitan Statistical Area definitions and (c) principal home-heating fuel taken from the 1980 Census of Housing. Incomplete records were eliminated according to the 1987 RECS procedures.

The present study chose to limit participation according to age; therefore, only those households with a householder aged 60 and older were used. The final sample resulted in 1390 respondents with 1200 households not participating on the budget billing plan and 190 households participating on the budget billing plan.

Variables

Variables can be classified into several categories. Nominal variables are those variables that must be classified into one and only one category. The categories must be mutually exclusive and mutually exhaustive. Variables that were coded as nominal in this study were: budget billing plan, sex, race, householder of Spanish origin, householder finished highest grade, employment of householder, marital status, main home heating equipment, tenure, and type of living quarters. Ordinal variables are those variables that have order among categories. A category might be thought of as higher than or lower than the adjacent category but the quantity of the intervals is not known. Number of household members, number of rooms in home, number of full and half baths were variables classified as ordinal. Interval variables also have categories but there are equal intervals between the units of measure. Variables that were coded as interval in this study were: highest grade attended by householder and family income in past 12 months. Ratio variables have the same characteristics as interval level variables with the additional property of a true zero (Roscoe, 1975). Variables classified as ratio in this study were: total energy consumption, age of householder, age of home. The variables included in the analysis of this study were household variables (sex, age, employment, number of household members, marital status, race, householder of Spanish origin, highest grade attended, if householder finished highest grade, and family income in past 12 months), housing variables (age of home, number of rooms in home, number of complete baths, main home heating equipment, tenure, total square footage heated and unheated, and type of living quarters), equipment (quantity of equipment), energy conservation behavior, structural efficiency (air infiltration and insulation), energy consumption (total Btu's) and payment plan choice.

Regarding the question used to ascertain age, respondents identified themselves as the householder or indicated their relation to the householder. Age listed the actual age the individual was on their last birthday. In order to see an inclusive breakdown of age as compared with the budget billing plan, all respondents in the 1987 RECS sample were included in initial analysis.

Income was measured by asking the respondent to list family income in past 12 months. For this study income was collapsed into three categories from the original twenty-five categories. These categories were low income, medium income and high income. Households with incomes less than $3,000 to 9,999 were the low income category; those with incomes ranging from $10,000 to 19,999 were in the medium income category; and those with incomes ranging from $20,000 to over $75,000 were in the high income category. In order to get an equal distribution among all three categories income was collapsed in the above mentioned order.

Educational attainment was indicated by two separate questions. The first question asked what educational level a respondent had attained to and the second question asked if the respondent completed that level of education. Scores could range from 0 to 18 for the first question and a yes or no response was indicated by the second question. Tenure was defined as whether a respondent owned a residence or rented a residence. Type of living quarters was collapsed into four categories from the original eight categories. They included: mobile home, one family dwelling unit, 2-4 family dwelling unit, and 5 or more family dwelling unit.

In order to utilize data in an effective manner square footage heated and unheated was collapsed into six categories for chi-square analysis. The original data listed square footage by exact measurement. The categories included 0-1000, 1001-1500, 1501-2000, 2001-2500, 2501-3000, and over 3,000 square feet. However, when performing multiple regression and logistic regression square footage was measured by using actual square footage imputed.

Scores

This study used an equipment score, energy conservation behavior score, and a structural efficiency score that had been previously created (UCER unpublished report, 1991). The following text briefly discusses the variables, ranges, and means of the Scores.

The Equipment score was a simplistic scale created by evaluating the quantity and use of appliances in the household related to energy consumption. A score of one would be given for each appliance in and/or used in the residence. The higher the score the more appliances. The following variables composed the Equipment score: hot running water in home, hot water system heats other water, central air conditioning, window or wall air conditioning, air conditioning unit cools other units, heated swimming pool, hot tub, jacuzzi, electric range used for cooking, micro-wave oven, other electric oven used, gas range used for cooking, gas oven used for cooking, outdoor piped gas grill, outdoor LPG grill, automatic clothes washer, electric wringer washer, electric dishwasher, electric clothes dryer, gas clothes dryer, outdoor gas light, electric dehumidifier, evaporative cooler, whole house cooling fan, window or ceiling fans, electric blanket, heated water bed, separate frost free freezer, separate manual defrost freezer, number of black and white TV's, number of color TV's, and other high energy equipment. The components of the Equipment score were selected based on EIA's data availability. The Equipment score ranges from 1 to 118 with a mean of 48.63.

The behavior conservation score was a simple scale created to measure household energy conservation behavior. The following variables were included in the Behavior score: adjust temperature by main heating thermostat, adjust temperature by auxiliary heating thermostat, adjust temperature by opening door, adjust temperature by opening vents, adjust temperature by turning heater off, adjust temperature by turning radiator off, adjust temperature by adjusting draft, adjust temperature by using oven, and can temperature be adjusted. The energy conservation behavior score ranged from 0.0 to 7.0 with a mean of 1.6. The higher the score the more energy conservation behavior actions adopted by elderly households studied.

The measure of housing quality related to energy conservation is adapted from information taken from the Energy Information Administration's insulation and air infiltration data. The Structural Efficiency Score included the following variables: attic insulation batt or blanket, attic insulation loose fill, attic insulation firm foam, insulation in attic or roof, attic insulation sprayed in foam, attic insulation since September 1985, caulking present, weather stripping in home, added caulking since September 1985, weather stripping added since September 1985, outer walls insulated since September 1985, basement or crawl space insulated, heating and cooling ducts insulated, ducts insulated since September 1985, floor insulation since September 1985, hot water heater insulated, and age of hot water heater.

In order to establish the extent of energy efficiency an estimation of quality for each structural conservation feature was determined. Air infiltration was composed of variables such as: caulking, weatherstripping, and percentage of storm windows and doors (number of storm divided by the total number multiplied by 100). For the pipe/duct insulation scores and for the caulking/weatherstripping score, the following assumptions were made: no=0, yes=1, and added since 1985=2. For insulation of the ceiling, floor, and wall, R-values were used.

The eight structural energy features outlined above were subjected to factor analysis and permitted two factors of home weatherization: (a) insulation (FACTOR 1) and (b) air-infiltration (FACTOR 2). These resulted in two factor scores which were used for further analysis. The insulation factor score ranges from -1.24 to 4.51 with a mean of -0.074. The factor score of air-infiltration ranged from -2.52 to 1.57 with a mean of 0.141.

Usage of natural gas, electricity, LPG, kerosene, and fuel oil during 1987 were converted to Btu's and the Btu value of the five fuel types was used for the score of total energy consumption. The average energy consumption of elderly households during 1987 was 103486.34 Btu's with a range of 1188.0 to 558071.0 Btus.

Analysis

Several statistical tests were used in the analysis of the data. First, a profile of the averagers and non-averagers was developed using chi-square procedures. According to Isaac et al., (1981, p. 158) chi-square is a "measure of squared deviations between observed and theoretical numbers in terms of frequencies in categories or cells of a table, determining whether such deviations are due to sampling error or some interdependence or correlation among the frequencies. It involves a comparison of frequencies of two or more reasoning groups." It looks for association between two variables and makes predictions. It can be used with nominal or ordinal data. Variables analyzed were: household characteristics, housing characteristics, household equipment, energy conservation behavior and structural efficiency as related to budget billing plan choice.

Multiple regression with stepwise techniques was then utilized to determine the 'best' fit equation for household and housing variables, household equipment, household conservation behavior, structural efficiency, and payment plan choice with total energy consumption. Baxter, Feldman, Schinnar, and Wirtshafter (1986) and Isaac et al., (1981) stated that multiple regression was a common approach used to study the influence of various social and economic factors on household energy consumption. One approach mentioned explored the variation in energy consumption using a variety of variables such as economic, demographic, climate and engineering variables as explanatory factors. This research attempted to use similar variables to explain energy consumption. Two important objectives of multiple regression are: to ascertain the degree of relationship between an index number, or multiple correlation coefficient, between a dependent variable and a combination or two or more predictor or independent variables and to predict the position or standing of respondents in a sample indicated from the scores earned in the combination of predictor variables along with an expected margin of error (Isaac et al., 1981). At each step, this technique chose the best single variable which in combination with previously selected variables maximized the coefficient of multiple 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, Wasserman, & Kutner, 1983). A backward elimination method as well as a stepwise regression method was used in the analysis.

A backward elimination method begins with the largest regression, using all variables, and subsequently reduces the number of variables in the equation until a decision is reached on the best equation to use. Draper and Smith (1977) stated that the backward elimination method is more 'economical' because it tries to examine only the 'best' regressions containing a certain number of variables. Backward elimination was used to eliminate the possibility of the exclusion of certain variables that are significant in the presences of other variables.

As previously stated, multiple regression analysis provides a means of analyzing how a dependent variable is affected simultaneously by several independent variables. The second objective sought to determine the individual impact of household and housing characteristics, household equipment, energy conservation behavior, structural efficiency, and payment plan choice on energy consumption. The following equation represents the relationship between the independent variables (household variables) and total energy consumption:

$$Y_1 = b_0 + b_1 SEX + b_2 AGE + b_3 EMPLOY + b_4 NUMMEM + b_5 MARRY + b_6 RACE + b_7 SPANISH + b_8 GRADE + b_9 FINISH + b_{10} INCOME + e$$

where

Y_1 = Total energy consumption

b_0 = Intercept

SEX = Sex of householder

AGE = Age of householder

EMPLOY = Employment of householder

NUMMEM = Number of household members

MARRY = Marital status of householder

RACE = Race of householder

SPANISH = Householder of Spanish origin

GRADE = Highest grade attended by householder

FINISH = Highest grade finished by householder

INCOME = Family income in past 12 months

e = Error term

The following equation represents the relationship between the independent variables (housing variables) and total energy consumption:

$$Y_1 = b_0 + b_1 HOME + b_2 ROOMS + b_3 YEAR + b_4 BATHS + b_5 HEAT + b_6 TENURE + b_7 FOOTHT + b_8 HT\&UN + b_9 QUART + e$$

where

Y_1 = Total energy consumption

b_0 = Intercept

HOME = Age of home

ROOMS = Number of rooms in home

YEAR = Year moved into home

BATHS = Number of complete baths

HEAT = Main home heating equipment

TENURE = Rent or own

FOOTHT = Total square footage heated

HT&UN = Total square footage heated and unheated

QUART = Type of living quarters

e = Error term

Using stepwise multiple regression, the remaining individual characteristics - household equipment, energy conservation behavior, structural efficiency and payment plan choice - were also individually combined and correlated with energy consumption to determine if the individual variables impacted energy consumption.

Finally, household and housing characteristics, household equipment, energy conservation behavior, structural efficiency, and payment plan choice were combined and regressed. This was done to determine the combined effect of all variables on energy consumption.

Logistic stepwise regression was then performed on the same variables with payment plan choice acting as the dependent variable. In the past few years, logistic regression has been used to study various topics related to households. Logistic is useful when one nominal- level variable is considered to be dependent on a set of predictor variables. Logistic must be used when there can only be a yes or no response.

Traditionally social scientists view relationships among variables according to percentage differences. Since logistic is a nonlinear test the results may require a different way of thinking. In order to understand logistic the concept of odds ratio must be understood (the odds between two ratios). Odds are defined as the frequency or probability of one category of a variable compared to the frequency of probability of another. Odds are generally expressed as ratios and can be calculated to determine the probability of an event occurring. The probability of a success is called **p.** The probability of a failure is called **1-p.** For example, if analysis reveals an odds ratio of 2.75, the odds of something occurring or being a success are 2.75 times higher for one specified group than for another specified group with particular variables controlled (Alba, 1987; Morgan & Teachman, 1988).

The odds ratio equation is as follows:

$$(1) \quad \log \frac{P}{1-P} = B_o + B_1X_1 + B_2X_2 + \ldots + B_nX_n$$

$$(2) \quad \text{odds} = \exp\,[\,B_o + B_1X_1 + B_2X_2 + \ldots + B_nX_n]$$

where:

B = Intercept

X = Variable

Exp = Exponential

Morgan & Teachman (1988) suggest that the odds ratio has four desirable qualities. First, the interpretation is clear. For example, an odds ratio greater than 1.0 shows that there is an increased likelihood of the event happening, whereas an odds ratio of less than 1.0 shows that there is a decreased likelihood of the event happening. The second quality is that it is constant under the interchange of rows or columns. The third quality, is that it is constant if rows or columns are multiplied. Possible shifts in size of sample or marginal shifts do not affect its value. Lastly, it can be used in tables of varying size or dimension. Morgan, et al., (1988) also suggested that if categorical variables were used, the weighted-least- squares or maximum-likelihood procedure must be used. The fourth objective of the present study was to determine the likelihood that household and housing characteristics, household equipment, energy conservation behavior, structural efficiency, and energy consumption contributed to elderly household's utility payment plan choice. Two equations were developed to determine the likelihood of those variables contributing to payment plan choice. The following equation represents the likelihood of the scores and energy consumption contributing to payment plan choice:

$$\text{logit}(p) = a + b_1\text{BEHAV} + b_2\text{EQUIP} + b_3\text{FACTOR1} + b_4\text{FACTOR2} + b_5\text{TOTALBTU}$$

where:

a = Intercept

BEHAV = Energy conservation behavior

EQUIP = Household equipment

FACTOR1 = Insulation score

FACTOR2 = Air infiltration score

TOTALBTU = Sum of LPG, KER, EL, NG, and FO

Additional logistic equations were developed for logistically regressing household and housing variables on payment plan choice.

Logistic regression was used to identify characteristics that would differentiate between those on the AMP plan and those not on the AMP plan. Variables with qualitative factors can be useful in regression analysis. These factors can be represented as dummy or indicator variables. These variables assume two values - usually zero and one. The numerical value of a dummy variables does not indicate any quantitative value. It only suggests that the variable belongs in a category or class. When using dummy variables the number of variables required is one less than the number of categories represented. A base category must be chosen in which to judge the remaining categories.

In order to accurately analyze the 1987 RECS data dummy variables were created for household and housing variables. The following variables were included: employment of householder, marital status of householder, race of householder, and family income in past 12 months, main home heating fuel, dwelling owned or rented and type of living quarters.

CHAPTER IV

RESULTS

Introduction

The first objective was to develop a profile of elderly AMP and Non-AMP residential energy consumers. The second and third objectives attempted to determine the individual and combined impact of household and housing characteristics, household equipment, energy conservation behavior, structural efficiency and payment plan choice on energy consumption. The fourth objective was to determine the likelihood that household and housing characteristics, household equipment, household behavior, structural efficiency, and energy consumption contributed to elderly consumer's utility payment plan choice. The purpose of this study was to determine if the AMP billing plan was reaching the target group of fixed and low-income elderly households. Further, the research proposed to focus on the impact of utility payment plan choice on the residential elderly consumer and to determine the impact it has had on energy consumption patterns. The following text gives characteristics of the sample, detailed descriptions of the statistical findings and finally summarizes the results.

Characteristics of the Sample

The aged as a group represent a growing proportion of the United States population. Information from RECS (1987) indicated that their energy needs differed from the non-elderly. Those aged 60 years and older constituted 28% of the total respondents in the survey.

Household Characteristics

Over 50% of the respondents were married with 37% of the sample widowed. Eighty-six percent were white and nearly 13% were black. Over 74% of the sample owned their homes while almost 25% rented. Eighty percent of the household heads were not employed. In 48% of the households there were two members.

Housing Characteristics

Thirty-three percent of the respondents lived in homes built prior to 1940 and nearly 80% lived in homes built before 1969. In regard to size of home, 45.1% lived in homes with five or six rooms. Seventy-seven percent had one complete bath in the residence. The primary home heating fuel was LPG (57.0%). Over 60% of the main heating equipment was 10 years or older. Sixty-five percent of the respondents lived in one family detached homes. Only 14.7% of the respondents were on a utility budget billing plan.

Energy Consumption

There was no statistically significant difference between the non-elderly's and elderly's overall per household energy consumption. Even after adjusting for the weather and residential structure size, the elderly used approximately 10% more energy to heat their homes than did the non-elderly although they used less energy for water heating, air conditioning, and appliance usage than did the non-elderly. However, there were statistically significant differences between the non-elderly and elderly in expenditures for energy. The elderly spent $98 dollars less per household for energy than the non-elderly households although they spent more (13% more) than the non-elderly for space heating. Factors that may be related to the increase for space heating expenditures were: (1) a greater number or proportion of the elderly lived in older homes that were less energy efficient and (2) elderly households in the 1987 survey kept their thermostats at a higher level than did the non-elderly households. In 1987, total energy consumption allocation for elderly households were as follows: 61% allocated for space heating, 15% for water heating, 4% for air conditioning, and 19% for appliances. Total non-elderly energy consumption included: 51% for space heating, 19% for water heating, 5% for air conditioning, and 24% for appliances (RECS, 1987).

Mean Results

Table I indicates the mean and standard deviation scores for selected variables. Variables not included in Table I had dummy variables created for them.

The mean scores indicate that the mean number of rooms was 5.195 with 1.23 complete baths and 0.219 half baths. There were on average, 1.844 household members with a 10.991 educational level (10th grade). Finally, results show that the mean age of head of household was 70.905.

Chi-square Analysis

Chi-square analysis was performed on household and housing variables in relation to budget billing plan. Significance level was set at the .10 level. After careful consideration the variable 'year moved into home' was not included in analysis due to the large percentage of data that were missing.

Profile of AMP and Non-AMP Consumers

Household Variables. The following household variables were analyzed using chi-square: sex of householder, age of householder, employment of householder, number of household members, marital status of householder, race of householder, householder of Spanish origin, highest grade attended by householder, householder finished highest grade, and family income in

TABLE I

MEANS AND STANDARD DEVIATION SCORES
FOR SELECTED VARIABLES

N=1390

Variable	Mean	Standard Deviation
Number of rooms	5.195	1.701
Number of complete baths	1.230	0.489
Number of half baths	0.219	0.455
Number of household members	1.844	0.927
High grade attended by householder	10.991	3.536
Total square footage	1761.38	1126.12
Age of head	70.905	7.774

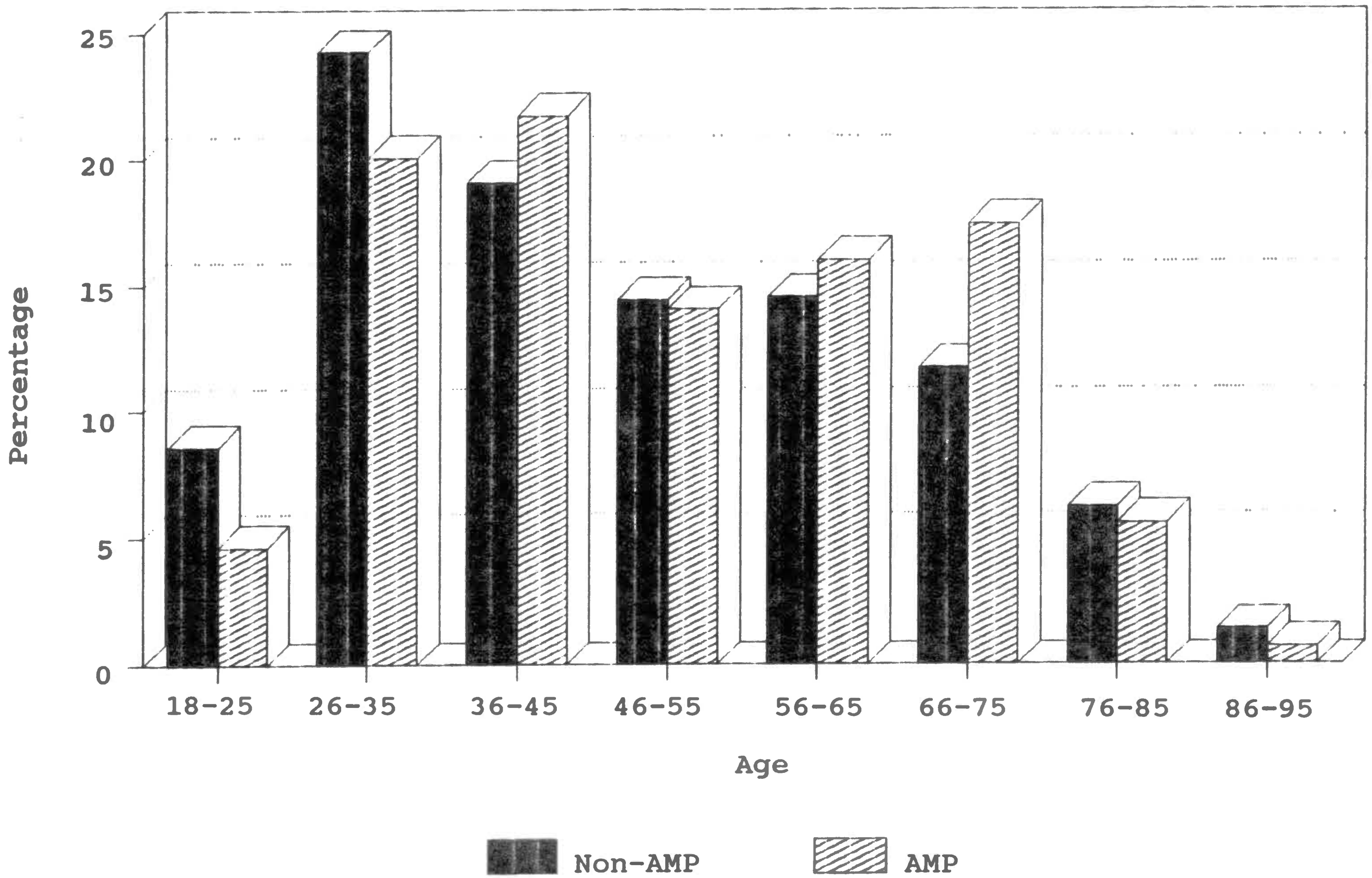


Figure 2: Comparison of Age of Householder.

past 12 months. Findings of the analysis are discussed in the following paragraphs.

Age of householder was significant at .001 level. Figure 2 shows the breakdown by age group and the frequency of those who tended to choose the AMP plan. In order to see an inclusive breakdown of age as compared with budget billing plan, all RECS respondents were included in the initial chi-square analysis. Age groups were as follows: 18-25, 26-35, 36-45, 46-55, 56- 65, 66-75, 76-85, and 86-95. Although this was not the age categories used in the remaining analysis, it was thought important to be used in this manner when viewing age independently. An overall view of age in comparison to choice of budget billing plan can be seen and differences between the elderly groups and the non- elderly groups can be viewed. The highest AMP plan participation rates for the group aged 60 and younger, occurred in the 36 to 45 year old group. The highest AMP plan participation rates of those 60 years of age and older appeared in the 66 to 75 year old group.

The householder of Spanish origin variable was also significant. Householders of non-Spanish origin were more likely to be on the AMP plan than those householders of Spanish origin. Significance level was .032.

Housing Variables. The following housing variables were analyzed using Chi-square: age of home, number of rooms in home, year moved into home, number of complete

TABLE II

CHI-SQUARE RESULTS FOR HOUSING CHARACTERISTICS AS RELATED TO BUDGET BILLING PLAN

N=1290

Variable	Non-AMP	AMP	P-value
Tenure			
Own	77.91	91.05	
Rent	20.36	7.89	.001 **
Type of living quarters			
Mobile home	5.18	5.79	
1-family dwelling	74.83	83.16	.069 *
2-4 units	9.64	6.84	
5 or more units	10.36	4.21	
Main heat fuel			
Piped gas	55.00	72.63	
LPG	6.55	4.21	.001 **
Fuel oil	16.82	13.68	
Kerosene or coal oil	1.55	1.05	
Electricity	13.36	8.42	
Coal or coke	0.91	0.00	
Wood	5.64	0.00	
Other	0.09	0.00	

*** p<.0001
** p<.001
* p<.05

baths, main home heating equipment, tenure, total square footage heated and unheated, and type of living quarters. Findings of the analysis are listed in the following text.

Housing variables that were significant were discussed in the text below. Table II shows the results of chi-square analysis of housing variables as related to budget billing plan. Ninety-one percent of those on the AMP tended to own their own homes as compared with 77.0% of those not on the AMP plan (=.001). Total square footage heated and unheated was significant at .001 level. Figure 3 further illustrates this finding by showing the breakdown of total square footage heated and unheated as related to choice of budget billing plan. As stated previously, square footage heated and unheated was collapsed into six categories. The categories included 0-1000, 1001-1500, 1501-2000, 2001-2500, 2501- 3000, and over 3,000 square feet. Thirty-four percent of those who did not choose the plan lived in homes with square footage of 0-1,000 as compared with 19.0% of those who chose the plan who lived in homes with square footage of 0-1,000. Table II indicates the significance of type of living quarters in relation to budget billing plan. As previously stated in Chapter III, the type of living quarters was collapsed into four categories: (1) mobile home (2) one family dwellings, (3) two family dwellings, and (4) dwellings with five or more units.

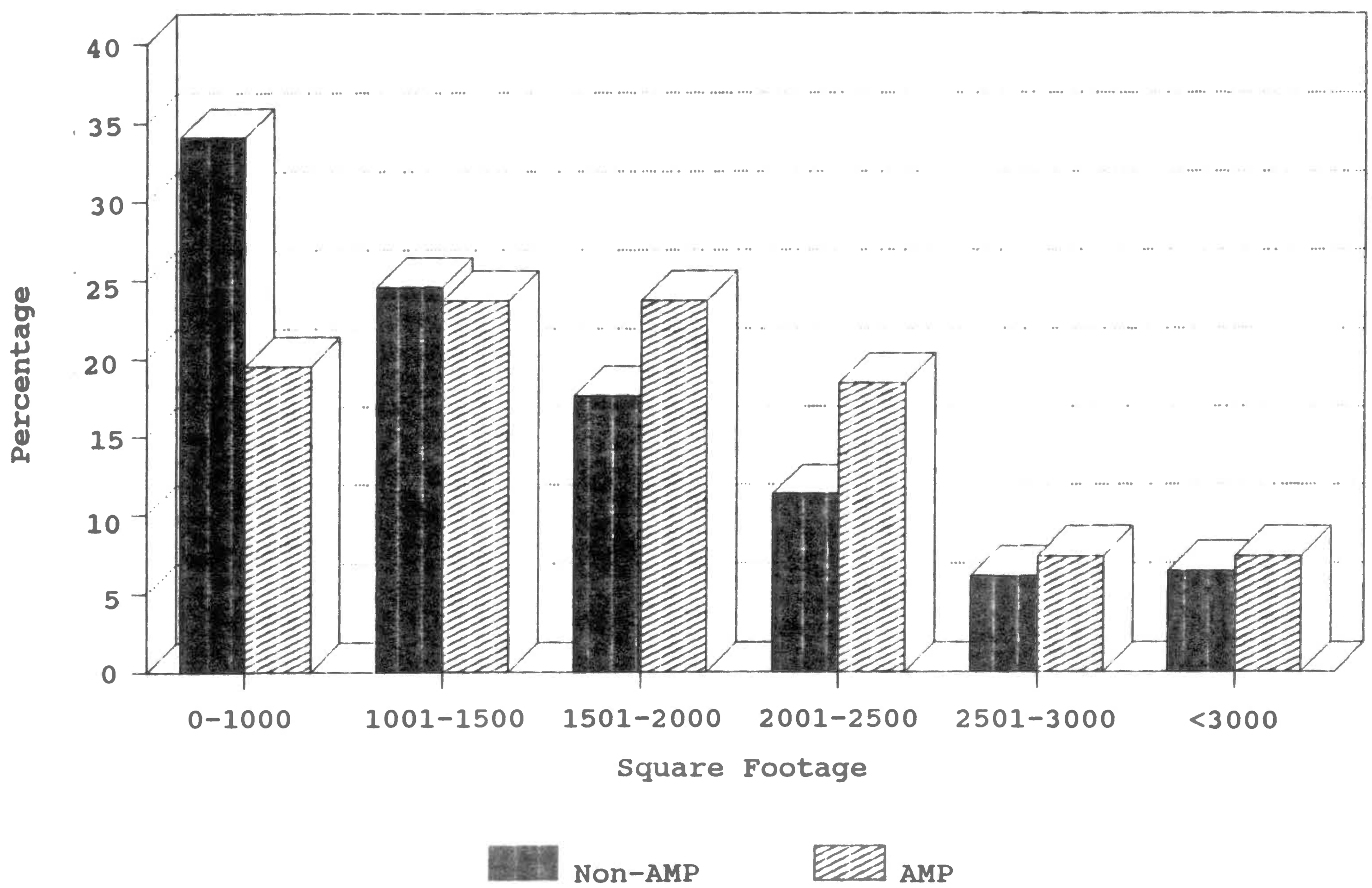


Figure 3: Comparison of Square Footage.

Those on the AMP plan tended to live in single family units (83.0%) as compared with 74.0% of those not on the AMP plan. The main home heating fuel was significantly related to budget billing plan (.008) at the .10 level. Those that tended to choose the budget billing plan tended to use piped gas and fuel oil as their main home heating fuel.

Stepwise Multiple Regression Analysis

To address the second and third objectives, the stepwise multiple regression approach was used to provide fundamental relationships among variables. Variables were inserted in turn until the 'best' regression equation was found. Due to the qualitative nature of some variables, indicator or dummy variables were used in their place (Chatterjee et al., 1977).

A backward elimination as well as regular stepwise multiple regression was used. The following text will indicate what type of variables were analyzed and the final model or equation that was developed from the analysis. First backward elimination using stepwise multiple regression was done on household variables with energy consumption and housing variables with energy consumption. Each score was individually regressed on energy consumption to determine the individual impact they had on energy consumption. Next, payment plan choice was regressed on energy consumption. Finally, all variables were regressed on energy consumption to determine the combined impact they had on energy consumption and whether they differed from the individual impact.

Household Variables

A backward elimination procedure of stepwise multiple regression was performed on the following independent household variables with energy consumption being the dependent variable: age of householder, number of household members, householder highest grade attended, sex of householder, employment of householder, marital status of householder, race of householder, is householder of Spanish origin, did householder finish highest grade attended, and family income in past 12 months. Dummy variables were created for employment of householder, marital status of householder, race of householder, and family income in past 12 months.

Table III indicates findings from stepwise multiple regression analysis on household variables as related to total energy consumption. As Table III indicates the following household variables were significantly related to energy consumption: number of household members, education, employment, marital status, race, and income. R_2 was equal to .1247. Approximately twelve percent of the variation of energy consumption was explained by the independent household variables in the final model.

TABLE III

STEPWISE MULTIPLE REGRESSION RESULTS FOR HOUSEHOLD VARIABLES USING BACKWARD ELIMINATION PROCEDURE

N=1290

Variable	Estimate	F-Ratio	P-value
Intercept 34160.95			
Household members	17070.62	73.80	0.0001 ***
Education	2090.57	15.77	0.0001 ***
Employment (= 1 if full-time)	-12666.16	6.65	0.0100 *
Marital status (= 1 if married)	11405.30	9.83	0.0018 **
Race (= 1 if White)	19432.22	15.60	0.0001 ***
Income (= 1 if low)			
	7151.66	3.14	0.0764 *
	21801.1	21.75	0.0001 ***

R^2=.1248
*** p<.0001
** p<.001
* p<.05

Housing Variables

A backward elimination procedure of stepwise multiple regression was performed on the following independent housing variables with energy consumption as the dependent variable: year home built, number of rooms in home, number of complete baths, main home heating fuel, dwelling owned or rented, square footage heated and unheated, and type of living quarters. Dummy variables were created for main home heating fuel, dwelling owned or rented and type of living quarters.

Table IV indicates findings from stepwise multiple regression analysis on housing variables as related to total energy consumption. As Table IV indicates the following housing variables were significantly related at the .1000 level to energy consumption: year home built, number of rooms, number of half baths, total square footage heated and unheated, main heat fuel, and type of living quarters. R_2 was equal to .4532. Approximately 45.0% of the variation of energy consumption was explained by the independent housing variables in the final model.

Results of Regression Analysis on Individual Variables

Table V indicates the findings of simple regression on the individuals scores and payment plan choice on energy consumption. A simple regression was performed with the Equipment Score as the independent variable and

TABLE IV

STEPWISE MULTIPLE REGRESSION RESULTS FOR HOUSING VARIABLES USING BACKWARD ELIMINATION PROCEDURE

N=1390

Variable	Estimate	F-Ratio	P-value
Intercept	53840.40		
Year home built	-5013.11	49.29	0.0001 ***
Number of rooms	8178.98	69.38	0.0001 ***
Number of half baths	7075.08	6.41	0.0114 *
Sq. ft. heat and unheat	15.14	110.14	0.0001 ***
Main heat fuel (= 1 if gas)			
oil	5343.84	2.88	0.0898 *
electric	-47130.65	158.68	0.0001 ***
Wood/coal	-60253.15	125.11	0.0001 ***
Type living quarters (= 1 if 1 family)			
mobile home	10529.66	3.31	0.0691 *
2-4 unit	10081.32	5.61	0.0180 *
>5 unit	7730.61	3.38	0.0663 *

R^2=.4532
*** p<.0001
** p<.001
* p<.05

TABLE V

RESULTS OF SIMPLE REGRESSION OF SCORES
AND PAYMENT PLAN CHOICE ON
ENERGY CONSUMPTION

N=1390

Variable	Intercept	Estimate	P-value
Equipment score	104682	-24.593	0.0001 ***
Behavior score	101113	1481.983	0.0001 ***
Payment plan choice	102388	25235	0.0001 ***

*** $p<.0001$
** $p<.001$
* $p<.05$

energy consumption as the dependent variable. Findings indicated that the Equipment Score was significantly related to energy consumption. A simple regression was performed with the Behavior Score as the independent variable and energy consumption as the dependent variable. Findings indicated that the Behavior Score was significantly related to energy consumption. A simple regression was also performed with payment plan choice acting as the independent variables and energy consumption as the dependent variable. Results indicated that payment plan choice was also significantly related to energy consumption. Table VI shows the results of multiple regression analysis of the Structural Efficiency Score. There were two components of the Structural Efficiency Score -Factor 1 (insulation score) and Factor 2 (air infiltration score). In the multiple regression analysis Factor 1 and Factor 2 were the independent variables and energy consumption was the dependent variable. Findings indicated that Factor 1 and Factor 2 were significantly related to energy consumption at the .1000 level.

<u>Stepwise Multiple Regression Analysis on Combined Variables</u>

The third objective was to determine the combined impact household characteristics, housing characteristics, household equipment, energy conservation behavior, structural efficiency, and payment plan choice had on

TABLE VI

RESULTS OF MULTIPLE REGRESSION OF
STRUCTURAL EFFICIENCY SCORE ON
ENERGY CONSUMPTION

N=1390

Variable		Estimate	P.value
Intercept	103656		
Structural efficiency SCORE			
FACTOR 1		3532.248	0.0331 *
FACTOR 2		16909.0	0.0001 ***

*** p<.0001
** p<.001
* p<.05

TABLE VII

RESULTS OF MULTIPLE REGRESSION OF COMBINED IMPACT OF VARIABLES ON ENERGY CONSUMPTION

N-1290

Variable	Estimate	F-Ratio	P-value
Intercept -886.051			
Household Characteristics			
age	417.680	5.67	0.0174 *
number household members	10403.172	43.87	0.0001 ***
education	777.802	3.60	0.0580 *
employment (= 1 if full-time)	8255.619	3.36	0.0671 *
Marital status (= 1 if married)	5648.266	3.68	0.0553 *
Race (= 1 if White)	23182.734	30.05	0.0001 ***
Finish education (=1 if not finish)	-6605.701	3.29	0.0698 *
Housing Characteristics			
year home built	-4019.512	28.55	0.0001 ***
number rooms	7220.946	51.58	0.0001 ***
number half baths	6629.702	5.87	0.0156 *
square footage	13.437	80.80	0.0001 ***
main heat fuel (= 1 if gas)			
electric	-44539.235	120.52	0.0001 ***
wood/coal	-58956.101	125.03	0.0001 ***
type living quarters (= 1 if 1 family)			
mobile home	10625.993	3.31	0.0690 *
2-4 unit dwelling	459.485	4.18	0.0412 **
SCORES			
FACTOR 2	10867.800	70.10	0.0001 ***
Payment plan choice	8736.604	6.39	0.0116 *

*** p<.0001
** p<.001
* p<.05

energy consumption. Table VII indicates the findings from the multiple regression analysis. Findings indicated that when all variables were combined the following variables were found to be significantly related to energy consumption: age, number of household members, education, employment (dv257_2 - part-time), marital status (dv315_1 -widowed), race (dv316_1 - blacks), finish education (dv319_1 -finished highest grade), year home built, number of rooms in home, number of half baths, total square footage heated and unheated, main home heating fuel (dv7_2 -electric), main home heating fuel (dv7_3 -wood/coal), Factor 2, payment plan choice, type of living quarters (dv544_1 - mobile home), and type of living quarters (dv544_2 - 2-4 unit dwelling). Finished education was the only variable that was significantly related to energy consumption in the combined model that was not included in the individual analysis of household variables. Variables that where significantly related to energy consumption when included in individual analysis but were not significantly related when included in the combined model were: income, main home heating fuel (dv7_1 -oil), type of living quarters (dv544_3 - 5 or more unit dwelling), Equipment Score, Behavior Score, and Factor 1. Payment plan choice is significantly related to energy consumption when correlated in an individual model and in a combined model; therefore, it appears that payment plan choice does impact energy consumption.

Logistic Multiple Regression

Household Variables

The fourth objective was to determine the likelihood that household and housing characteristics, Equipment score, Behavior score, Structural Efficiency score, and energy consumption contributed to elderly consumer's payment plan choice. Logistic multiple regression was the statistical procedure used for analysis. Significance level was set at .05. The following household variables were analyzed: age of householder, number of household members, householder highest grade attended, sex of householder, employment of householder, marital status of householder, race of householder, is householder of Spanish origin, did householder finish highest grade attended, and family income in past 12 months. Dummy variables were created for the following household variables: employment of householder, marital status of householder, race of householder, and family income in past 12 months.

Table VIII shows findings from logistic regression on household variables related to budget billing plan choice. The final equation included the following household variable which was significant at the .05 level. The only variable remaining in the equation was highest grade attended by householder.

TABLE VIII

LOGISTIC REGRESSION RESULTS FOR HOUSEHOLD VARIABLES VERSUS BUDGET BILLING PLAN CHOICE

N=1390

Variable	Parameter Estimate	Logit Coefficient	Standard Error	Wald Chi-Square	Pr > Chi-Square
Intercept	2.6361				
Education		-0.0785	0.0251	9.7561	0.0018**

*** p<.0001
** p<.001
* p<.05

Housing Variables

A Logistic multiple regression procedure was done on the following housing variables in order to determine what variables were significantly related to choice of budget billing plan. Significance level was set at the .05 level. Housing variables analyzed were: year home built, number of rooms in home, number of complete baths, main home heating fuel, dwelling owned or rented, square footage heated, square footage heated and unheated, and type of living quarters. Dummy variables were created for the following housing variables: main home heating fuel, dwelling owned or rented and type of living quarters.

Table IX shows findings from logistic regression on housing variables related to budget billing plan choice. Variables remaining in the final equation which were significant at the .0500 level were: number of complete baths, square footage heated and unheated, and dwelling owned or rented (dv344_1 - mobile home).

Scores and Energy Consumption

A logistic multiple regression procedure was performed on the Behavior Score, Equipment Score, Factor 1 and Factor 2 (Structural energy efficiency Score), and Total BTU (total energy consumption) in order to determine what scores or factors were significant at the .05 significance level.

TABLE IX

LOGISTIC REGRESSION RESULTS FOR HOUSING VARIABLES VERSUS BUDGET BILLING PLAN CHOICE

N=1390

Variable	Parameter Estimate	Logit Coefficient	Standard Error	Wald Chi-Square	Pr > Chi-Square
Intercept	1.4364				
Number of baths		0.4230	0.1775	5.6820	0.0171*
Square footage		-0.00017	0.000073	5.5742	0.0182*
Tenure base: (= 1 if own) rents		0.9900	0.2908	11.5904	0.0007***

*** p<.0001
** p<.001
* p<.05

TABLE X

LOGISTIC REGRESSION RESULTS FOR 'SCORES' AND ENERGY CONSUMPTION VERSUS BUDGET BILLING PLAN CHOICE

N=1390

Variable	Parameter Estimate	Logit Coefficient	Standard Error	Wald Chi-Square	Pr > Chi-Square
Intercept	2.7001				
Behavior		-0.1327	0.0715	3.4442	0.0635*
Factor 2		-0.4037	0.0959	17.7306	0.0001***
Total BTU		-5.27E-6	1.317E-6	16.0252	0.0001***

*** p<.0001
** p<.001
* p<.05

Table X shows findings from logistic regression on scores and energy consumption related to budget billing plan choice. The final equation included the following scores or factors which were significantly related to budget billing choice: Factor2 (air infiltration score), TotalBTU (energy consumption), and the Behavior Score.

Odds Ratio

When using logistic regression, odds ratios can be calculated to determine the probability of an event occurring. Odds ratios were calculated for household variables, housing variables, and the variables that constitute the five scores. Typically, one can view the outcome of an odds ratio as the probability of a success or the probability of an event occurring. However, the odds ratios calculated for this data will be viewed as the odds of the event **not** occurring. The information is in a more favorable and understandable format when analyzed in this manner. The following text will choose a combination of characteristics to insert into the odds ratio equation.

The following equation calculates an odds ratio for the household variable that was found to be significantly related to budget plan choice in the logistic regression model. For education, the mean value of 11 was substituted in for X_1. Eleven is representative of the mean years of education a householder completed.

$$\text{(1)} \quad \log \frac{P}{1-P} = 2.6361 - 0.0785 \text{ (EDUCATE)}$$

$$\text{(2)} \quad \text{odds} = \exp\,[2.6361 - 0.0785 \text{ (EDUCATE)}]$$

$$\text{odds} = -5.89$$

Thirteen percent of the sample were on the AMP plan and 83% of the sample were not on the AMP plan. The estimates of the likelihood of a respondent not choosing the budget billing plan are the marginal effects of each variables evaluated at the mean. The odds ratio of can be interpreted to mean that given a respondent has completed eleven years of education, the probability of not being on the plan is -5.89 times more likely than a respondent not completing a higher or lower educational level.

The following equation calculates an odds ratio for housing variables that were found to be significantly related to budget plan choice in the logistic regression model. The mean values for the variables will be included in the equation for analysis. For number of complete baths a value of 1 was substituted in for X_1. For total square footage heated and unheated, the mean value of 1761.38 was substituted in for X_2. For dv344_1 or rents home, the value of 0 was substituted in for X_3. The base value was owns home.

$$\text{(1)} \quad \log \frac{P}{1-P} = 1.4364 + 0.4230\ (NUMBATH) - 0.00017\ (SQFT) + 0.99\ (RENT)$$

$$\text{(2)} \quad odds = \exp\ [1.4364 + 0.4230\ (NUMBATH) - 0.00017\ (SQFT\ ) + 0.99\ (RENT)]$$

$$odds = -4.76$$

Thirteen percent of the sample were on the AMP plan and 83% of the sample were not on the AMP plan. The estimates of the likelihood of a respondent not choosing the budget billing plan are the marginal effects of each variables evaluated at the mean. The odds ratio of can be interpreted to mean that given a respondent has one complete bath, lives in an square foot home, and does not rent the probability of not being on the plan is -4.76 times more likely than a respondent not having those characteristics.

The following equation calculates an odds ratio for the energy conservation behavior score, air infiltration score, and total amount of Btus that were found to be significantly related to budget plan choice in the logistic regression model. For the behavior score a value of 1.6 was substituted for X_1. This value was the mean value calculated for the Behavior Score. For the Factor 2 or air infiltration score the value of .141 was substituted in for X_2. This value was the mean value calculated for the Factor 2 score. For total Btus consumed the value of 103486.34 was substituted for X_3. This value was the mean calculated for total Btus consumed.

$$(1)\qquad \log \frac{P}{1-P} = 2.7001 - 0.1327\ (BEHAV) - 0.4037\ (FACTOR2) - 5.27E\text{-}6\ (TOTALBTU)$$

$$(2)\qquad odds = \exp\ [2.7001 - 0.1327\ (BEHAV) - 0.4037\ (FACTOR2) - 5.27E\text{-}6\ (TOTALBTU)]$$

$$odds = -6.59$$

Thirteen percent of the sample were on the AMP plan and 83% of the sample were not on the AMP plan. The estimates of the likelihood of a respondent not choosing the budget billing plan are the marginal effects of each variables evaluated at the mean. The odds ratio of -6.59 can be interpreted to mean that given a respondent has an energy conservation behavior score of 1.6, an air infiltration score of .141, and 103486.34 total Btus consumed the probability of not being on the plan is - 6.59 times more likely.

Model Development

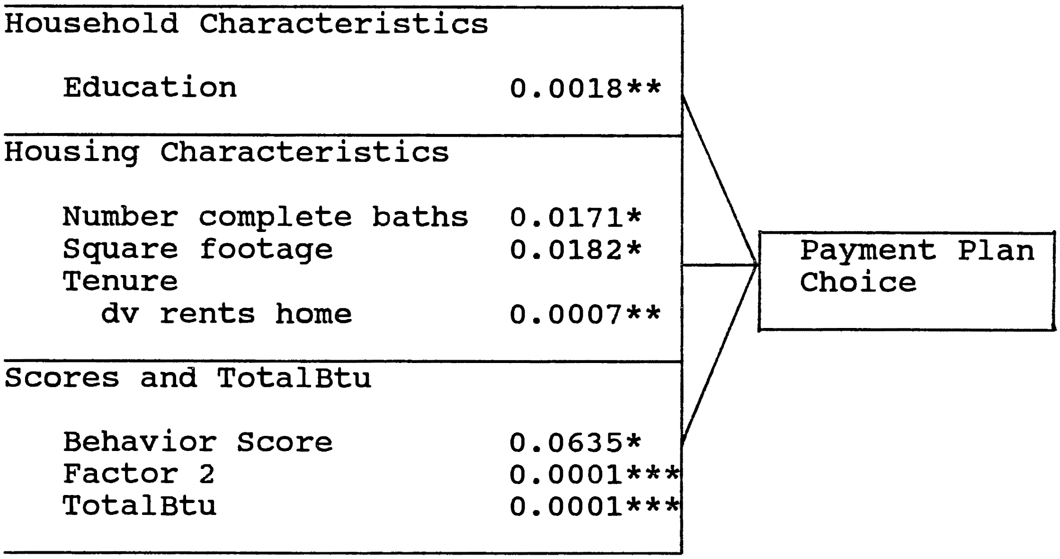
In Chapter II of this study a conceptualized model was proposed testing the interaction between energy consumption and payment plan choice with specific household and housing characteristics, household equipment, household conservation behavior, and structural efficiency. Figure 4 shows the final tested model for the impact of household and housing characteristics, household equipment, energy conservation behavior, structural efficiency, and payment plan choice on energy consumption. Figure 5 shows the final tested model for logistic regression analysis. This model shows the likelihood that particular household and housing characteristics, household equipment, household behavior, structural efficiency, and energy consumption factors contribute to elderly consumers' payment plan choice.

Household Characteristics	
Age	0.0174**
Number household members	0.0001***
Education	0.0580*
Employment	
dv part-time	0.0671*
Marital status	
dv widowed	0.0553*
Race	
dv black	0.0001***
Finish education	
dv finish ed.	0.0698*
Housing Characteristics	
Year home built	0.0001***
Number of rooms	0.0001***
Number half baths	0.0156*
Square footage	0.0001***
Main heat fuel	
dv electric	0.0001***
dv wood/coal	0.0001***
Type living quarters	
dv mobile home	0.0690*
dv 2-4 unit dwelling	0.0412*
Factor 2	0.0001***
Payment Plan Choice	0.0116*

→ Energy Consumption

***p<.0001
**p<.001
*p<.05

Figure 4: Tested Model of Impact of Household and Housing Characteristics, Household Equipment, Household Behavior, Structural Efficiency, and Payment Plan Choice on Energy Consumption.



***p<.0001
**p<.001
*p<.05

Figure 5: Tested Model of Household and Housing Characteristics, Household Equipment, Household Behavior, Structural Efficiency, and Energy Consumption on Payment Plan Choice.

CHAPTER V

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

Due to rising residential energy costs, utility regulators, consumer groups, and policy makers, created a variety of alternatives to assist low and fixed income households with fluctuating monthly utility bills. The AMP plan was one such budget billing alternative initiated to assist low and fixed income households. This study chose to concentrate on elderly households. Often the elderly are not employed, on a fixed budget or have a substantially low income. Previous research revealed that the elderly, on average, pay a larger portion of income for energy related costs than the non-elderly. A major concern regarding the AMP plan was the lack of prior research that directed policy formation prior to implementation (McDermott et al., 1980). Hence, this study was conducted to evaluate elderly household's characteristics and participation in the Average Monthly Payment plan.

Objectives of the Study

The major objective of this study was to determine if the AMP billing plan was reaching the target group of low, fixed-income, elderly households and further to ascertain the impact of this policy on this group. A series of specific objectives are discussed in the following text. Based on previous research, a model was developed to investigate the effect of household and housing characteristics, household equipment, energy conservation behavior, and structural efficiency on payment plan choice and energy consumption. The first objective was to develop a profile of the AMP and non- AMP consumers. This objective was reached by examining household and housing characteristics in relation to payment plan choice. The second and third objectives were to determine the individual and combined impact that household and housing characteristics along with household equipment, energy conservation behavior, structural efficiency and payment plan choice had on energy consumption. The fourth and final objective was to determine the likelihood that household and housing characteristics, household equipment, energy conservation behavior, structural efficiency and energy consumption contribute to elderly consumer's payment plan choice. Based on the above mentioned objectives a model was developed to investigate the interaction that household and housing characteristics, household equipment, energy conservation behavior, and structural efficiency, had on payment plan choice and energy consumption.

Summary and Conclusions

The original data contained 8,232 units for examination. This study focused on individuals aged 60 and older. The final sample for this study included 1390 respondents.

Sample Characteristics

Information from RECS (1987) indicated that elderly's energy needs differed from non-elderly's energy needs. Those aged 60 years and older constituted 28% of the total respondents in the survey.

Only significant findings will be reviewed in this section. Age of householder was significant at .001 level. Results suggested that the AMP plan is actually reaching a variety of age-related households and not specifically the groups targeted. Race appeared to be somewhat significant. Findings suggested that householders of Spanish origin were not likely to participate in the AMP plan.

A larger percentage of individuals on the AMP plan tended to own their own home as compared to those not on the plan. Results from chi-square analysis agreed with past studies (Iams et al., 1988; Sweet, et al., 1987): older Americans generally own their own homes. A larger proportion of respondents on the AMP plan tended to live in one family units as compared with those not on the AMP plan. Piped gas and fuel oil tended to be the main home heating fuel for averagers and non-averagers.

Averagers tended to live in slightly larger homes than non-averagers. In conclusion, only 14% of the elderly respondents were on the budget billing plan. It appears that the elderly segment of the population is not taking advantage of this program for reasons not known.

Summary of Results

Multiple regression and logistic regression were used to create the 'best' models to describe elderly household energy consumption and payment plan choice. The following text will highlight the results of the final models (Figures 4 and 5).

Using multiple regression analysis, two models were constructed to explain the impact individual variables have on energy consumption and the combined impact certain variables have on energy consumption. Logistic regression was then used to determine the likelihood that certain variables contributed to elderly consumer's payment plan choice. Household and housing characteristics, household equipment, household behavior, structural efficiency, payment plan choice, and energy consumption were the variables used.

An intermediate model was tested to determine the individual impact of household characteristics, housing characteristics, household equipment, household energy conservation behavior, structural efficiency, and payment plan choice had on energy consumption. Simple and multiple regression were the statistical tests used. The following household variables were found to be significantly related to energy consumption: number of household members, highest grade attended by householder, employment of householder, marital status of householder, race of householder, and family income in the past twelve months.

Number of household members had an effect on total energy consumption. Literature (Berry, et al., 1988; Iams, et al., 1988) indicated that the elderly tend to have fewer household members but constitute a greater proportion of the total households in the United States. Previous studies (Bailey, 1986; Junk, et al., 1988; Fritzche, 1981; Macey, 1989) have found that household income, age of head, education, and household size effected energy consumption. Junk et al., (1988) also found that having a higher education level, being young-old, and having a higher income level contributed to lower home-energy costs for elderly households. However, Ritchie, et al., (1981) found that education of householder did not provide significant incremental explanation for increased energy consumption. Researchers have had mixed opinions as to whether education impacted energy consumption. This study found that education does impact energy consumption. The following housing variables were found to be significantly related to energy consumption: year home built, number of rooms in home, number of half baths, total square footage heated and unheated, main home heating fuel, and type of living quarters.

Consistent with past research, the majority of elderly households in the sample owned their own homes. Literature (Junk et al., 1988; Sweet, et al., 1988; Iams, et al., 1988) revealed that being a home-owner, age of home, and type of residence effected energy consumption of elderly households.

Multiple regression analysis was used for the first final tested model to determine the combined impact household and housing characteristics, household equipment, energy conservation behavior, structural efficiency, and payment plan choice had on energy consumption. Findings indicated that the 'finish education' variable was the only variable that was significantly related to energy consumption in the combined model that was not significant in individual household analysis. Many variables that where significantly related to energy consumption when included in individual analysis were not significantly related when included in the combined model. Those variables or factors were: income, main home heating fuel, type of living quarters, Equipment Score, Behavior Score, and Factor 1. Previous studies have concluded that the physical condition of the house has a positive effect on energy consumption (Newman, et al., 1975; Verhallen et al., 1981; Sweet, et al., 1987). Structural characteristics were found to be more important than demographic factors in predicting energy consumption levels (Iams, et al., 1988). Household energy behavior also effected a households energy consumption. The elderly typically used energy less efficiently than the non-elderly population. They were more likely to not invest in conservation actions. However, physical limitations and economic difficulties often limited their participation. Payment plan choice appears to be significantly related to energy consumption when correlated in an individual model and in a combined model; therefore, it appears that payment plan choice does have an impact on energy consumption.

The final tested model used logistic regression to determine the likelihood that household and housing characteristics, household equipment, household behavior, structural efficiency, and energy consumption contributed to elderly consumer's payment plan choice. Highest grade attended by householder was the only household characteristic that explained any variation as to whether a respondent would choose the AMP plan or not. The number of complete baths, square footage heated and unheated, and tenure (dwelling owned or rented) were the three housing variables that explained the variation as to whether a respondent would choose the AMP plan or not. Finally, results indicated that the Behavior score, Factor 2 (air infiltration), and total energy consumption explained variation as to whether a respondent would choose the AMP plan or not. Findings from this research agree with numerous studies which have indicated that size of house impacts energy usage. Ritchie et al., (1981) found that households living in larger homes consumed significantly more energy. Previous studies (Worthington, 1991; Routh, 1989) on the AMP plan have also found that size of home and number of rooms to be positively related to energy consumption.

Researchers have suggested that AMP consumers receive a false price cue. If this is true, budget billing or utility bill averaging has serious implications for household energy consumption. Findings suggest that this policy is not reaching the elderly but for those choosing the plan there are serious economic implications. Payment plan choice was significantly related to energy consumption in both the individual model and the combined model. It appears that a number of household and housing characteristics, energy conservation behavior, air infiltration factors, and energy consumption help to predict the likelihood of an elderly consumer choosing the AMP plan.

Implications

Much of the current problems associated with energy assistance programs such as the AMP plan can be derived from a lack of prior research into the affects of the program. Findings from this research and other studies (Worthington, 1991; Routh, 1989) indicated that there is little difference between the characteristics of the AMP and the non-AMP consumer.

The original goal of the AMP policy may not be reaching those on low and fixed incomes. This study found that payment plan choice does impact energy consumption when regressed individually and when combined with other factors. Several studies (Worthington, 1991; Routh, 1989; Ritchie, et al., 1981) have indicated that a muted or false price signal is given to participants of the AMP plan resulting in increased energy consumption and cost. This does not appear to be a positive method of managing utility bills. Routh (1989) suggested that the although the AMP policy may be accomplishing the goal of providing consumers with a budgeting service, the costs of the policy may outweigh the benefits.

Encouragement of conservation should be a goal of all energy policies. The social costs of energy should be evaluated. Paul & Russo (1982) state that conservation enhances economic welfare and leaves society better off. Therefore, energy policies that directly or indirectly encourage increased energy consumption are neither effective nor efficient.

A coordinated effort by federal, state, and local levels should be considered in order to evaluate isolated energy-related situations or concerns that occur on an individual basis (Sweet et al., 1987). Utility companies can take a more active role in educating consumers about the costs and benefits of programs offered. Energy education should begin in school and the information should be made easily accessible in libraries, social service agencies and university outreach programs. Cullen et al., (1983) suggested two concerns that should be included in an energy policy. They were: (1) to provide emergency assistance to disadvantaged household through a program which is based on the principles of social and spatial equity and 2) to reduce consumption in all households through a system of information and feedback on energy use and conservation. The growth of residential energy use during the next 25 years will depend on many policy decisions and technology choices yet to be made (Geller, 1988). Bailey (1987, p. 97) stated, "Just as surely as night follows day, we will have another energy crisis. Natural reserves are limited, and sooner or later, they will again be scarce. The more we do now to conserve the energy we use, the less painful the next crisis will be." Americans have not been attentive to energy as a national issue, regardless of the facts that growing dependence on foreign imports is high. A balance is desired between domestic energy production, exploration, and environmental protection (Routh, 1989). In the past few years oil has not been a major concern. Environmental issues have pushed it into the spotlight on occasions, such as the Exxon Valdez oil spill in Alaska. As attention to the crisis faded so did the environmental spotlight.

Amid the apathy, caution is a key element. At a U.S. Senate hearing in the spring of 1990, it was argued that the likelihood of a major disruption in the oil field was minimal, at least for the next several years. On August 2, 1990 these illusions were ripped away. Iraq invaded Kuwait. Oil prices skyrocketed and financial markets dropped. Once again the world was reminded that unforeseen events can occur and threaten energy security at a moment's notice. This reminder should pervade the decisions made by individual consumers and public decision makers.

Summary

The following text will include a brief summary of the results and implications of this study for future utility policy. Little research had been done before the implementation of budget billing plans and little research continues to be done on the effectiveness of the policy. First, results from the limited research conducted indicate that the AMP policy should be evaluated and restructured. Secondly, it appears that the AMP plan does not promote conservation but encourages increased energy consumption for some households. Thirdly, the AMP plan does not appear to be meeting the needs of the low and fixed income households. If the plan has evolved into a consumer service other assistance programs should be developed to compensate for the loss of this particular programs for the low and fixed income households.

Recommendations

Energy research boomed in the late 1970s and early 1980s but as costs began to decrease and the political emphasis on energy shifted so did attention to energy-related issues. Foreign oil dependency continued to increase and with the latest events in the Middle East attention was again focused on oil and energy. Energy will continue to be an important area of research. The following are recommendations for future research:

1. Using the same data set, a comparison of elderly versus non-elderly should be done to determine existing differences that occur in household and housing characteristics, household equipment, household behavior, structural efficiency, and energy consumption as related to AMP plan.

2. The sample of AMP and Non-AMP respondents was not equally distributed (190 - AMP; 1200 - Non-AMP). A future study might try to get an equal amount of averagers and non-averagers in order to make comparisons.
3. It appears that the AMP plan has become a consumer service rather than a low and fixed income assistance program. If the AMP plan is not reaching low and fixed income households, new policies need to be created and implemented to meet the needs of that economically vulnerable segment of the population.
4. Findings suggest that the AMP plan provides consumers with a false price cue. Future research should include a longitudinal study on the perceptions of AMP versus non-AMP consumers regarding energy consumption and cost.
5. Future research may want to evaluate the likelihood that the combined household and housing characteristics, household equipment, household conservation behavior, structural efficiency, and energy consumption have on payment plan choice. 6. Determine the long and short term economic impact of the Average Monthly Payment Plan on elderly households.
7. Assess consumers attitudes related to energy use and attitudes toward energy management policies such as the AMP plan.

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VITA

Jamie S. Girard

Candidate for the Degree of

Master of Science

Thesis: AVERAGE MONTHLY PAYMENT (AMP) PLAN: POLICY IMPLICATIONS FOR ELDERLY HOUSEHOLDS

Major Field: Housing, Interior Design and Consumer Studies

Biographical:

Personal Data: Born in Lawton, Oklahoma, December 26, 1967, the daughter of James and Barbara Burd.

Education: Graduated from Lawton Christian School, Lawton, Oklahoma in May 1985; received Bachelor of Science degree in Human Ecology from Cameron University at Lawton, Oklahoma, in May 1989; completed requirements for the Master of Science degree at Oklahoma State University in December, 1991.

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