SOUTHWEST ECONOMETRICS, INC.

UNDERSTANDING TRENDS IN TEXAS PER CAPITA WATER CONSUMPTION

Prepared for

Texas Water Development Board

by

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I. INTRODUCTION

Recent Trends in Per Capita Water Consumption

Water planning entities in Texas and other areas of the Southwest have long held a common expectation concerning the water use rates of urban communities, namely that per capita water consumption would continue its long established upward trend. Such expectations were reinforced year after year as the data became available on current water use from municipalities which record and report their water use to planning agencies. This experience of the data consistently reinforcing the expectation continued unabated until the mid to late 1970s when use rates stopped rising. During the 1980s per capita water use began to decline and seems to have established a long term reversal of the upward trend.

The data show that municipal per capita water consumption in Texas "increased from about 100 gallons per capita per day (gpcd) in the post World War II era to levels slightly above 182 gpcd by the mid-1970s. Subsequent to then, average per capita use in the State had leveled out and...in 1978 averaged about 178 gpcd. By 1987,...consumption had fallen to about 170 gpcd, exhibiting a general declining trend over the ten-year period..." (see **Figure I-1**).[1]

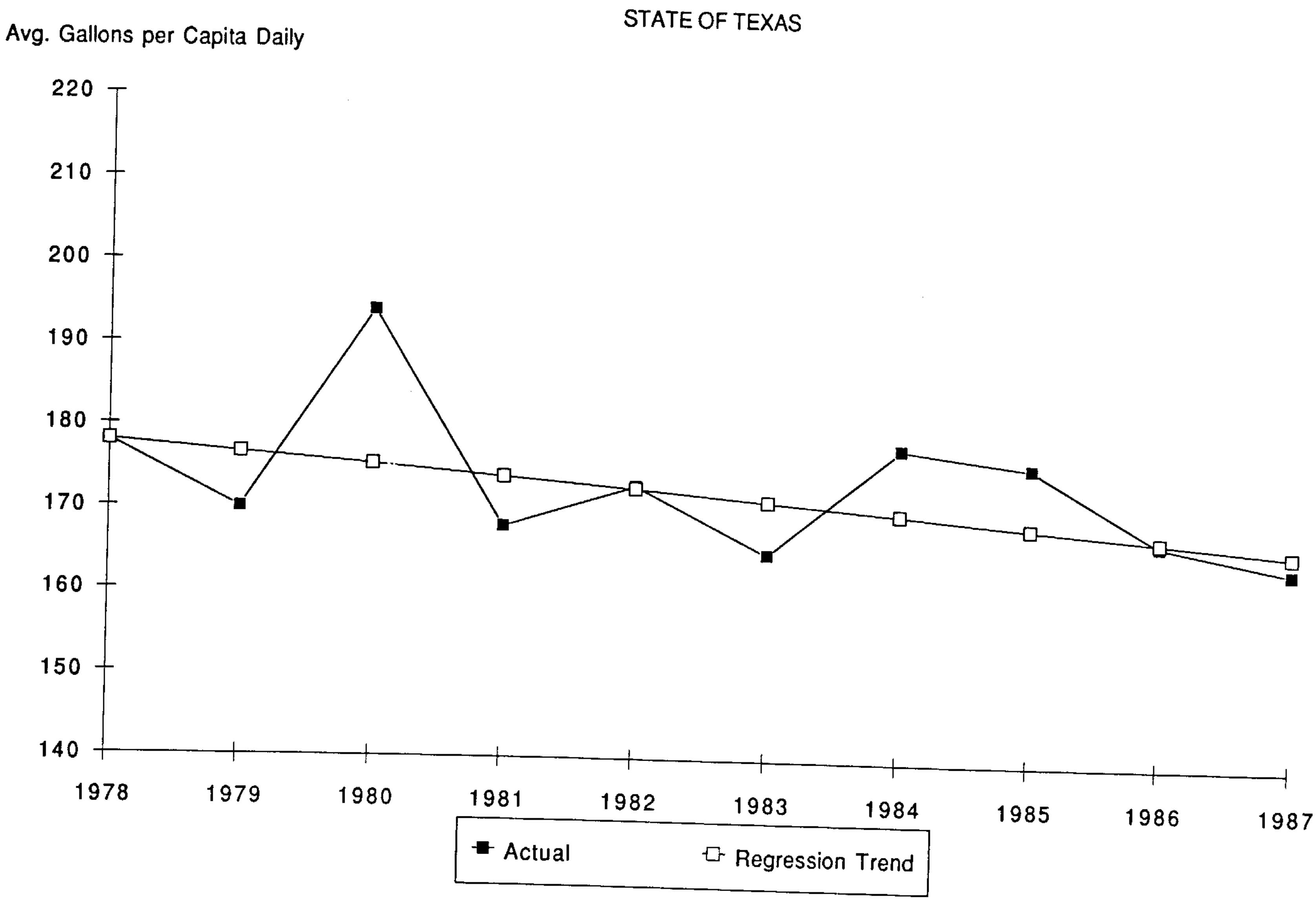
These downward trends can be seen graphically in the data for several cities in Texas including Austin, San Antonio, Corpus Christi, Beaumont, Arlington and Pasadena (**Figure I-2**). These downward trends have major implications for water planners, especially since the planning horizons are very long in the discipline, reaching out some 40 years into the future in order to allow time for facility construction that often requires years of planning, permit processing, land acquisitions and construction.

Due to the importance of this long term trend to water policy and planning agencies, it is very essential to know the factors which are driving the downward trend in consumption rates.

[1]**Water for Texas: Today and Tomorrow - 1990**, published and distributed by the Texas Water Development Board, Austin, Texas, December, 1990, p. 2-9.

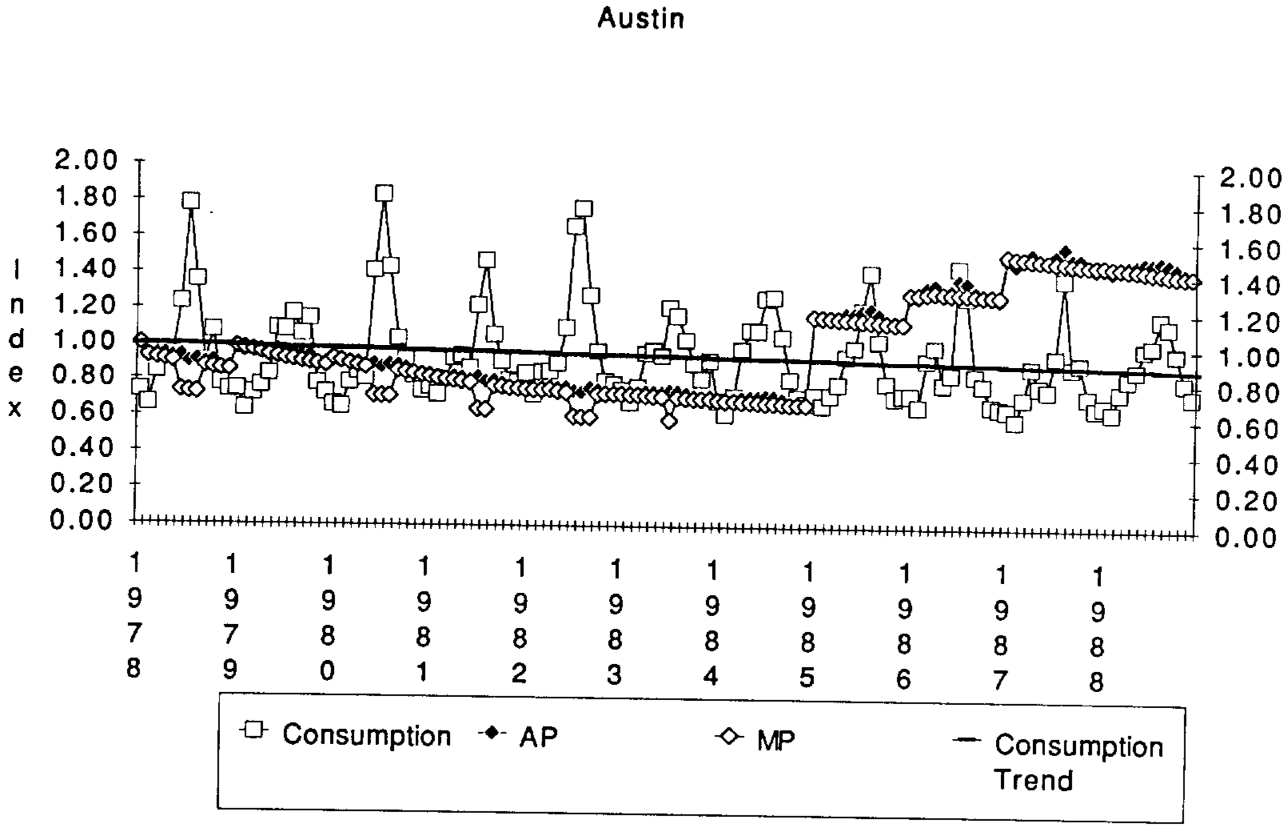
FIGURE I-1.

Texas Per Capita Municipal Water Use Trends



Source: Texas Water Development Board, Water for Texas: Today and Tomorrow - 1990, Austin, Texas, December 1990, p. 2-9.

Figure I-2. Trends in Per Capita Water Consumption in Major Texas Cities



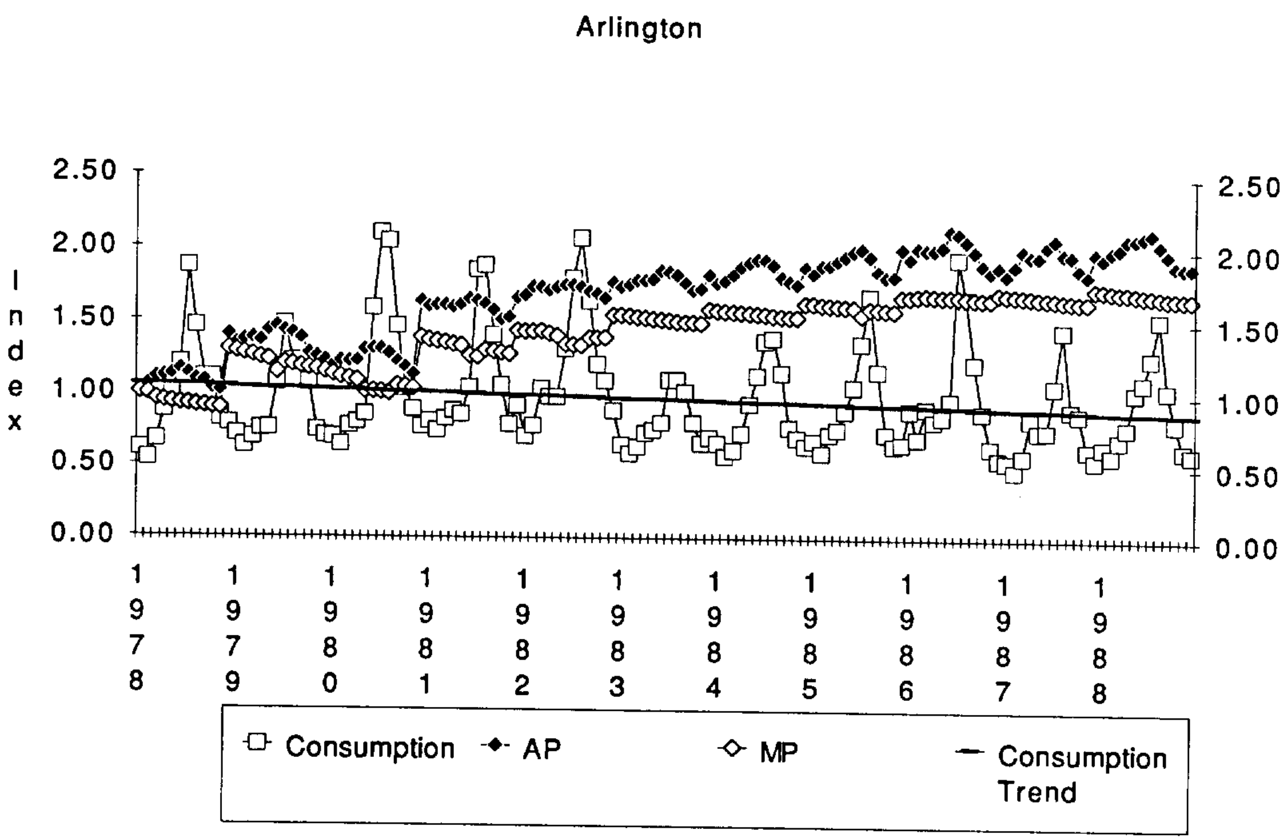
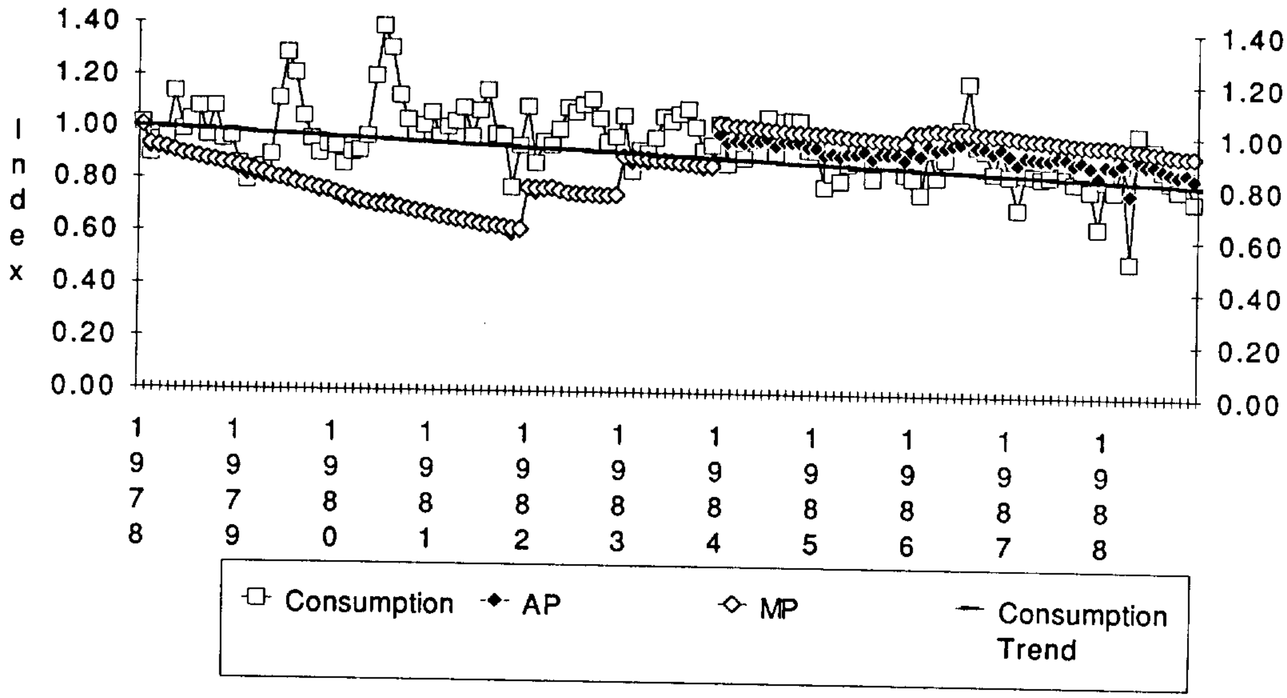


Figure I-2 (continued)

Beaumont



Corpus Christi

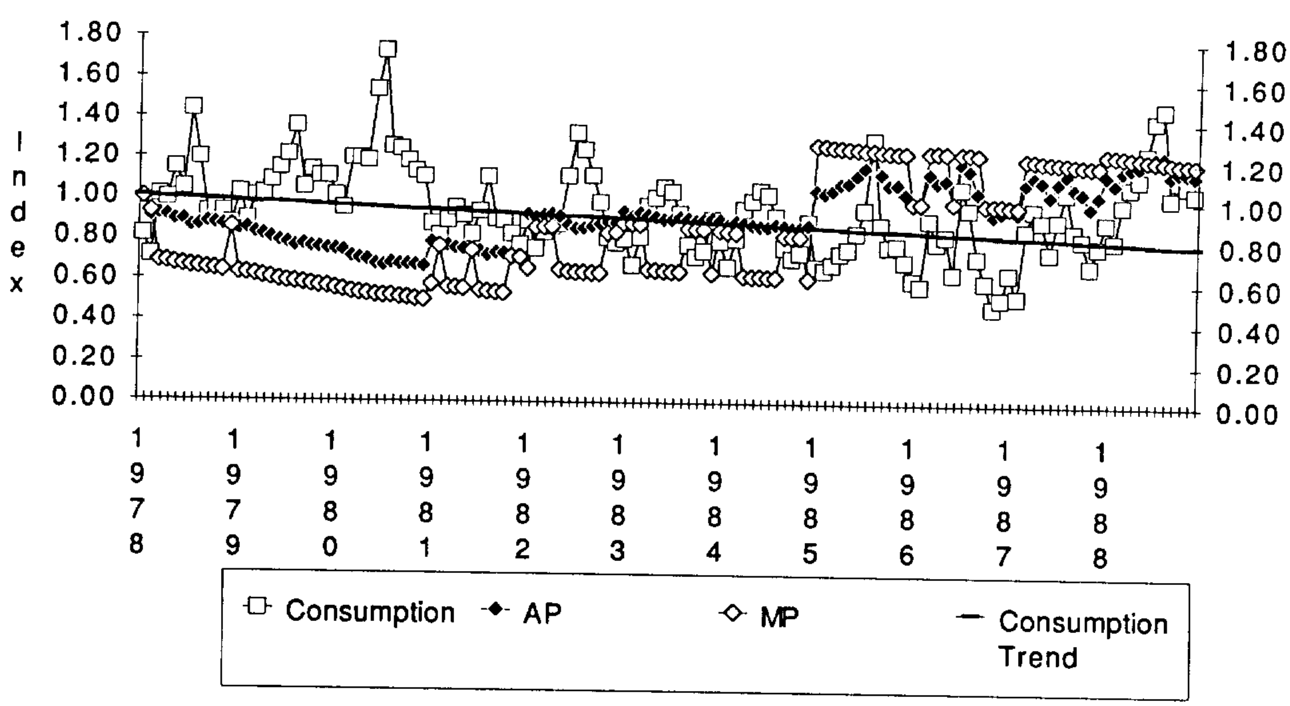
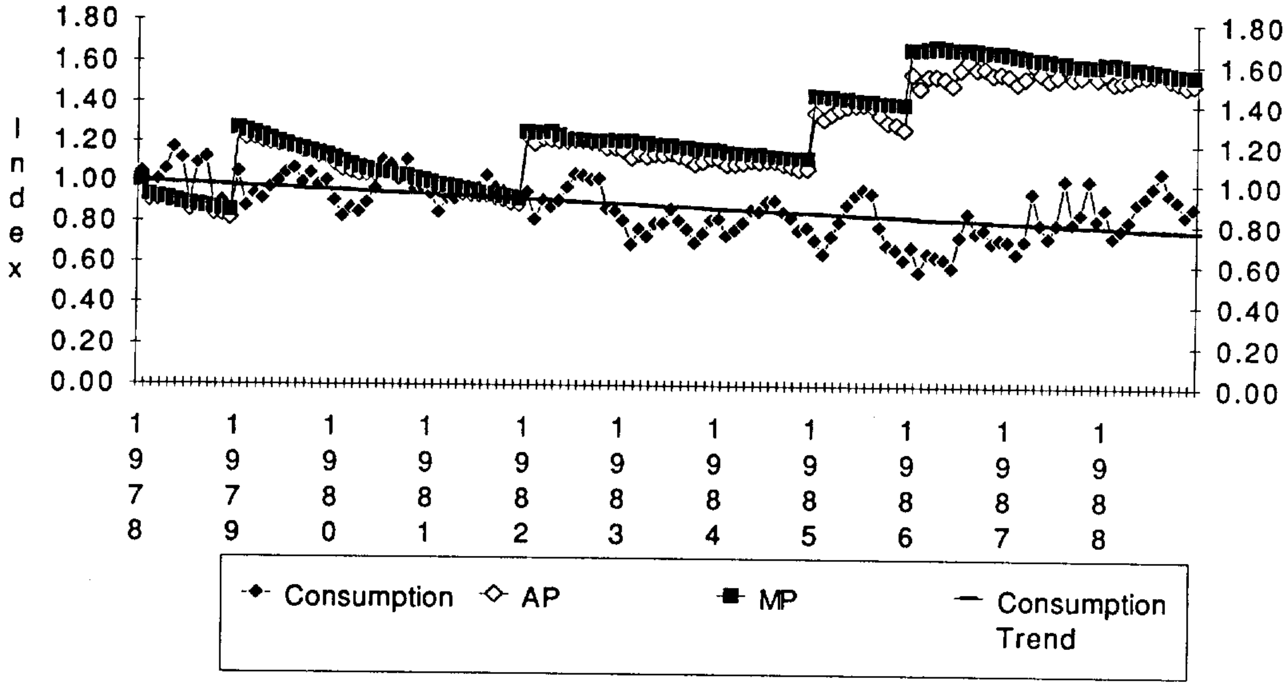
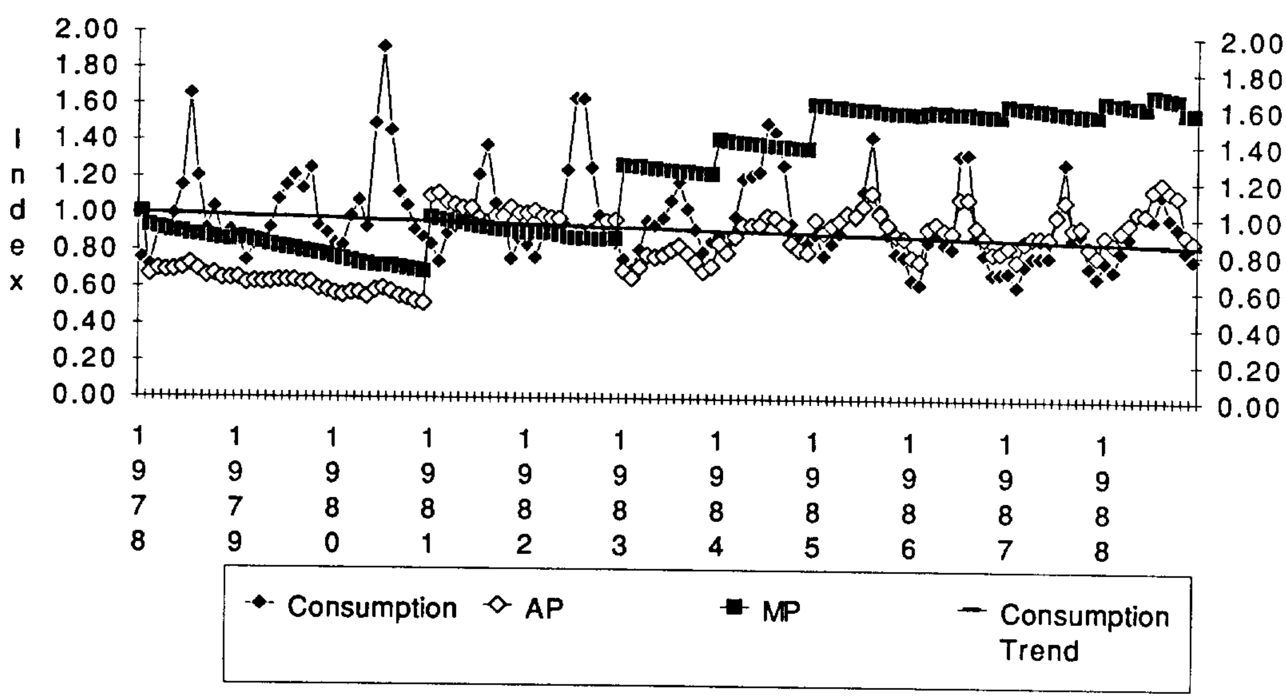


Figure I-2 (continued)

Pasadena



San Antonio



Price Structure Changes, Public Policy and Conservation

Several major events and public policy changes have, no doubt, had an important influence on water consumption in Texas including (1) the cyclical growth pattern of the Texas economy, (2) public policy in water and wastewater resources and (3) the development of a conservation ethic. During the 1970s and 1980s, Texas (and the nation) suffered three oil price shocks that brought long term shifts in the price structure of the economy which, in turn, have led to changes in energy costs of all types, changes in the use of materials and changes in the size of housing. These oil price shocks first increased the incomes of Texans relative to that of the nation in the 1970s and drastically reduced such in the 1980s following the oil price collapse in 1986.

The rapid growth of Texas communities in the late 1970s and early 1980s caused most communities to overbuild water and wastewater facilities since they expected growth to continue. Such overbuilding led to cost and rate increases above the long term trends.

Another important change that occurred during the period of the late 1970s and early 1980s was a major shift in Federal wastewater policy, namely the drastic reduction in funding for wastewater treatment plants, plants which were mandated to be built in order to meet Federal clean water standards. This reduction in Federal funding that had for years, stayed at 90% of the cost of wastewater treatment plants shifted the cost burden to state and local agencies. The end result was a significant increase in rates for wastewater services in many Texas communities. Federal Clean Water and Safe Drinking Water Acts also imposed higher costs on utilities by increasing the standards for the provision of wastewater and water services.

Another major public policy change occurred at the Texas State government level. A new statute amending the Texas Water Code was adopted by the Legislature in 1985 which, among other things, established a new set of financing mechanisms to provide low cost financing of local water projects by the extension of the state's credit capacity and cost of money to local government agencies. As a requirement of obtaining such State assistance, local entities were required to develop and submit a conservation plan that needs to include certain characteristics established by rule of the Water Development Board and/or by State statute.

Another factor, which is difficult to quantify, but which may indeed explain some of the trends at work, is the development of a broad based "conservation" ethic concerning the use of natural resources. The series of oil crises, water shortages and related general environmental awareness has no doubt been responsible for the development of this conservation ethic.

Purpose of This Study

The purpose of this study is to determine the several factors that underlie and explain the recent downward trends in per capita municipal water consumption in Texas. Further, the purpose of the study is to quantify the relationship between these various factors and per capita water use.

II. REVIEW OF LITERATURE ON WATER CONSUMPTION

Econometric Models of Consumption

Econometric methods have been used extensively over the last thirty or so years to estimate the relationship among various economic, climatic and sociological factors and water consumption. The literature of such studies is dominated by the work of economists and engineers.

The economics profession naturally thinks of the type of problem posed by this study in terms of micro economic theory, namely the supply and demand for a consumer item. Therefore, a review of the literature in economics publications will usually turn up a list of studies that concern attempts to estimate "demand functions" that relate water consumption to price, income, structure of the decision making unit (households), weather and climatic factors, and perhaps the structure of price.

A literature review of the topic of explanations of water consumption will also turn up numerous studies completed by engineers. Because engineers are less concerned with theoretical underpinnings than are economists, one often finds in these studies a process modeling approach that is more rigorous as a perceptive tool than as a descriptive tool. That is, the only ability to test the explanatory power of the model against historical experience in such models is by comparative statistics and visual inspection. Such processing models have their greater strength in organizing the informed judgment of the authors into a system that allows the inclusion of new influences not in the historical data. For example, one can model the expected influences of conservation programs on future water consumption by use of a process model even though conservation programs did not exist during the historical period from which economists derive data for econometric models. More discussion of this topic is included in the next section of the report.

The review of literature here focuses primarily on econometric models of water consumption since it is our main purpose to identify and quantify the factors that explain the recent trends in per capita water consumption. Because of the potential importance of conservation programs on the long term future of water consumption, however, some attention is also given to processing models and methods for considering influences in the future that do not exist in the historical experience.

A comprehensive review of the econometric water demand models was completed by the U.S. Army Corps of Engineers in

1984.[2] This publication not only reviews the work to date but focuses on the question of price elasticities of demand in water consumption. Several recent studies have been completed that focus directly on Texas.[3]

Boland et al. reviewed more than 50 substantial studies of the response of municipal and industrial water use to price. The review included mostly work done on the topic since the 1960s. Not only did Boland et al. review the content of the studies but made judgements about the statistical rigor of the studies and drew conclusions about the range of price elasticities that characterize demand by summer and winter use by region of the U.S. by user class. The studies typically included explanatory variables of price, number of households, persons per household, household income, property value, irrigable area and climate.

Boland et al. found that there had been a number of conventions used in the specification of the consumption variable and the price variable, as well as others. Important in explaining the overall variation in consumption in residential use is the number of households, and while often a statistically significant variable, price makes a relatively small contribution to the overall explanation of the variance in consumption.

Results of the Boland et al. study indicate that price elasticities of demand for water are likely to be in the following ranges:

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[2] Boland, John, Bondedykt Dziegielewski, Duane Baumann and Eva Opitz, Planning and Management Consultants, Ltd., **Influence of Price and Rate Structures on Municipal and Industrial Water Use**, for U.S. Army Corps of Engineers, Institute for Water Resources, Carbondale, IL, June 1984.

[3] The most comprehensive studies done in Texas in recent years include two state-wide studies by Ronald Griffin at Texas A&M and a focus study of the Texas Mexican border water demand by Milton Holloway. The Griffin studies are: Griffin, Ronald C., and Chan Chang, **Community Water Demand in Texas**, Texas Water Resources Institute, Texas A&M University, April 1989, and "Community Water Demand: New Specifications," **Western Agricultural Economics Association**, Honolulu, Hawaii, July 10-12, 1988. The Holloway study is: Holloway, Milton L. and Doug Tharp, **"A Methodology for Determining Ability to Pay: For Use in the Implementation of the Economically Distressed Areas Water Assistance Program,"** for the Texas Water Development Board, Austin, Texas, March 1990.

	Elasticity	
	Long Run	Short Run
Residential (winter)	**0.0 to -0.10**	**NA**
Residential (summer)		
Eastern U.S.	**-0.50 to -0.60**	**NA**
Residential (sprinkling)		
Eastern U.S.	**-1.30 to -1.60**	**NA**
Western U.S.	**-0.70 to -0.90**	**NA**
Residential Average	**-0.20 to -0.40**	**0.0 to -0.30**
Commercial	**-0.20 to -1.40**	**NA**

Griffin and Chang, in the 1989 study, estimated demand functions for municipal water use in Texas communities. The data base included 221 communities with data for the period 1981-1985.[4] Griffin found that average price is empirically preferred to marginal price, and that the monthly price elasticities are on the order of -.14 in the winter and -0.28 to -0.37 in the summer, measured at the means of monthly consumption. Griffin tested prices in both real and nominal terms, but did not express a strong preference as to which to use. He also included a sewer price in the definition of water price and found that it should be included. That is, he performed a test of sorts and concluded that the data suggest that consumers don't know water and wastewater prices separately, or individually for that matter, but instead are aware of only the monthly bill. The monthly bill usually includes both water and wastewater.

The Holloway and Tharp study of 1990 had the purpose of estimating the ability of communities in the Texas/Mexico border area to pay for water and wastewater services based on what persons of similar economic circumstances were in fact paying. The modeling involved the estimation of regional demand functions from cross-sectional data derived mostly from the Bureau of the Census 1980 public use sample data. Price elasticity estimates are in the neighborhood of -0.80 for the communities included in this study.

Measuring Conservation Effects

There is naturally a strong interest of policy makers and planners in knowing the extent to which conservation programs of one type or another have any impact on water consumption. It seems clear, for example, that an intensive public awareness program during a drought period, or perhaps the initiation of an odd-even day watering scheme, has a

[4]Several major MSA cities were eliminated from the data set, however, including San Angelo, Plano, Pasadena, Mesquite, McAllen, Lubbock, Houston, Grand Prairie, Dallas, Ft. Worth, Baytown and Abilene.

significant impact on water use. It is much less clear whether such programs of awareness or regulatory restriction have any lasting impact beyond the current crisis. On the other hand, incentive programs for the installation of low-flow shower heads and toilet dams are sure to have a measurable, long term impact on non-sprinkling water use.

A statistically valid method of evaluation of the contribution of conservation programs would be to complete a controlled experiment where selected households would be identified for record keeping over a long period of time. The group would be offered the benefits of a particular conservation program, e.g. free low-flow shower heads and toilet blocks. Those who took advantage of the program would be put in one class and those who did not, in another. Records on consumption, price, income, household size, weather and climate would be maintained over a long enough period of time to determine the behavior of the group who elected to take advantage of the program. One would want to know, for example, whether the shower heads were replaced with regular models and whether the units stayed in place after the house was sold, etc. That is, a well designed test of the difference made by the conservation program would require some control over the data in order to apply normal statistical methods to the question. There are no such studies in the literature that we are aware of.

Another method of analysis would be applied at the community level rather than the individual consuming level. That is, it is possible to statistically compare the water use of communities over time that have, among all the variables that tend to explain consumption, a set of communities that have conservation programs with those who do not. There is no evidence in the literature that such a study has been completed.

III. METHODOLOGY FOR EXPLAINING PER CAPITA WATER CONSUMPTION TRENDS

The method of analysis for explaining the Texas trends in per capita water use selected for this study is that of multiple regression. Time series and cross-sectional data were combined in a data base of per capita consumption for 72 communities for the time period of 1978-1988. The communities were grouped into various regional groupings and equations were estimated for each. The equations allow one to explain recent trends in consumption and to use these equations for forecasting future consumption. The data base and model specification are explained, respectively, in Chapters IV and V.

Definitions

There have been a number of conventions developed from studies of water consumption that have been considered in developing the current study. Some have been accepted and others have not. The issues surrounding the selection of variables, geographical coverage and time period of analysis are discussed in this section. Specific definitions of variables are in Chapter IV.

Consumption

Three types of consumption data are typically found in the literature on water demand. "Metered data" are most often used since they are unique to the consumer decision making unit (household or business) and are readily available from utility records. A second type is that of survey results where consumption is a derived calculation based on "reported expenditures" by the survey respondent. A third type is a "calculated disappearance" quantity that may be derived from gross withdrawal data reported by a utility serving a community.

The metered data has the obvious strength of being directly derived from the behavior of the decision making unit, the consumer, who makes the choices of budgeting and purchasing that is of the greatest interest in demand analyses. One weakness of this data is that billings information is collected by address, not household or business, so that the behavior of the decision maker over a period of time is not preserved in the data. Second, if one is interested in the explanation of, and forecast of, aggregate water consumption for a city, county or state, individual billing data are massive amounts of information to manage. Still another, and perhaps the most important weakness of billings data, is the absence of associated income, household size, housing characteristics or other likely independent variables for use in econometric analyses.

Survey results that allow derivation of consumption via billings and rate structure information have the strengths of going directly to the decision making unit to gather the data on consumption, and at the same time gathering income, household size, housing characteristics, etc. that are needed for econometric analysis. One weakness of such data is that respondents do not usually know quantity consumed and may be able to provide only "ball park" expenditure information from which to derive consumption. A second weakness is that of cost. If one is interested in explaining and forecasting community and state level water consumption, survey data are expensive to obtain and often impractical to gather.

Gross withdrawal derived data have the strength of accounting for the total water consumption of a community. One of the weaknesses is that it is impossible to capture the direct association of the individual decision maker's water consumption with income, household size, housing characteristics, etc. that are needed to distinguish water consumption behavior in the context of budgeting and consuming decisions. Therefore, this type of data only allow analyses among communities where each community is, in essence, treated as a decision making unit. This allows the consumption of water to be associated with income, household size, climate and weather factors and price at the community level.

The consumption data selected for this study are a mixture of two of the three types discussed above. The Water Development Board has for years, maintained a community level data base of water consumption consisting of derived annual per capita consumption and a monthly distribution function that allows the derivation of per capita consumption by month by community. This data base is constructed by first calculating the total disappearance of water within a community based on the net of gross withdrawals and wholesale sales of the utility that serves the community. Since large industrial users are usually independent of the utility serving the community, the resulting data are residential plus small and medium commercial users divided by the number of people in the community. While this characterization of "per capita water consumption" has some obvious weakness, such as the variance due to the number and character of commercial consumers in the data, from an overall perspective, these data are the best available for this study. First, the data base represents the combined experience of several professionals over a long period of time with knowledge of each community in the set. Second, the data are based on utility reported information that captures accurately the total water consumption by month for each community. For purposes of explaining and forecasting community level consumption for the State of Texas, this is the preferred data base.

Price

The problem of how to characterize the price of water for demand analyses is not an easy one. First of all, consumers usually are faced with a combined bill for water and wastewater so that price for the individual service of providing water and wastewater on a monthly basis is not recognized by the typical consumer. Second, there is the problem of whether one is interested in the average or the marginal price which in today's utility pricing are often quite different. Another problem is a conceptual one for demand analysis purposes. Theoretically one expects to use the marginal price for demand analysis because the micro economic theory of markets tells us that prices are determined at the margin or, said another way, that individual consumers are always faced by the marginal price when deciding whether or how much additional service or commodity to purchase.

There are many practical problems that cloud this issue. It is practically difficult to obtain either average or marginal prices for individual consumers since the only access to such information is through surveys or individual billings data. Community averages can be derived from total consumption and total utility revenues, but the marginal price that corresponds to that average must incorporate the rate structure of the utility.

The data chosen for the study are described in detail in Chapter IV, but as a general matter it was determined that we should test both the average and marginal price and that such could be derived by combining the average monthly per capita consumption data with average number of persons per connection and the rate structure for the utility, for each year of the period 1978-1988. That is, average and marginal prices at the average per capita consumption level by month by community can be derived for each community in the data set.

Income

A significant explanatory variable for explaining the level of water consumption among communities and over time is income. This variable captures a combined set of factors that relate to the housing and commercial building stock in a community that, in turn, has much to do with water consumption. The idea is that income of a community determines the size and character of housing for the residential sector and building space for the commercial sector. Implicit in the purchase of such building space is the number of bathrooms and showers, as well as the size of lawn which requires irrigation. As income rises over time, water use and water using capacity also tend to rise, other things equal.

The only comprehensively available source for income data is that of the Bureau of Economic Analysis, U.S. Department of Commerce. This data is available at the county level for years up through 1988. This data was selected to represent each community within each county of the data set.

Weather

Any study seeking to explain variations in water consumption will need to take account of weather conditions that have an obvious influence on short term variations in consumption. Weather conditions may also influence consumption over the long term within the cycles of weather patterns that sometimes last for years.

Fortunately, Texas has a large number of weather stations located throughout the State, such that there is a data gathering system near almost every city within the Metropolitan Statistical Areas (MSA) of Texas. These data are public information and available through organized data systems such as the Texas Natural Resources Information System (TNRIS).

The variables of interest from weather station sources include temperature and precipitation. The expectation is that summer sprinkling water use, in particular, is heavily influenced by the extent of hot, dry days when transpiration rates are high. While forecasting by use of equations estimated from historical data will normally assume normal long term weather conditions, it is essential that adequate weather representations be included in the use of econometric models of historical consumption. Typical representation of weather includes maximum or average daily temperature and number of dry days. The specific form of these variables for the current study are discussed in Chapter IV.

Conservation

The term "conservation" has a variety of popular uses, but there is no commonly accepted definition of the term for analytical work. One confusing area concerns the use of the rate structure for "conservation" purposes. If asked to list and describe the conservation programs being implemented, utility employees often list a change in rate structure that has been revised from a declining or flat price per unit to an increasing block structure. One might well classify the use of an increasing block rate structure as a conservation program if the increasing structure, in fact, bears no correspondence with marginal costs. The matter is complicated by conventions of pricing by regulated utilities.

Other common responses to questions about the definition of conservation programs include education, rationing during drought conditions, and subsidy programs to encourage investment in water savings technologies such as low-flow shower heads and toilet dams.

For our purposes in this study we have included all rate structures in the calculation of average and marginal prices for each city included in the analysis, regardless of whether the utility listed the rate structure as a conservation program. Education programs and subsidy programs to encourage installation of water conserving technology have been classified as conservation programs. Rationing during drought periods has been eliminated from the analysis altogether.

Conservation, as defined above, has been included in the analysis by testing whether there is a statistically discernable difference in per capita consumption due to the presence of a program. That is, a conservation variable has been defined and included in the regression analysis. The method of inclusion was to identify which communities have conservation programs and at what point in time they were begun.

Extent of Geographical Coverage

This study of per capita water use trends distinguishes municipal water use from other types of use, namely, industrial, electric utility and agricultural uses. The analysis deals only with municipal water use which includes the retail water sales of utilities to residential and small commercial classes of users. Large commercial/industrial users typically provide their own water and wastewater service or purchase from a utility on an individual contract basis.

Since the study is designed to deal with municipal water use only, a decision was made to limit the data gathering and analysis to the set of 72 cities that make up the 28 MSAs in Texas. These cities account for about 85% of the municipal water use in Texas.

Importance of Diversity Among Cities

One of the strengths of econometric analyses is that one can be definite about the population to which the analysis is applicable. That is, the statistical tests that allow one to have confidence in the value of parameters estimated statistically apply only to the population from which the data were drawn. In this case, the results will apply to each and every city included in the analysis, but not to others. Therefore, the results will be strictly applicable to all the utilities within the MSAs of Texas that consume 85% of the municipal water in Texas; no more or no less.

The inclusion of each city in all of the MSAs in Texas insures that the diversity of climate, geology, culture and costs get considered. It insures that we will be able to derive meaningful information for the full range of diversity among Texas cities.

Changes Over Time

Most dynamic processes involve some time lapse before all of the influence of a prior change is fully played out. For example, if relative prices change, influencing the economics of choice between two consumer goods, the ability to take advantage of the favorable price change may involve some investment in new equipment, such that the change in consumption patterns is not really evident until later periods. For this and related reasons it is usually advisable to include several time periods in an analysis.

This study of per capita water use trends makes use of 11 years of data (1978-1988). One year completes a seasonal cycle of water use patterns that are influenced by weather and plant growing seasons. The inclusion of 11 years of time series data allows the analysis to span a major rise and fall of the Texas economy and to consider the lag effects that may accompany consumer response to price and income changes of the late 1970s and early 1980s.

Strengths and Weaknesses of Econometric Analyses

The strengths of econometric analyses fall into two categories. The first has to do with the degree of confidence one may have in the parameters that quantify relationships among variables. For example, the measure of consumer response to price changes can be estimated using such analyses, and these price effects may be separated from another influence such as income changes. Not only can one separate the effects of two such influences, but he can also derive statistical tests that allow a measure of confidence in the estimate.

Another strength of econometrics is that it allows one to analyze an enormous amount of data efficiently. The current study, for example, involves 72 cities and 132 monthly observations each.

The only significant weakness of econometric analysis for the purposes of this project is that it is limited to factors and relationships that are present in the historical period. One cannot measure the future effects of a conservation program being put in place today using econometrics if there is no comparable set of programs included in the available historical data. Other modeling approaches will be required for such problems. For example, one could construct a prescriptive model based on cost minimizing behavioral assumptions for such a question.

Formulation of an Econometric Model of Texas Water Consumption

There are two sources for developing a hypothesized mathematical model of Texas municipal water consumption. One is from economic theory of consumer behavior that provides the information that consumers' economic choices tend to follow general rational responses, such as decreasing consumption when prices rise and increasing consumption when incomes rise (other things equal). From economic theory we bring the following information to the current problem:

(1) quantity consumed is inversely related to price (inflation removed);
(2) quantity consumed is directly related to incomes (inflation removed);
(3) quantity consumed is directly related to family size or persons per household;
(4) quantity consumed is directly related to temperature and plant moisture stress; and
(5) there are complementary and substitute consumer products that may come into play when relative prices change.

Another important source of information for formulation of the current model of water consumption is the literature. A number of "hints" and "leads" come from past efforts to solve similar problems. From the literature, for example, we have expectations about the range of price elasticities that may come from the current work (see Chapter II). We also have accounts of variable definitions, mathematical formulations and statistical test results obtained by others.

Based on both sources of information discussed above, the following general model was formulated for the current analysis:

Q_i = the per capita consumption in time period i (i = 1...132), for MSA j (j = 1...28)
NP_{ij} = number of persons per connection in time period i and MSA j
AP_{ij} = real average price per 1,000 gallons per month in time period i and MSA j
MP_{ij} = real marginal price per 1,000 gallons per month in time period i and MSA j
I_{ij} = real per capita income in time period i and MSA j
T_{ij} = temperature by month in time period i and MSA j
DD_{ij} = number of dry days per month in time period i and MSA j

Our prior expectation is that the signs on coefficients estimated for these variables will be positive (+) for NP, negative (-) for AP and MP, positive (+) for I, positive (+) for T and positive (+) for DD.

An alternative specification of a model would include a representation of a supply function and the equation specification would be a simultaneous equation set. Such a specification is needed, conceptually, to separate shifts over time in a demand function from movements along a demand function that may accompany supply function shifts. This problem in applied economics is known as the identification problem. The literature on the topic suggests that attempts to estimate a simultaneous equation set is unlikely to succeed. As discussed later, an attempt to estimate a simultaneous equation set did not prove successful here either.

IV. DATA BASE

Metropolitan Statistical Areas

Four types of data constitute the data base for evaluating trends in per capita municipal water use in Texas: water consumption, water price, income and climate. The Metropolitan Statistical Area (MSA) was the basic demographic unit by which these data were collected. The time period of record is 1978 through 1988.

Geographic Coverage

Cities (utilities) for which data were collected represent the cities within each MSA required to total at least 80 percent of the population of each of the 28 MSAs in Texas. This selection process yielded 72 cities with populations within a wide range (**Table IV-1**). Monthly data for 1978-1988 exist for each city in the data base.

Water Consumption

Monthly water consumption data were derived from the data base of the Water Development Board, which includes annual average per capita consumption per day, and the monthly distribution of the annual average daily consumption. The Water Development Board's population estimates and the number of residential connections reported by each utility were used to convert per capita daily consumption to household consumption in gallons per month. Household consumption is used instead of per capita consumption in order to be consistent with billing practices and to measure economic responses at the basic decision making unit.

Income

Income data are derived from the county per capita annual income estimates of the Bureau of Economics Analysis (BEA), regional Economic Measurement Division, as updated in May 1990. The BEA's income data were deflated by the consumer price index for the South (1982-84 = 100), published by the Bureau of Labor Statistics.

Average and Marginal Price

Average and marginal prices were derived for each city in the analysis through municipal rate schedules on file

TABLE IV-1. MSAs, CITIES AND COUNTIES

MSA#	MSA	CITY#	UTILITY	COUNTY	MSA#	MSA	CITY#	UTILITY	COUNTY
1	Abilene	2	Abilene	Taylor	12	Galveston	219	Friendswood	Galveston
2	Amarillo	14	Amarillo	Potter	12	Galveston	227	Galveston	Galveston
3	Austin	30	Austin	Travis	12	Galveston	350	League City	Galveston
4	Beaumont/PtArthur	43	Beaumont	Jefferson	12	Galveston	602	Texas City	Galveston
4	Beaumont/PtArthur	476	Port Arthur	Jefferson	13	Houston	42	Baytown	Harris
5	Brazoria	13	Alvin	Brazoria	13	Houston	285	Houston	Harris
5	Brazoria	18	Angleton	Brazoria	13	Houston	456	Pasadena	Harris
5	Brazoria	72	Brazoria	Brazoria	13	Houston	130	Conroe	Montgomery
5	Brazoria	118	Clute	Brazoria	14	Killeen/Temple	322	Killeen	Bell
5	Brazoria	217	Freeport	Brazoria	14	Killeen/Temple	597	Temple	Bell
5	Brazoria	338	Lake Jackson	Brazoria	14	Killeen/Temple	134	Copperas Cove	Coryell
5	Brazoria	457	Pearland	Brazoria	15	Laredo	347	Laredo	Webb
6	Brownsv/Harlingen	80	Brownsville	Cameron	16	Longview/Marshall	321	Kilgore	Gregg
6	Brownsv/Harlingen	265	Harlingen	Cameron	16	Longview/Marshall	367	Longview	Gregg
7	Bryan/College Station	82	Bryan	Brazos	16	Longview/Marshall	388	Marshall	Harrison
7	Bryan/College Station	124	College Station	Brazos	17	Lubbock	370	Lubbock	Lubbock
8	Corpus	135	Corpus	Nueces	18	McAl/Edin/Mission	182	Edinburg	Hidalgo
9	Dallas	472	Plano	Collin	18	McAl/Edin/Mission	376	McAllen	Hidalgo
9	Dallas	98	Carrollton	Dallas	18	McAl/Edin/Mission	397	Mercedes	Hidalgo
9	Dallas	151	Dallas	Dallas	18	McAl/Edin/Mission	408	Mission	Hidalgo
9	Dallas	230	Garland	Dallas	18	McAl/Edin/Mission	463	Pharr	Hidalgo
9	Dallas	245	Grand Prairie	Dallas	18	McAl/Edin/Mission	638	Weslaco	Hidalgo
9	Dallas	298	Irving	Dallas	19	Midland	404	Midland	Midland
9	Dallas	401	Mesquite	Dallas	20	Odessa	438	Odessa	Ector
9	Dallas	498	Richardson	Dallas	21	San Angelo	529	San Angelo	Tom Green
9	Dallas	159	Denton	Denton	22	San Antonio	530	San Antonio	Bexar
10	El Paso	189	El Paso	El Paso	23	Sherman/Denison	158	Denison	Grayson
11	Fort Worth	115	Cleburne	Johnson	23	Sherman/Denison	556	Sherman	Grayson
11	Fort Worth	25	Arlington	Tarrant	24	Texarkana	429	New Boston	Bowie
11	Fort Worth	44	Bedford	Tarrant	24	Texarkana	601	Texarkana	Bowie
11	Fort Worth	193	Euless	Tarrant	24	Texarkana	628	Wake Village	Bowie
11	Fort Worth	213	Fort Worth	Tarrant	25	Tyler	613	Tyler	Smith
11	Fort Worth	249	Grapevine	Tarrant	26	Victoria	624	Victoria	Victoria
11	Fort Worth	261	Haltom City	Tarrant	27	Waco	47	Bellmead	McLennan
11	Fort Worth	293	Hurst	Tarrant	27	Waco	626	Waco	McLennan
11	Fort Worth	435	North Richland Hills	Tarrant	27	Waco	667	Woodway	McLennan
					28	Wichita Falls	654	Wichita Falls	Wichita

residential and commercial use. Weighted marginal and average prices were derived by the relative mix of residential and commercial water connections reported annually to the Water Development Board by each utility.

Climate

National Weather Service (NWS) data regarding precipitation and temperature for selected Texas weather stations were acquired from TNRIS. Data were selected from the NWS station nearest the city for which data exist for the period of record 1978-1988.

Temperature data are the average monthly temperatures at the NWS station nearest the city, and for which data exist for the period of record 1978-1988. Average monthly temperature is the mean of the average daily high temperature and average daily low temperatures as reported in two separate data bases at TNRIS.

Precipitation data are the total number of days in a month with less than 0.25 inches of precipitation at the NWS station nearest the city, and for which data exist for 1978-1988.

V. THE MODEL

Important Factors Affecting Consumption

The model for evaluating trends in per capita municipal water use in Texas was specified as a demand model, or a model in which the effect of price on consumption is measured. Important factors other than price which affect consumption are income, number of persons per household, average monthly temperature, the number of days per month without significant rainfall and the level of commercial development. Not all of these factors affect each city or MSA uniformly but are always important.

Nine Regional Models

Early analysis revealed that water consumption is better evaluated on a regional basis. Therefore, equations were estimated for nine regions of Texas. MSAs were grouped together based on a combination of criteria: location with respect to vegetational and geological designations, general precipitation patterns based on data from 1950 through 1981, commercial distinctiveness and city size.

Twenty-eight MSAs were grouped into the nine regions (**Table V-1**). The Metroplex (Dallas-Fort Worth) area constitutes two separate regions, each of which includes cities from both the Dallas MSA and the Fort Worth MSA. The distinction is due to suburban location of cities in both MSAs.

Cross-Sectional/Time-Series Combination

The period of record is 1978-1988 from which a data base was constructed containing monthly information for each city within each region. This time series affords the ability to analyze the response over time of water consumption to the explanatory variables of the model.

Grouping several MSAs, each of which contains one or more cities, allows cross-sectional analysis by which to examine the relationship between consumption and the explanatory variables for multiple locations within one period of time. The combination of time-series and cross-sectional data for analysis allows for explaining region-wide structural relationships and changes in those relationships over time.

TABLE V-1
MSA Groupings for Regional Models

REGION	MSA #	MSA
West		
	10	El Paso
	20	Odessa
	19	Midland
	17	Lubbock
	2	Amarillo
Rolling Plains		
	28	Wichita Falls
	1	Abilene
	21	San Angelo
	15	Laredo
Metroplex[1]		
	9	Dallas
	11	Fort Worth
Metroplex Suburban[2]		
	9	Dallas
	11	Fort Worth
Central		
	23	Sherman-Denison
	27	Waco
	14	Killeen-Temple
	7	Bryan-College Station
I-35 South		
	3	Austin
	22	San Antonio
	26	Victoria
Southeast		
	5	Brazoria
	12	Galveston
	8	Corpus Christi
East		
	24	Texarkana
	25	Tyler
	16	Longview-Marshall
	4	Beaumont-Port Arthur
	13	Houston
Valley		
	6	Brownsville-Harlingen
	18	McAllen-Edinburg-Mission

[1]Includes cities of Fort Worth, Arlington, Dallas, Plano, Carrollton, Irving and Richardson.
[2]Includes cities of Cleburne, Bedford, Euless, Grapevine, Haltom City, Hurst, North Richland Hills, Garland, Grand Prairie, Mesquite and Denton.

Functional Forms of Nine Regional Models

In general form, the model for water consumption is specified as:

CONS = f (MP, FAMLYINC, TEMP, DAYS, COMPROXY, DSEAS,Dn)

where:

- CONS = per household water consumption in gallons per month;
- MP = weighted marginal price in dollars per thousand gallons;
- FAMLYINC = per capita income multiplied by the number of persons per residential connection, in dollars;
- TEMP = the average monthly temperature in degrees Fahrenheit;
- DAYS = the number of days with precipitation of less than 0.25 inches;
- COMPROXY = the fraction of total water connections attributable to commercial use;
- DSEAS = dummy variable which distinguishes summer-time consumption from consumption in the rest of the year.
- Dn = locational dummy variables for MSA number n which distinguishes one MSA from another (number designations in **Table V-1**).

Three functional forms of each regional model were estimated econometrically using the Statistical Analysis System (SAS) regression procedure. The three forms are linear, log-linear and log-log, all results of which are in **Appendix A**.

Table V-2 contains the parameter estimates, t statistics, F test and number of observations (n) for the preferred functional forms for all nine regions. The log-linear form provided the best results for all regions except the East and the Rolling Plains. The Rolling Plains region was estimated in linear form. The East region was estimated in log-log form.

All parameter estimates in all nine equations are statistically significant with signs which are intuitively correct. The relationship between consumption and price is inverse, and the relationship between consumption and income is direct. The signs in the TEMP and DAYS parameters are all positive, indicating that higher monthly average temperatures and a larger number of days without significant rainfall tend to induce higher water consumption, all other variables remaining unchanged.

insignificant in early equations in which the sign on the parameter was negative.

Explanation of Historical Water Consumption

Data from seven cities from six separate regions were used to indicate the performance of the models in explaining historical consumption. **Figures V-1** through **V-7** show the actual vs. predicted values of dependent variables for water consumption in El Paso, Abilene, Dallas, San Antonio, Austin, Corpus Christi and Houston. Actual data are city-specific. The models are the respective regional models contained in **Table V-2**.

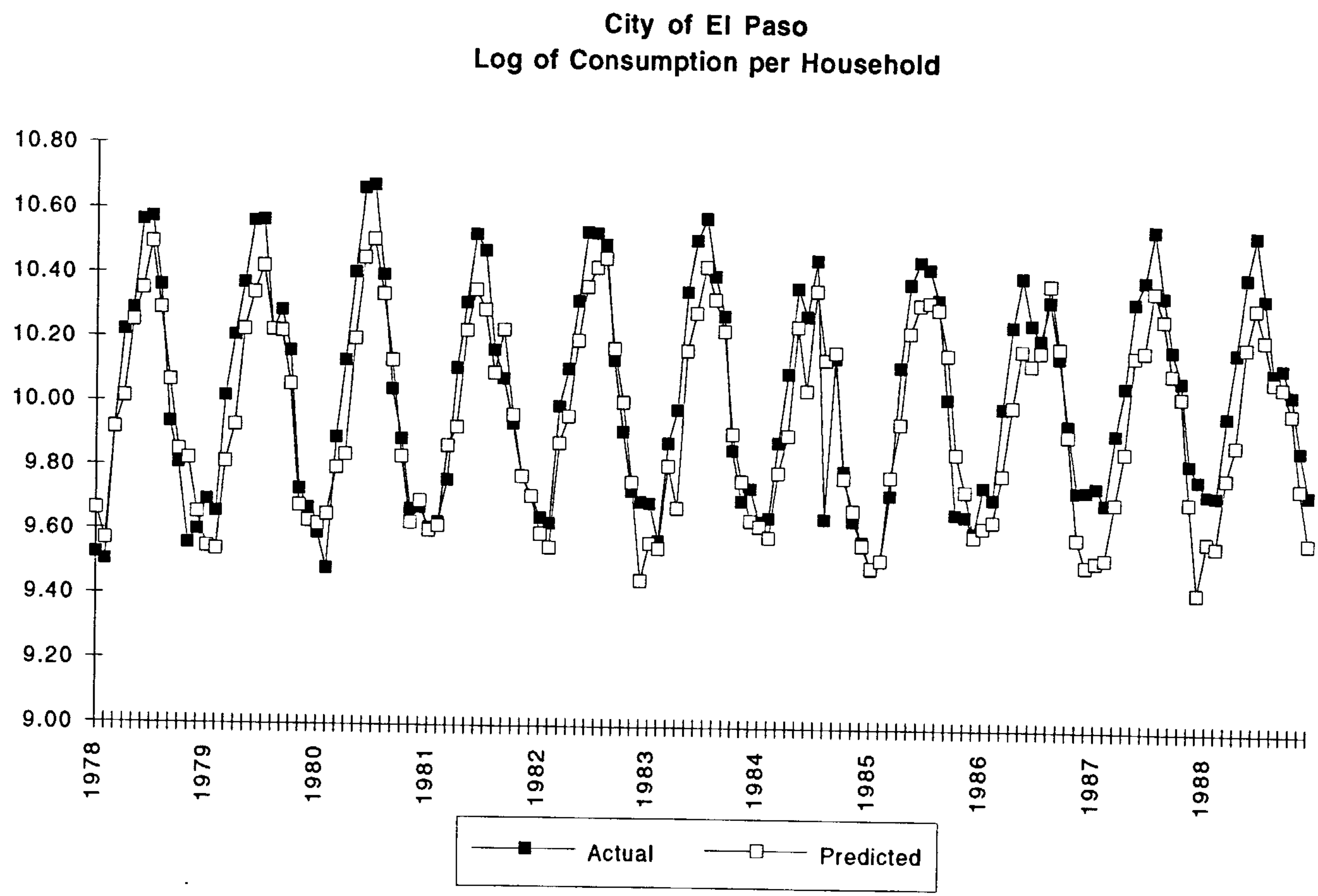
Variations in consumption were explained well for El Paso (**Figure V-1**), Abilene (**Figure V-2**), Dallas (**Figure V-3**), San Antonio (**Figure V-4**), Austin (**Figure V-5**) and Houston (**Figure V-7**) with predicted values approaching the actual values even in the summer peak consumption periods. Consumption patterns in El Paso, Abilene, Dallas, San Antonio, Austin, Corpus Christi and Houston appear to typify the patterns of their respective models. That is, the combined effects of variation in price, income, dry days, temperature and concentration of commercial water users do a good job of explaining the variation in monthly consumption in these cities using the applicable regional model. Only Corpus Christi (**Figure V-6**) reflects results atypical of its regional model.

The predicted values in Corpus Christi vary most from actual values in 1980, 1986 and 1988. Directional patterns show underestimation in 1980 and 1988, and overestimation in 1986. **Figure V-6** shows a tendency to over-predict in the last half of the period, which could be the result of the model's failure to capture the effect of conservation programs in Corpus implemented in the last half of the 1980s. The strong reversal to a high level of underestimation in 1988, however, seems to discount this possibility.

As mentioned earlier, attempts to estimate a conservation parameter did not prove successful. That is, the set of explanatory variables do not include conservation. Since a number of cities implemented conservation programs during the 1980s, we are interested in checking the patterns of predicted vs. actual consumption residuals to see if unexplained variation has a long-term trend that possibly could be explained by conservation programs.

An examination of residuals (**Appendix B**) indicates that the Southeast regional model explains variation in Lake Jackson and Galveston similar to the way it explains

Figure V-1



City of El Paso
Log of Consumption per Household
10.80
10.60
10.40
10.20
10.00
9.80
9.60
9.40
9.20
9.00
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
Actual
Predicted

Figure V-2

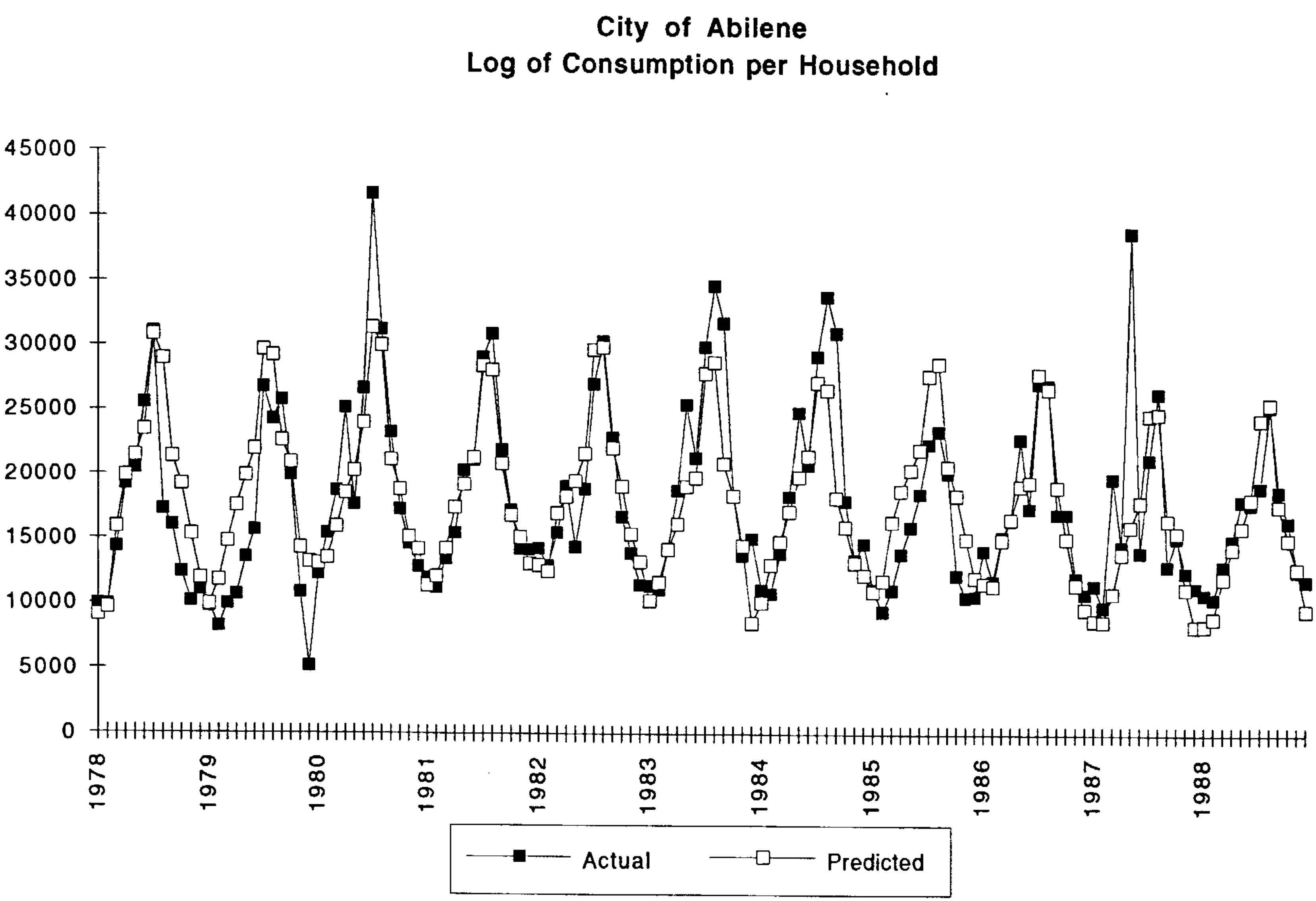

City of Abilene
Log of Consumption per Household
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
Actual
Predicted

Figure V-4

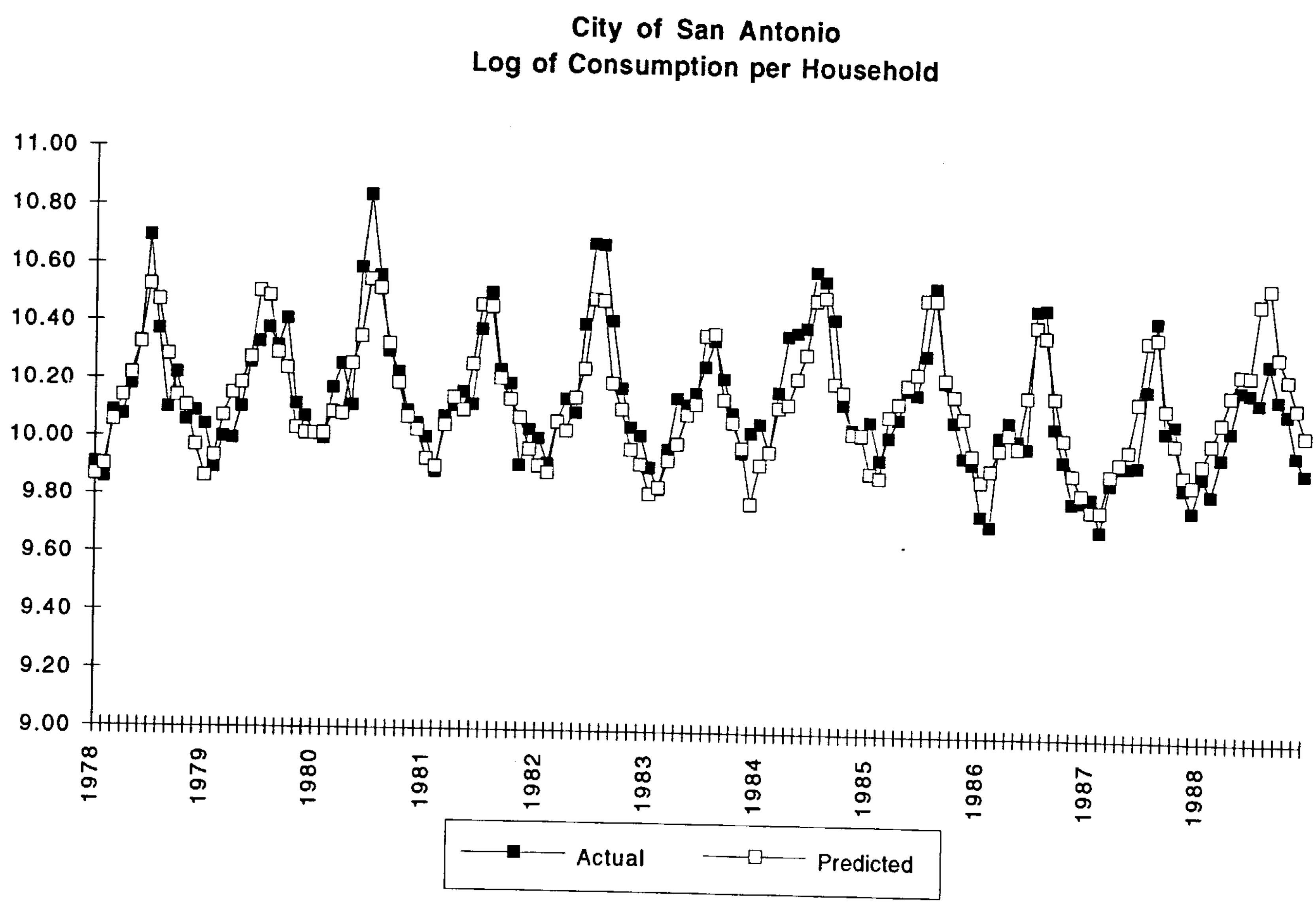

City of San Antonio
Log of Consumption per Household
11.00
10.80
10.60
10.40
10.20
10.00
9.80
9.60
9.40
9.20
9.00
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
Actual
Predicted

Figure V-5

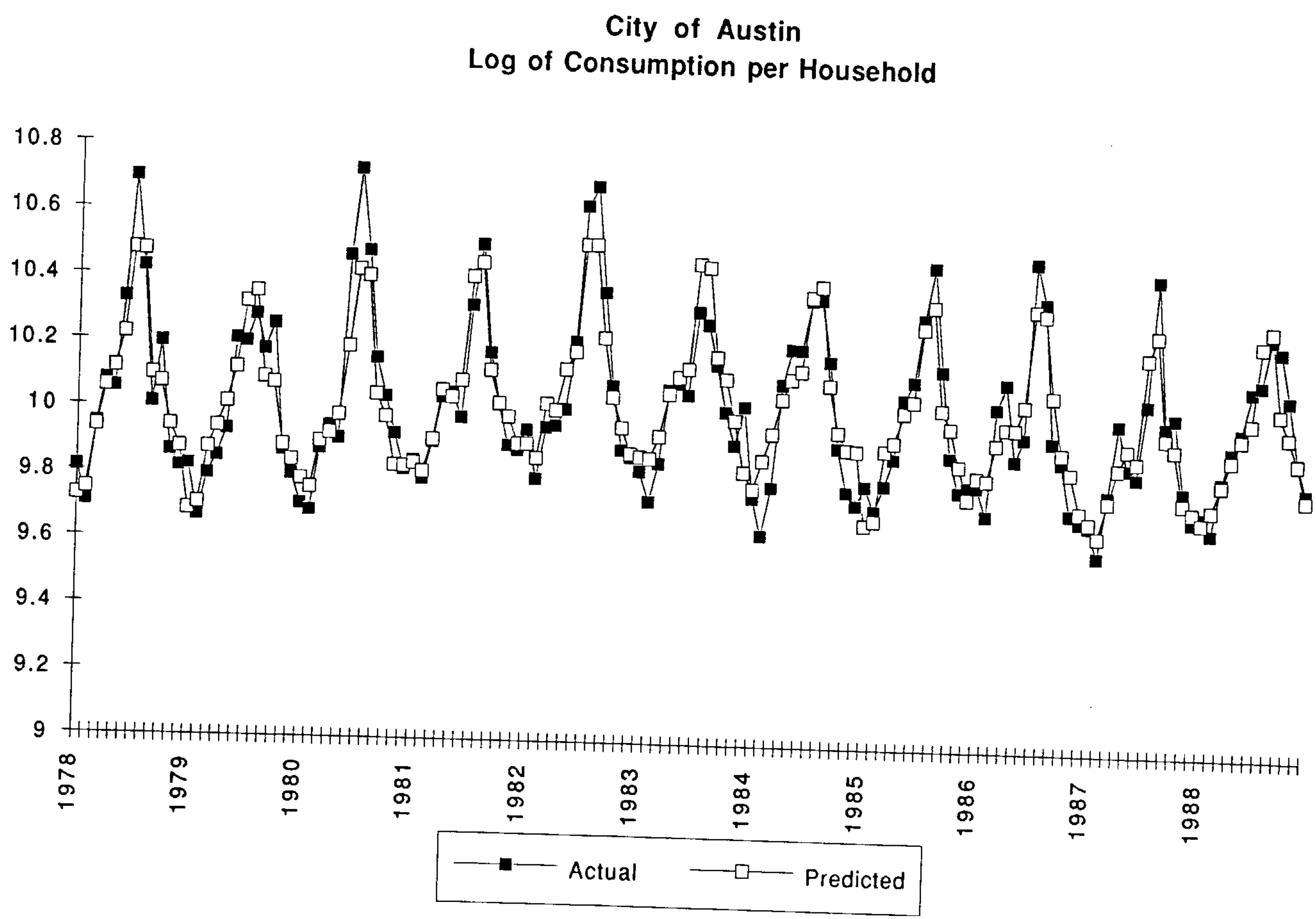

City of Austin
Log of Consumption per Household
10.8
10.6
10.4
10.2
10
9.8
9.6
9.4
9.2
9
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
Actual
Predicted

Figure V-6

City of Corpus Christi
Log of Consumption per Household

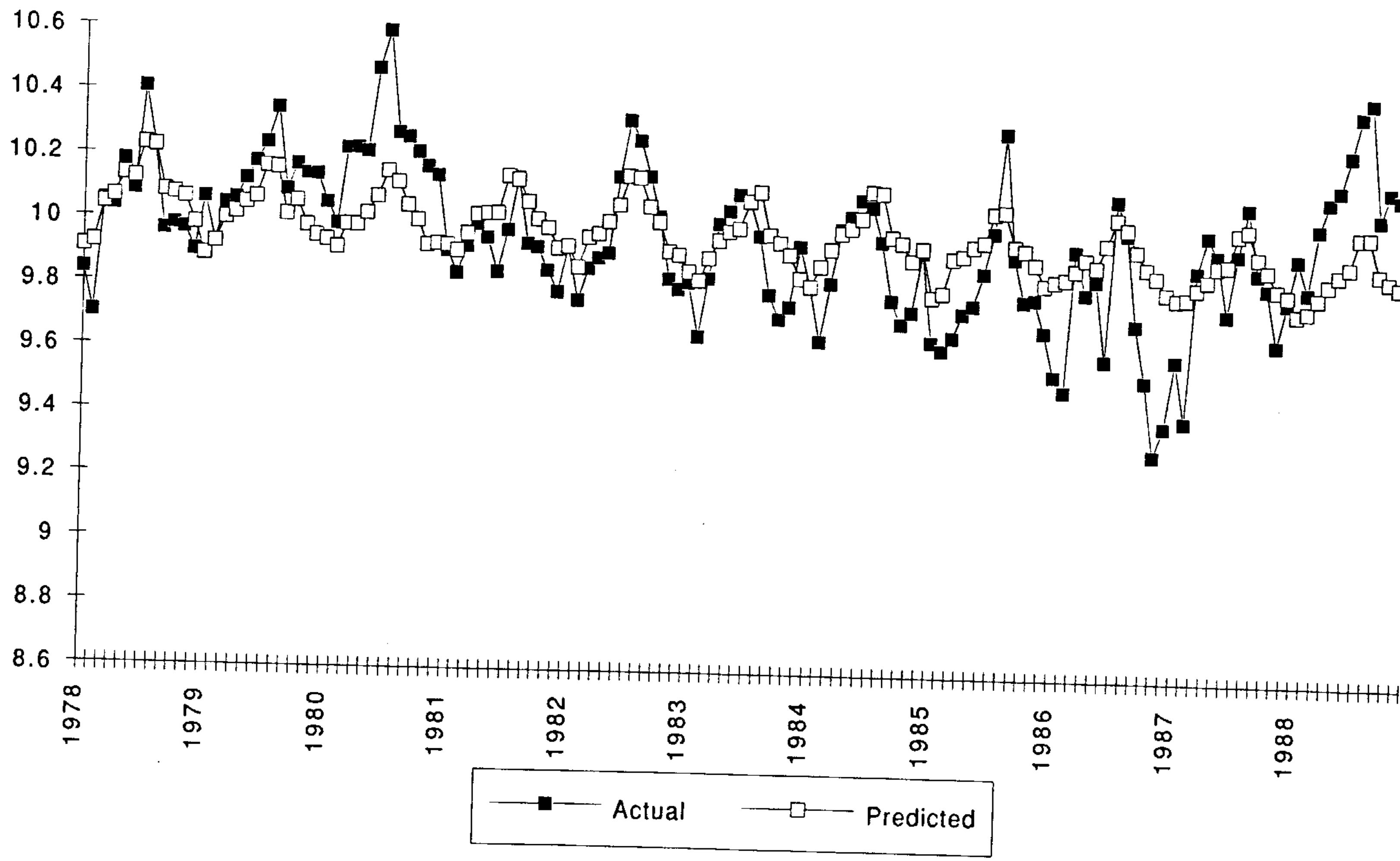
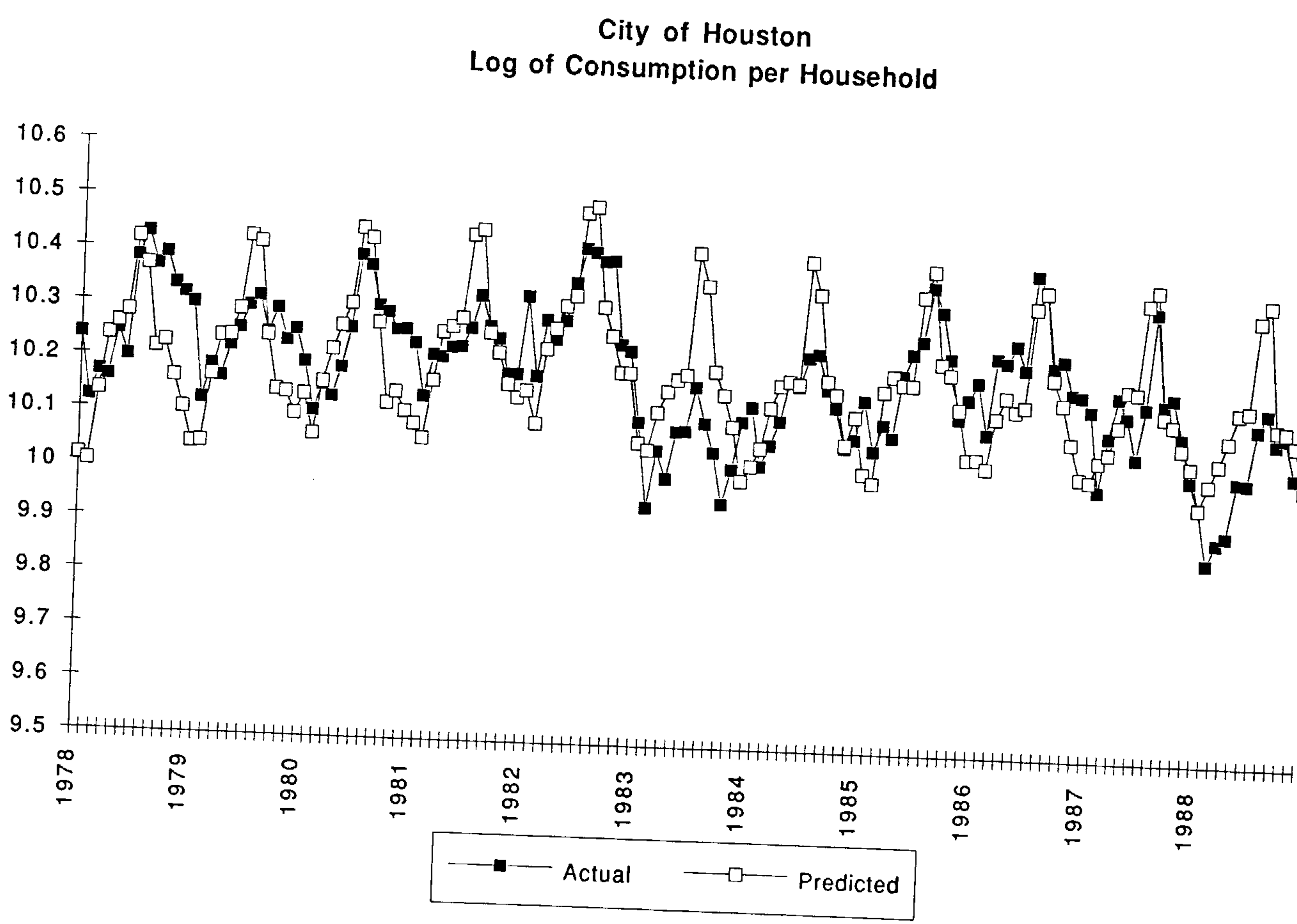


Figure V-7


City of Houston
Log of Consumption per Household
10.6
10.5
10.4
10.3
10.2
10.1
10
9.9
9.8
9.7
9.6
9.5
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
Actual
Predicted

actual consumption for all three cities, although Lake Jackson and Galveston had no conservation programs until as recently as 1988.

There is no constant pattern of overestimation at El Paso and Austin, two other Texas cities with notable conservation programs implemented in the mid 1980s. If overestimation in the late 1980s could be taken as an indication of the model's inability to capture the effects of conservation, residuals should show a positive upward trend. That is, the residuals would reflect this failure and show rising, positive values, but they do not (**Appendix B**).

In summary, the statistical tests of the models give us confidence that we have explained a large portion of the variation in monthly consumption by the set of variables that we expect to be important, namely price, income, commercial concentration, dry days, temperature and city/regional location. Further, we have confidence that while some equations show non-uniform patterns of actual minus predicted consumption, such patterns do not seem consistent with expected conservation program effects. While conservation programs are no doubt having some impact in certain cities, we are unable to quantify such with econometric methods, given the available data.

Elasticity Estimates

Price elasticity of demand measures the response of consumption to a one-percent change in the price of water. **Table V-3** shows summer and winter price elasticities for each region. The highest elasticity coefficients are for MSAs in the East region. The coefficients are lowest in the Valley region, indicating that consumption will drop only slightly as price rises. Water is a more precious commodity in the Valley than in the Rolling Plains. Price elasticity increases slightly for non-peak consumption periods except in Victoria (I-35), Dallas/Fort Worth (Metroplex), Sherman/Denison and Waco, where elasticity decreases in non-peak consumption periods, and in the East region which has constant elasticity coefficients due to the log-log form of the equation.

The response of consumption to a one-percent change in income is quite variable over the state (**Table V-4**). The response to rising income is lowest in the Valley region, at 0.031 in the McAllen-Edinburg-Mission MSA. The highest income elasticities are in MSAs in the Rolling Plains region, where Wichita Falls area residents tend to increase water consumption in winter by 2.3 percent for every one-percent increase in income.

TABLE V-3. PRICE ELASTICITY OF DEMAND FOR WATER BY REGION BY MSA IN TEXAS

MSA\REGION	EAST	I-35	METRO-PLEX	METRO-PLEX SUB	ROLLING PLAINS	WEST	SOUTH-EAST	CENTRAL	VALLEY
ABILENE					-0.173 -0.450				
AMARILLO						-0.047 -0.048			
AUSTIN		-0.293 -0.316							
BEAUPORT	-0.090 -0.090								
BRAZORIA							-0.087 -0.088		
BRNSVHAR									-0.024 -0.026
BRYANCOL								-0.127 -0.130	
CORPUS							-0.074 -0.078		
DALLAS			-0.066 -0.065	-0.177 -0.187					
EL PASO						-0.042 -0.043			
FTWORTH			-0.066 -0.065	-0.177 -0.187					
GALVESTON							-0.108 -0.110		
HOUSTON	-0.090 -0.090								
KILLTEMP								-0.143 -0.147	
LAREDO					-0.095 -0.159				
LONGMARS	-0.090 -0.090								
LUBBOCK						-0.068 -0.071			
MCAEDMIS									-0.033 -0.034
MIDLAND						-0.075 -0.078			
ODESSA						-0.072 -0.078			
SANGELO					-0.167 -0.288				
SANTONIO		-0.224 -0.228							
SHERMDEN								-0.132 -0.130	
TEXARKNA	-0.090 -0.090								
TYLER	-0.090 -0.090								
VICTORIA		-0.216 -0.207							
WACO								-0.134 -0.133	
WICHITAF					-0.181 -0.543				

NOTE: The first elasticity in each set is the value for summer and the second is for winter.

TABLE V-4. INCOME ELASTICITY OF DEMAND FOR WATER BY REGION BY MSA IN TEXAS

MSA\REGION	EAST	I-35	METRO-PLEX	METRO-PLEX SUB	ROLLING PLAINS	WEST	SOUTH-EAST	CENTRAL	VALLEY
ABILENE					0.818 2.056				
AMARILLO						0.205 0.205			
AUSTIN		0.941 0.941							
BEAUPORT	0.533 0.533								
BRAZORIA							0.738 0.738		
BRNSVHAR									0.034 0.035
BRYANCOL								1.267 1.267	
CORPUS							0.712 0.712		
DALLAS			0.802 0.802	0.962 0.962					
EL PASO						0.194 0.194			
FTWORTH			0.802 0.802	0.962 0.962					
GALVESTON							0.733 0.733		
HOUSTON	0.533 0.533								
KILLTEMP								0.978 0.978	
LAREDO					0.492 0.812				
LONGMARS	0.533 0.533								
LUBBOCK						0.244 0.244			
MCAEDMIS									0.031 0.032
MIDLAND						0.302 0.302			
ODESSA						0.259 0.259			
SANGELO					0.779 1.540				
SANTONIO		0.948 0.948							
SHERMDEN								1.006 1.006	
TEXARKNA	0.533 0.533								
TYLER	0.533 0.533								
VICTORIA		0.840 0.840							
WACO								1.015 1.015	
WICHITAF					0.836 2.301				

NOTE: The first elasticity in each set is the value for summer and the second is for winter.

VI. USE OF ECONOMETRIC MODELS FOR FORECASTING

This section of the report provides an example of how to use the econometric models for forecasting per capita monthly water consumption. The forecasts presented here are for exemplary purposes only. A forecast for planning use should be done paying particular attention to reasonable projections of region and city specific independent variables. The common set of assumed projections of independent variables used here are, however, within a reasonable range for the examples chosen.

Projections of Independent Variables

The independent variables which determine the following trends of per capita water consumption in Texas are price and income. All nine regional models include FAMLYINC, described as income per household which is the product of real per capita income and the number of persons per residential connection. Four scenarios for price and income were used to derive four alternative forecasts of water consumption for El Paso, Abilene, Dallas, San Antonio, Corpus Christi and Houston. The assumptions for marginal price (MP) in the forecast period were 1) flat real prices throughout the forecast period 1989-1999, using the monthly values for 1988, the last year of historic data; and 2) annual growth in real prices of 4.1% (the average rate of increase for the 72 cities during 1980-1988). The assumptions for per capita income were 1) annual growth of 1.5% over the forecast period (the Texas Comptroller's current 20 year forecast rate of increase), and 2) zero growth, keeping income unchanged from the December 1988 level.

Persons per residential connection, and the commercial growth variable (COMPROXY) were held constant at their December 1988 levels. The number of dry days (DAYS) and the average monthly temperatures (TEMP) were forecast by projecting the average monthly values for the historic period.

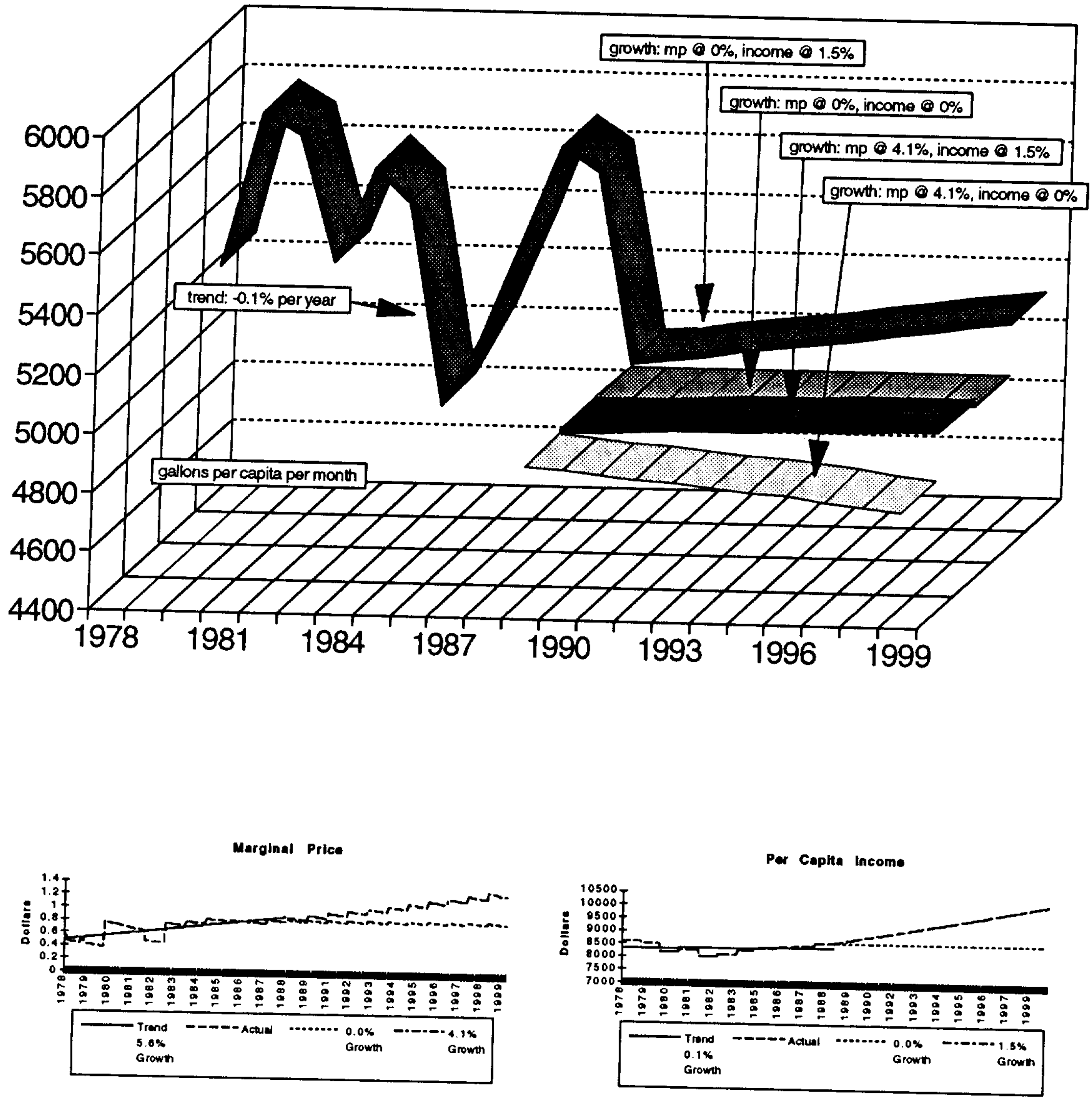
Projections of Per Capita Water Consumption

Forecasts of per capita water consumption for El Paso, Abilene, Dallas, San Antonio, Austin, Corpus and Houston are shown with projected assumptions of price, income and persons per residential connection in **Figures VI-1 and VI-7**. Historical data are also shown for perspective. The forecast results are summarized below by price/income scenario:

a. <u>Growth rates of 0% for price, 1.5% for personal income</u>. Water consumption forecasts for all seven

Figure VI-1

EL PASO WATER CONSUMPTION
four scenarios for price, income

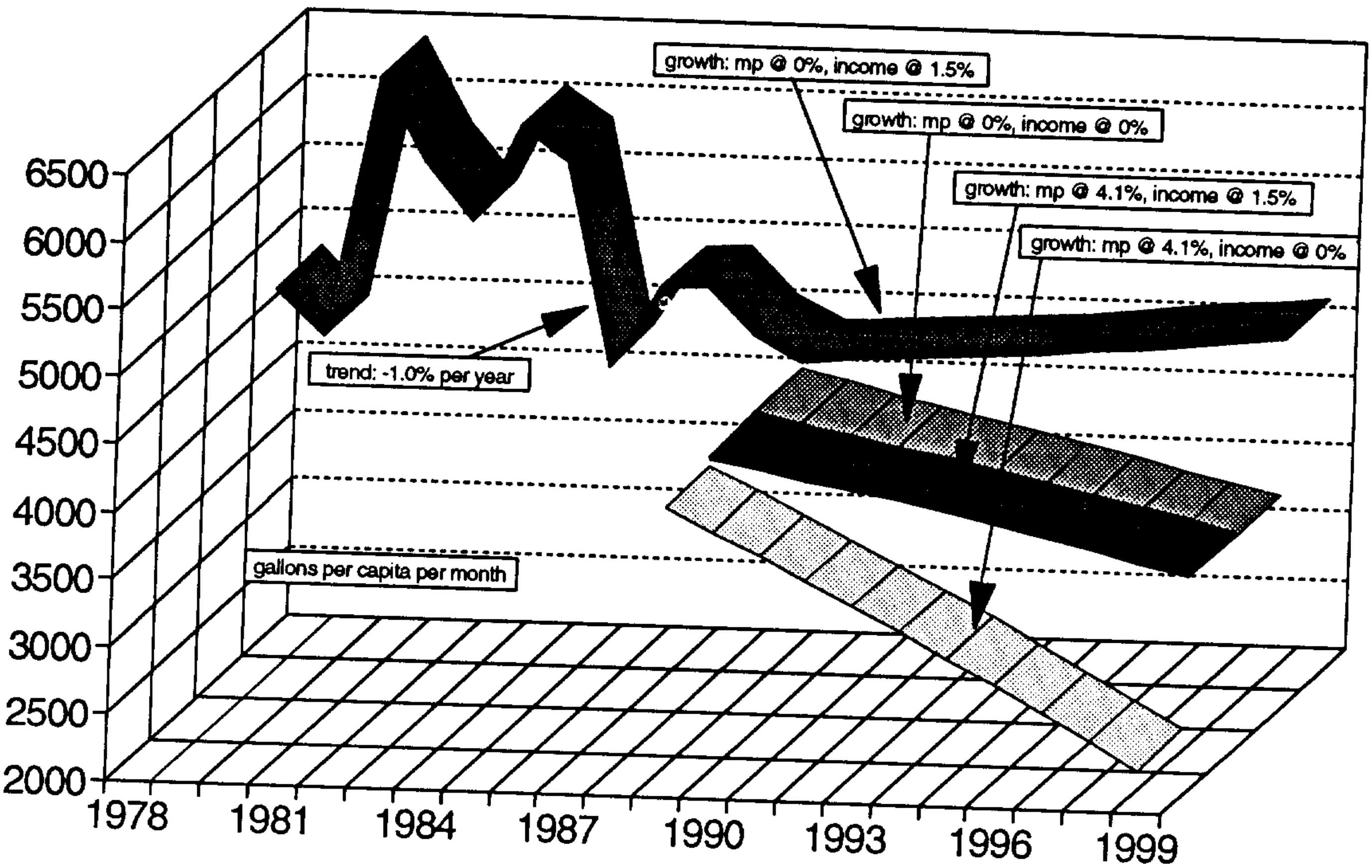


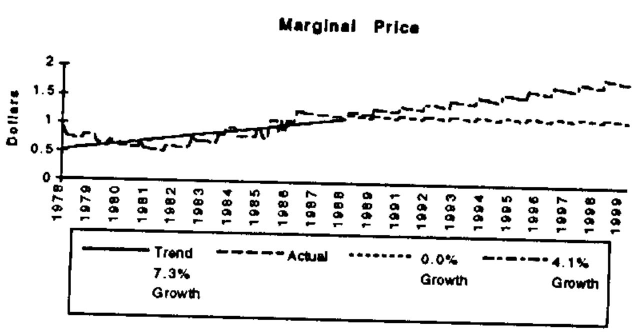
Persons Per Residential Connection held constant in projections

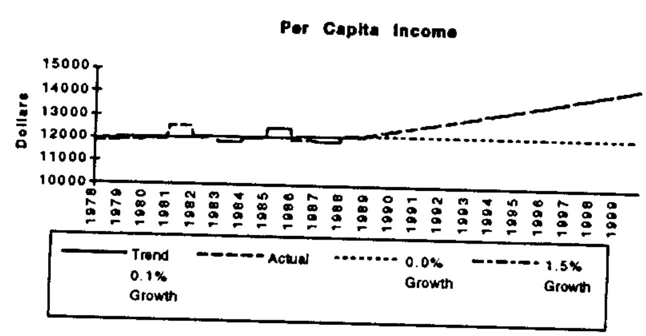
Figure VI-2

ABILENE WATER CONSUMPTION

four scenarios for price, income



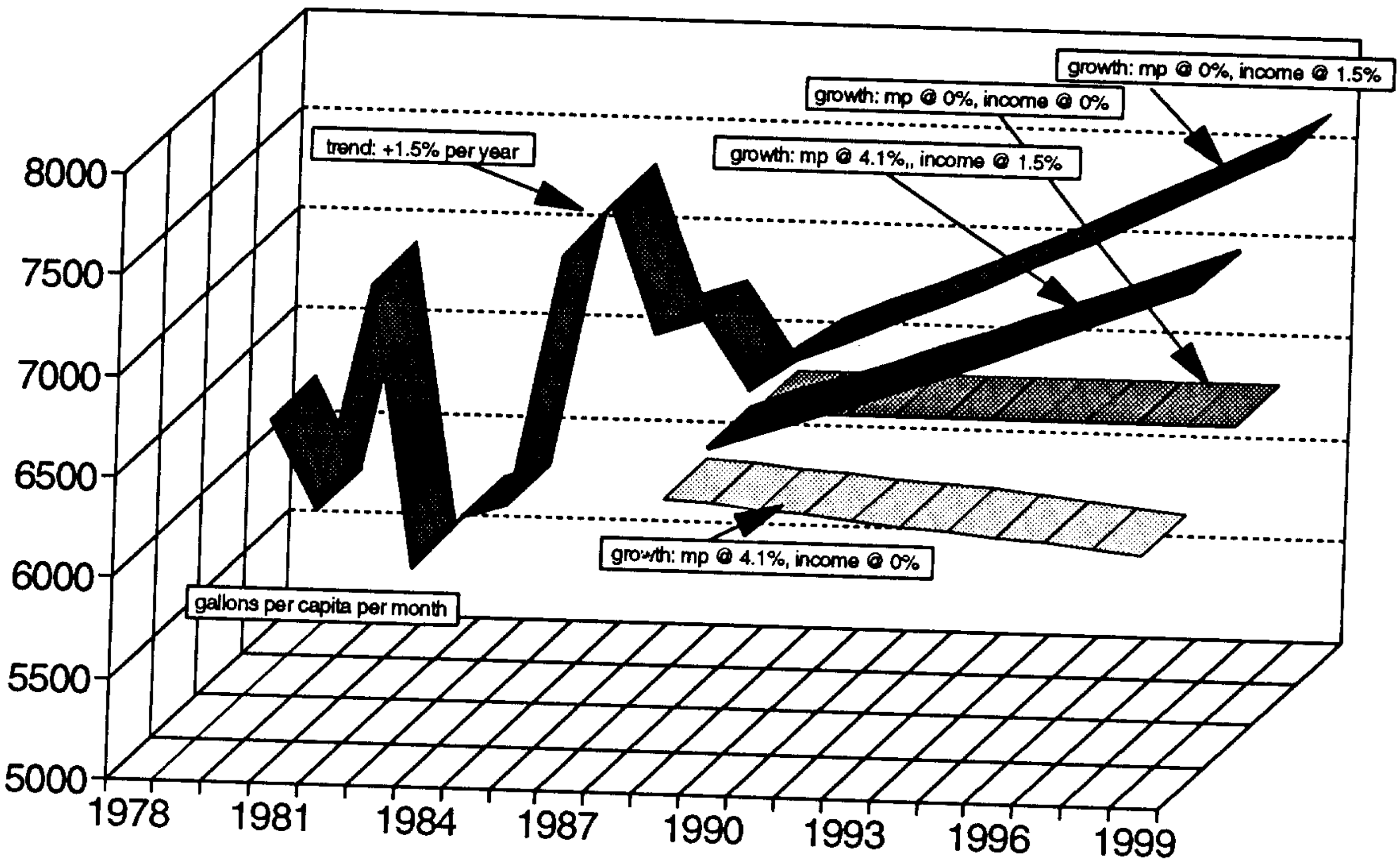


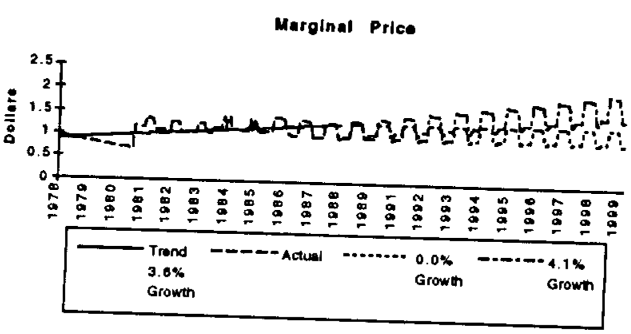


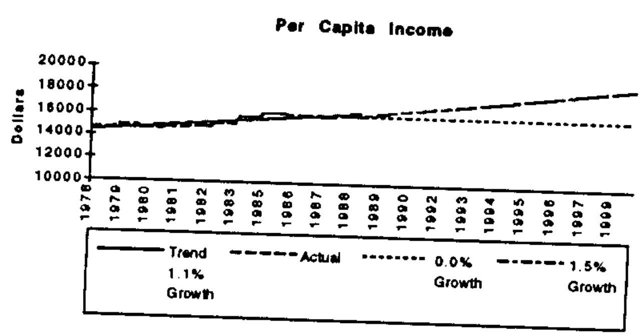
Persons Per Residential Connection held constant in projections

Figure VI-3

DALLAS WATER CONSUMPTION
four scenarios for price, income



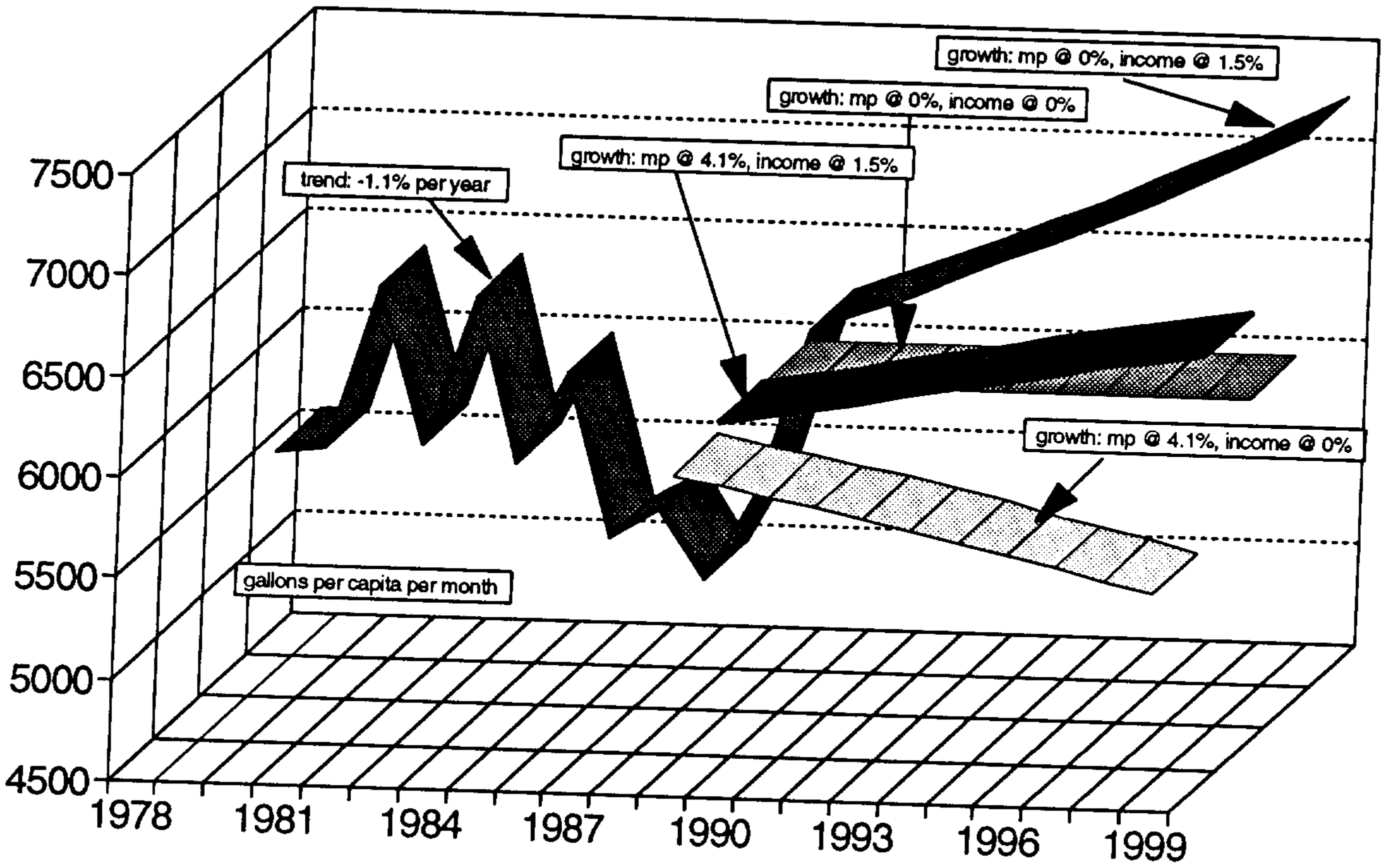


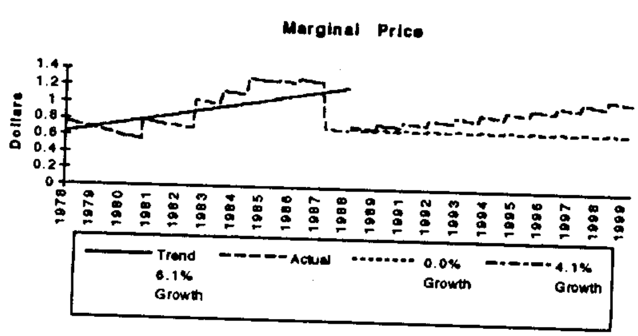


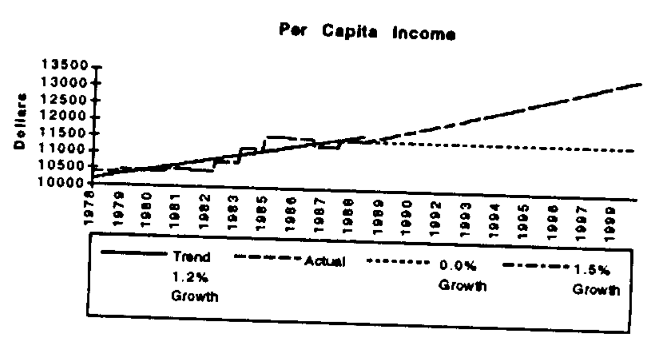
Persons Per Residential Connection held constant in projections

Figure VI-4

SAN ANTONIO WATER CONSUMPTION
four scenarios for price, income





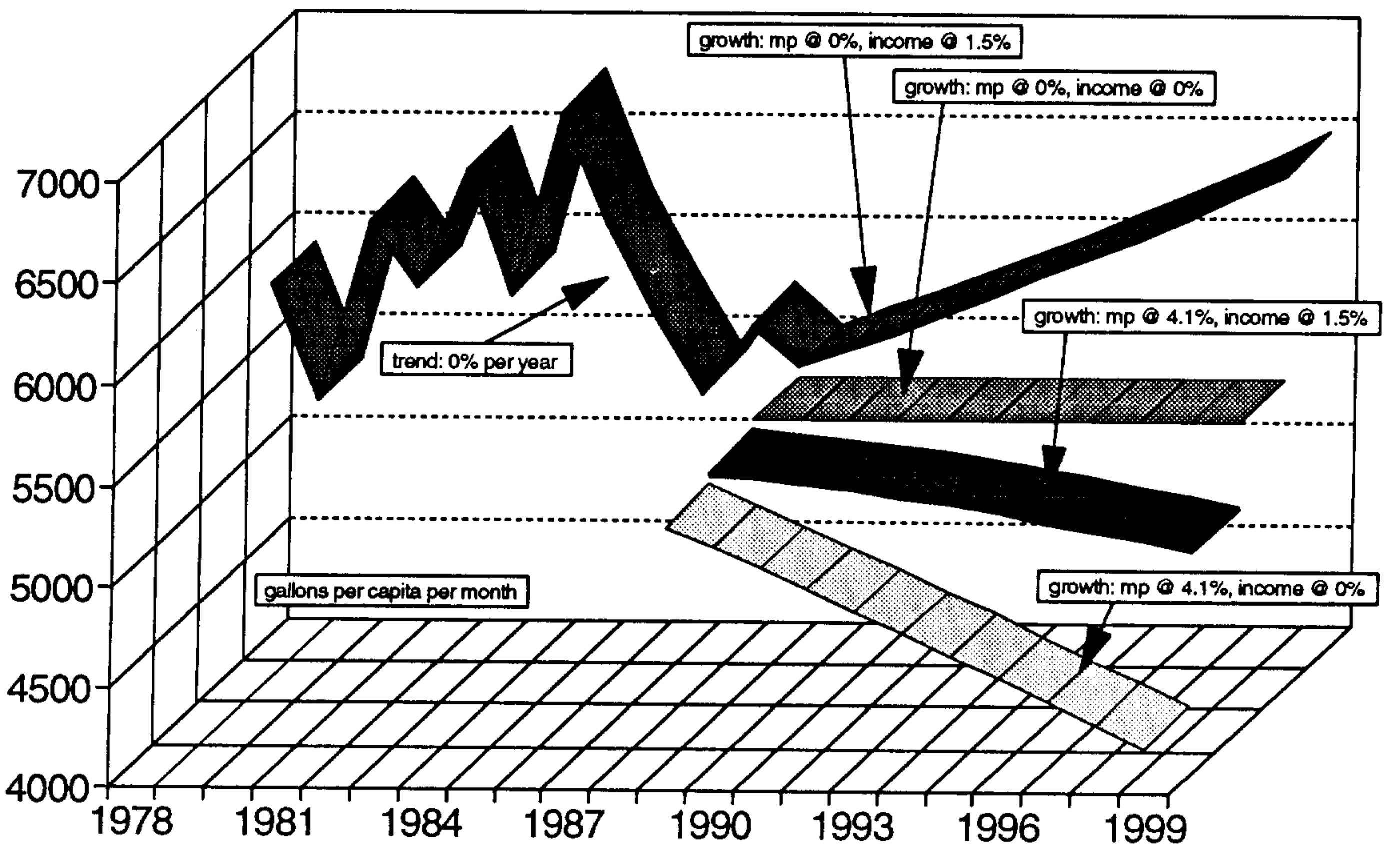


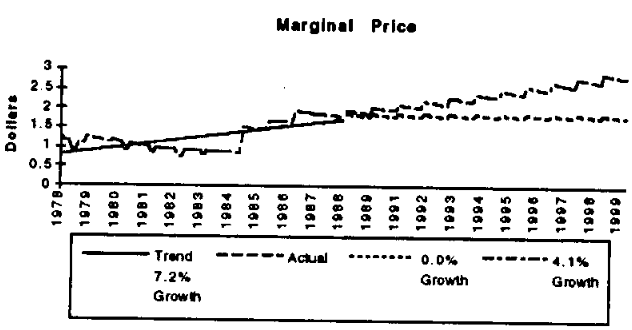
Persons Per Residential Connection held constant in projections

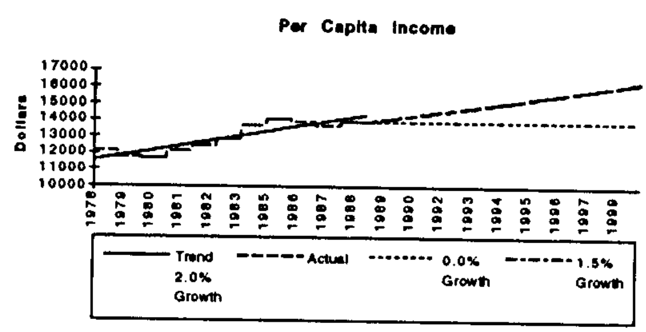
Figure VI-5

AUSTIN WATER CONSUMPTION

four scenarios for price, income





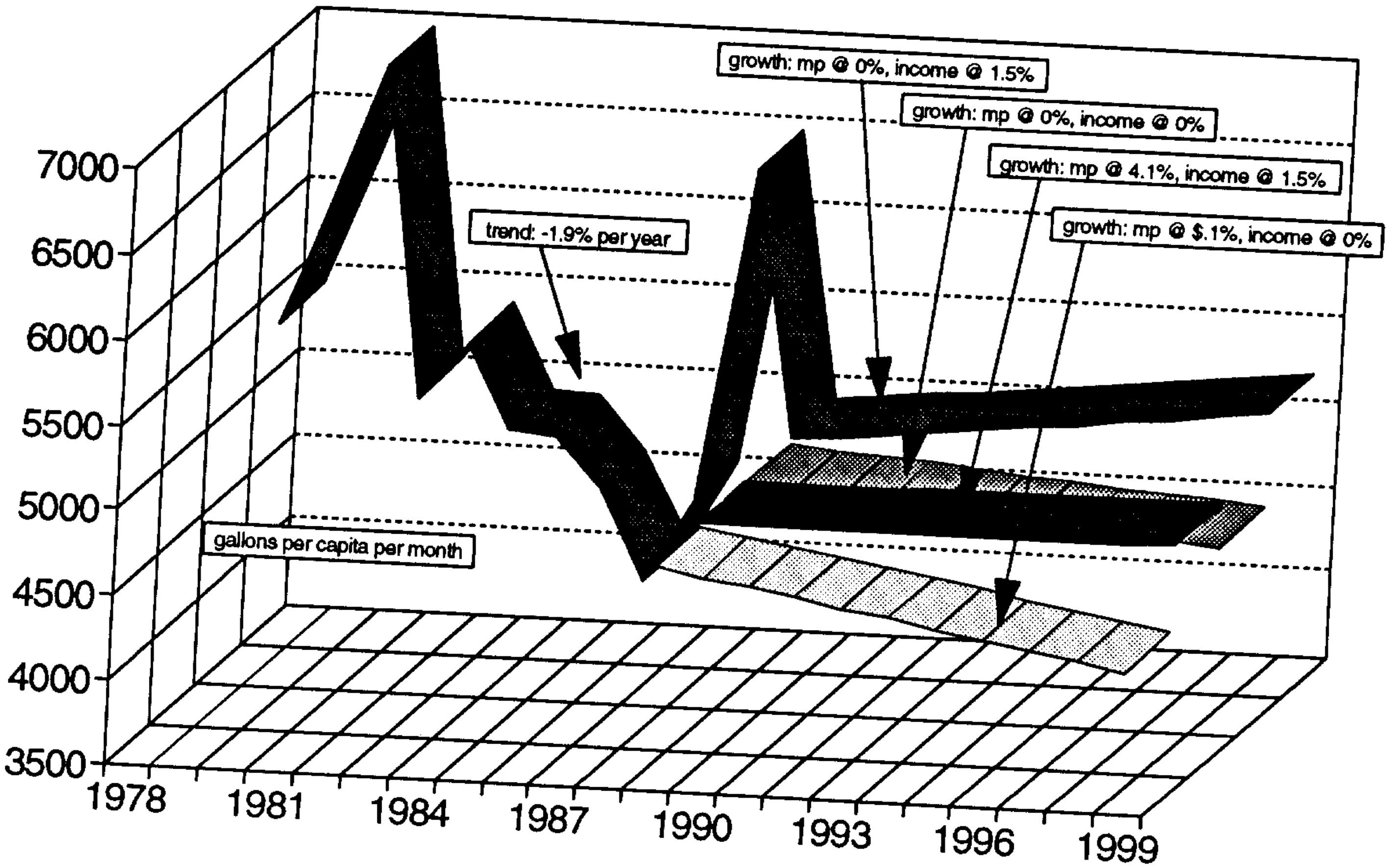


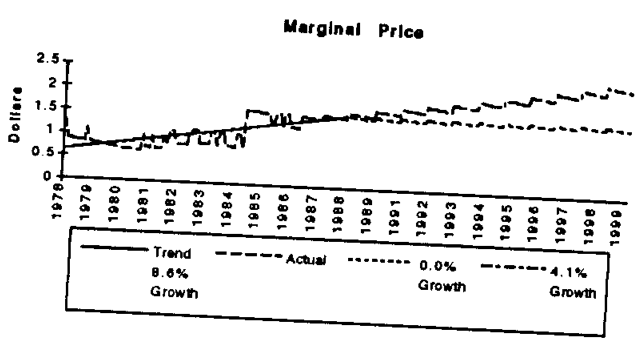
Persons Per Residential Connection held constant in projections

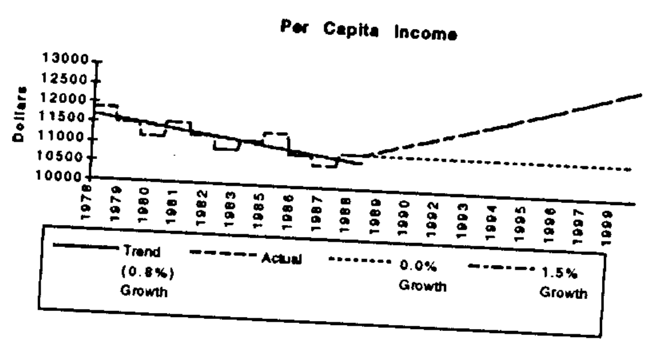
Figure VI-6

CORPUS WATER CONSUMPTION

four scenarios for price, income





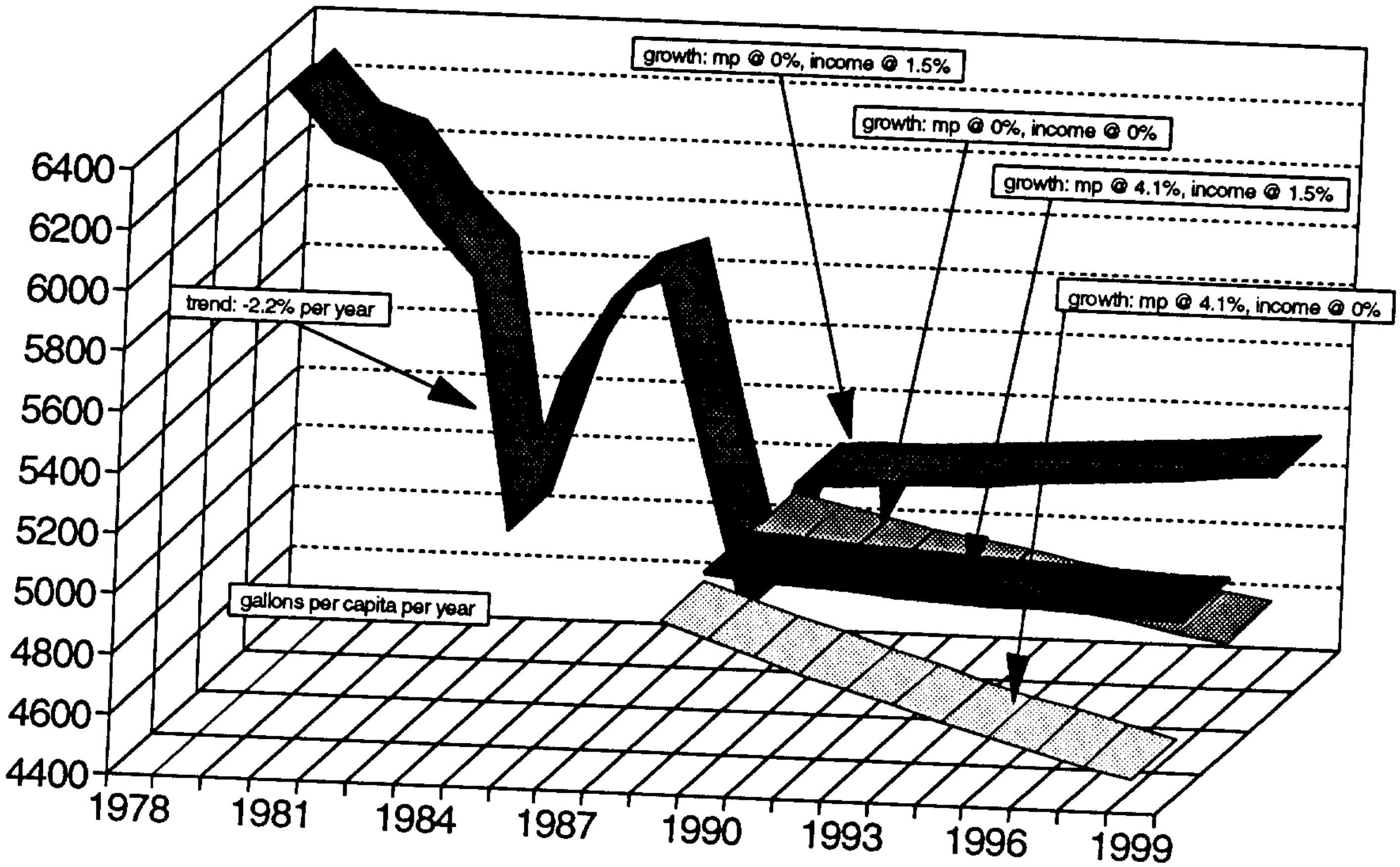


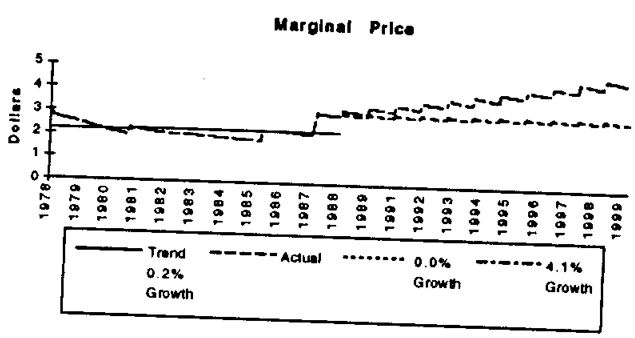
Persons Per Residential Connection held constant in projections

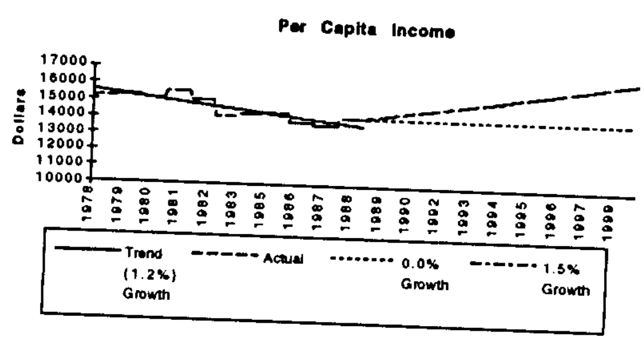
Figure VI-7

HOUSTON WATER CONSUMPTION

four scenarios for price, income







Persons Per Residential Connection held constant in projections

cities is projected to rise over the 1989-1999 period. Especially sharp increases are shown for Dallas, San Antonio and Austin relative to the other cities. The level of persons per residential connection for all these cities fell from 1978 to 1988. The arresting of that downward trend with a flat-growth assumption boosts the FAMLYINC variable for each city and therefore, the level of consumption. Persons per residential connection trended higher or remained virtually stable through 1988 for Houston, El Paso, Corpus and Abilene. The flat-growth assumption had a dampening effect, if any on income in the regional equations.

Note from **Table V-4** that the income elasticities of demand for water for the Dallas, San Antonio, Austin and Houston MSAs are higher than for the El Paso, Abilene and Corpus MSAs, and higher than most MSAs in the table. Income elasticity of demand measures the response of consumption to a one-percent change in income per residential connection. With other factors held constant, a 1.5% increase in income at San Antonio will yield an increase in water consumption of 1.4%. A 1.5% increase in income for El Paso yields only a 03% increase in water consumption, and **Figure VI-1** reflects the smaller response to income change.

b. <u>Growth rates of 0% for price and 0% for personal income</u>. This scenario is unlikely over the period 1989-1999. This scenario produces forecasts for El Paso, Dallas, San Antonio and Austin of zero-growth in consumption because income and price are held constant, along with other predictive variables in the forecast period. Only for the cities of Abilene, Corpus and Houston, whose equations include the variable TIME, does consumption change over the forecast period. Consumption declines for Abilene, Corpus and Houston because TIME is inversely related to water consumption in their respective regional models.

c. <u>Growth rates of 4.1% for price and 1.5% for personal income</u>. This scenario is very plausible. Under these assumptions of price and income growth, per capita water consumption would increase through the forecast period for El Paso, Dallas and San Antonio; would decrease for Abilene, Austin and Houston; and would remain virtually unchanged for Corpus.

The effect of the assumption of flat-growth in persons per residential connection is important again as it was in scenario a, but its importance is countered by the relative importance of price growth as seen by comparing price elasticities in **Table V-3** with income elasticities in **Table V-4**.

Price elasticity of demand for water is a measure of the percent change in water consumption associated with a one-percent change in the price of water. Dallas consumption under scenario "a" shows an upward growth rate of **1.6%** annually in **Figure VI-3**, assuming 1.5% growth in income and 0% growth in price. With the assumption of 4.1% annual growth in price, consumption still shows upward growth over the forecast period. This persistent growth in consumption for Dallas is reflected in a relative insensitivity to water price changes combined with a relatively high income elasticity. The price elasticity for Dallas is quantified as -0.066. Of the MSAs representing the forecast cities, only the El Paso MSA has a lower price elasticity than that of Dallas (**Table V-3**). Price elasticity for Austin is nearly 4.5 times greater than for Dallas. The result of a 4.1% increase in price for Austin would result in declining consumption over the forecast period, other factors held constant.

d. <u>Growth rates of 4.1% for price and 0% for personal income</u>. It is perhaps unlikely to have escalating real prices occurring with flat real personal income in the forecast period, but it is possible since that is basically the experience of the 1980s. If such a scenario were to happen, consumption would decline in all seven forecast cities.

Conservation Program Adjustments to Forecasts

Attempts to quantify conservation program effects using econometric methods applied in this analysis were not successful. Either the data are too weak, the effects not yet evident or the effects are not very important, independent of the other variables included in the models. One difficulty is the non-uniform definition of what constitutes a conservation program. The most important ambiguity is probably pricing. The analysis here reported includes marginal prices and, in many cases, utilities switched from flat or declining block rate structures to increasing block structures during the period of analysis, and classify such a change as a conservation program. If one accepts such a definitive, then the analysis in this report quantifies such a relationship.

The effects of mandatory government rules concerning appliance standards are not explicitly included in the current analysis. Projections of the effects of such mandates may be included for planning purposes by subtracting expected impacts from forecasts made using the equations estimated in this study, but such a practice is an ad hoc method that is apt to overstate the case. That is, one would not expect per capita consumption reductions forthcoming from higher prices to be the same response that would ensue after water saving devices have been installed under government rules. The problem is that we cannot be sure how much reliance to place on the elasticity estimates in a market where behavior has been changed by government rule when the estimates of price response came for a market where such rules did not exist. The other difficulty is that municipal water is supplied by cost of service regulated utilities who may change rates in the future in a different time path under mandtory appliance standard than would be the case without them. The point is that price and price elasticities may be different with and without mandatory appliance standards so that accounting for the impacts of one cannot be considered independent of the other. This topic may need further research.

VII. SUMMARY AND FINDINGS

Summary

Eleven years of monthly consumption data for each of 72 cities in 28 MSAs of Texas were analyzed in this study in order to determine the underlying causes of declining per capita water use. Nine regional econometric models were estimated by grouping the 28 MSA sets of cities into homogeneous climatic and geographical groups. Each model allows an explanation of historical water consumption for each city in the group.

The set of six regional models all contain variables that we expect a priori to be important determinants of per capita water consumption. The equation forms and specific variables included differ among regions, and in some cases variables were ultimately dropped from the final equation because the estimated parameters were statistically insignificant; that is, we could not say with confidence that they had anything at all to do with consumption. In the end, however, the variables we believe should explain water consumption do in fact test significant and include (1) marginal price, (2) household income, (3) number of dry (low rainfall) days in the month, (4) temperature and (5) the concentration of commercial customers on the system. The fact that different forms and model specifications apply to different regions of the state also means that regional location and city size are important in explaining per capita municipal water consumption. The statistical properties of the models are all quite acceptable, and in fact are improved over many such results cited in the literature.

Price elasticity of demand estimates from the 72 cities in nine regions range from -0.042 to -0.543 while income elasticity estimates range from 0.031 to 1.267. These elasticities are well within the range of estimates obtained by others in the econometrics field. These elasticities allow simple calculation of the expected demand response to price and income changes.

Findings

The study of per capita municipal water demand during the 1978-1988 period leads to some interesting and important findings. The first important finding is that price, household income, concentration of commercial users, weather conditions, city size and location are all important variables in explaining historical water consumption and for forecasting future consumption. Seasonal variations are mostly explained by temperature and the lack of rainfall.

Long term trends are explained by household income, price and concentration of commercial users.

The general downward trend in per capita water consumption during 1978-1988 was the result of two sets of forces working at different parts of the time period, but themselves interrelated. The late 1970s and early 1980s brought rapid economic growth to Texas cities, resulting in at one and the same time, higher per capita incomes (exceeding the national average in 1982 for the first time ever) and explosive growth. Municipalities responded by constructing new facilities planned to catch up with growth and to meet a continued high growth in demand. By the mid-1980s growth had stopped and debt service requirements began to be realized, forcing utility rates to rise. Water supply, treatment and wastewater disposal costs also increased due to growing scarcity of supply and more stringent wastewater regulations. During this period of rising rates, many utilities switched from flat or declining block rate structures to increasing block structures, meaning that the marginal price of water rose above the average cost, a reversal of the historical relationship of the two prices. This sequence of events - rapid income and population growth - followed by stagnation and the lagged supply price response by cost of service based utilities meant that consumers were hit with stagnating incomes and rising marginal prices of water at the same time. The net result was a decline in per capita consumption rates.

If the above explanation of the past eleven years is correct, the question arises, "Will this downward trend in per capita consumption continue?" The analysis suggests that if the same forces of price, income, weather and persons per connection continue to determine consumption, per capita consumption is likely to continue declining in the foreseeable future.

There are two reasons why the trend, as influenced by the above factors, will continue. First, although Texas is now coming out of the longest recession it has had since WWII, the long term prospects for a per capita income growth near that of the post WWII era will be difficult to attain. Second, the overbuilding of utility capacity which occurred in the 1980s, leaving us with considerable excess capacity and high prices, should begin to abate soon, perhaps relieving the upward price pressure for a time, but in the long term prices are destined to rise rapidly. Most of the real price increases needed to retire the debt of the overbuilding have already been realized and real rates should begin to decline. The net result is that per capita consumption is likely to decline or stabilize in the long term.

The above conclusion will be reinforced by public policy driven by a number of interests ranging from public finance to environmental concerns. A case in point is an initiative to require certain water saving technologies to be installed by users, perhaps with the help of a public subsidy. Such mandates could further alter the consumption levels and trends of the future.

APPENDIX A

Statistical Output of Six Regional Models

Model: CENTRAL REGION: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	180.15052	12.86789	182.755	0.0001
Error	1305	91.88586	0.07041		
C Total	1319	272.03638			

Root MSE	0.26535	R-square	0.6622
Dep Mean	9.68666	Adj R-sq	0.6586
C.V.	2.73933		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	8.070488	0.13094643	61.632	0.0000
MP	1	-0.121359	0.03815518	-3.181	0.0015
FAMLYINC	1	0.000028325	0.00000195	14.542	0.0001
TEMP	1	0.009232	0.00063210	14.606	0.0001
DAYS	1	0.010401	0.00326716	3.183	0.0015
COMPROXY	1	0.758233	0.24811419	3.056	0.0023
BRY	1	-0.252587	0.03905116	-6.468	0.0001
BEL	1	-0.348467	0.04392496	-7.933	0.0001
WAC	1	0.363213	0.03308491	10.978	0.0001
WOO	1	0.176476	0.03376189	5.227	0.0001
COP	1	-0.385938	0.04336887	-8.899	0.0001
KIL	1	-0.531600	0.02927929	-18.156	0.0001
SHE	1	-0.383254	0.03369371	-11.375	0.0001
DEN	1	-0.352713	0.03511444	-10.045	0.0001
DSEAS	1	0.179495	0.02517266	7.131	0.0001

Model: CENTRAL REGION: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	177.92388	12.70885	176.226	0.0001
Error	1305	94.11250	0.07212		
C Total	1319	272.03638			

Root MSE	0.26855	R-square	0.6540
Dep Mean	9.68666	Adj R-sq	0.6503
C.V.	2.77233		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-3.419455	0.95563867	-3.578	0.0004
LOGMP	1	-0.160874	0.03960477	-4.062	0.0001
LOGFINC	1	1.037026	0.08182628	12.674	0.0001
LOGTEMP	1	0.510024	0.03773387	13.516	0.0001
LOGDAYS	1	0.187562	0.07605561	2.466	0.0138
LOGPROXY	1	0.090974	0.02269853	4.008	0.0001
BRY	1	-0.322024	0.04064294	-7.923	0.0001
BEL	1	-0.332745	0.03770657	-8.825	0.0001
WAC	1	0.352985	0.03332756	10.591	0.0001
WOO	1	0.217403	0.03512248	6.190	0.0001
COP	1	-0.424992	0.04810884	-8.834	0.0001
KIL	1	-0.539542	0.02973162	-18.147	0.0001
SHE	1	-0.435916	0.03466293	-12.576	0.0001
DEN	1	-0.401759	0.03656183	-10.988	0.0001
DSEAS	1	0.222774	0.02422265	9.197	0.0001

Model: CENTRAL REGION: LINEAR
Dependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	85847139955	6131938568.2	157.729	0.0001
Error	1305	50733600381	38876322.131		
C Total	1319	136580740336			

Root MSE	6235.08798	R-square	0.6285
Dep Mean	18057.72424	Adj R-sq	0.6246
C.V.	34.52865		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-21392	3076.9268493	-6.952	0.0001
MP	1	-2094.880831	896.55505433	-2.337	0.0196
FAMLYINC	1	0.841070	0.04576768	18.377	0.0001
TEMP	1	158.520521	14.85293142	10.673	0.0001
DAYS	1	188.335911	76.77035019	2.453	0.0143
COMPROXY	1	325.211345	5830.0878418	0.056	0.9555
BRY	1	-6260.006893	917.60844340	-6.822	0.0001
BEL	1	-4441.321867	1032.1311749	-4.303	0.0001
WAC	1	5503.321598	777.41604396	7.079	0.0001
WOO	1	4455.657161	793.32327048	5.616	0.0001
COP	1	-5169.700281	1019.0643732	-5.073	0.0001
KIL	1	-12312	687.99309407	-17.896	0.0001
SHE	1	-7779.144144	791.72125551	-9.826	0.0001
DEN	1	-6812.752594	825.10503953	-8.257	0.0001
DSEAS	1	4504.858248	591.49713271	7.616	0.0001

CENTRAL REGION

CORRELATION ANALYSIS

5 'VAR' Variables: MP FAMLYINC TEMP DAYS COMPROXY

Simple Statistics

Variable	N	Mean	Std Dev	Sum
MP	1320	1.11217	0.23656	1468
FAMLYINC	1320	36966	6201	48794707
TEMP	1320	65.69037	14.48127	86711
DAYS	1320	27.12879	2.34320	35810
COMPROXY	1320	0.09497	0.05994	125.35589

Simple Statistics

Variable	Minimum	Maximum
MP	0.33841	2.07254
FAMLYINC	25042	54936
TEMP	30.87000	89.23000
DAYS	5.00000	31.00000
COMPROXY	0.01000	0.30000

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 1320

	MP	FAMLYINC	TEMP	DAYS	COMPROXY
MP	1.00000 0.0	0.23771 0.0001	-0.01572 0.5683	0.00671 0.8076	-0.20257 0.0001
FAMLYINC	0.23771 0.0001	1.00000 0.0	0.05296 0.0544	0.06463 0.0189	0.22793 0.0001
TEMP	-0.01572 0.5683	0.05296 0.0544	1.00000 0.0	0.07000 0.0110	0.02417 0.3803
DAYS	0.00671 0.8076	0.06463 0.0189	0.07000 0.0110	1.00000 0.0	-0.02355 0.3926
COMPROXY	-0.20257 0.0001	0.22793 0.0001	0.02417 0.3803	-0.02355 0.3926	1.00000 0.0

Model: EAST REGION: LINEAR
Dependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	52912708524	3779479180.3	325.748	0.0000
Error	1701	19735785576	11602460.656		
C Total	1715	72648494100			

Root MSE	3406.23849	R-square	0.7283
Dep Mean	16260.43531	Adj R-sq	0.7261
C.V.	20.94802		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-1579.937997	1124.6315610	-1.405	0.1602
TIME	1	-0.364233	0.07521000	-4.843	0.0001
MP	1	-1150.623861	253.97766279	-4.530	0.0001
FAMLYINC	1	0.129296	0.01038690	12.448	0.0001
TEMP	1	109.997310	7.55527808	14.559	0.0001
DAYS	1	112.519242	28.58107062	3.937	0.0001
COMPROXY	1	20658	1650.2929431	12.518	0.0001
D25	1	5877.016682	354.01056669	16.601	0.0001
D4	1	2154.868306	274.49483884	7.850	0.0001
TXK	1	8736.179747	428.44861753	20.390	0.0001
CON	1	9358.399530	395.11488863	23.685	0.0001
HOU	1	12702	508.29071316	24.991	0.0001
BAY	1	1408.586397	370.94263328	3.797	0.0002
D16	1	4286.580079	277.69934681	15.436	0.0001
DSEAS	1	2597.416524	269.67593575	9.632	0.0001

Model: EAST REGION: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	189.02420	13.50173	338.696	0.0000
Error	1701	67.80846	0.03986		
C Total	1715	256.83266			

Root MSE	0.19966	R-square	0.7360
Dep Mean	9.62164	Adj R-sq	0.7338
C.V.	2.07511		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	8.316178	0.06592118	126.153	0.0000
TIME	1	-0.000020700	0.00000441	-4.696	0.0001
MP	1	-0.054906	0.01488710	-3.688	0.0002
FAMLYINC	1	0.000011725	0.00000061	19.258	0.0001
TEMP	1	0.007283	0.00044286	16.445	0.0001
DAYS	1	0.005839	0.00167530	3.485	0.0005
COMPROXY	1	0.996068	0.09673325	10.297	0.0001
D25	1	0.394668	0.02075061	19.020	0.0001
D4	1	0.225046	0.01608974	13.987	0.0001
TXK	1	0.671280	0.02511386	26.729	0.0001
CON	1	0.556300	0.02315998	24.020	0.0001
HOU	1	0.604033	0.02979387	20.274	0.0001
BAY	1	0.132475	0.02174310	6.093	0.0001
D16	1	0.365347	0.01627757	22.445	0.0001
DSEAS	1	0.127176	0.01580727	8.045	0.0001

Model: EAST REGION: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	189.06908	13.50493	338.025	0.0000
Error	1692	67.59957	0.03995		
C Total	1706	256.66865			

Root MSE	0.19988	R-square	0.7366
Dep Mean	9.62178	Adj R-sq	0.7344
C.V.	2.07738		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.132205	0.47267635	6.627	0.0001
LOGTIME	1	-0.211328	0.03766911	-5.610	0.0001
LOGMP	1	-0.090163	0.02059166	-4.379	0.0001
LOGFINC	1	0.533279	0.02595968	20.543	0.0001
LOGTEMP	1	0.419240	0.02636114	15.904	0.0001
LOGPROXY	1	0.069177	0.00941798	7.345	0.0001
LOGDAYS	1	0.266285	0.05493009	4.848	0.0001
D25	1	0.377579	0.02088575	18.078	0.0001
D4	1	0.181877	0.01634712	11.126	0.0001
TXK	1	0.771895	0.02829364	27.282	0.0001
CON	1	0.564478	0.02305658	24.482	0.0001
HOU	1	0.613263	0.02761729	22.206	0.0001
BAY	1	0.107874	0.02177453	4.954	0.0001
D16	1	0.371030	0.01575022	23.557	0.0001
DSEAS	1	0.145817	0.01527212	9.548	0.0001

EAST REGION

CORRELATION ANALYSIS

6 'VAR' Variables: LOGTIME LOGMP LOGFINC LOGTEMP LOGDAYS LOGPROXY

Simple Statistics

Variable	N	Mean	Std Dev	Sum
LOGTIME	1716	0.25911	0.31671	444.63488
LOGMP	1716	0.25911	0.31671	444.63488
LOGFINC	1716	10.60316	0.35252	18195
LOGTEMP	1716	4.16216	0.22288	7142
LOGDAYS	1707	3.26597	0.08990	5575
LOGPROXY	1716	-2.45621	0.63691	-4215

Simple Statistics

Variable	Minimum	Maximum
LOGTIME	-0.54000	1.13051
LOGMP	-0.54000	1.13051
LOGFINC	9.58014	11.30459
LOGTEMP	3.45774	4.46740
LOGDAYS	2.89037	3.43399
LOGPROXY	-3.90197	-0.98450

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

	LOGTIME	LOGMP	LOGFINC	LOGTEMP	LOGDAYS	LOGPROXY
LOGTIME	1.00000 0.0 1716	1.00000 0.0 1716	0.08991 0.0002 1716	-0.02804 0.2456 1716	0.02123 0.3808 1707	-0.26653 0.0001 1716
LOGMP	1.00000 0.0 1716	1.00000 0.0 1716	0.08991 0.0002 1716	-0.02804 0.2456 1716	0.02123 0.3808 1707	-0.26653 0.0001 1716
LOGFINC	0.08991 0.0002 1716	0.08991 0.0002 1716	1.00000 0.0 1716	0.16801 0.0001 1716	0.04395 0.0695 1707	0.22642 0.0001 1716
LOGTEMP	-0.02804 0.2456 1716	-0.02804 0.2456 1716	0.16801 0.0001 1716	1.00000 0.0 1716	0.12853 0.0001 1707	0.05454 0.0239 1716
LOGDAYS	0.02123 0.3808 1707	0.02123 0.3808 1707	0.04395 0.0695 1707	0.12853 0.0001 1707	1.00000 0.0 1707	0.00125 0.9589 1707
LOGPROXY	-0.26653 0.0001 1716	-0.26653 0.0001 1716	0.22642 0.0001 1716	0.05454 0.0239 1716	0.00125 0.9589 1707	1.00000 0.0 1716

Model: I-35 REGION: LINEAR
Dependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	15232634292	2176090613.1	245.938	0.0001
Error	388	3433068803.4	8848115.4727		
C Total	395	18665703095			

Root MSE	2974.57820	R-square	0.8161
Dep Mean	21774.67172	Adj R-sq	0.8128
C.V.	13.66073		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-20263	3215.9384331	-6.301	0.0001
MP	1	-5563.864316	620.15135631	-8.972	0.0001
FAMLYINC	1	0.344895	0.05434269	6.347	0.0001
TEMP	1	227.528724	14.56079069	15.626	0.0001
DAYS	1	329.728042	71.40199608	4.618	0.0001
D3	1	7392.749386	469.20350222	15.756	0.0001
D22	1	8301.879576	471.03971698	17.625	0.0001
DSEAS	1	5449.013913	493.00895467	11.053	0.0001

Model: I-35 REGION: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	30.73045	4.39006	332.095	0.0001
Error	388	5.12909	0.01322		
C Total	395	35.85954			

Root MSE	0.11498	R-square	0.8570
Dep Mean	9.94242	Adj R-sq	0.8544
C.V.	1.15641		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	7.964865	0.12430443	64.075	0.0001
MP	1	-0.244931	0.02397047	-10.218	0.0001
FAMLYINC	1	0.000018551	0.00000210	8.832	0.0001
TEMP	1	0.010514	0.00056281	18.682	0.0001
DAYS	1	0.011598	0.00275987	4.202	0.0001
D3	1	0.352806	0.01813594	19.453	0.0001
D22	1	0.388082	0.01820692	21.315	0.0001
DSEAS	1	0.187767	0.01905609	9.853	0.0001

Model: I-35 REGION: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	30.38941	4.34134	307.935	0.0001
Error	388	5.47013	0.01410		
C Total	395	35.85954			

Root MSE	0.11874	R-square	0.8475
Dep Mean	9.94242	Adj R-sq	0.8447
C.V.	1.19424		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-3.620332	1.16299161	-3.113	0.0020
LOGMP	1	-0.261124	0.02689529	-9.709	0.0001
LOGFINC	1	0.894294	0.10477027	8.536	0.0001
LOGTEMP	1	0.640729	0.03687404	17.376	0.0001
LOGDAYS	1	0.279285	0.07438467	3.755	0.0002
D3	1	0.345736	0.01894379	18.251	0.0001
D22	1	0.382372	0.01910090	20.019	0.0001
DSEAS	1	0.215919	0.01905356	11.332	0.0001

I-35 REGION

CORRELATION ANALYSIS

4 'VAR' Variables: MP FAMLYINC TEMP DAYS

Simple Statistics

Variable	N	Mean	Std Dev	Sum
MP	396	1.01047	0.32806	400.14477
FAMLYINC	432	48962	4015	21151478
TEMP	432	68.92685	12.65283	29776
DAYS	432	27.35880	2.12454	11819

Simple Statistics

Variable	Minimum	Maximum
MP	0.55944	1.94192
FAMLYINC	41498	57675
TEMP	40.39000	88.11000
DAYS	19.00000	31.00000

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

	MP	FAMLYINC	TEMP	DAYS
MP	1.00000 0.0 396	0.51068 0.0001 396	-0.05152 0.3065 396	0.02505 0.6192 396
FAMLYINC	0.51068 0.0001 396	1.00000 0.0 432	-0.04084 0.3972 432	0.05952 0.2170 432
TEMP	-0.05152 0.3065 396	-0.04084 0.3972 432	1.00000 0.0 432	-0.02557 0.5961 432
DAYS	0.02505 0.6192 396	0.05952 0.2170 432	-0.02557 0.5961 432	1.00000 0.0 432

Model: METROPLEX REGION: LINEAR
Dependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	52822846616	7546120945.2	433.794	0.0001
Error	916	15934390605	17395622.931		
C Total	923	68757237221			

Root MSE	4170.80603	R-square	0.7683
Dep Mean	21575.16126	Adj R-sq	0.7665
C.V.	19.33152		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-33339	2581.8729505	-12.913	0.0001
MP	1	-959.272337	413.05544855	-2.322	0.0204
FAMLYINC	1	0.336998	0.03246403	10.381	0.0001
TEMP	1	281.819178	11.50629529	24.493	0.0001
DAYS	1	506.864726	65.72032717	7.712	0.0001
COMPROXY	1	39487	5795.5374962	6.813	0.0001
D11	1	2539.022545	370.14284720	6.860	0.0001
DSEAS	1	7058.573488	496.04309413	14.230	0.0001

Model: METROPLEX REGION: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	103.43517	14.77645	486.338	0.0001
Error	916	27.83092	0.03038		
C Total	923	131.26608			

Root MSE	0.17431	R-square	0.7880
Dep Mean	9.90660	Adj R-sq	0.7864
C.V.	1.75951		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	7.315527	0.10790235	67.798	0.0000
MP	1	-0.053469	0.01726253	-3.097	0.0020
FAMLYINC	1	0.000014511	0.00000136	10.695	0.0001
TEMP	1	0.014284	0.00048087	29.703	0.0001
DAYS	1	0.024448	0.00274660	8.901	0.0001
COMPROXY	1	2.137456	0.24220871	8.825	0.0001
D11	1	0.142162	0.01546911	9.190	0.0001
DSEAS	1	0.201805	0.02073077	9.735	0.0001

Model: METROPLEX REGION: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	99.60714	14.22959	411.710	0.0001
Error	916	31.65895	0.03456		
C Total	923	131.26608			

Root MSE	0.18591	R-square	0.7588
Dep Mean	9.90660	Adj R-sq	0.7570
C.V.	1.87662		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-5.279767	0.89394871	-5.906	0.0001
LOGMP	1	-0.073329	0.02324518	-3.155	0.0017
LOGFINC	1	0.929430	0.07492974	12.404	0.0001
LOGTEMP	1	0.792572	0.02995773	26.456	0.0001
LOGDAYS	1	0.595566	0.07601118	7.835	0.0001
LOGPROXY	1	0.105710	0.01459278	7.244	0.0001
D11	1	0.128456	0.01753912	7.324	0.0001
DSEAS	1	0.270423	0.02097728	12.891	0.0001

METROPLEX REGION

CORRELATION ANALYSIS

5 'VAR' Variables: MP FAMLYINC TEMP DAYS COMPROXY

Simple Statistics

Variable	N	Mean	Std Dev	Sum
MP	924	1.20908	0.33655	1117
FAMLYINC	924	55038	7975	50855321
TEMP	924	65.27315	15.11004	60312
DAYS	924	27.46861	2.26617	25381
COMPROXY	924	0.08372	0.04056	77.35477

Simple Statistics

Variable	Minimum	Maximum
MP	0.64000	2.34005
FAMLYINC	39711	76343
TEMP	32.58500	90.90000
DAYS	15.00000	31.00000
COMPROXY	0.01000	0.20000

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 924

	MP	FAMLYINC	TEMP	DAYS	COMPROXY
MP	1.00000 0.0	0.01219 0.7114	0.02425 0.4616	-0.04852 0.1405	0.10195 0.0019
FAMLYINC	0.01219 0.7114	1.00000 0.0	-0.00263 0.9365	-0.00092 0.9777	0.76307 0.0001
TEMP	0.02425 0.4616	-0.00263 0.9365	1.00000 0.0	0.09801 0.0029	0.01196 0.7165
DAYS	-0.04852 0.1405	-0.00092 0.9777	0.09801 0.0029	1.00000 0.0	-0.03465 0.2927
COMPROXY	0.10195 0.0019	0.76307 0.0001	0.01196 0.7165	-0.03465 0.2927	1.00000 0.0

Model: METROPLEX SURBURBAN: LINEAR
)ependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	46988787930	5873598491.3	411.303	0.0000
Error	1443	20606694942	14280453.875		
C Total	1451	67595482872			

Root MSE	3778.94878	R-square	0.6951
Dep Mean	15463.00000	Adj R-sq	0.6935
C.V.	24.43865		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-21570	1823.8601874	-11.826	0.0001
TIME	1	0.253081	0.09118303	2.776	0.0056
MP	1	-1824.539417	309.65156086	-5.892	0.0001
FAMLYINC	1	0.295782	0.01231313	24.022	0.0001
TEMP	1	193.357955	8.32224752	23.234	0.0001
DAYS	1	274.499875	49.93061661	5.498	0.0001
COMPROXY	1	6504.072456	1632.0700390	3.985	0.0001
D11	1	1890.103558	285.36042013	6.624	0.0001
DSEAS	1	5919.128716	355.52834295	16.649	0.0001

Model: METROPLEX SURBURBAN: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	172.54513	21.56814	490.170	0.0000
Error	1443	63.49395	0.04400		
C Total	1451	236.03907			

Root MSE	0.20976	R-square	0.7310
Dep Mean	9.56174	Adj R-sq	0.7295
C.V.	2.19380		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	7.144859	0.10124033	70.573	0.0000
TIME	1	0.000021755	0.00000506	4.298	0.0001
MP	1	-0.137026	0.01718839	-7.972	0.0001
FAMLYINC	1	0.000019751	0.00000068	28.897	0.0001
TEMP	1	0.013067	0.00046196	28.286	0.0001
DAYS	1	0.016637	0.00277159	6.003	0.0001
COMPROXY	1	0.341381	0.09059428	3.768	0.0002
D11	1	0.112936	0.01584002	7.130	0.0001
DSEAS	1	0.251443	0.01973496	12.741	0.0001

Model: METROPLEX SUBURBAN: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	172.79151	21.59894	492.782	0.0000
Error	1443	63.24756	0.04383		
C Total	1451	236.03907			

Root MSE	0.20936	R-square	0.7320
Dep Mean	9.56174	Adj R-sq	0.7306
C.V.	2.18954		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-5.139531	0.58384730	-8.803	0.0001
LOGTIME	1	0.135581	0.04235433	3.201	0.0014
LOGMP	1	-0.124848	0.02225116	-5.611	0.0001
LOGFINC	1	0.842886	0.03061132	27.535	0.0001
LOGTEMP	1	0.734592	0.02697762	27.230	0.0001
LOGDAYS	1	0.467252	0.07352911	6.355	0.0001
LOGPROXY	1	0.101949	0.00970706	10.503	0.0001
D11	1	0.078444	0.01579085	4.968	0.0001
DSEAS	1	0.305530	0.01876254	16.284	0.0001

CORRELATION ANALYSIS

6 'VAR' Variables: TIME MP FAMLYINC TEMP DAYS COMPROXY

Simple Statistics

Variable	N	Mean	Std Dev	Sum
TIME	1452	8568	1160	12440472
MP	1452	1.32790	0.38287	1928
FAMLYINC	1452	48482	10777	70396490
TEMP	1452	65.17119	15.16228	94629
DAYS	1452	27.54821	2.15550	40000
COMPROXY	1452	0.09139	0.06618	132.69237

Simple Statistics

Variable	Minimum	Maximum
TIME	6575	10562
MP	0.64286	2.30438
FAMLYINC	26312	87883
TEMP	32.58500	91.98500
DAYS	19.00000	31.00000
COMPROXY	0.01000	0.47917

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 1452

	TIME	MP	FAMLYINC	TEMP	DAYS	COMPROXY
TIME	1.00000 0.0	0.30441 0.0001	0.00895 0.7332	0.04390 0.0945	-0.03705 0.1582	0.00738 0.7788
MP	0.30441 0.0001	1.00000 0.0	-0.16430 0.0001	-0.09208 0.0004	-0.04319 0.0999	-0.08983 0.0006
FAMLYINC	0.00895 0.7332	-0.16430 0.0001	1.00000 0.0	-0.01140 0.6642	-0.06932 0.0082	0.37098 0.0001
TEMP	0.04390 0.0945	-0.09208 0.0004	-0.01140 0.6642	1.00000 0.0	0.09785 0.0002	-0.01485 0.5717
DAYS	-0.03705 0.1582	-0.04319 0.0999	-0.06932 0.0082	0.09785 0.0002	1.00000 0.0	-0.02979 0.2567
COMPROXY	0.00738 0.7788	-0.08983 0.0006	0.37098 0.0001	-0.01485 0.5717	-0.02979 0.2567	1.00000 0.0

Model: ROLLING PLAINS REGION: LINEAR
Dependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	26430705741	2643070574.1	137.263	0.0001
Error	517	9955096869.0	19255506.516		
C Total	527	36385802610			

Root MSE	4388.10967	R-square	0.7264
Dep Mean	21172.86364	Adj R-sq	0.7211
C.V.	20.72516		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-11913	6064.0404578	-1.964	0.0500
TIME	1	-0.776597	0.20586188	-3.772	0.0002
MP	1	-5931.982953	1269.1684474	-4.674	0.0001
FAMLYINC	1	0.547395	0.19111070	2.864	0.0043
TEMP	1	286.207899	16.33152561	17.525	0.0001
DAYS	1	200.609337	97.19864266	2.064	0.0395
COMPROXY	1	33642	16283.981798	2.066	0.0393
D1	1	-9059.204931	2573.5042314	-3.520	0.0005
D21	1	-7901.579490	2367.1474687	-3.338	0.0009
D28	1	-9643	2826.3196940	-3.412	0.0007
DSEAS	1	5345.606923	635.77889602	8.408	0.0001

Model: ROLLING PLAINS REGION: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	61.40194	6.14019	136.704	0.0001
Error	517	23.22164	0.04492		
C Total	527	84.62358			

Root MSE	0.21193	R-square	0.7256
Dep Mean	9.88248	Adj R-sq	0.7203
C.V.	2.14454		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	8.015805	0.29287736	27.369	0.0001
TIME	1	-0.000028619	0.00000994	-2.878	0.0042
MP	1	-0.299427	0.06129753	-4.885	0.0001
FAMLYINC	1	0.000030872	0.00000923	3.345	0.0009
TEMP	1	0.015248	0.00078877	19.332	0.0001
DAYS	1	0.009884	0.00469444	2.105	0.0357
COMPROXY	1	1.354971	0.78647391	1.723	0.0855
D1	1	-0.487448	0.12429355	-3.922	0.0001
D21	1	-0.418419	0.11432706	-3.660	0.0003
D28	1	-0.521871	0.13650388	-3.823	0.0001
DSEAS	1	0.172291	0.03070646	5.611	0.0001

lodel: ROLLING PLAINS REGION: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	60.72633	6.07263	131.377	0.0001
Error	517	23.89725	0.04622		
C Total	527	84.62358			

Root MSE	0.21500	R-square	0.7176
Dep Mean	9.88248	Adj R-sq	0.7121
C.V.	2.17552		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-6.442416	3.87235629	-1.664	0.0968
TIME	1	-0.000029889	0.00000988	-3.025	0.0026
LOGMP	1	-0.275934	0.05368670	-5.140	0.0001
LOGFINC	1	1.198870	0.36294393	3.303	0.0010
LOGTEMP	1	0.871546	0.04696277	18.558	0.0001
LOGDAYS	1	0.233351	0.12088692	1.930	0.0541
LOGPROXY	1	0.122509	0.06121544	2.001	0.0459
D1	1	-0.500443	0.12209892	-4.099	0.0001
D21	1	-0.427581	0.11529756	-3.708	0.0002
D28	1	-0.518969	0.13425101	-3.866	0.0001
DSEAS	1	0.224957	0.02981238	7.546	0.0001

ROLLING PLAINS REGION

CORRELATION ANALYSIS

6 'VAR' Variables: TIME MP FAMLYINC TEMP DAYS COMPROXY

Simple Statistics

Variable	N	Mean	Std Dev	Sum
TIME	576	8385	1266	4829880
MP	528	0.79049	0.19714	417.37956
FAMLYINC	576	40442	4822	23294502
TEMP	576	66.27068	15.08794	38172
DAYS	576	27.96528	2.01529	16108
COMPROXY	576	0.09876	0.03096	56.88847

Simple Statistics

Variable	Minimum	Maximum
TIME	6210	10562
MP	0.52321	1.36442
FAMLYINC	30353	45445
TEMP	30.08000	91.90500
DAYS	13.00000	31.00000
COMPROXY	0.03000	0.16000

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

	TIME	MP	FAMLYINC	TEMP	DAYS	COMPROXY
TIME	1.00000 0.0 576	0.10292 0.0180 528	0.19152 0.0001 576	0.01078 0.7962 576	-0.04857 0.2445 576	0.38428 0.0001 576
MP	0.10292 0.0180 528	1.00000 0.0 528	0.58620 0.0001 528	-0.18135 0.0001 528	-0.11763 0.0068 528	-0.38412 0.0001 528
FAMLYINC	0.19152 0.0001 576	0.58620 0.0001 528	1.00000 0.0 576	-0.25169 0.0001 576	-0.13207 0.0015 576	-0.32234 0.0001 576
TEMP	0.01078 0.7962 576	-0.18135 0.0001 528	-0.25169 0.0001 576	1.00000 0.0 576	-0.03190 0.4448 576	0.14894 0.0003 576
DAYS	-0.04857 0.2445 576	-0.11763 0.0068 528	-0.13207 0.0015 576	-0.03190 0.4448 576	1.00000 0.0 576	-0.02403 0.5649 576
COMPROXY	0.38428 0.0001 576	-0.38412 0.0001 528	-0.32234 0.0001 576	0.14894 0.0003 576	-0.02403 0.5649 576	1.00000 0.0 576

Model: SOUTHEAST REGION: LINEAR
Dependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	26298551955	1643659497.2	311.859	0.0000
Error	1423	7499954375.5	5270523.1029		
C Total	1439	33798506331			

Root MSE	2295.76199	R-square	0.7781
Dep Mean	15434.25417	Adj R-sq	0.7756
C.V.	14.87446		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-1996.386490	1154.4456417	-1.729	0.0840
TIME	1	-0.181954	0.06163899	-2.952	0.0032
MP	1	-1395.244115	236.28005589	-5.905	0.0001
FAMLYINC	1	0.237526	0.01331346	17.841	0.0001
TEMP	1	86.421350	6.30083100	13.716	0.0001
DAYS	1	96.150638	25.70203944	3.741	0.0002
COMPROXY	1	4990.709171	1262.0879326	3.954	0.0001
D8	1	6408.858508	262.22546199	24.440	0.0001
GAL	1	4732.750454	276.68752336	17.105	0.0001
LEA	1	-1648.659662	339.59336569	-4.855	0.0001
TEX	1	-1009.821740	259.24902778	-3.895	0.0001
ALV	1	-1409.286176	253.19825131	-5.566	0.0001
ANG	1	-2687.339961	252.73317654	-10.633	0.0001
BRA	1	-4057.631951	297.05337000	-13.660	0.0001
FRE	1	5035.064919	313.38021464	16.067	0.0001
LAK	1	-2423.920637	252.37558931	-9.604	0.0001
DSEAS	1	1349.493424	195.41129353	6.906	0.0001

Model: SOUTHEAST REGION: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	115.17673	7.19855	376.446	0.0000
Error	1423	27.21116	0.01912		
C Total	1439	142.38789			

Root MSE	0.13828	R-square	0.8089
Dep Mean	9.59558	Adj R-sq	0.8067
C.V.	1.44112		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	8.493204	0.06953729	122.139	0.0000
TIME	1	-0.000013442	0.00000371	-3.620	0.0003
MP	1	-0.069661	0.01423218	-4.895	0.0001
FAMLYINC	1	0.000015305	0.00000080	19.085	0.0001
TEMP	1	0.005717	0.00037953	15.064	0.0001
DAYS	1	0.006189	0.00154815	3.998	0.0001
COMPROXY	1	0.237329	0.07602105	3.122	0.0018
D8	1	0.340880	0.01579498	21.582	0.0001
GAL	1	0.276078	0.01666609	16.565	0.0001
LEA	1	-0.138328	0.02045519	-6.762	0.0001
TEX	1	-0.060800	0.01561570	-3.894	0.0001
ALV	1	-0.094087	0.01525123	-6.169	0.0001
ANG	1	-0.190705	0.01522322	-12.527	0.0001
BRA	1	-0.397627	0.01789282	-22.223	0.0001
FRE	1	0.286827	0.01887625	15.195	0.0001
LAK	1	-0.178845	0.01520168	-11.765	0.0001
DSEAS	1	0.068892	0.01177047	5.853	0.0001

Model: SOUTHEAST REGION: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	114.96438	7.18527	372.842	0.0000
Error	1423	27.42351	0.01927		
C Total	1439	142.38789			

Root MSE	0.13882	R-square	0.8074
Dep Mean	9.59558	Adj R-sq	0.8052
C.V.	1.44673		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1.389987	0.61790246	2.250	0.0246
LOGTIME	1	-0.152247	0.03095027	-4.919	0.0001
LOGMP	1	-0.087162	0.02005363	-4.346	0.0001
LOGFINC	1	0.718286	0.04094729	17.542	0.0001
LOGTEMP	1	0.354680	0.02438446	14.545	0.0001
LOGDAYS	1	0.142706	0.04028980	3.542	0.0004
LOGPROXY	1	0.037680	0.00966490	3.899	0.0001
D8	1	0.330731	0.01584576	20.872	0.0001
GAL	1	0.280520	0.01695594	16.544	0.0001
LEA	1	-0.145589	0.01979059	-7.356	0.0001
TEX	1	-0.044898	0.01740176	-2.580	0.0100
ALV	1	-0.086214	0.01532686	-5.625	0.0001
ANG	1	-0.195783	0.01536812	-12.740	0.0001
BRA	1	-0.380608	0.01830996	-20.787	0.0001
FRE	1	0.297972	0.01714965	17.375	0.0001
LAK	1	-0.179347	0.01533369	-11.696	0.0001
DSEAS	1	0.080547	0.01149926	7.005	0.0001

SOUTHEAST REGION

CORRELATION ANALYSIS

6 'VAR' Variables: TIME MP FAMLYINC TEMP DAYS COMPROXY

Simple Statistics

Variable	N	Mean	Std Dev	Sum
TIME	1440	8565	1165	12333272
MP	1440	1.32836	0.45820	1913
FAMLYINC	1440	47817	6993	68857159
TEMP	1440	68.78029	11.64441	99044
DAYS	1440	26.77361	2.41955	38554
COMPROXY	1440	0.10522	0.07447	151.52273

Simple Statistics

Variable	Minimum	Maximum
TIME	6575	10562
MP	0.65268	3.28659
FAMLYINC	30266	65054
TEMP	43.13000	87.87000
DAYS	18.00000	31.00000
COMPROXY	0.02020	0.40404

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 1440

	TIME	MP	FAMLYINC	TEMP	DAYS	COMPROXY
TIME	1.00000 0.0	0.29621 0.0001	-0.07862 0.0028	0.06388 0.0153	0.05639 0.0324	0.17312 0.0001
MP	0.29621 0.0001	1.00000 0.0	0.16675 0.0001	0.00753 0.7754	0.01296 0.6232	0.28966 0.0001
FAMLYINC	-0.07862 0.0028	0.16675 0.0001	1.00000 0.0	-0.01030 0.6960	-0.01305 0.6206	0.48177 0.0001
TEMP	0.06388 0.0153	0.00753 0.7754	-0.01030 0.6960	1.00000 0.0	-0.00211 0.9362	0.01014 0.7005
DAYS	0.05639 0.0324	0.01296 0.6232	-0.01305 0.6206	-0.00211 0.9362	1.00000 0.0	-0.01926 0.4653
COMPROXY	0.17312 0.0001	0.28966 0.0001	0.48177 0.0001	0.01014 0.7005	-0.01926 0.4653	1.00000 0.0

Model: VALLEY REGION: LINEAR
Dependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	23350872225	2122806565.9	85.118	0.0001
Error	912	22745023776	24939719.053		
C Total	923	46095896002			

Root MSE	4993.96827	R-square	0.5066
Dep Mean	22954.61147	Adj R-sq	0.5006
C.V.	21.75584		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	5505.802596	3664.6024603	1.502	0.1333
TIME	1	-0.829722	0.16237484	-5.110	0.0001
MP	1	-8656.641869	1264.4735182	-6.846	0.0001
FAMLYINC	1	0.220667	0.04318008	5.110	0.0001
TEMP	1	203.516656	19.09267294	10.659	0.0001
DAYS	1	409.280531	86.11968404	4.752	0.0001
COMPROXY	1	24930	4142.5910635	6.018	0.0001
MCA	1	3543.464684	522.40251895	6.783	0.0001
EDI	1	1856.729183	623.37364733	2.979	0.0030
PHA	1	905.216465	691.43213718	1.309	0.1908
HAR	1	-6967.380343	665.20517369	-10.474	0.0001
DSEAS	1	3145.192855	522.37571337	6.021	0.0001

Model: VALLEY REGION: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	45.55071	4.14097	92.801	0.0001
Error	912	40.69554	0.04462		
C Total	923	86.24625			

Root MSE	0.21124	R-square	0.5281
Dep Mean	9.99500	Adj R-sq	0.5225
C.V.	2.11346		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	9.211863	0.15500906	59.428	0.0000
TIME	1	-0.000036579	0.00000687	-5.326	0.0001
MP	1	-0.411456	0.05348598	-7.693	0.0001
FAMLYINC	1	0.000010704	0.00000183	5.861	0.0001
TEMP	1	0.009106	0.00080760	11.276	0.0001
DAYS	1	0.017671	0.00364278	4.851	0.0001
COMPROXY	1	1.042447	0.17522751	5.949	0.0001
MCA	1	0.180689	0.02209711	8.177	0.0001
EDI	1	0.112436	0.02636809	4.264	0.0001
PHA	1	0.072082	0.02924690	2.465	0.0139
HAR	1	-0.299632	0.02813752	-10.649	0.0001
DSEAS	1	0.115354	0.02209598	5.221	0.0001

Model: VALLEY REGION: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	45.03913	4.09447	90.619	0.0001
Error	912	41.20712	0.04518		
C Total	923	86.24625			

Root MSE	0.21256	R-square	0.5222
Dep Mean	9.99500	Adj R-sq	0.5165
C.V.	2.12670		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	8.961255	0.73180172	12.245	0.0001
LOGTIME	1	-0.340250	0.05561928	-6.117	0.0001
LOGMP	1	-0.389120	0.04188872	-9.289	0.0001
LOGFINC	1	0.055281	0.02653176	2.084	0.0375
LOGTEMP	1	0.617653	0.05604660	11.020	0.0001
LOGDAYS	1	0.414961	0.09606856	4.319	0.0001
LOGPROXY	1	0.141904	0.01713603	8.281	0.0001
MCA	1	0.159901	0.02238454	7.143	0.0001
EDI	1	0.162060	0.02483033	6.527	0.0001
PHA	1	0.142604	0.02746259	5.193	0.0001
HAR	1	-0.397773	0.02691119	-14.781	0.0001
DSEAS	1	0.126584	0.02175719	5.818	0.0001

VALLEY REGION

CORRELATION ANALYSIS

6 'VAR' Variables: TIME MP FAMLYINC TEMP DAYS COMPROXY

Simple Statistics

Variable	N	Mean	Std Dev	Sum
TIME	924	8568	1160	7916664
MP	924	0.81986	0.20528	757.55452
FAMLYINC	924	31167	5216	28798617
TEMP	924	73.57111	10.31188	67980
DAYS	924	28.04870	1.93581	25917
COMPROXY	924	0.11519	0.05849	106.43547

Simple Statistics

Variable	Minimum	Maximum
TIME	6575	10562
MP	0.46012	1.29199
FAMLYINC	2993	48955
TEMP	50.12500	89.61000
DAYS	16.00000	31.00000
COMPROXY	0.01010	0.36842

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 924

	TIME	MP	FAMLYINC	TEMP	DAYS	COMPROXY
TIME	1.00000 0.0	0.28738 0.0001	-0.19077 0.0001	0.05093 0.1219	0.03006 0.3614	0.03664 0.2659
MP	0.28738 0.0001	1.00000 0.0	0.03932 0.2324	0.00483 0.8833	-0.05041 0.1257	-0.01003 0.7608
FAMLYINC	-0.19077 0.0001	0.03932 0.2324	1.00000 0.0	0.00101 0.9756	-0.00437 0.8944	0.30401 0.0001
TEMP	0.05093 0.1219	0.00483 0.8833	0.00101 0.9756	1.00000 0.0	-0.12053 0.0002	0.00581 0.8600
DAYS	0.03006 0.3614	-0.05041 0.1257	-0.00437 0.8944	-0.12053 0.0002	1.00000 0.0	-0.00582 0.8598
COMPROXY	0.03664 0.2659	-0.01003 0.7608	0.30401 0.0001	0.00581 0.8600	-0.00582 0.8598	1.00000 0.0

Model: WEST REGION: LINEAR
Dependent Variable: CONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	31332251800	5222041966.7	297.255	0.0001
Error	653	11471626569	17567575.145		
C Total	659	42803878370			

Root MSE	4191.36913	R-square	0.7320
Dep Mean	21941.36818	Adj R-sq	0.7295
C.V.	19.10259		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-36654	3412.3052204	-10.742	0.0001
MP	1	-1929.111210	717.35804521	-2.689	0.0073
FAMLYINC	1	0.122150	0.02604647	4.690	0.0001
TEMP	1	382.317129	20.79378033	18.386	0.0001
DAYS	1	1021.504243	104.76109354	9.751	0.0001
COMPROXY	1	8231.467259	2180.7883385	3.775	0.0002
DSEAS	1	3141.149196	647.23688346	4.853	0.0001

Model: WEST REGION: LOG-LINEAR
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	63.99562	10.66594	335.751	0.0001
Error	653	20.74412	0.03177		
C Total	659	84.73973			

Root MSE	0.17823	R-square	0.7552
Dep Mean	9.93168	Adj R-sq	0.7530
C.V.	1.79460		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	7.381892	0.14510516	50.873	0.0001
MP	1	-0.063118	0.03050500	-2.069	0.0389
FAMLYINC	1	0.000005209	0.00000111	4.703	0.0001
TEMP	1	0.018515	0.00088424	20.938	0.0001
DAYS	1	0.040344	0.00445487	9.056	0.0001
COMPROXY	1	0.384444	0.09273603	4.146	0.0001
DSEAS	1	0.097948	0.02752316	3.559	0.0004

Model: WEST REGION: LOG-LOG
Dependent Variable: LOGCONS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	61.81668	10.30278	293.491	0.0001
Error	653	22.92305	0.03510		
C Total	659	84.73973			

Root MSE	0.18736	R-square	0.7295
Dep Mean	9.93168	Adj R-sq	0.7270
C.V.	1.88650		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.857688	0.76959397	-1.114	0.2655
LOGMP	1	-0.099418	0.03133803	-3.172	0.0016
LOGFINC	1	0.305497	0.05608852	5.447	0.0001
LOGTEMP	1	0.866224	0.04760267	18.197	0.0001
LOGDAYS	1	1.187610	0.12995848	9.138	0.0001
LOGPROXY	1	0.040590	0.01467332	2.766	0.0058
DSEAS	1	0.205719	0.02587832	7.949	0.0001

WEST REGION

CORRELATION ANALYSIS

6 'VAR' Variables: MP FAMLYINC TEMP DAYS COMPROXY DSEAS

Simple Statistics

Variable	N	Mean	Std Dev	Sum
MP	660	0.97979	0.29601	646.66131
FAMLYINC	720	46401	8231	33408653
TEMP	720	61.31661	15.07809	44148
DAYS	720	28.60139	1.67057	20593
COMPROXY	720	0.11817	0.07649	85.08445
DSEAS	720	0.41667	0.49335	300.00000

Simple Statistics

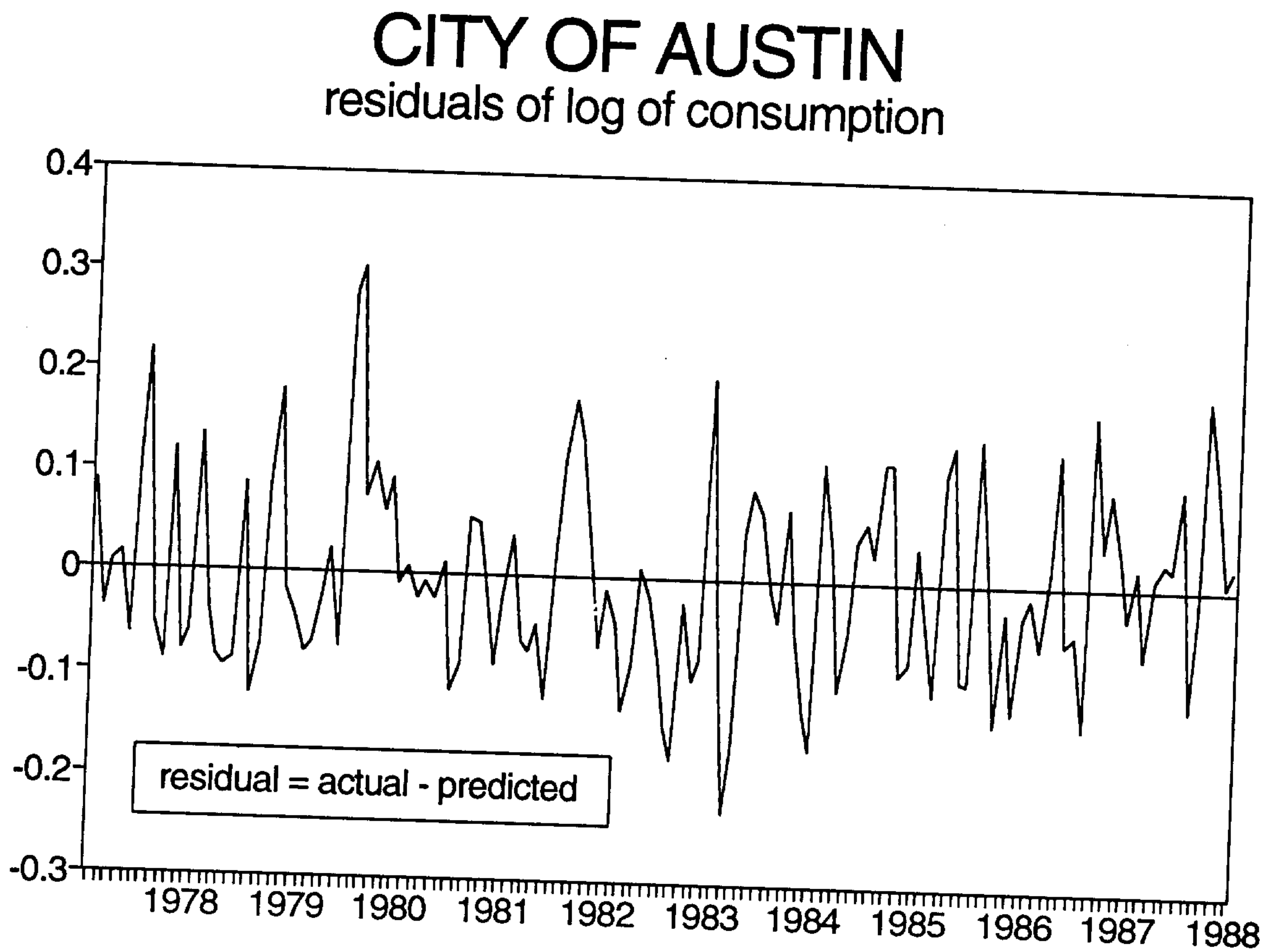
Variable	Minimum	Maximum
MP	0.38008	1.83861
FAMLYINC	35396	61683
TEMP	24.71000	87.14500
DAYS	22.00000	31.00000
COMPROXY	0.04167	0.41000
DSEAS	0	1.00000

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0
/ Number of Observations

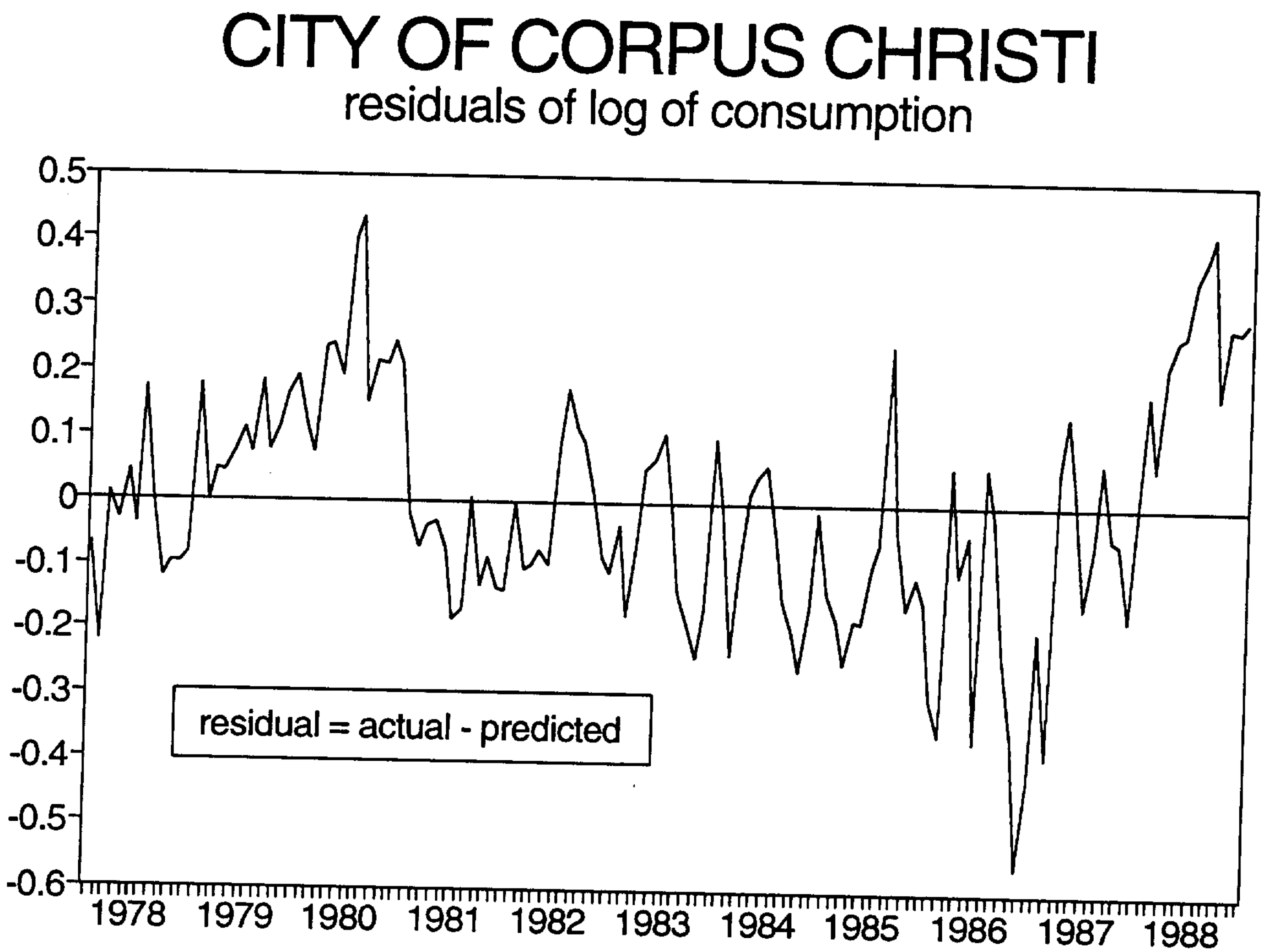
	MP	FAMLYINC	TEMP	DAYS	COMPROXY	DSEAS
MP	1.00000 0.0 660	0.63148 0.0001 660	-0.00873 0.8229 660	-0.11917 0.0022 660	0.19112 0.0001 660	-0.04058 0.2979 660
FAMLYINC	0.63148 0.0001 660	1.00000 0.0 720	0.07132 0.0558 720	-0.12847 0.0005 720	0.16096 0.0001 720	0.00000 1.0000 720
TEMP	-0.00873 0.8229 660	0.07132 0.0558 720	1.00000 0.0 720	-0.25119 0.0001 720	-0.06139 0.0998 720	0.84892 0.0001 720
DAYS	-0.11917 0.0022 660	-0.12847 0.0005 720	-0.25119 0.0001 720	1.00000 0.0 720	-0.11694 0.0017 720	-0.32640 0.0001 720
COMPROXY	0.19112 0.0001 660	0.16096 0.0001 720	-0.06139 0.0998 720	-0.11694 0.0017 720	1.00000 0.0 720	0.00000 1.0000 720
DSEAS	-0.04058 0.2979 660	0.00000 1.0000 720	0.84892 0.0001 720	-0.32640 0.0001 720	0.00000 1.0000 720	1.00000 0.0 720

APPENDIX B

Residuals Comparisons for Selected Cities

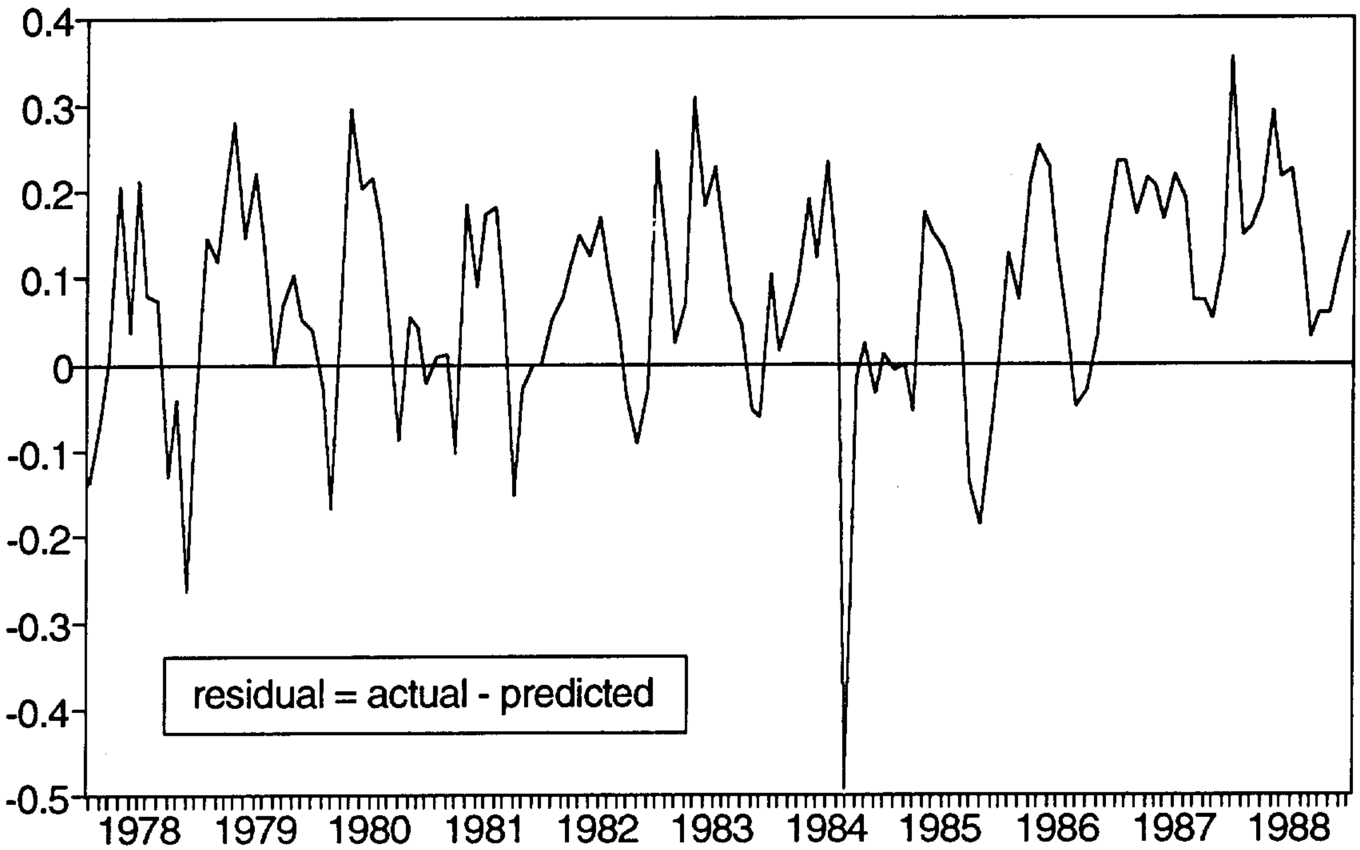


CITY OF AUSTIN
residuals of log of consumption
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
residual = actual - predicted
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988


CITY OF CORPUS CHRISTI
residuals of log of consumption
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
residual = actual - predicted
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988

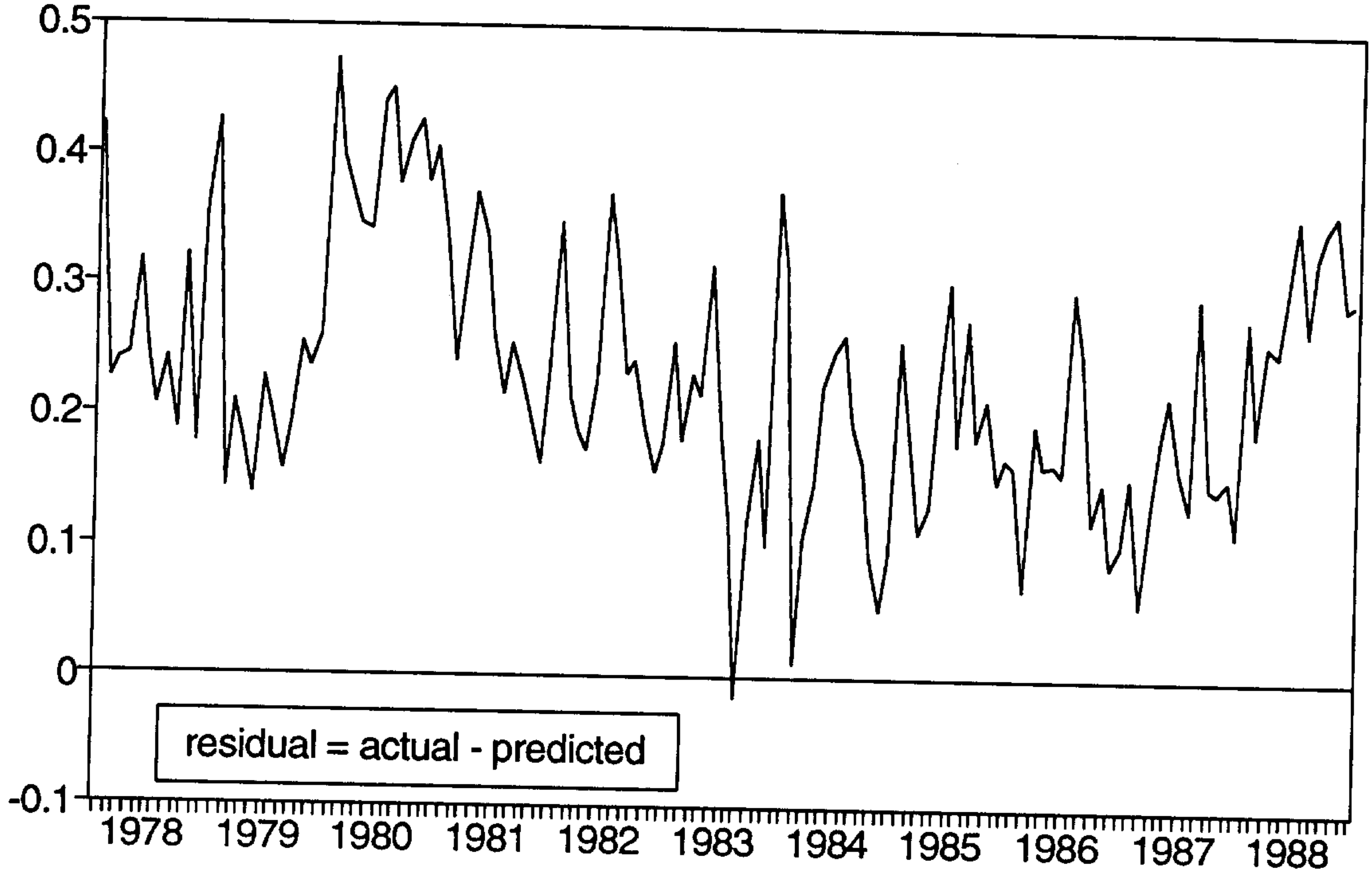
CITY OF EL PASO

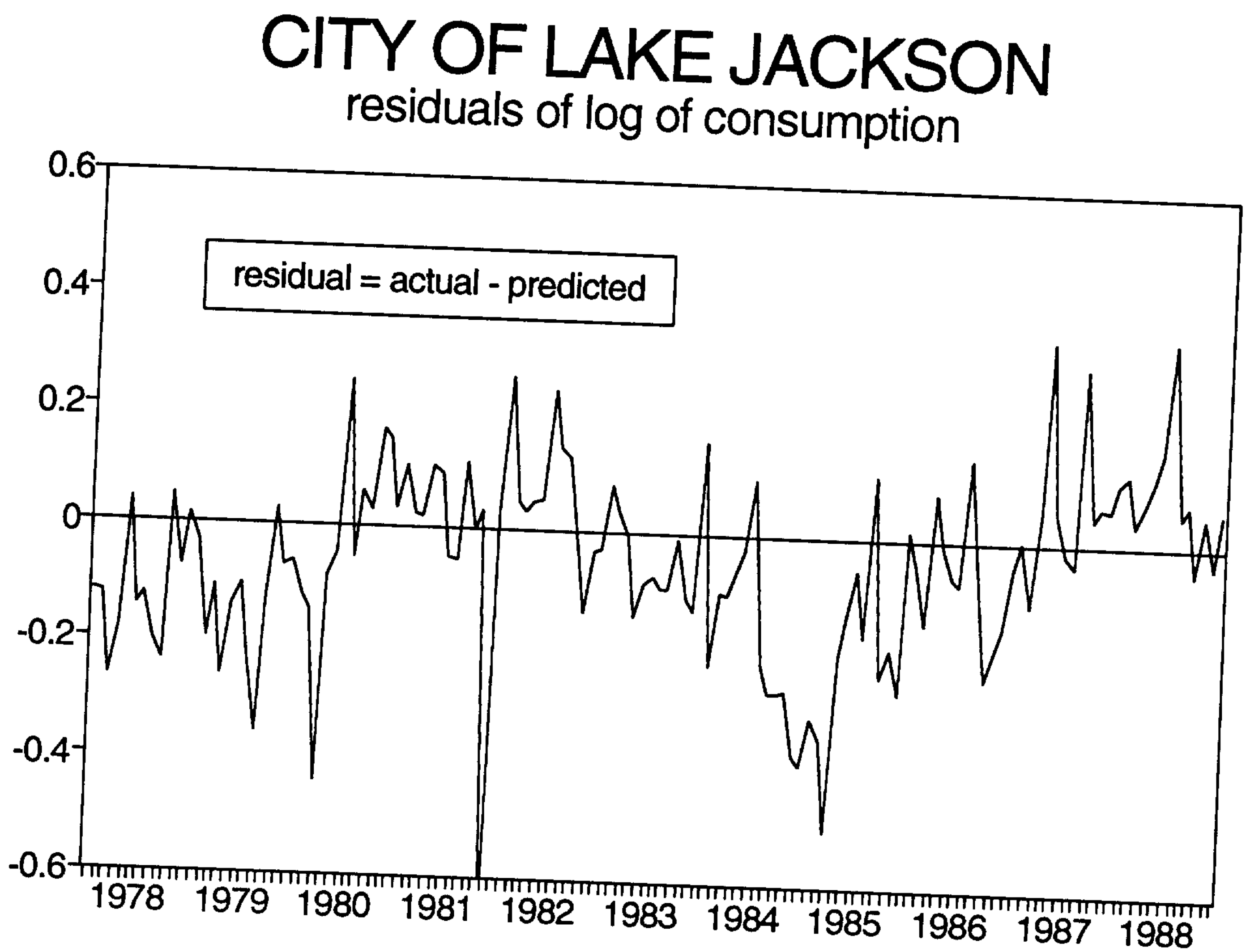
residuals of log of consumption



CITY OF GALVESTON

residuals of log of consumption




CITY OF LAKE JACKSON
residuals of log of consumption
residual = actual - predicted
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988