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Econometric Analysis of the Demand for Gasoline at the State Level

David L. Greene

TRANSPORTATION ENERGY PROGRAM: MONOGRAPH SERIES

OAK RIDGE NATIONAL LABORATORY
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Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
Price: Printed Copy \$7.25; Microfiche \$3.00

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Contract No. W-7405-eng-426

MASTER

ECONOMETRIC ANALYSIS OF THE DEMAND FOR GASOLINE
AT THE STATE LEVEL

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Date Published: July 1978

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ABSTRACT

This report is a detailed description of an investigation into factors influencing levels of highway gasoline use per household and per vehicle at the state level. The considerable variability in consumption rates is documented. Gasoline use per vehicle ranged from 588.7 gal in Pennsylvania to 900.0 gal in Arkansas in 1975. Household use in the same year was lowest in New York (864.5 gal) and highest in Wyoming (2222.0 gal).

Determinants of the demand for highway gasoline were identified based on economic theory of the demand for travel. Exploratory theoretical analyses led to the conclusion that important state-specific influences were not being adequately accounted for by the available time series (1966-75) of cross-sectional (state) variables. These state effects appeared to be strongly correlated with income. Two time-series cross-sectional (TSCS) regression techniques were employed producing reasonable and consistent models. Elasticity estimates were slightly higher than estimates using earlier data.

In order to analyze the determinants of differences in state gasoline use rates, a two-phase modeling approach was used which first estimates a demand equation utilizing key socioeconomic variables. The TSCS technique used to estimate the equation produces quantitative estimates of state-specific deviations from predicted consumption levels. In the second stage these state-specific effects are regressed against a set of explanatory variables describing such state characteristics as spatial structure, climate, and employment in agriculture. State household gasoline use rates were found to be negatively related to population density, percent of population living in metropolitan areas, agricultural employment, severe winter weather, and small car share of the vehicle fleet. They were positively related to the percentage of the population of working age and to the level of tourist activity.

A companion report in this series (ORNL-5391, "An Investigation of the Variability of Gasoline Consumption among States," D. L. Greene) summarizes the major findings of this study.

1. SUMMARY OF FINDINGS

This study has attempted to contribute to the understanding of variations in rates of gasoline use among states. The variability is considerable. Total highway gasoline sales in 1975 ranged from a low of 193.7 million gal in Alaska to a high of 10.2 billion gal in California, a vast difference which is obviously a function of population size. However, of far greater interest for both practical and theoretical reasons is the variability in consumption rates per unit whether households, individuals, or vehicles.

Considerable variability exists in state-level highway gasoline use regardless of the method of measurement used. The variability of consumption rates, that is, gasoline consumption per vehicle and per household, is masked in these total gasoline sales data. Statistics summarizing the differences in per vehicle and per household consumption are presented in the following two paragraphs.

In 1975 gasoline consumption *per household* in the states of Wyoming (2222 gal), New Mexico (1904 gal), Nevada (1885 gal), Texas (1810 gal), Georgia (1732 gal), Utah (1706 gal), South Carolina (1694 gal), and South Dakota (1689 gal), was more than 20% above the national mean (1389 gal). Only the state of New York (864 gal) had a per household gasoline consumption level more than 20% below the mean. However, the more densely populated northeastern states generally displayed lower per household consumption patterns.

In the same year annual gasoline consumption *per vehicle* varied from 589 gal annually in Pennsylvania to 934 gal in Washington, D.C., with a national mean of 754 gal per vehicle. Above the national mean,

Washington, D.C., is followed by Arkansas, Missouri, Texas, Georgia, and Delaware (900, 874, 872, 856, and 856 gal per vehicle, respectively). Below the mean, Pennsylvania is followed by North Dakota, Hawaii, Rhode Island, and Washington (593, 602, 664, and 665 gal per vehicle, respectively). The smaller variability of per vehicle fuel consumption can be attributed to the strong positive correlation (0.771, simple correlation coefficient using 1975 data) between ownership rates (vehicles per household) and household gasoline consumption rates.

The results of numerous regression analyses demonstrated that household gasoline consumption is most strongly related to vehicle ownership rates. In over 20 stepwise regressions (conducted to explore relationships between gasoline per household, per capita, and per vehicle and vehicle miles traveled (VMT) per household as dependent variables and a host of independent variables), ownership rates always entered first as the variable with the highest explanatory power. With ownership and an intercept alone, R^2 s of 0.50 to 0.60 were consistently achieved. More adequate models indicated that a doubling of household vehicle ownership rates at the state level would bring forth a 40-50% increase in average household gasoline consumption. This means that the additional cars in states with large vehicle fleets are used much less intensively than the vehicles in states with low ownership rates. With state ownership rates varying from approximately 1.5 to 2.5 vehicles per household in 1975, ownership could account for a 35% greater total fuel consumption by high ownership states.

Household disposable income was another important source of explanation for variations in gasoline consumption. In the two models

that accounted for state-specific consumption effects, income elasticities ranged from 0.24 to 0.31. That is, a 10% difference in average household disposable incomes will be accompanied by an upward 2.5 to 3.0% change in gasoline consumption. These estimates are only slightly higher than those obtained in a previous time-series (1955-1970) analysis of the demand for highway motor fuel using state-level data. (Burright and Enns estimated an income elasticity of 0.18 for highway motor fuel.¹)

Gasoline prices also were a significant variable. The data base for this analysis includes embargo and postembargo years when gasoline prices rose sharply as well as earlier years when prices in constant dollars were declining. Estimated price elasticities ranged from -0.18 to -0.33, well within the range of estimates by other models based on preembargo data.² These values imply that a 10% increase in prices at the pump would cause consumption to be reduced 2 to 3%. Other significant variables included drivers per household (a measure of household demand) and household size (important since household, not per capita, disposable income was used in most models). The elasticity of number of drivers was 0.11, suggesting that the presence of additional drivers in the household exerts a positive, though muted, influence on gasoline consumption.

Because the measure of gasoline consumption used in this analysis (all gasoline used on the highways) includes fuel consumed by numerous trucks not used for personal transportation, the percent of trucks in the total vehicle fleet was introduced to correct for this influence. The variable was significant and indicated that a 10% increase in the truck population of a state would cause its gas consumption to increase by 0.5%.

Even taking into account the influence of state-to-state variations in all the variables discussed above, there still remained significant, unexplained state-specific influences on household gasoline demand. Analysis of residuals from the regressions indicated that these state influences persisted over time and could therefore not be attributed to random error or to chance fluctuations in demand. In the most extreme case, a deviation of 300 gal from the predicted level of household annual consumption occurred.

Two models [Variance Components (VC) and Least Squares Dummy Variables (LSDV)] were used to estimate the relationships described above. Both are well-known econometric techniques specifically designed for analyzing the type of data used in this analysis. The LSDV model produces quantitative estimates of the state effects as average deviations from the predicted levels of household gasoline demand. Since we may assume that these effects are not attributable to the economic and demographic factors included in the demand equation, it is clear that they must be attributable to other state characteristics. These state effects ranged from -306.6 gal per household per year (-257.6 gal per vehicle per year) for North Dakota to 300.5 gal per household per year (175.7 gal per vehicle per year) for New Mexico. They were found to result from state-to-state variations in annual vehicle miles of travel, fuel intensity of the vehicle fleet, and the *net* export of gasoline via sales to out-of-state vehicles not counter-balanced by gasoline purchases in other states for vehicles registered within the state. A detailed theoretical explanation for state effects was constructed which was strongly supported by regression analysis of

the state effects on a set of explanatory variables. Despite important limitations of the data, a state-effects model was constructed and statistically significant parameter estimates with appropriate signs and orders of magnitude were obtained.

To summarize:

1. There is considerable variation in the levels of gasoline use per household and per gasoline-powered vehicle among states.
 Pennsylvania was lowest in 1975 (588.7 gal per vehicle per year) and Arkansas (900.0 gal) highest of the states in gasoline per vehicle (753.9 gal = national mean). In gasoline per household Wyoming was highest with 2222.0 gal per household per year while New York was lowest at 864.5 gal per household per year (national mean = 1388.7 gal).
2. Even after statistically correcting for levels of ownership, disposable income, licensed drivers, household size, and truck composition of the fleet, large differences exist which persisted over the period 1966-75. Average state deviations from predicted levels of household gasoline consumption ranged from -306.6 gal per household for North Dakota (-257.6 gal per vehicle) up to 300.5 gal per household for New Mexico (175.7 gal per vehicle).
3. These time-persistent state effects result from differences in annual VMT, fuel intensity of the vehicle fleet, the net export of gasoline to out-of-state vehicles, and the method of reporting agricultural gasoline use. Specifically, household gasoline consumption rates were found to be negatively related to density, urbanization, agricultural employment, severe winter weather, and

the small car share of the vehicle fleet. Positive relationships were found with the percent working age population and levels of tourist expenditures per capita.

2. INTRODUCTION

The transportation sector may provide the greatest opportunities and the greatest challenges for energy consumption conservation in the United States today. This sector accounted for approximately 27% of the total U.S. energy budget and over 53% of the total U.S. petroleum consumption in 1976. Of the total U.S. petroleum consumption, approximately 40% was gasoline used for highway travel. Petroleum is a dwindling natural resource upon which much of our society depends. Since 1970, domestic supplies have comprised a declining portion of our total petroleum use. In 1976, 39% of the total petroleum consumed in the United States was imported. Any effective national energy policy will have to address the critical need to reduce highway gasoline use.

In order to understand the likely impacts on individual states of policies designed to reduce gasoline consumption, it is necessary to understand the nature of state-to-state variations in gasoline use. This is true regardless of whether the policies are market oriented, like taxes on fuel, or nonmarket oriented such as government rationing. This study seeks to make a contribution to that requisite understanding.

If every state in the United States were identical, there would be no need for this study. Yet even if the states' populations were identical with respect to income, household characteristics, and personal preferences for travel, the fact of space alone would cause the states to differ from one another. Their different geographic locations produce variations in climates, and the variegated landscape of North America accounts for differences in topography and natural resources. Differences in cultural, economic, and demographic factors as well as variations in

the travel environment may all be expected to influence the average household use of gasoline. In this investigation we will have to assume only that the cultural factor is unchanging: we assume that, in the aggregate, inherent individual preferences for gasoline use do not change from state to state. The very useful implication of this assumption is that the form of the demand equation for each state will be identical to that of every other state. The same variables will enter into each equation, and each variable's influence will depend only on its value.

The purpose of this study is to explain the variations observed in state rates of gasoline consumption per household and per vehicle. We have sought to identify the key factors which result in some states having more than twice the annual gasoline use per household as certain other states. In 1975, sales of gasoline for highway use reached a high of 2222 gal annually per household for Wyoming; the comparable figure for New York (with the lowest consumption rate) was 864 gal. These are drastically different consumption patterns emanating from two profoundly different states. It is the goal of this analysis to explain such dramatic variations in fuel consumption.

2.1 The Demand for Gasoline

Our approach to the problem is rooted in the neoclassical economic theory of the consumer. (It is neither possible nor necessary to do justice to the theory of the consumer here. Excellent discussions can be found in Refs. 3-5 from which the theoretical foundation of this study has been extracted. Our approach is essentially the same as that

taken in Ref. 1 where a more detailed exposition may be found. For the most part, households do not purchase travel as a commodity ready for consumption like clothing or cigars. Rather, they buy the factors necessary for the production of travel (vehicles, fuel, and maintenance) and add their own time to create the desired product. We can represent this situation symbolically by writing travel (T) as some function of the input vehicles (V), fuel [which in this case is all but exclusively gasoline (G)], and the household's time (t):

$$T = T(G, t | V) .$$

We have written the travel equation for a given size of the vehicle stock because we will be dealing with annual data and have assumed that the size and composition of the vehicle stock will not change in any significant way within a single year. This assumption is largely a matter of convenience because there is no definitive empirical evidence to either support or contradict it. Based on historical sales and scrappage rates, almost 10% of the U.S. automobile fleet turns over every year.⁶ Thus a drastic change in consumer preferences in one year could conceivably result in a significant change in the composition but probably not in the number of vehicles. For the period of interest (1966-75) we feel fairly confident in defining one year as a short-run situation over which the vehicle fleet size and characteristics are fixed. For simplicity we represent all consumption goods produced by the household by a single vector Q. Q is produced using a vector of purchased inputs (X), travel (T), and nontravel time (t'):

$$Q = Q(X, T, t') .$$

The satisfaction or utility (U) the household derives from the consumption of these goods (Q) is an increasing function of the quantities consumed. In accordance with traditional consumer theory, we assume that the household seeks to maximize this utility function,

$$U = U[Q(T(G, t/V), t^*)]$$

subject to a budget constraint. The budget constraint requires that all expenditures of both time and money must equal all income. A further constraint requires that the time used in the production of travel and the composite good must not exceed the total time available to the household for its activities. Under the usual assumptions of the theory of the consumer, this maximization problem can be solved to yield a demand equation for each good which is a function of the prices of other goods, income, and the available stock of automobiles. Since the exact mathematical form (if any) of these functions is unknown, we will approximate them by linear or log-linear equations, depending on which gives a better approximation.

Although the demand for gasoline is clearly derived from the demand for travel, it will have its own demand function derivable from the above maximization problem. Economic theory specifies that the slope of this function will be negative in the good's own price and positive in income. We would also expect it to be an increasing function of the number of vehicles available to the household and of the number of potential users of those vehicles (i.e., licensed drivers, because this represents a relaxation of the constraint on time available for travel). We might also expect household size to influence the

demand for gasoline although the direction of its influence is not as obvious. On the one hand, as household size increases we would expect a greater potential demand for trips. On the other hand, there will be an increased need for the composite good, which includes housing, food, and clothing. For a given number of drivers and a given level of income, it seems entirely reasonable to expect the household to substitute the composite other good for gasoline consumption as household size increases. However, this remains to be established empirically.

Another influence, which was considered important enough by Burright and Enns¹ to be included in their demand equation, is the efficiency of state vehicle travel. A fixed level of travel demand can be satisfied within a range of gasoline consumption levels depending on the fuel efficiency of the vehicles used and on the driving habits of the drivers. We have assumed the vehicle stock to be constant over the short run and have also assumed that the fleet efficiencies will be constant. This leaves only changes in driver habits as a possible source of changes in miles per gallon (mpg) within a year. While there is some evidence that a well-trained driver can achieve fuel economies up to a maximum of 15% greater economy than an untrained driver,⁷ there have not been any large-scale training programs in the states nor is there substantial evidence that the necessary changes in driving habits have actually occurred. If this is true, it implies that ownership and fuel efficiency are predetermined variables in our problem. That is, their values are given at the beginning of the year and are constant for its duration. In fact, what we are arguing is that their values change so slowly that they do not significantly influence fuel consumption over so short a

period. Preliminary statistical analyses further indicated that when other important factors were taken into account, variations in fleet mpg across states were not a statistically significant influence on state fuel consumption rate.* This held true provided that the automobile-truck fleet mix had been accounted for. This correction was necessary because of the limitations of the available data. Since highway gasoline use is calculated by each state based on the gasoline sales on which highway gasoline taxes were actually paid, there is no way to distinguish use by commercial trucks from individual household purchases. Therefore, we included the percent of the vehicle fleet that was trucks as a variable in the equation in an attempt to correct for this problem.

The household demand equation can now be written as

$$G = G(P_g^-, Y^+, O^+, D^+, S^-, \%_{tr}^+) ,$$

where

P_g = price of gasoline adjusted to 1975 dollars using the CPI,

Y = personal disposable income adjusted using the CPI and a state CLI,

O = vehicle ownership per household,

D = licensed drivers per household,

S = average household size,

$\%_{tr}$ = trucks per total vehicles,

*Probably a major reason for the lack of statistical significance for the mpg variable is the poor quality of the data. The mpg was derived as the quotient of state VMT and highway motor fuel consumption. Many believe the VMT data contain errors of 20% or more.

and superscripts indicate the expected sign for each coefficient.

In this equation we are allowing variations in prices, incomes, ownership rates, licensed driver rates, household size, and truck composition of the fleet to vary across states and over time. But as we indicated above, there are many other factors that vary from one state to the other and may be expected to influence gasoline consumption. Figure 1 contains an enumeration of the factors we have been able to identify as important and indicates linkages between them. The economic and demographic factors already discussed are located mostly to the middle and right of the diagram. On the left are largely geographic factors: the social organization of space labeled "spatial structure" and aspects of the physical environment labeled "physical geography." Together these comprise what has been referred to above as the travel environment. Mediating the influence of these on travel demand are the technology of transportation and governmental policy. The diagram constitutes a graphical model upon which the following analysis is based.

2.2 The Rate of Gasoline Use per Vehicle — Household Automobile Use and Ownership

The final output of our conceptual diagram is gasoline consumption per vehicle, which is determined by the quotient of gasoline per household and vehicle ownership. Although we are ultimately interested in the per vehicle as well as the per household rate of consumption, we elected to attack the question of gasoline use per vehicle indirectly through an analysis of household gasoline consumption rather than by trying to directly estimate statistical relationships between gas per

Fig. 1. Gasoline Consumption per Vehicle at the State Level: A Conceptual Diagram.

vehicle and a set of explanatory variables. The reason for this is implicit in the discussion of gasoline demand above. Attempting to explain state levels of annual gasoline consumption per vehicle via direct estimation of a single equation with gas per vehicle as the dependent variable does not make sense from an economic viewpoint. Automobiles do not have demands for goods; people do. Thus there exists no vehicle gasoline demand equation to be estimated. Vehicles are not economic decision makers. Their use of gasoline is determined by their owners' demand for travel in conjunction with their demand for vehicles.

In the long run, auto ownership and use decisions are logically interdependent. That is, households do not decide on the number of cars they will own without regard to how much highway traveling they expect to do, and likewise the amount of traveling they do will depend on the stock of vehicles available to them. Because automobile purchases involve a relatively large expenditure for the average family, it would seem reasonable to assume, as we have, that ownership decisions are made based on expectations about travel demands and income levels over a period greater than one year.³⁴ Since we are estimating a short-run equation that is conditional on ownership, simultaneity of ownership and use decisions is not a problem.

Although we will be treating ownership rates as a predetermined variable and will not be attempting to construct an ownership model of our own, some understanding of the determinants of vehicle ownership is important. As our diagram indicates, ownership and household fuel use determine vehicle fuel use. Our data reveal that both determinants

vary considerably across states. While there have apparently been no studies of the determinants of automobile ownership at the state level of aggregation, several national surveys and analyses have been done, and it would seem reasonable to assume that the same type of economic relationships would apply at both levels of aggregation. [The basic data sources are the 1972 National Personal Transportation Survey (NPTS)⁸ and the 1970 University of Michigan, Institute for Social Research Survey.⁹] Tabular data presented in the NPTS survey reports (especially No. 11) suggest very strongly that the key determinants of household auto ownership are household income and size. This indication was partially confirmed in recent studies^{10,11} which utilized data from both surveys (the Michigan survey probably gives a better indication of relationships between ownership rates and income class because higher income groups seem to have been systematically underreported in the NPTS survey). In Leape's study, the number of adult household members and income were the two most important determinants of ownership rates.

Controlling for the number of adults, household size had an inverse relationship to auto ownership rates. This was probably due to its negative impact on household disposable income per capita. Locational factors, however, have also been found to be important. The NPTS survey data show that only about 15% of households in central cities of large Standard Metropolitan Statistical Areas (SMSAs) own two or more cars while over 43% of households in their suburbs do. The data lend strong support to the hypothesis that activity patterns and the spatial organization of population exert an influence on automobile ownership decisions. A multiple regression of auto ownership on

locational and regional dummy variables in the presence of other, socioeconomic variables revealed that the influence of spatial structure persists even when such factors as income and household size have been taken into account.¹¹

Since the data were available to us, we did attempt to estimate a simple demand equation for vehicle ownership for illustrative purposes only. Most previous studies such as those mentioned above have utilized data made up of observations of individual households. As a result, the dependent variable is discrete (0, 1, 2, 3, ..., cars) and simple linear regression techniques are not the best choice.¹²⁻¹⁴ However, our data consist of average aggregate household ownership rates for states (1966-75), and thus the dependent variable is continuous (though logically bounded by zero). Ownership in 1975 ranged from 9.1 (Washington, D.C.) to 2.71 (North Dakota) vehicles per household. Ordinary least squares regression techniques are better suited to this type of dependent variable. Despite the differences in data, our results largely confirm the results of the studies cited above. Both linear and double log forms were estimated. Since the log-log did slightly better than the simple linear ($R^2 = 0.80$ as opposed to $R^2 = 0.72$), its results are presented below. (Significance levels for a two-sided t test are given in parentheses below each variable.)

$$\begin{aligned} \text{OWN} = & 1.97 + 0.124\text{LOG}(\text{INC}) + 0.248\text{LOG}(\text{VMT}) + 0.528\text{LOG}(\text{DR}) \\ & (0.00) \quad (0.00) \quad (0.00) \quad (0.00) \\ & - 0.015\text{LOG}(\text{SMSA}) - 0.049\text{LOG}(\text{DEN}) \\ & (0.11) \quad (0.00) \end{aligned}$$

479 observations; $F = 378.87$, $\text{Prob} > F = 0.0001$; $R^2 = 0.7999$

where

OWN = registered vehicles per household,

INC = personal disposable income in 1975 dollars (CPI),

VMT = vehicle miles of travel per household,

DR = licensed drivers per household,

SMSA = percent of state population living in Standard Metropolitan
Statistical Areas,

DEN = state population density in persons per square mile.

The estimated income elasticity is 0.12. The elasticity of household travel (VMT) is 0.25 and that of drivers per household is logically the highest at 0.53. Thus, the results suggest that a 10% increase in the number of licensed drivers per household will result in a 5% increase in the state's auto ownership rates. Two measures of state spatial structure — gross state population density and the percent of state population living in SMSAs had usually significant effects (percent SMSA was significant in the linear form) of the expected sign (negative). It seems that in this equation, variations in VMT due to levels of urbanization may be accounting for much of the influence of SMSA on ownership. Unfortunately this equation probably contains a simultaneous equation bias¹⁵ because, as we have argued above, the level of VMT should be determined in part by the availability of vehicles, that is, ownership rates. Nonetheless, the results lend general support to the conclusions of previous studies conducted at the household level.

Although we recognize that vehicle ownership is influenced by factors such as spatial structure through the demand for highway travel, in the remainder of this study ownership will be treated as given.

Figure 1 reflects this de-emphasis of the ownership decision, focusing on the gasoline demand decision. This is a far more tractable problem for economic analysis and will bring us a long way toward understanding variations in consumption per vehicle.

There is one final note of caution before beginning this analysis. The data utilized in this study do not, strictly speaking, represent the attributes of individual economic units (households) but rather of aggregations of economic units (states). One must therefore exercise caution in drawing inferences about personal or household behavior based on this study's results. In the strictest sense, our results apply only to the behavior of the aggregates of consumers who make up states.

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3. DATA

All of the data used in this study were obtained from published sources identified by the Transportation Research Staff at ORNL or were derived from these original data sources (e.g., fleet mix data, deflated disposable income, density variables, etc.).

Appendix A provides a listing of the base variables and sources used in the study. Also included are any caveats or limitations that may be associated with the data (e.g., gasoline prices while available for the continental U.S. were not available for Alaska or Hawaii). Of particular importance are those instances where time series data were not available. In general, data on fuel consumption, registered vehicles, and licensed drivers were obtained from U.S. Department of Transportation (DOT) *Highway Statistics: Summary to 1975*.¹⁶ Demographic data were obtained from U.S. Bureau of the Census publications, income data came from the Bureau of Economic Analysis, and information on gasoline prices from Platt's OIL GRAM price service. The wide range of variables used in the analysis of state consumption effects was drawn from diverse sources.

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4. CARTOGRAPHIC ANALYSIS

As a starting point for the analysis, a series of state-level maps was generated depicting the 1975 values for gasoline consumption per household, per gasoline-powered vehicle, and for vehicle ownership rates. The intervals used for mapping purposes were 0 to 10%, 10 to 20%, and greater than 20% of the mean on either side of the national mean value for the particular variable.

Figure 2 displays a range of gasoline consumption per vehicle from 588.7 gal in Pennsylvania to 933.7 gal per vehicle in Washington, D.C. The national mean value for this variable is 753.9 gal, and the standard deviation is 80 gal. Per vehicle consumption patterns tend to be higher in the southern states, the east north central states, and the sparsely populated states of Wyoming and Nevada although there are numerous exceptions. Below the national mean (excluding those states less than 10% below), there appears to be no consistent spatial configuration. Washington, Idaho, Montana, North Dakota, and Pennsylvania are all considerably below the mean. It is significant to note that of the three variables considered, the range of variability appears lowest in the case of gasoline consumption per vehicle. This is because vehicle ownership per household tends to mitigate the effects of per household gasoline consumption differences. That is, states having high per household gasoline consumption tend to have higher vehicle ownership rates and vice versa. As Fig. 3 shows, there appears to be a distinct pattern of high vehicle ownership in the west-central portion of the United States. This is perhaps the only consistent regional pattern on any of the maps.

PERCENT ABOVE OR BELOW NATIONAL MEAN
(MEAN=753.9 GAL)

Fig. 2. 1975 Gasoline Consumption per Vehicle.

PERCENT ABOVE OR BELOW NATIONAL MEAN
(MEAN=1.84 VEH)

Fig. 3. 1975 Vehicle Ownership per Household.

The national mean value of vehicle ownership is 1.84 vehicles per household, ranging from 0.91 vehicles in Washington, D.C., to 2.71 vehicles per household in North Dakota. The standard deviation is a fairly high 0.31 vehicles. The national mean is simply the population-weighted average of the state means. A state mean not weighted by population was computed resulting in a value considerably higher than the national mean (1.97 vehicles per household). This can be explained by the fact that while most states have vehicle ownership rates above the national mean, the urbanized, more densely populated, larger states tend to have vehicle ownership rates below the mean.

As is reflected in Fig. 4 there is also considerable variability in total gasoline consumption per household. The states of Wyoming (2222 gal), New Mexico (1904 gal), Nevada (1885 gal), Texas (1810 gal), Georgia (1732 gal), Utah (1706 gal), South Carolina (1694 gal), and South Dakota (1689 gal) all have consumption levels greater than 20% above the national mean (1388.8 gal). Only the state of New York (864.5 gal) has a per household gasoline consumption level more than 20% below the mean. However, in general the more densely populated, older northeastern states tend to have lower per household consumption patterns.

Perhaps the most salient aspect of both gasoline consumption maps (Figs. 2 and 4) is the lack of any obvious, consistent patterns. The generally low consumption levels of highly urban states may be the only exception. (There is even a counterexample for this because Texas, with 80% metropolitan population in 1975, is among the highest in household gasoline consumption.) This lack of obvious spatial patterns

PERCENT ABOVE OR BELOW NATIONAL MEAN
(MEAN=1,388.8 GAL)

Fig. 4. 1975 Gasoline Consumption per Household.

is attributable to the complexity of the problem, as will become clear. The multiplicity of factors influencing fuel consumption rates makes it virtually impossible to pick out one or two simple factors which explain most of the variation.

5. PRELIMINARY EXPLORATIONS

We began our investigation of household gasoline consumption with a series of exploratory regressions using a variety of models and approaches. In the first phase, stepwise regression techniques were used to probe relationships among four dependent variables: VMT per household, gasoline consumption per household, gasoline consumption per capita, gasoline consumption per vehicle, and the entire set of potential explanatory variables. Both log transform and linear forms were estimated. In all, 60 separate equations were scrutinized. While none produced an acceptable model, they served the intended purpose by indicating several key relationships and by identifying important shortcomings of this simple approach.

In every case, without exception, automobile ownership rates proved to be the single factor with the most explanatory power (in the statistical sense). R^2 s for ownership and an intercept alone ranged from 0.10 in the linear gasoline per vehicle equation to 0.67 in the log-log regression for gasoline per household. On reflection this result is not surprising since it simply indicates the basic relationship between household travel and the key material input used by households to produce it. As the household demand for travel increases, more of each input must be used in its production. As was shown above, the demand for gasoline is thus derived from the demand for travel. As the household increases its consumption of travel, it must increase its consumption of gasoline proportionately (holding auto efficiency constant). As the demand for travel increases, it eventually exceeds the capacity of a single automobile to produce it, and additional units

must be purchased. Thus the strong association between ownership and gasoline consumption rates results from their technical relationship in the production of household travel.

A second important finding of the preliminary stepwise analyses was the stability of certain key relationships and the instability of others. Gasoline prices in constant dollars and the percent of state vehicles registered as trucks were two variables in particular whose estimated coefficients were consistent in sign and approximate magnitude across all the gasoline consumption equations estimated by the stepwise procedure. This held true whether gasoline per household or per vehicle was the dependent variable. Ownership obviously had a positive sign in per-household and a negative sign in per-vehicle equations. Percent of state population living in metropolitan areas consistently had a negative effect on gas consumption but was often not statistically significant. Surprisingly, income was another variable whose coefficient was often not significantly different from zero and most often had a counter-intuitive sign (negative, implying that gasoline, hence highway travel, is an inferior good). Another usually insignificant variable was state population density.

These problems involving variables measuring state spatial structure and income indicated the inadequacy of this simple linear model approach. The only consistently significant measure of state spatial structure with an appropriate sign was a measure of recent development. This variable was the ratio of current to 1940 total state population and was intended to measure the degree to which the spatial structure of the state, the layout of its communities, and its transportation

infrastructure was adapted to automobile travel. The use of this variable is in accord with the theory that the density of development depends directly on the ease of mobility provided by the dominant transportation mode.¹⁷ It was reasoned that newer states would be best adapted to the increased mobility of auto travel and less suitable for walking and other travel modes. In line with this expectation, the regressions suggested that a state whose population had doubled since 1940 would, other things being equal, consume about 10% more gasoline than a state whose population had remained constant.

One final important result of these exploratory regressions was that the equations with gas *per vehicle* as the dependent variable achieved just over half the R^2 of the gasoline or VMT *per household* equations (e.g., 0.43 as compared to 0.78). These empirical results tended to support what we had argued on both statistical and theoretical grounds: that the appropriate way to attack the question of gasoline consumption per vehicle is by explaining gasoline per vehicle as the ratio of household gasoline use and vehicle ownership.

A second series of exploratory regressions used an approach identical to that just described except that all state observations were expressed as ratios to national values. The results of this analysis were very similar to the first with a few exceptions. This ratio approach had the effect of removing secular national trends from the data. One result was that the effect of price became insignificant in many cases due to the relatively small variability of prices from state to state as opposed to variability over time. Also spatial variables were much more important in these regressions, suggesting

that significant state effects attributable to spatial structure were discoverable if only we could find an appropriate way to measure them.

While the levels of statistical explanation achieved by these simple linear models were satisfactory ($R^2 = 0.60 - 0.80$), it was felt that the majority of the unexplained variance was due to factors left out of the models rather than to random error. In fact, given that R^2 s of 0.40 to 0.60 could be attained with the single variable ownership by itself, we concluded that the unexplained variance probably consisted mostly of the state-specific influences we were attempting to capture in our analysis.

Furthermore, our estimates of income elasticities were at odds with all existing estimates and also contrary to economic theory. The generally poor performance of our spatial variables indicated serious shortcomings in either our estimation approach or our variables or both. For these reasons an analysis of residuals was carried out in an attempt to identify the specific problem areas. For both the linear and log-log regressions, plots of observed vs predicted values of the dependent variables were created in addition to plots of residuals (observed-predicted) vs real disposable income.

The observed vs predicted plots (Figs. 5 and 6) indicated no particular statistical problems with either the log-log or linear approaches. In fact neither the plots nor the levels of explanation gave any strong reason for choosing one approach over the other. Both appeared to fit the data equally well. Thus the linear approach may be preferred for its simplicity and the log-log approach will sometimes be preferable because it produces constant elasticity estimates.

Fig. 5. Observed (GASPHH) vs Predicted (PGASPHH) Values of Dependent Variable — Simple Linear Gasoline per Household Model.

The graphs of income vs residuals (Figs. 7 and 8), on the other hand, indicated very strongly that problems existed in the model which might be partly related to the income variable. The first letter of the state name was plotted as a symbol for each residual. This technique made it possible to discern clusters or strings of residuals all from the same state. If our models were accurately capturing all state-specific effects on gasoline demand, there would be no tendency for a state's residuals to be concentrated on one or the other side of zero (i.e., no tendency toward consistent under- or overestimation of that state's consumption). Yet such clusterings are clearly evident in the residual plots.

Thus the graphical evidence contained in the residual plots confirmed what the regression analyses had led us to suspect: our simple models had not accounted for some very important state-specific effects on gasoline consumption. The evidence further suggested that these state effects were related to income and state spatial structure and tended to persist over time. It seemed likely that our inability to include these state effects was causing biased estimates of variable coefficients due to omitted variables. In particular, income may be strongly correlated with these state effects resulting in a seriously biased estimate of its actual coefficient. These problems led us to investigate econometric techniques better adapted to the analysis of time-series, cross-sectional data.

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6. TIME-SERIES CROSS-SECTIONAL MODELS

6.1 Variance Component Model (VC)

In the ordinary least-squares regressions estimated above, it is implicitly assumed that the error terms across observations are uncorrelated. In pooled, time-series, cross-sectional data this assumption is very often invalid. Not only may there be disturbance effects particular to a given time period (year) which persist across all cross-sectional units (states), but there may be effects specific to the observational units which persist over time. When ordinary least-squares techniques are applied in such situations, inefficient estimates of the model coefficients result. What is worse, when the cross-sectional unit effects are due to omitted explanatory variables, as we suspect is the case here, the estimated coefficients will very likely be biased.¹⁸

One possible solution to this problem is to employ a generalized least-square regression technique termed Variance (or Error) Component Analysis. Consider the following linear model:

$$Y_{it} = A + BX_{it} + V_{it}, \quad i = 1, \dots, 51, t = 1, \dots, 10,$$

where Y_{it} is an observation on the dependent variable Y for the i^{th} state in the t^{th} time period (year), A is a constant, B a $1 \times p$ vector of coefficients and X_{it} a $p \times 1$ vector of observations on the independent variables for the i^{th} state and t^{th} period, and V is the error term. Several assumptions about the structure of the variance-covariance matrix of this model,

$$E[VV'] = \Omega$$

(where E is the expected value, V a 1×510 vector of disturbances and Ω the variance-covariance matrix), can be made depending on the presumed associations between error terms.¹⁹ The particular structure employed here assumes that the error term V_{it} can be decomposed into three separate, statistically independent elements or components:

$$V_{it} = U_i + E_t + W_{it}.$$

The error components U_i , E_t , and W_{it} are independent random variables with zero means and variances of σ_U^2 , σ_E^2 , and σ_W^2 , respectively. The U_i are state effects which are constant over time for each state but which vary from state to state. Similarly E_t are year effects and the W_{it} term is a random error across both time periods and cross-sectional units. It is of no particular importance what the cause of the U_i are. In fact, U is assumed to be a random variable with realizations for each state.

Gasoline consumption equations were estimated using the TSCREG routine of the SAS statistical package. This routine produces estimates of the variances of U , E , and W , but no specific estimates of individual U_i or E_t for states and years. Furthermore, no R^2 statistic is given since it does not have the same meaning in this context as the R^2 measure in ordinary least squares. The results (Tables 1 and 2) are most interesting for the estimated values of the coefficients since they indicate what values might have been obtained via the ordinary least-squares techniques employed above had we been able to adequately capture

Table 1a. Variance Component Model — Linear Household
Gasoline Demand Equation

(dependent variable GASPHH = average annual highway
gasoline sales per household)

Variable	Estimated coefficient	t-statistic ^a	Significance level
INT ^b	0.636970	6.7901	0.0000
DPRICE ^c	-0.712546	-6.7073	0.0000
DINCOME ^d	0.0000520956	5.1324	0.0000
OWN ^e	0.374884	11.952	0.0
AGE ^f	0.00627200	0.47090	0.6379
PCTRUCK ^g	0.740267	4.9369	0.0000
DRHH ^h	0.0877337	4.3787	0.0000
PCMSA ⁱ	-0.127833	-2.9517	0.0033

^aDegrees of freedom for t-statistics = 482.

^bIntercept.

^cPrice of gasoline in 1975 dollars.

^dDisposable income per household regionally and temporally deflated
1975 dollars.

^eRegistered vehicles per household.

^fPresent population as a ratio to 1940 population.

^gTrucks as percent of registered vehicles.

^hLicensed drivers per household.

ⁱPercent of population living in SMSAs.

Table 1b. Variance Component Estimates

Variance component for cross sections (σ_V^2) = 0.011570519

Variance component for time series (σ_E^2) = 0.00045361561

Variance component for error (σ_ϵ^2) = 0.0011074009

Transformed regression M.S.E.^a = 0.0011990688

^aM.S.E. degrees of freedom = 482.

Table 2a. Variance Component Model — Log-Linear Household
Gasoline Demand Equation

(Dependent variable LGASPHH = logarithm of average annual
highway gasoline sales per household)

Variable ^a	Estimated coefficients	t-statistic ^b	Significance level
INT	-2.11066	-8.0475	0.0000
LDPRICE	-0.185687	-5.2319	0.0000
LDINCOME	0.236949	8.0463	0.0000
LOWN	0.380154	9.8994	0.0
LAGE	0.0158775	0.66153	0.5086
LDEN	-0.0352912	-4.1641	0.0000
LDRHH	0.112145	4.7366	0.0000
LPCMSA	-0.0256228	-1.7158	0.0868
LPCTRUCK	0.0582084	3.2951	0.0011

^aL indicates the logarithm of a variable. DEN indicates gross population density. For definitions of other abbreviations, see Table 1a.

^bDegrees of freedom for t-statistics = 481.

Table 2b. Variance Component Estimates

Variance component for cross sections (σ_V^2) = 0.0049462895

Variance component for time series (σ_E^2) = 0.00025928770

Variance component for error (σ_ϵ^2) = 0.00041736557

Transformed regression M.S.E.^a = 0.00046257262

^aM.S.E. degrees of freedom = 481.

all the relevant influences leading to different state levels of household gasoline consumption.

The most striking difference between this model and those previously estimated is the significant positive coefficient for income in every equation. Estimates of income elasticities in the variance component models ranged from +0.21 to +0.25, depending on the particular constellation of other explanatory variables included in the regression. These estimates are more in agreement with previous studies (Burright and Enns (Ref. 1) estimated an income elasticity of 0.18 using annual data while Data Resources, Inc. (Ref. 20) obtained an estimate of 0.303 using a different measure of gasoline use and quarterly data) and with *a priori* expectations based on consumer theory. This result, in conjunction with the residuals analysis from previous regressions, strongly supports the contention that significant state effects exist which are associated with state income levels. These effects are closely correlated with income and tend to reduce levels of gasoline consumption per household. When omitted from the equation or inadequately represented, they create a downward bias in income elasticity estimates. Our original surmise that these effects are closely related to state spatial structure is also strengthened by these results since the explanatory power of spatial variables is considerably reduced in these equations. In the logarithmic specification of the model, only gross population density, a crude measure of spatial structure indeed, survived a test of significance at the 0.05 level. In the linear model only percent of population in SMSAs was a significant spatial variable.

Incidentally, estimated price elasticities, as well as those for other variables, were comparable to those of the simple linear models. The preferred model had a price elasticity of -0.19 ,^{*} an ownership elasticity of 0.38 , an elasticity of drivers per household of 0.11 , and an elasticity of percent truck of 0.06 .

While the variance components approach must be considered a significant improvement over the previous models, it has two shortcomings: (1) it produces no R^2 measure, and so its goodness effort of fit to the data is difficult to evaluate, and (2) state effects are treated as realizations of a random variable, and no quantitative estimates of their magnitudes are provided. If we were only interested in good estimates of income and price elasticities, we would be home free. But our primary interest is in the state effects themselves, and therefore the variance component approach still leaves much to be desired.

6.2 The Least-Squares Dummy Variable (LSDV) Approach

An alternative means of dealing with cross-sectional time-series data when time period and observational unit effects are suspected is the least-squares dummy variable (LSDV) approach. This technique simply introduces a dummy variable for each cross-sectional unit except one with the following properties:

$$x_i = \begin{cases} 1 & \text{if unit} = i \\ 0 & \text{otherwise} \end{cases} .$$

^{*}This is also quite compatible with existing estimates (e.g., see Ref. 21). McGillivray (Ref. 2) concluded, "Based on our work and the work of others, we conclude that the short-run price elasticity of demand for gasoline is of the order of magnitude of -0.10 to -0.30 on an annual basis in the sort of market there has been over the past 20 or so years."

The same may be done for each time period resulting in the addition of $t + m - 2$ (where there are t time periods and m units) dummy variables. Where only significant cross-sectional effects are suspected, the time dummies are simply omitted as was done here.* The coefficients of the dummy variables represent specific intercept terms for each state, but the slope coefficients are assumed to be identical for all states. That is, we are in fact estimating a set of parallel regression planes, one for each state which differ only by the fact that some are shifted upward or downward with respect to the reference state whose state effect is assumed to be zero. It is obviously important to select a reference state with desirable properties. We looked for the state which most closely approximated the average household consumption levels of the nation as a whole. On the basis of minimum sum of squared deviations from the U.S. average consumption levels over the ten-year period, Wisconsin was chosen as by far the most representative state. It averaged a deviation of $\pm 1.5\%$ of the national average, and in no year did it deviate by more than 4%. Thus the state effects may be reasonably considered deviations from the national average.

Maddala^{22,23} has shown that under certain conditions the VC and LSDV estimators are identical.** For simplicity, consider a single variable VC model in which only cross-sectional unit effects are present:

$$Y_{it} = bx_{it} + U_i + W_{it}, \quad i = 1, \dots, 51, \quad t = 1, \dots, 10.$$

*Time dummy variables for even the embargo years of 1973 and 1974 proved not to be significant in earlier regressions on the time-series, cross-sectional data.

**This discussion closely follows Maddala's exposition in Ref. 21.

According to the VC model, both U_i and W_{it} are independent random variables. However, the residual term is $V_{it} = U_i + W_{it}$ and residuals within the same cross-sectional unit will therefore be correlated with each other but uncorrelated with residuals of other cross-sectional units. That is,

$$\text{cov}(V_{it} V_{is}) = \sigma_u^2 + \sigma_w^2 \quad \text{for } t = s ,$$

$$\text{cov}(V_{it} V_{is}) = \sigma_w^2 \quad \text{for } t \neq s ,$$

$$\text{cov}(V_{it} V_{js}) = 0 \quad \text{for all } t, s \text{ when } i \neq j .$$

The ordinary least-squares (OLS) estimator would give an inefficient estimate of b in this case because the residuals are correlated as we have just shown. Therefore the generalized least-squares (GLS) estimator must be used²⁴ to get efficient estimates. In this single variable case, the GLS estimator of b can be written simply as

$$\hat{b}_{\text{GLS}} = \frac{W_{xy} + \theta B_{xy}}{W_{xx} + \theta B_{xx}} ; \theta = \frac{\sigma_w^2}{\sigma_w^2 + t\sigma_u^2} .$$

W is the sum of squares within cross-sectional units summed over all units while B represents the between units sum of squares. That is,

$$W_{xy} = \sum_i \sum_t (x_{it} - \bar{x}_i)(y_{it} - \bar{y}_i) ,$$

where $\bar{x}_i$ and $\bar{y}_i$ are the sample means for the i^{th} group. If we define the total sum of squares for x, y as

$$T_{xy} = \sum_i \sum_t (x_{it} - \bar{x})(y_{it} - \bar{y}) ,$$

where $\bar{x}$ and $\bar{y}$ are the total sample means, then

$$B_{xy} = T_{xy} - W_{xy} .$$

Now the LSDV estimator of b is given by

$$\hat{b}_{\text{LSDV}} = \frac{W_{xy}}{W_{xx}}$$

so that if $\theta \approx 0$, the LSDV estimator and the GLS estimator in the VC model will be approximately equal. Although the VC estimation procedure we used included a time component, its variance proved to be very small so that we can do a reasonable check of $\theta \approx 0$ using σ_u^2 and σ_w^2 only. Plugging in the numbers for the linear VC equation* we get

$$\theta = \frac{0.0011}{0.0011 + (10)0.0116} = 0.0094 .$$

With θ so close to zero, the LSDV and variance component estimators should be virtually identical. The LSDV model has the important advantage of being able to produce a set of quantitative estimates of state effects. These calculated state effects are time invariant. It is assumed that they have not changed over the ten-year period from 1966 to 1975. In general this will not be true because, as will be seen in the analysis of state effects, the factors upon which the levels of state effects depend are not all constant. The national household gasoline consumption rate increased about 15% over the period, and it is possible that the absolute value of states' deviations from the

*Though the actual numbers are different, the qualitative results apply to the log form of the equation as well.

predicted state consumption rates may have increased as well. If, as seems likely, the assumption of time invariance is not exactly correct, then what do the state effects (dummy variable coefficients) actually represent? By definition they are the difference of the state mean ($\bar{y}_i$) minus the predicted state mean ($\hat{b}_{LSDV} \bar{x}_i$),

$$U_i = \bar{y}_i - \hat{b} \bar{x}_i = \frac{1}{T} \sum_{t=1}^T (y_{it} - \hat{b} x_{it}) ,$$

that is, they are the average deviation of the actual state values from predicted state values over the entire 10-year period. Thus they might more accurately be termed *average state effects*.

6.3 Results of Estimation of the LSDV Demand Equation

The results of the estimation of the LSDV model were quite satisfactory (Tables 3 and 4). Both the linear and log-log models achieved an R^2 of 0.98; thus, no real improvement on these models is possible from the standpoint of statistical explanation. The coefficients of the log-log model are most easily interpreted as elasticities, and so they will be used when elasticities are discussed. However, the state effects of the linear model may be directly interpreted as thousands of gallons of gasoline per household per year above or below the national mean, and so they will be used for this purpose.

The regression results are presented below. Dummy variable coefficients from the linear form of the equation are presented in Table 3.

Table 3. Least Squares Dummy Variable Model — Linear Household Gasoline Demand Equation

DEPENDENT VARIABLE: CASPHH								
SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.	
MODEL	54	25.47068638	0.47167939	357.24	0.0001	0.977948	2.5223	
ERROR	435	0.57434874	0.00132034				GASPHH MEAN	
CORRECTED TOTAL	489	26.04503562			STD DEV	0.03633651	1.43491503	
PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE				
INTERCEPT	1.24501162	13.45	0.0001	0.09255858				
DPRICE	-0.58784058	-20.73	0.0001	0.04765732				
OWN	0.39507317	11.76	0.0001	0.03359388				
SIZE	-0.20872696	-11.33	0.0001	0.01842923				
DRHM	0.08795050	4.19	0.0001	0.02098342				
DINCOME	0.00002506	7.90	0.0001	0.00000317				
PCTRUCK	0.55165478	3.04	0.0025	0.18137235				
X2	0.06125054	2.75	0.0062	0.02226977				
X3	0.09383570	2.96	0.0032	0.03168120				
X4	0.04752656	2.07	0.0392	0.02297269				
X5	-0.16156874	-9.58	0.0001	0.01651290				
X6	-0.13828254	-6.22	0.0001	0.02220752				
X7	-0.17722006	-7.55	0.0001	0.02348536				
X8	-0.21085384	-5.40	0.0001	0.03907346				
X9	0.09025705	4.75	0.0001	0.01883826				
X10	-0.09066754	-4.86	0.0001	0.01866272				
X11	0.16073673	8.78	0.0001	0.01825890				
X13	-0.10706066	-5.35	0.0001	0.02001957				
X14	-0.05777046	-1.72	0.0865	0.03362482				
X15	-0.11045255	-5.16	0.0001	0.02140982				
X16	0.06155369	3.56	0.0004	0.01729129				
X17	-0.21555574	-8.18	0.0001	0.02640716				
X18	0.02646661	1.22	0.2237	0.02172281				
X19	0.00499237	0.26	0.7951	0.01521034				
X20	-0.05311605	-2.59	0.0099	0.02049040				
X21	-0.01057875	-0.59	0.5547	0.01857173				
X22	0.15645929	8.56	0.0001	0.01833714				
X23	0.05015327	2.68	0.0076	0.01866860				
X24	-0.02330419	-1.27	0.2050	0.01836027				
X25	0.06363268	3.27	0.0012	0.01544691				
X26	0.17645615	6.80	0.0001	0.02593870				
X27	-0.08572796	-2.17	0.0307	0.03954188				
X28	0.09838142	5.00	0.0001	0.01566797				
X29	-0.30661245	-6.97	0.0001	0.04397418				
X30	-0.09711945	-3.94	0.0001	0.02461957				
X31	0.08452738	5.15	0.0001	0.01647743				
X32	-0.09353641	-4.20	0.0001	0.02225935				
X33	0.30047643	9.68	0.0001	0.03102810				
X34	0.17554291	7.95	0.0001	0.02207394				
X35	-0.19395571	-7.01	0.0001	0.02766915				
X36	-0.07602389	-3.80	0.0002	0.02003049				
X37	-0.05695294	-2.12	0.0348	0.02691607				
X38	-0.07324685	-3.85	0.0001	0.01901781				
X39	-0.21353284	-11.60	0.0001	0.01840968				
X40	-0.18678227	-9.66	0.0001	0.01934079				
X41	0.21371562	11.10	0.0001	0.01925165				
X42	-0.02990273	-0.89	0.3762	0.03375845				
X43	0.09176466	5.13	0.0001	0.01788833				
X44	0.12524127	6.06	0.0001	0.02065355				
X45	0.07145286	2.46	0.0142	0.02902209				
X46	0.10232852	6.13	0.0001	0.01669557				
X47	0.20680418	12.47	0.0001	0.01658262				
X48	-0.20274772	-10.41	0.0001	0.01947214				
X50	-0.07585663	-3.62	0.0003	0.02098656				
X51	0.27950132	7.21	0.0001	0.03878795				

Table 4. Least Squares Dummy Variable Model - Log-Linear Household Gasoline Demand Equation

STATISTICAL ANALYSIS SYSTEM

22:21 WEDNESDAY, NOVEMBER 16, 1977

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LGASPHH

SOURCE	DF	SS OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	54	13.40261045	0.24819649	411.53	0.0001	0.990801	7.0647
ERROR	435	0.26235024	0.00060310		STD DEV		LGASPHH MEAN
CORRECTED TOTAL	489	13.66496028			0.02455818		0.34761683

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE
INTERCEPT	-2.57252825	-8.34	0.0001	0.30842884
LDPRICE	-0.33581331	-20.61	0.0001	0.01605813
LOWN	0.49130786	11.82	0.0001	0.04157733
LDINCOME	0.30713934	9.82	0.0001	0.03226183
LDRHH	0.11485300	4.16	0.0001	0.02759605
LPCTRUCK	0.04277489	2.02	0.0437	0.02114645
Lsize	-0.47000456	-11.84	0.0001	0.03970111
X2	0.05565475	3.63	0.0003	0.01540201
X3	0.10388807	5.83	0.0001	0.01877925
X4	0.04710027	1.12	0.0019	0.01511100
X5	-0.11884632	-10.44	0.0001	0.01137884
X6	-0.07864834	-5.33	0.0001	0.01476918
X7	-0.13398193	-7.40	0.0001	0.01811266
X8	-0.16736163	-5.00	0.0001	0.03347793
X9	0.05633170	4.45	0.0001	0.01264996
X10	-0.06839496	-5.41	0.0001	0.01263946
X11	0.10565639	8.45	0.0001	0.01251158
X13	-0.06225035	-4.88	0.0001	0.01260182
X14	-0.00099240	-0.05	0.6603	0.01592446
X15	-0.09106499	-6.25	0.0001	0.01447841
X16	0.04748041	3.55	0.0001	0.01189386
X17	-0.12178845	-7.15	0.0001	0.01648923
X18	0.03200184	2.13	0.0339	0.01503521
X19	0.00976153	0.45	0.4535	0.01301020
X20	-0.04655319	-2.56	0.0032	0.01587836
X21	-0.01458259	-1.17	0.2414	0.01277180
X22	0.12045680	9.64	0.0001	0.01246586
X23	0.02956082	2.15	0.0193	0.01259113
X24	-0.00967375	-0.77	0.4414	0.01255337
X25	0.05690390	4.11	0.0001	0.01319876
X26	0.14335175	8.81	0.0001	0.01627612
X27	-0.01087661	-0.46	0.6216	0.02201932
X28	0.07575658	5.64	0.0001	0.01342932
X29	-0.14711902	-5.98	0.0001	0.02460863
X30	-0.04518285	-2.90	0.0040	0.01560186
X31	0.05862705	5.26	0.0001	0.01113850
X32	-0.07839214	-4.72	0.0001	0.01661643
X33	0.20385042	10.59	0.0001	0.01924690
X34	0.11072400	7.21	0.0001	0.01455695
X35	-0.19061850	-8.74	0.0001	0.02181786
X36	-0.06031812	-4.17	0.0001	0.01445774
X37	-0.01534671	-0.61	0.3627	0.01684339
X38	-0.04244020	-3.26	0.0012	0.01303208
X39	-0.17667576	-13.67	0.0001	0.01265101
X40	-0.15601388	-11.10	0.0001	0.01405490
X41	0.14754470	11.82	0.0001	0.01207626
X42	0.01303769	0.66	0.5100	0.01377454
X43	0.07183705	5.67	0.0001	0.01224586
X44	0.08464686	6.05	0.0001	0.01398547
X45	0.06834580	3.65	0.0003	0.01870373
X46	0.07261840	6.44	0.0001	0.01127954
X47	0.14375758	12.60	0.0001	0.01123675
X48	-0.13435623	-10.04	0.0001	0.01238213
X50	-0.04538665	-3.20	0.0015	0.01416441
X51	0.18090786	8.43	0.0001	0.02146242

Linear form:

$$\begin{aligned} \text{GASPHH} = & 1.245 - 0.988 * \text{PRICE} + 0.025 * \text{INC} + 0.395 * \text{OWN} \\ & (0.001) \quad (0.001) \quad (0.001) \quad (0.001) \\ & - 0.209 * \text{SIZE} + 0.088 * \text{DRHH} + 0.552 * \text{PCTRUCK} + \sum_{i=1}^{48} c_i d_i . \\ & (0.001) \quad (0.001) \quad (0.002) \end{aligned}$$

$$R^2 = 0.978 .$$

A prefix L indicates the natural logarithm of a variable.

Log-linear form:

$$\begin{aligned} \text{LGASPHH} = & -2.572 - 0.336 * \text{LPRICE} + 0.307 * \text{LINC} + 0.491 * \text{LOWN} \\ & (0.001) \quad (0.001) \quad (0.001) \quad (0.001) \\ & - 0.470 * \text{LSIZE} + 0.115 * \text{LDRHH} + 0.043 * \text{LPCTRUCK} \\ & (0.001) \quad (0.001) \quad (0.05) \\ & + \sum_{i=1}^{48} c_i d_i . \\ R^2 = & 0.981 , \end{aligned}$$

where

GASPHH = annual highway gasoline use per household,

PRICE = gasoline price in constant 1975 cents,

INC = deflated personal disposable income,

OWN = registered gasoline powered vehicles per household,

SIZE = household size,

DRHH = licensed drivers per household,

PCTRUCK = gasoline powered trucks as a percent of gasoline powered
registered vehicles.

The coefficients of all variables but price are virtually identical to those of the VC model. This difference in the estimated price coefficient though not particularly great is probably attributable to

the omission of time effects and all spatial variables from the LSDV model as well as to a slightly different set of explanatory variables. Just as in the VC model, the elasticity estimates are all quite reasonable (see Refs. 2 and 25). The price elasticity of -0.33 is on the high end of the range of previous estimates, but then the period in question includes recent years when prices changed considerably whereas other studies do not include this period. The elasticity of ownership is 0.49 , suggesting that a 10% increase in ownership rates would cause a 5% increase in gasoline consumption. The income elasticity of 0.31 indicates that a 10% increase in real disposable income would cause consumption to rise by 3%. The elasticity of drivers per household is, once again, positive while that of family size is negative. This appears to support the hypothesis that, holding income and number of drivers constant, an increase in family size will cause a substitution of purchases toward other necessities and away from travel. That is, additional nondriving family members exert a greater demand for nontravel purchases than for travel. Finally, as the truck share of the vehicle fleet increases, gasoline consumption tends to increase, probably because of the greater fuel intensity of trucks.

Spatial variables had even less success in the LSDV equation than in the VC model. It appears that all significant spatial influences have been captured in the state effects dummy variables. Due to lack of significant explanatory power, all spatial variables were dropped from the LSDV estimation of the final forms of the equations. The omission of these variables, that is their representation by a single dummy variable instead, may also have contributed a small amount to

differences in the values of estimated coefficients. All but 6 of the 48 state-effect coefficients are significant at the 0.05 level.

The state effects estimates are listed in Table 5. They range from a high of +300 gal for New Mexico to a low of -307 gal for North Dakota. Other states on the very low side were Kansas, Pennsylvania, Washington, New York, Rhode Island, Connecticut, and the District of Columbia. States on the very high side included South Carolina, Vermont, Wyoming, Georgia, Mississippi, Nevada, and Maine. Figure 9 is a map of state effects.

An analysis of the goodness of fit of the time-series cross-sectional models using graphical techniques revealed their clear superiority to ordinary least-squares approaches. Plots of observed vs predicted values of gasoline per household and gasoline per vehicle (calculated by dividing predicted gas per household by observed vehicle ownership rates) demonstrate an excellent linear fit of model to data (Figs. 10 and 11). The linearity displayed by the data is striking. Residuals plots against income, however, are the most satisfying (Figs. 12 and 13). Not only is the range of error greatly reduced (almost all observations for all states for every year lie between ± 100 gal of the predicted value) but the residuals for individual states are far more randomly distributed about zero. Once again both the linear and log-log forms appear to fit the data equally well. The residuals analysis serves to confirm the initial impression based on high levels of R^2 that state effects have been adequately captured by the LSDV model. Furthermore, from a statistical viewpoint, the model provides an outstanding fit to the data. In our opinion this is the single best model that we produced.

Table 5. Estimated Average State Effects

State	10 ³ gallons	State	10 ³ gallons
AK		MS	0.17645619
AL	0.06125054	MT	0.08572796
AR	0.09383970	NC	0.09838142
AZ	0.04752656	ND	0.30661245
CA	-0.16196874	NE	-0.09711945
CO	-0.13828254	NH	0.08492738
CT	-0.17722006	NJ	-0.09353641
DC	-0.21085384	NM	0.30047643
DE	0.09025705	NV	0.17554291
FL	-0.09060754	NY	-0.19398571
GA	0.16073073	OH	-0.07602389
HI		OK	-0.05699294
IA	-0.10706066	OR	-0.07320685
ID	-0.05777046	PA	-0.21353284
IL	-0.11045259	RI	-0.18678227
IN	0.06159369	SC	0.21371562
KS	-0.21598974	SD	-0.02990273
KY	0.02646661	TN	0.09176469
LA	0.00499237	TX	0.12524127
MA	-0.05311605	UT	0.07145286
MD	-0.01097875	VA	0.10232852
ME	0.15699929	VT	0.20680418
MI	0.05015327	WA	-0.20274772
MN	-0.02330419	WI	0.00000000
MO	0.06363268	WV	-0.07589663
		WY	0.27950132

GALLONS ABOVE AND BELOW NATIONAL MEAN
(INTERVALS = 10% OF NATIONAL MEAN, 1975)

Fig. 9. Estimated State Effects.

Fig. 10. Observed (GASPHH) vs Predicted (PGASPHH) Values of Dependent Variable — LSDV Linear Form.

Fig. 11. Observed (GH) vs Predicted (PGH) Values of Dependent Variable — LSDV Log-Linear Form.

Fig. 12. Residuals (RGASPHH) vs Income (DINCOME) — LSDV Linear Form.

The demand model specification adopted here does not allow variable coefficients to vary from state to state. Instead, we have assumed that once such factors as income, demographic factors, and the travel environment have been accounted for, the aggregate response to such factors as a price change will not vary across states. In the linear model this implies, for example, a constant price slope. In the log-linear model it implies a constant price elasticity across states. We believe that this assumption has considerable intuitive appeal. In essence it posits that if we were to take a New Yorker and move him to Tennessee, he would drive in very much the same way that Tennesseans do. However, it should be acknowledged that our assumption has never been established empirically and is thus arguable.²⁶⁻²⁷ Additional, careful research is needed to shed some light on the issue.

Our analysis thus far has led us to one overwhelming conclusion: *important state-to-state differences exist in gasoline consumption which are not attributable to ownership rates, rates of licensed drivers, household size, differences in fuel prices or income, or even to the truck-automobile breakdown of the vehicle fleet.* These differences are large relative to total consumption rates — in some cases on the order of 30%. Apart from this major conclusion, *we hypothesize that these state effects are attributable in large part to state spatial structure and degree of urbanization.* They are also due to the effects of the automobile fleet mix of small and large cars, the population age structure of the state, its major economic activities, and the supply of highways and other types of personal transportation. Last but not least, *in the case of a few states there are likely to be significant within-state*

purchases of gasoline by out-of-state vehicles resulting in sizable net exports of gasoline to out-of-state vehicles. This may be due to tourism in a small state such as Wyoming or due to through freight in a state such as Delaware. The following chapter explores these possible relationships in further analyses. The main challenge is finding variables which accurately capture isolated influences. In fact, it was the lack of just such variables which forced us to use the LSDV approach to estimate the demand equation in the first place.

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7. ANALYSIS OF TIME-INVARIANT STATE DEVIATIONS FROM AVERAGE NATIONAL GASOLINE CONSUMPTION RATES

7.1 Introduction

Many factors influence household gasoline demand other than fuel prices, incomes, numbers of vehicles (truck and auto), drivers, and household size. Important influences on travel behavior which vary significantly from state to state include whether or not the majority of the state population lives in urban or rural environments, whether most travel is under congested or uncongested conditions, whether small cars or pick-up trucks are commonly owned vehicles, and even whether or not climatic conditions often impede travel. One has only to imagine what the difference between an average trip to the grocery store in New York and one in Wyoming might be to begin to appreciate the importance of environmental influence on travel behavior.

Our analysis of gasoline consumption began with the hypothesis that states' demands were determined by traditional economic factors such as prices and incomes; in addition, certain other characteristics largely related to the travel environment play an important role. This constellation of relevant factors was represented in Fig. 1. In the process of estimating the demand equation for gasoline, it was discovered that good estimates of key price and income coefficients could not be obtained without adequately accounting for state-specific consumption effects associated with spatial structure, climate, and other factors. Because of the complex relationships between these effects and because the available measures of these state-specific characteristics were usually only proxies for desired but unavailable

data, we employed a set of state dummy variables to capture the state effects on gasoline consumption. From a statistical viewpoint, this procedure worked extremely well. However, the problem of identifying and quantifying relationships between state characteristics not included in the demand equation and the estimated state effects remained. Our estimated demand equation accounted for the influences of varying prices, incomes, vehicle ownership rates, licensed driver rates, household size, and the truck-automobile fleet composition on household gasoline consumption. The state dummy variables soaked up virtually all the remaining variation in the time series cross-sectional data and gave an R^2 of 0.98.

Thus, the state effects can be thought of as resulting from all those state-specific determinants of gasoline use left out of the demand equation. We can explain these relationships most succinctly by constructing an exact equation for state effects. State household gasoline consumption can be expressed as simply the product of average household vehicle miles of highway travel (T) and the average fuel intensity (I) of highway travel, $GASPHH = TI$. Thus the deviation of a state's consumption levels from those predicted by the national demand function can be expressed in terms of deviations (Δ) in its VMT and intensity. Signifying the expected demand with a bar we have:

$$\begin{aligned}\Delta GASPHH &= TI - \bar{T}\bar{I} \\ &= (\bar{I} + \Delta I)\Delta T + \bar{T} \Delta I .\end{aligned}$$

Of course, T and I are themselves functions of state characteristics. In particular, efficiency should depend on the fleet mix (f) and its

associated average mpg on congestion (c) which is the ratio of urban, stop-and-go driving to freely flowing traffic conditions and on physiographic influences, topography (t) and altitude (a). Thus we have

$$I = I(f, c, t, a) .$$

VMT will likewise depend on several factors including average trip length (l) and trip rates (r), and on modal split (m) which represents the percent of all travel made by automobile and other modes. In addition, we posit that severe winter weather (w) will inhibit travel. Thus,

$$T = T(l, r, m, w) .$$

The relationships of all these variables to I and T are fairly well known, at least with respect to the direction of influence. Greater proportions of smaller, more efficient cars will decrease fuel intensity (f^-); the opposite applies to less efficient vehicles such as trucks. Congestion increases intensity (c^+), as do mountainous topography (t^+) and higher altitudes (a^+). Longer average trip lengths (l^+) and greater trip rates (r^+) increase VMT, while a greater diversion of travel to other modes (m^-) reduces auto VMT.

If we were dealing with states in isolation, our theoretical analysis would be finished (for present purposes). But states do not exist in isolation, and a significant amount of travel crosses state lines. In numerous instances, metropolitan areas extend across state boundaries so that even the journey to work may traverse boundaries.

The resulting sales of gasoline to out-of-state vehicles cannot be expected to balance purchases by state vehicles in other states in all cases. Thus a state will have a net export of gasoline to vehicles registered in other states. The size of this export will not necessarily depend directly on the state characteristics described above. The level of tourist activity, quantities of freight shipments, and the state's location relative to important interstate routes are likely to be among the most important factors. Daily commutation across state lines would be another, but no such data could be discovered. We would expect exports to be most important in states with heavily travelled interstate routes but very small indigenous populations. Under such conditions, the impact of exported gasoline on measured household consumption levels could be dramatic.

There is another important factor which has nothing to do with gasoline demand itself but rather with the states' method of reporting gasoline sales. Every state provides for refunds or special accounting of gasoline used off the highway. The most significant off-highway use is in agriculture (50% of all nonhighway gasoline in 1975), with marine use far behind (23% in 1975).²⁸ Since gasoline taxes are intended primarily as user taxes collected to maintain and expand the road network, farmers may apply for tax refunds for gasoline used for agricultural purposes. In predominantly agricultural states, the quantity of gasoline for which refunds are granted can be substantial. In 1975 the five states with the highest percentage of agricultural gasoline to total gasoline use were North Dakota (27.8%), South Dakota (18.2%), Iowa (10.6%), Wyoming (8.8%), and Nebraska (8.2%).²⁹ Even

in Illinois with its large urban population almost 4% of all gasoline used was for agricultural purposes.

The effect of the level of agricultural activity on gasoline consumption data may be twofold. First, the use of gasoline in transportation of agricultural workers and products on the farm itself is not included in our measure of gasoline consumption. Recall that our measure is *all* highway gasoline consumption (by all gasoline consuming vehicles), and thus business use of gasoline is included — consumption is not restricted to household use alone. We have attempted to correct for this somewhat by including the percent truck composition of the fleet as an explanatory variable in the demand equation. This is a crude attempt indeed because many trucks are used by households for personal transportation, and many automobiles are operated in business fleets. Thus, to a large degree, we still have to account for highway gasoline consumption for business activities. We surmise that farming activities, especially where farms are very large, generate relatively little highway gas consumption within the state. Secondly, whereas other workers make their journey to work on highways and are thus subject to gasoline tax, many farmers travel to work predominantly on their own farms. Gasoline used in such travel is not reported as highway gasoline use by the states.

There are two remaining possibilities whose importance is not known but which deserve mention. First, it is not known to what extent gasoline claimed as used on the farm is actually consumed in household travel on the roadway. Once again this could be particularly important in states with large farms which have their own gasoline pumps. Where

individual vehicles such as pick-up trucks are used both on the farm and on the highway, the problems of keeping track of how much of each tankful went to each use would be quite burdensome for farmers. The simplest and most economically advantageous solution would be to report it all as agricultural use. FHWA makes no systematic attempt to adjust highway gasoline totals for such a possibility.³⁰ Second, it is possible that trip generation rates and average trip lengths are lower in agricultural regions. We had no evidence to document this one way or the other.

7.2 Statistical Analysis of State Effects

We can now construct an equation for state effects which includes all the factors described above.

$$\Delta \text{GASPHH} = \text{EFFECT} = [\bar{I} + \Delta I(f, c, t, a)] \Delta T(l, r, m, w) \\ + \bar{T} \Delta I(f, c, t, a) - E - A ,$$

where E and A stand for exported gasoline and household and/or highway gasoline counted as used in agriculture. If good measures of all the variables mentioned above were available to us and the exact form of the functions ΔI and ΔT were known, we could estimate the equation via nonlinear least squares. But we do not have good measures for these variables. In fact, the lack of adequate measures is what produced biased coefficient estimates in our original demand equations and forced us to adopt the dummy variable approach eventually selected to estimate the demand equation.

We have available a set of proxies that reflect the influences of the desired variables to some unknown degree. For this reason we decided not to attempt to estimate the equation for state effects in the precise form outlined above. Such apparent precision could be

misleading when we know in advance that we do not have the necessary variables, for such an approach would pretend greater accuracy than can be achieved. Instead we elected to estimate a simple linear equation as an approximation (a Taylor Series approximation) to the true functional form. *Great restraint should be exercised in interpreting the coefficients of the estimated equation.* Because of the limitations of the data and the fact that most variables are proxies for what we would like to be able to measure, estimated coefficients should be taken as indications of the direction, order of magnitude, and significance of the underlying factors. It is well known that the use of proxy variables tends to produce biased estimates. In general the coefficient of a single proxy variable in an equation will be biased towards zero.³¹ However, when there are many proxy variables in the equation, as is the case here, even this is not certain. An additional caveat is that this analysis is predicated on the assumption that our specification of the demand model (constant coefficients across states except for intercepts) is correct.

A further implication of the data limitations is that a very high R^2 value should not be expected. The approximate nature of the explanatory variables should preclude an extremely close fit between model and data. The fact that the original LSDV estimated demand equation may not have completely captured the effects of such factors as prices and income will compound the problem. Even the apparently exact variables present in the demand equation have their shortcomings. To summarize, the purpose of the state effects model is to identify the important factors determining household gasoline consumption rates,

to establish the order of magnitude of their effects, and to substantiate our theoretical explanation of the effects by means of the signs and significance levels of the coefficients.

7.3 Results of Regression Analysis

A determined effort was made to obtain data on variables which approximated as closely as possible the desired factors identified as important influences on state deviations from average national gasoline consumption rates. The fact that the estimated state effects are presumed constant over the period 1966-1975 suggests that the explanatory variables should be constant also. In general, neither will be. But since the time interval is reasonably short, the relative values of variables should not change drastically from year to year, and this is what is important. As a result, variables available for any year from 1966-75 could be used. All variables used in the final equation apply to the period 1970-75. The key factors and variables obtained and tested are reviewed below. In one or two instances very good measures were available; in one or two others no satisfactory measures were found.

7.3.1 Vehicles miles of travel

1. Trip length — While average trip length depends on a number of factors including climate, we believe that it depends most strongly on state spatial structure. Two categories of variables were considered as descriptors of state spatial structure: measures of population density (i), and degree of urbanization (ii). The first is a fairly straightforward attempt to capture the average

proximity of origins and destinations, an obvious influence on the length of trips. The second to some degree measures the same thing but undoubtedly also captures some of the impact of the availability of alternative transportation modes on the quantity of highway travel. Several measures for density and urbanization were tried. Percent of population living in SMSAs and the sum of rural and urban population densities weighted by their respective percent shares of the total state population performed the best.

2. Modal split — For a given level of travel demand, the more the demand is satisfied by nonhighway modes, the less the total highway travel. Also the greater vehicle load factors (more carpooling) the lower the total VMT. Modal split in the journey to work is available for states from the 1970 census. The variable used was the sum of percent shares for all modes except private car driver and taxi. This took load factors into account by including automobile passengers with all others who did not drive to work.
3. Trip frequency — Unfortunately, data were not available at the state level on annual trip frequencies. However, we hypothesize that climate is a major influence on trip rates. More specifically, we contend that severe winter weather will produce travel conditions which will significantly reduce the number of trips made. Three measures of winter severity were considered: (1) mean January temperatures, (2) average annual snowfall, and (3) mean days per year with below freezing temperatures. Days with freezing temperatures were selected, but they performed only slightly better than the other two variables.

Another important influence on the number of trips generated by the state's population is the age structure of that population. One study relating demographic and lifestyle factors to automobile usage and ownership indicated that the 18-44 year-old age group had considerably higher levels of auto usage than any other group.¹¹ While the percentage of population in this group does not vary greatly across states, it can be an important factor since it includes the larger part of the working age population.

7.3.2 Fuel intensity

1. Fleet mix — Detailed data on state automobile stocks are available from R. L. Polk and Company and could have been used to obtain precise indices of state fleet mixes. But the cost of such detailed data is prohibitive for this study, and so we resorted to the use of a crude proxy. Published data are available on total automobile sales and sales of foreign cars by state. Since almost all foreign cars sold are small and obtain high gasoline mileage compared with U.S. cars, the size of the foreign car fleet will have a positive relationship to the size of the small car fleet (this is especially true for the period prior to 1970). Unfortunately, this variable has a sizeable bias since consumers in coastal states buy many more foreign cars than those in the continental interior. This is due both to higher delivery costs and the lack of an adequately developed service network in the interior. Consequently, the variable should do well for coastal states but may seriously underrepresent the small car presence in midcontinent states.

On the other hand, the more light trucks in the vehicle fleet the higher the fuel intensity of travel will be. A measure of the percent of all vehicles used predominantly for personal transportation which are light trucks was estimated for 1975 using ORNL estimates of vehicles in the two categories for all states. This variable did not have a significant influence on the state effects. The apparent reason for this is that the demand equation has already corrected for the truck composition of the total vehicle fleet.

2. Physiographic factors — Both terrain and altitude are known to affect fuel consumption rates. Measures of terrain by states have been developed by Claffey,³² but no single terrain factor which represents the total effect of terrain could be found. A dummy variable for mountainous and nonmountainous states based on Claffey's terrain factors was tried but without success. Altitude measured in thousands of feet above sea level was entered as an explanatory variable but was similarly unsuccessful. Whether the failure of physiography to explain fuel consumption rates was due to the crudeness of the measures or to the actual lack of important impact is not known.
3. Congestion — As Environmental Protection Agency (EPA) estimates of fuel economy in urban and free flowing driving indicate, considerably lower fuel economy is achieved under congested driving conditions. The problem in obtaining a measure of congested driving conditions is separating the positive effect of congestion on fuel intensities from the negative effect of urbanization and higher densities on

VMT. In an attempt to separate these effects, the ratio of urban population to the supply of urban highway miles (weighted by the percent of all vehicle travel which takes place in urban areas) was entered as an explanatory variable. But this variable was highly correlated with degree of urbanization and is only a proxy for congestion. It was unsuccessful in separating the influence of congestion on fuel consumption from that of urbanization.

7.3.3 Export of gasoline

No statistics directly measuring travel within a state by out-of-state vehicles are collected. In fact, the state highway VMT statistics reported to the Federal Highway Administration (FHWA) are not disaggregated in any way. Figures on annual numbers of visitors to states are published by the U.S. Travel Data Center. However, the states' methods of collecting these data vary greatly from state to state. For example, many states count only out-of-state visitors while others include state residents who visit tourist attractions as well. Some states estimate tourist levels while others use actual visitor counts from tourist centers. We believe that a better variable is the Travel Data Center's data on expenditures by all travellers who make overnight stays within a state. While this measure is not perfect, it is at least consistent from state to state. For travellers making an overnight stay within the state, it consists of the sum of expenditures on public and auto transportation, food, lodging, entertainment and recreation, and incidental purchases. The numbers are derived from surveys conducted in 1974 by the Travel Data Center to update the National Travel Survey.³³

Another variable that was tried as a measure of through traffic was the number of interstate highway miles per household. It was reasoned that the level of through traffic would be positively related to the supply of interstate highways. However, the variable was not statistically significant.

7.3.4 Accounting of agricultural gasoline use

The percent of total employment in the agricultural sector was used as a measure of the level of agricultural activity in the state.

The important determinants of state deviations from the levels of household demand predicted by the LSDV demand model and the variables used to represent those effects are summarized in Table 6. Some, such as the agricultural variable, are reasonably precise measures. Others are only crude approximations. As a result, the coefficients of all variables in the equation may be biased to some degree. The results of our regression analysis should, therefore, be interpreted with caution. While we are confident of the signs and order of magnitude of the coefficients, the exact numeric values should be taken *cum grano salis*.

7.4 State Effects Regression Model

Results of the regression analysis of the linear state effects model are summarized in Table 7. All variables included in the final model are significant at the 0.01 level with the exception of the intercept term, which is significant at the 0.10 level. Given all the reasons why a high level of statistical explanation should not be expected of this model, the R^2 of 0.63 is quite satisfactory. To

Table 6. Determinants and Variables Included
in the State Effects Equation

Determinants		Variables
VMT	Trip length	Weighted average of urban and rural densities (WTDEN) Urbanization (PCSMSA)
	Trip frequency	Climate — days below freezing (FREEZE) Percent of population 18-44 yrs. — (MIDAGE)
	Modal split	Journey-to-work modal split Urbanization (PCSMSA)
	Fleet mix	Foreign cars, % (PCFOR) Light trucks for personal use, %
Fuel intensity	Physiography	Altitude Terrain
	Congestion	Urban population per urban highway miles, weighted by percent urban travel
Gasoline export	Travel by out-of-state vehicles	Tourist expenditures (TOUR) Interstate highway miles per household
Accounting of agricultural gasoline use	Agricultural activity	Percent employment in agricultural sector (AGRIC)

Table 7. State-Effects Regression Model

DEPENDENT VARIABLE: EFFECT							
SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	7	0.60749131	0.08578447	9.97	0.0001	0.629928	1495.3313
ERROR	41	0.35689149	0.00870467		STD DEV		EFFECT MEAN
CORRECTED TOTAL	48	0.96438281			0.09329882		-0.00623934
PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > T	STD ERROR OF ESTIMATE			
INTERCEPT	-0.65559003	-1.73	0.0920	0.37993286			
PCFOR	-1.98100995	-3.95	0.0003	0.50132534			
WTAVEDEN	-0.03894809	-3.84	0.0004	0.01013907			
PCSM5A	-0.40672414	-4.64	0.0001	0.08763265			
TOURISM	0.19909148	2.86	0.0066	0.06956198			
MIDAGE	3.44907051	3.48	0.0012	0.99222869			
FREEZE	-0.00077645	-2.55	0.0147	0.00030472			
AGRIC	-1.25784768	-4.56	0.0001	0.41645964			

review, the potential sources of residual error in this model are the following:

1. Errors in the estimation of the dependent variable (state effects).
The dummy variable coefficients are random variables and may be expected to deviate from their expected value. Estimation error may also have resulted from errors in the other explanatory variables in the demand equation or from the reasonable but inaccurate assumption that state effects are constant over time.
2. Errors in explanatory variables in the state effects equation itself and from the omission of explanatory variables which belong in the equation.
3. Errors resulting from the approximation of the true functional form of the equation by a linear estimating form.

Number 2 also implies that the coefficient estimates will be biased to some degree. As a result, we strongly recommend that no great significance be attached to the exact numerical values of coefficients. Only the orders of magnitude, signs and approximate significance levels can be meaningfully interpreted. Despite all these important caveats, the results are quite enlightening.

The most important inference which can be drawn from these results is that they strongly support our theoretical explanation of the determinants of state-specific deviations from average national consumption levels. *All variables are significant and, more importantly, all signs are in accord with theory. Foreign car share of the fleet (PCFOR), density (WTDEN), urbanization (PCSMSA), agricultural employment (AGRIC), and freezing temperatures (FREEZE) all have significant negative*

impacts on state levels of gasoline consumption. The level of tourism (TOUR) and the fraction of the population from 18-44 (MIDAGE) have the expected positive impacts.

As has already been stressed, the estimated coefficients may be biased to some degree. Therefore, in interpreting the quantitative impacts of each variable one must keep in mind the fact that differences in order of magnitude only can safely be distinguished. Provided this crucial fact is kept in mind, we can derive some insights into the relative importance of each factor by calculating its impact in terms of annual gallons per household on each state. This can be done by multiplying the estimated coefficient for a variable times its value for a particular state. The resulting number is the weight a given variable contributes to the predicted level of gasoline use for a state. It can be interpreted directly as gallons of gasoline annually. The importance of a factor in determining state fuel consumption depends not only on the magnitude of its coefficient but also on the underlying variability of the factor itself across states. Thus, the variable weights in Table 8 give the best indication of the relative importance of different factors. The state dummy variable coefficient (the dependent variable) is EFFECT.

7.4.1 VMT

The two factors describing state spatial structure apparently also account for the effect of mode split. It appears that modal split is so closely related to density and urbanization that it is not significant in the equation when the other two are present.

Table 8. Variable Weights -- State Effects Model

STATE	EFFECT	WTPCFOR	WTWTDEN	WTPCSMSA	WTTOUR	WTRIDAGE	WTFREEZE	WTAGRIC
AK	.	-0.43352	-0.02127	-0.17910	0.183537	1.56776	-0.11802	-0.00934
AL	0.06125	-0.18512	-0.01831	-0.25045	0.032020	1.25422	-0.01553	-0.13856
AR	0.09384	-0.17402	-0.01062	-0.16095	0.055378	1.22761	-0.05047	-0.25767
AZ	0.04753	-0.28005	-0.02448	-0.30504	0.076990	1.29418	-0.01165	-0.05608
CA	-0.16197	-0.40516	-0.11202	-0.37643	0.076622	1.37471	-0.00466	-0.07251
CO	-0.13828	-0.32701	-0.06916	-0.32813	0.121563	1.43338	-0.12889	-0.11138
CT	-0.17722	-0.29658	-0.05141	-0.37458	0.044796	1.29952	-0.10793	-0.02193
DC	-0.21085	-0.23407	-0.46488	-0.40672	0.168950	1.45478	-0.06212	0.00000
DE	0.09026	-0.21881	-0.08696	-0.28028	0.060037	1.37010	-0.07997	-0.05452
FL	-0.09061	-0.24146	-0.04362	-0.34025	0.133004	1.18523	-0.00155	-0.06337
GA	0.16073	-0.21731	-0.02134	-0.23143	0.055496	1.36604	-0.04659	-0.10033
HI	.	-0.57718	-0.07401	-0.33035	0.205743	1.43844	0.00000	.
IA	-0.10706	-0.13399	-0.01632	-0.15135	0.039319	1.41782	-0.10870	-0.33516
ID	-0.05777	-0.28319	-0.00646	-0.06854	0.087620	1.22120	-0.09783	-0.25305
IL	-0.11045	-0.14895	-0.09420	-0.33147	0.049072	1.25700	-0.09706	-0.06752
IN	0.06159	-0.13294	-0.03235	-0.26824	0.040156	1.31393	-0.09473	-0.12252
KS	-0.21599	-0.17268	-0.02795	-0.17457	0.049716	1.29169	-0.08852	-0.21619
KY	0.02647	-0.16297	-0.04736	-0.18877	0.051028	1.29938	-0.07376	-0.21783
LA	0.00499	-0.18540	-0.04615	-0.25631	0.053620	1.38193	-0.00932	-0.09795
MA	-0.05312	-0.26992	-0.07291	-0.39225	0.062818	1.38244	-0.07997	-0.01491
MD	-0.01098	-0.23231	-0.09612	-0.34476	0.050096	1.37143	-0.07842	-0.04133
ME	0.15700	-0.26711	-0.00570	-0.12455	0.112060	1.24532	-0.12501	-0.10214
MI	0.05015	-0.11233	-0.06727	-0.33396	0.056819	1.33670	-0.11647	-0.06431
MN	-0.02330	-0.14431	-0.04347	-0.25829	0.098693	1.31066	-0.13510	-0.22472
MO	0.06363	-0.15968	-0.08886	-0.26002	0.059907	1.27521	-0.08075	-0.20138
MS	0.17646	-0.18153	-0.01370	-0.10680	0.039835	1.23643	-0.03882	-0.21834
MT	-0.08573	-0.24721	-0.01515	-0.09923	0.117427	1.27144	-0.12035	-0.23102
NC	0.09838	-0.20851	-0.01615	-0.18471	0.045790	1.37304	-0.06212	-0.15022
ND	-0.30661	-0.12563	-0.00899	-0.05172	0.083950	1.23993	-0.14442	-0.41511
NE	-0.09712	-0.15604	-0.04372	-0.18071	0.068831	1.27106	-0.10793	-0.32673
NH	0.08493	-0.32604	-0.01940	-0.20336	0.110751	1.32526	-0.13510	-0.03813
NJ	-0.09354	-0.23463	-0.10582	-0.37648	0.054718	1.25875	-0.08929	-0.01465
NM	0.38048	-0.25801	-0.02302	-0.13794	0.083987	1.32054	-0.09317	-0.10646
NV	0.17554	-0.29177	-0.04345	-0.32952	0.320908	1.36209	-0.14597	-0.03609
NY	-0.19359	-0.21593	-0.11632	-0.36152	0.044601	1.28873	-0.10715	-0.02979
OH	-0.07602	-0.15277	-0.05500	-0.32541	0.042474	1.10923	-0.09628	-0.07271
OK	-0.05699	-0.17829	-0.02622	-0.22541	0.056945	1.28450	-0.06367	-0.19834
OR	-0.07330	-0.37600	-0.03964	-0.24478	0.089252	1.11300	-0.03416	-0.13279
PA	-0.21353	-0.21075	-0.06895	-0.32757	0.045568	1.23833	-0.08929	-0.05646
RI	-0.18678	-0.26318	-0.04565	-0.37177	0.036418	1.22996	-0.09861	-0.01242
SC	0.21372	-0.20321	-0.02093	-0.19672	0.068792	1.36837	-0.05047	-0.13292
SD	-0.02990	-0.12610	-0.00904	-0.05972	0.086039	1.21047	-0.13355	-0.49076
TN	0.09176	-0.18408	-0.02690	-0.25697	0.050087	1.32428	-0.06289	-0.15934
TX	0.12524	-0.18606	-0.01611	-0.31930	0.055259	1.34090	-0.02718	-0.10258
UT	0.07145	-0.28316	-0.05183	-0.32220	0.111842	1.34178	-0.10637	-0.09344
VA	0.10233	-0.24321	-0.03901	-0.26708	0.051300	1.40088	-0.05435	-0.09140
VT	0.20680	-0.34529	-0.00077	0.00000	0.131645	1.32994	-0.13044	-0.15385
WA	-0.20275	-0.34376	-0.04517	-0.29080	0.078245	1.35746	-0.03882	-0.12105
WI	0.00000	-0.13458	-0.03859	-0.24675	0.067992	1.28823	-0.11569	-0.20134
WV	-0.07590	-0.18989	-0.01413	-0.15001	0.063471	1.22621	-0.07764	-0.13468
WY	0.27950	-0.22160	-0.00006	0.00000	0.165786	1.30257	-0.13433	-0.18013

1. Weighted average of rural and urban densities — Though the magnitude of this coefficient is small, its impact is considerable. Its influence on gasoline consumption in Wyoming is almost zero, whereas it reduces consumption in New York by roughly 10% of the national average.
2. Percent of population living in SMSAs — This variable likewise has considerable impact. The difference between Vermont (with no SMSAs) and Pennsylvania is roughly 25% of the national average consumption in 1975.
3. Mean annual days of below-freezing temperatures — The difference in impact of this variable on Georgia and North Dakota, for example, amounts to about 5% of the 1975 national average use.
4. Fraction of population between 18 and 44 years of age — While the magnitude of this coefficient is extremely large, the variation from state to state in the variable itself is not, and thus its impact is not as great as one might expect. The problems which can arise when coefficients are improperly interpreted is well illustrated by this variable. A change in this variable of from 40% to 0% would imply no gasoline consumption at all. But it would also imply virtually no working age population, an equally absurd possibility. In fact, the range of the variable is only about ± 0.05 , and the coefficient really only applies to this range. The difference between Florida, with a very low value, and Texas, with an above average value, is only about 10% of average national consumption in 1975.

7.4.2 Fuel intensity

The only fuel intensity variable which was consistently significant was percent foreign car composition of the fleet. We have already noted that this variable will systematically underrepresent the number of fuel efficient cars in midcontinent states. Not surprisingly, the largest differences in the impact of this variable are between coastal and interior states. Even between coastal states, however, there is a considerable impact. The difference between California (high) and Virginia (moderate) is roughly 10% of the 1975 national average household gasoline use.

7.4.3 Net export of gasoline

Only overnight-tourist expenditures per capita were statistically significant. The difference between Mississippi (low) and Wyoming (3rd highest behind Nevada and Hawaii) amounts to approximately 10% of national average consumption levels in 1975. There are only a few such extreme differences, however, with most states clustered within 2% or so of each other.

7.4.4 Agricultural gasoline use

The level of agricultural activity in a state has the greatest range of effect on gasoline consumption of all variables. Interpreted very crudely, the coefficient of this variable suggests that as the farm population increases, average household gasoline consumption will decrease by an amount of the same order of magnitude as average national household consumption. We conjecture that this is due to both the practice of granting tax refunds on gasoline used for agricultural

purposes and probably also to different transportation characteristics of farm households and the agricultural sector. This factor alone goes a long way toward accounting for the very large negative state effect of North Dakota. The difference between the impact of this variable on North or South Dakota (highest percent farm population) and Massachusetts (lowest except Alaska and Washington, D.C.) is approximately 30% of the 1975 average household consumption.

Clearly, variations in all the variables employed in this equation (i.e., spatial structure, agricultural activity, age structure, tourism, fleet mix, and even climate) can produce large variations in fuel consumption rates. Such factors as climate and spatial structure are clear examples of the impact of the travel environment on travel behavior. The overwhelming implication of this regression analysis is that differences in state characteristics can be responsible for very large differences in fuel consumption rates. The results strongly support our hypotheses about the factors causing these differences and thus lead us to conclude that our analysis is essentially correct.

7.5 Residuals Analysis

An analysis of residuals was conducted in order to further evaluate the goodness of fit between model and data and to test the reasonability of the assumptions underlying the regression model. Plots of observed vs predicted values of state effects were obtained and are presented in Fig. 14. This graph indicates no drastic problems with the use of a linear approximation as the functional form of the equation. It does, however, identify two states, North Dakota and Kansas, that are poorly

Fig. 14. Observed (GASPHH) vs Predicted (PGASPHH) State Effects.

fitted by the model. The dispersion of points is fairly large simply because over 30% of the variance remains unexplained. The reasons for this have been described in detail above.

Plots of residuals vs selected explanatory variables were also created to discover nonlinear relationships or dependence of variability on the levels of independent variables (heteroscedasticity). No striking nonlinearities are apparent, but there does appear to be some degree of heteroscedasticity. It seems that the variance of the error term decreases as urbanization and density decrease and that the variance increases with the level of agricultural activity (Figs. 15-17). In addition, it may be that variance also decreases with the percent foreign cars. Heteroscedasticity is a statistical problem which does not additionally bias the coefficient estimates but will tend to increase the variance of the estimators. Compared to the other statistical problems which have been enumerated above, this one is relatively insignificant. The interesting aspect of these graphs is that apparently the rural states are least explained by the model. This may be due to previously mentioned deficiencies in the explanatory variables. The rural-agricultural states tend to be in the continental interior where the percent foreign car serves least well as a proxy for small cars. In addition, they tend to be states with relatively low levels of total gasoline consumption (because of small resident populations). Therefore, their average household consumption rates are likely to be affected most strongly by through traffic. Our measure of this factor is admittedly crude (it does not even consider nontourist traffic).

Fig. 15. Residuals (REFFECT) vs Percent of Population in SMSAs (PCSMSA) — State Effects Model.

Fig. 16. Residuals (REFFECT) vs Weighted Population Density (WTAVEDEN) — State Effects Model.

Fig. 17. Residuals (REFFECT) vs Percent of Agricultural Employment (AGRIC) — State Effects Model.

These problems are being addressed by a follow-up study which will resolve the problems of proxy variables or, short of that, will address serious discrepancies on a state-by-state basis.

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8. CONCLUSIONS

This study has attempted to advance the understanding of why households in some states consume more highway gasoline than households in others. To our knowledge it is the first study to do so. While a few previous studies have utilized state-level data, their motivation has been to obtain better estimates of key national economic parameters such as income and price elasticities. This study extends the analysis of gasoline consumption to include factors which vary from state to state such as spatial structure, climate, and types of economic activities. In doing so, the spatial dimension has been introduced into the analysis of gasoline demand.

Because of the focus of this study we have gone beyond the estimation of a demand equation to quantitatively estimate state gasoline consumption effects. The estimation technique adopted enabled us to get unbiased estimates of the parameters of the demand equation and thus remove, as accurately as possible, the effects of those variables from the data. The remaining variation was partitioned into an average state deviation from its predicted value and a small, residual, unexplained variance. The average state effects represent state deviation from predicted values due to a set of other factors which could not be included in the equation because either no measures or only proxy measures were available for them. Apparently these other factors are correlated with the variables in the demand equation, especially income. By including only a few proxy measures of these other factors, some important variables were, in effect, excluded from the equation resulting in biased estimates of

the parameters of the demand equation. Rather than using the incomplete information available, we adopted an approach which assumed we knew nothing about the causes of these state effects. This not only enabled us to obtain good estimates of the parameters of the demand equation but also produced quantitative estimates of the impacts of these other variables which could be subjected to a separate analysis.

The estimates of the parameters of the demand equation are of some interest in themselves. In general, our results confirmed the results of previous investigators despite the fact that our study utilized more recent data. The best demand equation contained an estimated price elasticity of -0.33 and an estimated income elasticity of 0.31 . These fall into the upper range (in absolute value) of existing estimates, perhaps indicating a greater sensitivity to gasoline prices and gasoline as a share of the consumer budget in recent years. The estimated elasticity of automobile ownership of 0.49 suggests, for example, that a doubling of state ownership rates from one to two cars per household would be accompanied by a 50% increase in gasoline consumption. This obviously is indicative of the fact that multicar households use cars less intensively than those with only one car. The elasticity of drivers per household indicates that only about 10% of the increased travel demands of additional drivers are translated into increased gasoline consumption, *ceteris paribus*. The estimated effect of the elasticity of the percent truck composition of the fleet might be most easily interpreted as follows. Suppose gasoline-consuming trucks constitute 5% of the vehicle fleet and are twice as fuel intensive as automobiles. If an average group of cars comprising 10% of the fleet consume X gal

of gasoline, then the total consumption is $10.5X = 0.5(2X) + 9.5(X)$.

If the percent truck composition of the fleet doubles to 10% (total fleet size constant) then the total consumption will increase to $11X = 1(2X) + 0.9(X)$, roughly a 4.8% increase (our estimated elasticity says 4.3%). The elasticity of household size may seem rather large, but it must be remembered that the range of household sizes across states is not great [3.63 (Alaska) to 2.55 (Washington, D.C.)]. For illustration, if average state household size increased from 2.5 to 3.0, *holding income and drivers per household constant*, gasoline consumption would decline by 9%. In most cases both income and drivers per household will increase with household size, and the net effect can be positive.

The demand model also produced estimates of average (1966-75) state deviations from national consumption levels, correcting for state income, price, household size, ownership rates, drivers per household, and truck-auto fleet mix. These state effects ranged from -306.6 gal per household per year (-257.6 gal per vehicle per year) for North Dakota up to 300.5 gal per household per year (175.7 gal per vehicle per year) for New Mexico. We hypothesized that these average state effects resulted from state differences in annual VMT, fuel intensity of the vehicle fleet, the *net* export of gasoline to out of state vehicles, and the method of reporting agricultural gasoline use. A regression analysis gave strong support to this hypothesis. Household consumption rates were found to be negatively related to density, urbanization, agricultural employment, severe winter weather, and the small car share of the vehicle fleet. Positive relationships were found with the percent working age population and the levels of tourist expenditures per capita.

The conceptual structure of this investigation is captured in our diagram of gasoline consumption at the state level (Fig. 1). In this study we have attempted to explain and quantify as many of the complex linkages between spatial structure, physical geography, demography, technology, government policy, and the economics of gasoline consumption as possible. To accomplish this task, a successful demand equation was estimated relating gasoline consumption to key economic and demographic characteristics of states. While previous studies stopped at this point, we went on to estimate average state deviations from national consumption rates. We then proceeded to establish relationships between these state effects and a variety of state characteristics. In doing so we have gone a long way toward explaining why households in some states use more gasoline than those in others and, consequently, why per vehicle consumption rates vary from state to state. However, largely due to data limitations, important work remains to be done. We are presently pursuing a case study analysis of selected states in order to verify the general relationships identified in this study and to overcome some of the data limitations which were encountered in analyzing all states at once. We hope that we have broken some ground for further study of the spatial variations in transportation energy use.

Appendix A
DESCRIPTION OF DATA

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Appendix A

DESCRIPTION OF DATA

Automobiles in Operation. Domestic and Imports (actual units). These data were used in determining the base year (1966) fleet characteristics (percent domestic and foreign vehicles) for the fleet mix model. The national ratio of 4.79% foreign in 1966 was assumed to be applicable across states. For the years 1967-75, an iterative process of adding foreign sales and total sales and applying an annual scrappage factor was used. The percent foreign cars in 1975 was determined in this manner. Source for the various data: *Automotive News Market Data Book*, Detroit, Michigan, 1967-75 issues.

Bus Registrations, 1966-75 (actual units). Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics*, Washington, D.C., 1966-1975.

Climatological Factors. These data included mean January temperature, average annual inches of snowfall, and average annual days below freezing. The data on annual days below freezing were found to be slightly more significant than the other two. However, each of the three had coefficients and significance levels that were practically identical. Source: U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract*, 1976.

Density Measures. (A) Urban Area Density (i.e., persons per square mile in areas with greater than 50,000 population). Source: U.S. Department of Transportation, Federal Highway Administration, *National Functional System Mileage and Travel Summary*, Washington, D.C., 1977. (B) Gross Density - Persons per square mile by state. Source: U.S. Dept. of Commerce, Bureau of the Census, *Statistical Abstract*, 1976.

Fleeted Automobiles, 1975 (actual units). Source: The Motor Vehicle Manufacturers Association, *Motor Vehicle Facts and Figures '77*, Detroit, Michigan, 1977. The data on average annual VMT for fleeted vehicles (21,563 miles) was provided by Bobit Publishers, Redondo Beach, Calif. Lastly, the fleet fuel efficiency data (13.4 mpg) was provided by the National Association of Fleet Administrators, New York, N.Y.

Fuel Efficiency of Trucks by Weight Class. Source: Jack Faucett and Associates, *Trucking Activity and Fuel Consumption*, Washington, D.C., 1976.

Gasoline Prices. These data consist of average prices for 55 cities representing each of the states except Alaska and Hawaii. For the study, these values were assumed to be representative of the entire state. In instances where more than one city within a state was surveyed, the values were weighted according to population and a composite value was derived. Source: Platt's OIL GRAM Price Service, New York, N.Y., 1966-1975.

Highway Use of Motor Fuel by State, 1966-75 (gallons). Highway, use of gasoline by state is also included. Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics Summary to 75*, Washington, D.C., Table MF-226, 1966-1975.

Income Data (actual dollars). State-level cost of living factors derived by the Rand Corp. (Rand Corp., *Residential Energy Use: An Econometric Analysis*, 1973, p. 61) were applied to the per capita state disposable income in order to normalize prices and income across states. The Rand data developed for 1970 were checked for reasonableness using U.S. Bureau of Labor Statistics cost of living factors for sample metropolitan areas in 1975. Source for original disposable income data: Bureau of Economic Analysis, U.S. Bureau of the Census, "Per Capita State Disposable Income," Washington, D.C., 1966-1975.

Mode to Work. These data provide the percentage travel by mode and by state for 1970 (i.e., drive automobile, auto passenger, public transit, taxi, and other). Source: U.S. Bureau of the Census, *1970 Census of Population*, Washington, D.C., 1970.

Motor Vehicle Registrations by State, 1966-75 (actual units). U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics Summary to 1975*, Washington, D.C., Table MV-1, 1966-75.

New Vehicle Registrations - Foreign and Domestic, 1966-75 (actual units). Data for Oklahoma were not included beyond 1968. Consequently, the 1968-1975 Oklahoma data had to be estimated. Oklahoma registrations exhibited a fairly constant ratio to registrations in Texas during the 1965-1968 period. This ratio was assumed to remain constant through 1975, and the factor was applied to the Texas data to obtain data for Oklahoma. Source: *The Automotive News Market Data Book*, Detroit, Michigan, 1966-75 issues.

Number and Classification of Trucks and Tractor Trucks Registered, 1966-75 (actual units). The data used included total trucks registered and total diesel, butane, and other trucks registered. Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics*, Washington, D.C., Table MV-9, 1966-1975.

State Population and Age Structure, 1966-1975. The age groupings utilized were: <18, 18 to 44, 45 to 64, and >64. Source: U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract*, Washington, D.C., 1966-75.

Terrain Factor. This variable was represented by a dummy variable with a value of 1 for mountainous states and 0 for nonmountainous. The authors classified a state mountainous if 10% of its major transportation corridors (interstates, federal-aid-to-primary, and federal-aid-to-secondary roads) were judged mountainous. Source: Claffey, Paul, J., "Travel Estimates from Fuel Consumption Information," DOT-FH-11-7833, Washington, D.C., 1972.

Total Number of Households by States, 1966-1975. Source: U.S. Department of Commerce, Bureau of the Census, *Current Population Reports*, Households and Family Characteristics, Series P-20, 1966-75.

Total Number of Licensed Drivers by State (10^3), 1966-75. Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics Summary to 1975*, Washington, D.C., Table DL-1A, 1966-75.

Tourism. Data on total travel-related expenditures by state (10^3 dollars) were converted to per capita expenditures in order that a relative measure of the impact of tourism by state be developed. These data are U.S. Travel Data Center estimates based on the 1972 National Travel Survey. Source: U.S. Travel Data Center, *The Impact of Travel on State Economics - 1974*, Washington, D.C. 1975.

Trucks (10^3) and Truck Miles (10^6) by State, 1972. Source: U.S. Department of Commerce, Bureau of the Census, *Truck Inventory and Use Survey*, Washington, D.C., 1973.

Truck Vehicle Miles Traveled by Vehicle Size Classification and State, 1972. Source: U.S. Department of Commerce, Bureau of the Census, *Truck Inventory and Use Survey*, Washington, D.C., 1973.

Urban and Small Urban Road Miles and Urban Highway Miles. Urban areas are defined as areas with a 1970 census population of 5,000 or more; small urban are those with 5,000 to 49,999. For a more exact definition, see the original source. Urban highway miles include all freeways and expressways within the designated area. Source: U.S. Department of Transportation, Federal Highway Administration, *National Functional System Mileage and Travel Summary*, Washington, D.C., 1977.

Urban Population and Urban Land Area, Small Urban Population and Small Urban Land Area. Source: U.S. Department of Transportation, Federal Highway Administration, *National Functional System Mileage and Travel Summary*, Washington, D.C., 1977.

Urban/Rural Daily VMT (10^3). Source: U.S. Department of Transportation, Federal Highway Administration, *National Functional System Mileage and Travel Summary*, Washington, D.C., 1977.

Urbanization Measures. Population by state (10^3), population of cities of 100,000 or more (10^3), and population of SMSAs by state (10^3). Source: U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract*, Washington, D.C., 1966-1976.

Vehicle Miles Traveled by State (10^6). Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics Summary to 1975*, Washington, D.C., Table VM-2, 1966-1975.

Vehicle Scrappage Rates. Source: *Automotive News Market Data Book*, Detroit, Michigan, 1965-1975 issues.

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Appendix B

SELECTED STEPWISE REGRESSION MODELS

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Table 9. Simple Linear Model — Gasoline per Household

S T A T I S T I C A L A N A L Y S I S S Y S T E M

STEPWISE REGRESSION PROCEDURE FOR DEPENDENT VARIABLE GASPHH						
STEP 8	VARIABLE D INCOME REMOVED	R SQUARE = 0.73970079				
		DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
	REGRESSION	6	19.55320746	3.25886791	233.50	0.0001
	ERROR	493	6.88073402	0.01395686		
	TOTAL	499	26.43394149			
		B VALUE	STD ERROR	TYPE II SS	F	PROB>F
	INTERCEPT	1.14510589				
	DPRICE	-1.10519320	0.13106234	0.99243158	71.11	0.0001
	OWN	0.35148900	0.03046394	1.85797156	133.12	0.0001
	AGE	0.07293492	0.00914357	0.88802916	63.63	0.0001
	SIZE	-0.05341474	0.02743452	0.05290727	3.79	0.0521
	LICPC	0.24979416	0.04432838	0.44318861	31.75	0.0001
	PCMSA	-0.31422407	0.02839870	1.70871632	122.43	0.0001

ALL VARIABLES IN THE MODEL ARE SIGNIFICANT AT THE 0.1000 LEVEL.

Table 10. Simple Linear Model -- Gasoline per Vehicle

STATISTICAL ANALYSIS SYSTEM

STEPWISE REGRESSION PROCEDURE FOR DEPENDENT VARIABLE GASPV

STEP 9 VARIABLE SIZE REMOVED		R SQUARE = 0.41248523				
		DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
	REGRESSION	7	1.26597116	0.18085302	49.35	0.0001
	ERROR	492	1.80315970	0.00366496		
	TOTAL	499	3.06913086			
		B VALUE	STD ERROR	TYPE II SS	F	PROB>F
	INTERCEPT	1.28605858				
	DPRICE	-0.57401904	0.06737423	0.26603215	72.59	0.0001
	OWN	-0.23415803	0.02016046	0.49440888	134.90	0.0001
	DENSITY	0.02009640	0.00474026	0.06587213	17.97	0.0001
	AGE	0.03735097	0.00467755	0.23368767	63.76	0.0001
	LICPC	0.12262193	0.02286393	0.10541526	28.76	0.0001
	PCMSA	-0.15339233	0.01811047	0.26291588	71.74	0.0001
	PCTRUCK	0.15150584	0.07638913	0.01441704	3.93	0.0479

ALL VARIABLES IN THE MODEL ARE SIGNIFICANT AT THE 0.1000 LEVEL.

Table 11. Simple Log-Linear Model — Gasoline per Household

S T A T I S T I C A L A N A L Y S I S S Y S T E M

MAXIMUM R-SQUARE IMPROVEMENT FOR DEPENDENT VARIABLE LGASPHH

STEP 9 VARIABLE LMPG ENTERED

R SQUARE = 0.77979072

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	9	9.53038414	1.05893157	184.93	0.0001
ERROR	470	2.69133629	0.00572625		
TOTAL	479	12.22172043			
	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	3.45584557				
LDPRICE	-0.42076944	0.05018038	0.40261564	70.31	0.0001
LCWN	0.38994760	0.04447294	0.44024143	76.88	0.0001
LMPG	-0.04062895	0.02191890	0.01967451	3.44	0.0644
LDINCOME	-0.09441103	0.02882384	0.06143443	10.73	0.0011
LDEN	0.02497478	0.00631718	0.08950083	15.63	0.0001
LDRHH	0.37426503	0.05479197	0.26717437	46.66	0.0001
LAGE	0.09809222	0.01264772	0.34444071	60.15	0.0001
LPCTR LCK	0.19100626	0.02456980	0.34609663	60.44	0.0001
DUMMY	0.04220594	0.01358005	0.05531138	9.66	0.0020

Table 12. Simple Log-Linear Model — Gasoline per Vehicle

S T A T I S T I C A L A N A L Y S I S S Y S T E M

		MAXIMUM R-SQUARE IMPROVEMENT FOR DEPENDENT VARIABLE LGASPV				
STEP 9	VARIABLE LMPG ENTERED	R SQUARE = 0.43366271				
		DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
	REGRESSION	9	2.06084292	0.22898255	39.99	0.0001
	ERROR	479	2.69133629	0.00572625		
	TOTAL	479	4.75217921			
		B VALUE	STD ERROR	TYPE II SS	F	PROB>F
	INTERCEPT	3.45584557				
	LDPRICE	-0.42076544	0.05018038	0.40261564	70.31	0.0001
	LCWN	-0.61335240	0.04447294	1.07748862	188.17	0.0001
	LMPG	-0.04062895	0.02191890	0.01967451	3.44	0.0644
	LDINCOME	-0.09441103	0.02882384	0.06143443	10.73	0.0011
	LDEA	0.02497478	0.00631718	0.08950083	15.63	0.0001
	LDRHH	0.37426503	0.05479197	0.26717437	46.66	0.0001
	LAGE	0.09809222	0.01264772	0.34444071	60.15	0.0001
	LPCTRUCK	0.19100626	0.02456880	0.34609663	60.44	0.0001
	DUMMY	0.04220594	0.01358005	0.05531138	9.66	0.0020

Appendix C

DATA

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Table 13. Time-Series Cross-Sectional Data Base - Variables*

S T A T I S T I C A L A N A L Y S I S S Y S T E M																
OBS	ST	YEAR	HH	HMF	HMGAS	PCDI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPOP	A2
1	AK	1966	64.0	69592	67231	2957	108.0	.	108128	108.8	36577	311	830	1467059	265	105.0
2	AK	1967	64.0	72927	70396	3193	115.0	.	110382	113.1	34876	351	873	1467059	278	109.0
3	AK	1968	66.0	75600	66827	3368	115.0	.	123329	117.4	34201	554	908	1467059	285	108.0
4	AK	1969	72.5	84700	79991	3498	125.0	.	131407	121.7	39592	724	1152	1467059	296	120.0
5	AK	1970	79.0	99408	88864	3882	141.0	.	138759	126.0	43764	746	1387	1467059	302	132.0
6	AK	1971	84.0	105318	102242	4129	147.0	.	150655	133.0	48326	761	1469	1467059	315	141.0
7	AK	1972	86.0	109500	98041	4281	154.0	.	148756	140.0	47059	1490	1528	1467059	325	141.0
8	AK	1973	90.0	116729	107689	5021	161.0	.	172167	146.0	57040	1836	1628	1467059	330	146.0
9	AK	1974	94.0	150186	120035	5701	179.0	.	193598	151.0	66163	2110	2095	1467059	341	151.0
10	AK	1975	97.0	183517	148291	7609	208.0	.	225575	155.0	81857	2831	2560	1467059	352	160.0
11	AK	1976	109.0	219872	175084	8061	213.6	.	250435	167.5	92976	3037	3067	1467059	382	177.0
12	AL	1966	574.0	1331212	1246736	1889	1554.0	0.3248	1731836	2072.2	319476	8691	14890	131334	3526	1226.0
13	AL	1967	592.0	1390040	1256855	2004	1598.0	0.3297	1735179	2086.4	329713	10298	15950	131334	3458	1240.0
14	AL	1968	1006.0	1473165	1366642	2180	1614.0	0.3365	1806111	2100.6	352187	11576	16530	131334	3446	1239.0
15	AL	1969	1020.0	1556206	1436548	2351	1687.0	0.3340	1857338	2114.8	378680	13983	17030	131334	3440	1216.5
16	AL	1970	1034.0	1655662	1527691	2572	1740.0	0.3523	1965932	2129.0	399028	14870	19754	131334	3444	1194.0
17	AL	1971	1075.0	1772744	1627315	2770	1801.0	0.3562	2092971	2054.0	428556	15970	21164	131334	3482	1250.0
18	AL	1972	1116.0	1900473	1735271	2999	1806.0	0.3679	2227293	2068.0	472882	20458	22736	131334	3521	1250.0
19	AL	1973	1117.0	2018689	1828089	3377	1851.0	0.3857	2353629	2191.0	516794	22402	24078	131334	3546	1277.0
20	AL	1974	1135.0	2000126	1806873	3694	1903.0	0.5167	2409744	2201.0	547374	24427	23922	131334	3575	1314.0
21	AL	1975	1162.0	2055998	1861917	4043	1944.0	0.5315	2492785	2226.0	584074	26775	24838	131334	3615	1346.0
22	AL	1976	1201.0	2192985	1973892	4417	2083.9	0.5825	2575877	2266.3	615993	28818	26677	131334	3665	1389.0
23	AR	1966	580.0	822093	756367	1900	983.0	0.3257	955091	689.2	282413	5318	9403	134538	1964	641.0
24	AR	1967	591.0	844044	775839	2008	1013.0	0.3248	982936	700.4	294658	6211	9712	134538	1901	652.0
25	AR	1968	604.0	912158	834961	2158	1051.0	0.3248	930402	711.6	302220	6693	10230	134538	1902	663.0
26	AR	1969	609.5	973660	885852	2308	1035.0	0.3198	1018804	722.8	289544	7602	10879	134538	1913	643.5
27	AR	1970	615.0	1017188	922822	2542	1058.0	0.3432	1043336	734.0	310754	7754	11285	134538	1923	624.0
28	AR	1971	648.0	1101356	988725	2704	1081.0	0.3557	1055373	748.0	319616	8515	12109	134538	1965	666.0
29	AR	1972	681.0	1211265	1079361	2954	1119.0	0.3465	1099862	756.0	332540	11079	12809	134538	2008	666.0
30	AR	1973	680.0	1285531	1129609	3492	1203.0	0.3698	1185423	781.0	372988	12449	13414	134538	2035	698.0
31	AR	1974	698.0	1262652	1110907	3845	1269.0	0.5066	1245543	799.0	390217	13415	13515	134538	2068	719.0
32	AR	1975	717.0	1288475	1142058	4132	1312.0	0.5734	1283321	835.0	411105	14449	13943	134538	2110	751.0
33	AR	1976	726.0	1384217	1214119	4497	1358.3	0.6032	1349047	809.7	440101	15105	14677	134538	2109	760.0
34	AZ	1966	457.0	701355	634631	2246	941.0	0.3332	862950	1165.4	193262	11435	8861	293750	1603	564.0
35	AZ	1967	469.0	723646	651339	2412	964.0	0.3490	889615	1204.8	202058	12242	9215	293750	1646	582.0
36	AZ	1968	487.0	796491	716403	2629	1004.0	0.3373	943598	1244.2	217665	13862	10042	293750	1682	591.0
37	AZ	1969	513.0	915978	818039	2848	1045.0	0.3348	1024293	1283.6	239820	17196	11505	293750	1737	607.0
38	AZ	1970	539.0	976203	879530	3119	1124.0	0.3507	1093312	1323.0	262424	17118	12124	293750	1772	623.0
39	AZ	1971	597.0	1061023	945355	3384	1173.0	0.3590	1184972	1381.0	289797	12979	13235	293750	1868	703.0
40	AZ	1972	655.0	1185768	1058992	3689	1184.0	0.3540	1301870	1440.0	327821	10056	14781	293750	1963	703.0
41	AZ	1973	663.0	1302170	1152556	4180	1222.0	0.3828	1419452	1542.0	368453	11437	16219	293750	2073	751.0
42	AZ	1974	702.0	1229138	1077648	4426	1284.0	0.5132	1473935	1607.0	389595	12341	15686	293750	2158	794.0
43	AZ	1975	730.0	1282931	1128228	4635	1326.0	0.5773	1459492	1659.0	392025	12741	15983	293750	2212	830.0
44	AZ	1976	759.0	1356630	1189696	5055	1373.0	0.6048	1479356	1697.2	405361	13192	16895	293750	2270	859.0
45	CA	1966	5578.0	7745332	7293963	3034	10356.0	0.3244	10347012	17009.2	1638920	45476	100958	404975	18679	6847.0
46	CA	1967	6070.0	8008678	7552723	3193	10688.0	0.3357	10849514	17416.4	1704729	50783	103818	404975	19176	6901.0
47	CA	1968	6232.0	8534558	8042178	3436	11324.0	0.3347	11123467	17823.6	1782714	54539	106070	404975	19394	6934.0
48	CA	1969	6403.0	9058449	8480798	3613	11425.0	0.3436	11601480	18230.8	1894444	61788	111744	404975	19711	7208.5
49	CA	1970	6574.0	9445993	8846685	3865	11646.0	0.3498	11900896	18638.0	1996334	65778	116992	404975	19953	7483.0
50	CA	1971	6874.5	9817725	9157397	4097	12130.0	0.3557	12367181	18661.0	2111817	70951	118023	404975	20238	7859.0
51	CA	1972	7175.0	10500391	9790977	4284	12650.0	0.3489	12852228	18810.0	2270630	77179	126488	404975	20411	7859.0
52	CA	1973	7191.0	10884457	10102925	4717	12775.0	0.3856	13412774	19232.0	2479152	87371	129849	404975	20652	8006.0
53	CA	1974	7429.0	10426956	9662532	5214	13176.0	0.5279	13684399	19373.0	2498811	92669	127600	404975	20848	8232.0
54	CA	1975	7639.0	10768379	9985654	5707	13564.0	0.5867	13890670	19619.0	2643397	104965	132600	404975	21198	8449.0

* See p. 119 for an explanation of variable names.

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OBS	ST	YEAR	HH	HWF	HMGAS	PCDI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPQP	A2
55	CA	1976	7849.0	11366251	10494542	6155	14047.0	0.6079	14315843	19960.2	2814744	129144	139700	404975	21520	8709.0
56	CO	1966	598.0	838773	787267	2484	1227.0	0.3253	1200777	1596.0	281058	4442	10478	268754	1969	687.0
57	CO	1967	620.0	877428	820873	2598	1261.0	0.3448	1241870	1641.0	291730	5032	10643	268754	2053	718.0
58	CO	1968	648.0	958802	897542	2786	1261.0	0.3382	1299608	1686.0	302012	5464	11044	268754	2120	752.0
59	CO	1969	669.5	1028140	962563	2982	1333.0	0.3307	1373550	1731.0	320635	6516	12492	268754	2166	795.5
60	CO	1970	691.0	1119268	1049639	3292	1380.0	0.3373	1442478	1776.0	339135	6773	13198	268754	2207	839.0
61	CO	1971	746.5	1203726	1124158	3597	1475.0	0.3648	1547598	1637.0	366424	6857	14263	268754	2281	929.0
62	CO	1972	802.0	1324128	1233942	3888	1536.0	0.3515	1679702	1693.0	404302	14317	15886	268754	2364	929.0
63	CO	1973	810.0	1400346	1294033	4368	1611.0	0.3887	1802567	2004.0	443922	15773	16210	268754	2468	981.0
64	CO	1974	844.0	1341415	1236551	4672	1643.0	0.5225	1862127	2041.0	462708	16954	16156	268754	2515	1024.0
65	CO	1975	855.0	1400773	1297997	5115	1690.0	0.5818	1925198	2050.0	480369	18078	16597	268754	2541	1056.0
66	CO	1976	894.0	1462850	1348630	5499	1774.3	0.5123	2027288	2082.2	509920	18191	17637	268754	2583	1095.0
67	CT	1966	846.0	1043021	985904	3188	1843.0	0.3040	1489148	2621.2	160579	2331	13652	12593	2887	988.0
68	CT	1967	860.0	1076857	1015909	3441	1898.0	0.3282	1544761	2666.9	165651	2564	14014	12593	2935	1002.0
69	CT	1968	833.0	1148420	1079977	3649	1983.0	0.3432	1626186	2712.6	174371	2830	14937	12593	2964	1017.0
70	CT	1969	883.0	1208908	1132242	3880	1710.0	0.3615	1677073	2758.3	181304	3304	15704	12593	3000	1037.0
71	CT	1970	933.0	1265126	1137124	4191	1724.0	0.3698	1732609	2804.0	191321	3688	16445	12593	3032	1057.0
72	CT	1971	963.5	1318714	1237805	4355	1760.0	0.3782	1791011	2613.0	157693	3792	17121	12593	3077	1105.0
73	CT	1972	994.0	1383077	1298183	4543	1798.0	0.3765	1860385	2626.0	157920	10891	17797	12593	3080	1105.0
74	CT	1973	995.0	1422319	1329756	5072	1808.0	0.4098	1949832	2842.0	160172	11030	18421	12593	3080	1114.0
75	CT	1974	1005.0	1387622	1295895	5559	1785.0	0.5463	1991397	2849.0	154918	10923	18005	12593	3086	1143.0
76	CT	1975	1024.0	1404039	1320158	6070	1961.0	0.5757	1949239	2855.0	148599	10644	18234	12593	3100	1168.0
77	CT	1976	1053.0	1450256	1359579	6394	1989.7	0.5999	2087121	2868.9	159135	11827	18880	12593	3117	1197.0
78	DC	1966	262.0	243874	230216	3307	344.0	0.3165	241749	759.8	20952	89	2599	158	807	280.0
79	DC	1967	262.0	242146	228391	3527	344.0	0.3322	246712	759.1	20059	93	2643	158	791	281.0
80	DC	1968	263.0	246201	232048	3800	343.0	0.3418	257405	758.4	20273	99	2731	158	778	274.0
81	DC	1969	263.0	249966	235783	3961	346.0	0.3515	254222	757.7	19730	111	2785	158	762	290.5
82	DC	1970	263.0	251724	236868	4302	339.0	0.3573	256670	757.0	18266	139	2821	158	757	307.0
83	DC	1971	265.0	255177	237665	4652	345.0	0.3605	260108	753.0	18711	224	2886	158	758	307.0
84	DC	1972	275.0	253744	237022	5022	345.0	0.3765	259492	748.0	18245	924	2945	158	752	307.0
85	DC	1973	272.0	268935	251278	5439	335.0	0.3907	261207	734.0	17755	934	3004	158	734	310.0
86	DC	1974	277.0	251645	233966	6001	332.0	0.5433	262598	721.0	13894	920	2957	158	721	302.0
87	DC	1975	280.0	254984	237688	6580	336.0	0.5848	255472	716.0	16994	893	3082	158	716	302.0
88	DC	1976	274.0	246212	228647	7346	335.4	0.6040	264975	.	17186	903	3175	158	702	300.0
89	DE	1966	145.0	225421	215039	2902	286.0	0.3148	256481	354.4	37846	2763	2590	5133	515	180.0
90	DE	1967	149.0	230227	220073	3063	295.0	0.3202	267660	362.3	39871	2997	2683	5133	525	190.0
91	DE	1968	152.0	243766	232008	3274	312.0	0.3315	283118	370.2	42853	3378	2610	5133	534	186.0
92	DE	1969	156.5	258969	246513	3539	308.0	0.3465	296665	378.1	45092	3982	2867	5133	540	192.5
93	DE	1970	165.0	270852	258143	3699	327.0	0.3573	312342	386.0	48034	3630	2958	5133	548	199.0
94	DE	1971	173.0	287254	272077	4033	340.0	0.3648	316512	391.0	51147	3703	3202	5133	560	212.0
95	DE	1972	181.0	298264	282796	4305	349.0	0.3806	322971	394.0	52008	7309	3425	5133	571	212.0
96	DE	1973	180.0	317061	300235	4836	371.0	0.3881	333137	398.0	54569	7689	3541	5133	573	220.0
97	DE	1974	185.0	304854	286745	5207	370.0	0.5098	343832	400.0	57575	8398	3475	5133	577	223.0
98	DE	1975	187.0	311639	292617	5686	374.0	0.5668	350992	399.0	60424	9026	3625	5133	579	230.0
99	DE	1976	192.0	328702	308245	6101	381.4	0.5732	361583	401.2	62638	9911	3850	5133	582	236.0
100	FL	1966	1875.0	2428962	2317716	2287	3237.0	0.3273	3221307	5064.2	396908	24808	31157	140093	5934	1999.0
101	FL	1967	1922.0	2561693	2436299	2468	3336.0	0.3290	3392661	5225.9	425408	28612	32766	140093	6242	2072.0
102	FL	1968	2015.0	2803753	2659855	2698	3425.0	0.3232	3627987	5387.6	453563	31981	34838	140093	6433	2131.0
103	FL	1969	2150.0	3069173	2899615	2946	3614.0	0.3448	3894756	5549.3	507387	40275	37595	140093	6641	2177.0
104	FL	1970	2225.0	3312830	3129151	3227	3994.0	0.3507	4120363	5711.0	556210	36973	41781	140093	6789	2223.0
105	FL	1971	2502.0	3585727	3363503	3496	4084.0	0.3465	4534300	5908.0	606281	38822	47473	140093	7051	2405.0
106	FL	1972	2715.0	4045322	3778532	3839	4361.0	0.3598	4835986	6105.0	695291	43106	54589	140093	7347	2405.0
107	FL	1973	2741.0	4494951	4170530	4396	4759.0	0.3815	5347245	6491.0	801791	49986	59265	140093	7745	2576.0
108	FL	1974	2910.0	4342185	4028165	4661	4945.0	0.5131	5616070	6780.0	896583	57048	58023	140093	8092	2745.0

S T A T I S T I C A L A N A L Y S I S S Y S T E M

OBS	ST	YEAR	HH	HWF	HWGAS	PCDI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPOP	A2
109	FL	1975	3039.0	4456610	4154294	4946	5674.00	0.5498	5395372	6982.0	878389	56880	61715	140093	8346	2868.0
110	FL	1976	3113.0	4650302	4321000	5339	6256.32	0.5715	5847984	.	991195	60874	64492	140093	8421	2933.0
111	GA	1966	1223.0	1847087	1699566	2121	2208.00	0.3270	2099247	2375.6	389252	5398	23008	150409	4450	1615.0
112	GA	1967	1243.0	1953292	1789617	2296	2153.00	0.3292	2164367	2430.2	410899	6305	24221	150409	4408	1633.0
113	GA	1968	1287.0	2142451	1956085	2474	2279.00	0.3312	2324317	2484.8	445169	7212	26051	150409	4482	1687.0
114	GA	1969	1328.0	2330918	2122272	2883	2470.00	0.3490	2487394	2539.4	481785	8960	28310	150409	4551	1698.5
115	GA	1970	1369.0	2478665	2248815	2881	2710.00	0.3501	2584042	2594.0	510886	14515	29530	150409	4590	1710.0
116	GA	1971	1432.0	2694752	2425221	3118	2731.00	0.3623	2752904	2638.0	548337	17117	31449	150409	4677	1793.0
117	GA	1972	1495.0	2929489	2630641	3374	3206.00	0.3615	2959454	2673.0	576986	23836	33324	150409	4733	1793.0
118	GA	1973	1504.0	3135720	2781136	3811	3339.00	0.3857	3170412	2721.0	631262	26154	35360	150409	4818	1842.0
119	GA	1974	1541.0	3032916	2680824	4113	3452.00	0.5259	3243807	2764.0	696911	29751	35097	150409	4877	1906.0
120	GA	1975	1572.0	3041988	2722133	4419	3038.00	0.5823	3210973	2803.0	688310	30094	39272	150409	4926	1951.0
121	GA	1976	1618.0	3202512	2859916	4825	2897.69	0.5899	3332202	2824.0	721810	32111	41161	150409	4970	2005.0
122	HI	1966	177.0	179398	173752	2729	380.00	.	324521	578.6	36773	1045	2479	16641	733	281.0
123	HI	1967	185.0	189736	184039	2938	393.00	.	336498	591.7	37776	1140	2721	16641	723	298.0
124	HI	1968	193.0	203444	196525	3188	375.00	.	354973	604.8	38954	1240	2863	16641	734	302.0
125	HI	1969	198.0	218064	210044	3423	463.00	.	374557	617.9	41202	1493	3164	16641	750	307.0
126	HI	1970	203.0	239164	230797	3822	501.00	.	405441	631.0	45860	1440	3409	16641	770	312.0
127	HI	1971	217.5	251888	242246	4042	524.00	.	426219	645.0	49585	1629	3656	16641	796	327.0
128	HI	1972	232.0	267386	256833	4215	492.00	.	447409	660.0	53556	1675	3758	16641	816	327.0
129	HI	1973	234.0	285054	273498	4612	475.00	.	477780	686.0	58961	1848	4058	16641	841	341.0
130	HI	1974	242.0	278245	265826	4962	492.00	.	485305	697.0	62890	2070	3920	16641	854	351.0
131	HI	1975	246.0	290202	276266	5595	518.00	.	462011	705.0	65081	3170	4146	16641	868	362.0
132	HI	1976	261.0	304311	289315	5813	532.36	.	497808	718.4	70414	4461	4314	16641	887	373.0
133	IA	1966	855.0	1186098	1098619	2650	1513.00	0.3323	1609004	994.6	324538	3337	13100	144887	2764	856.0
134	IA	1967	864.0	1273533	1174497	2684	1584.00	0.3432	1651549	1004.2	345638	3818	13473	144887	2793	869.0
135	IA	1968	879.0	1321129	1214421	2833	1598.00	0.3215	1703221	1013.8	361464	4202	15776	144887	2803	880.0
136	IA	1969	887.5	1379928	1261482	3032	1633.00	0.3365	1754055	1023.4	379825	4978	16627	144887	2805	900.0
137	IA	1970	896.0	1391162	1259372	3257	1678.00	0.3532	1709061	1033.0	395126	5538	17108	144887	2825	920.0
138	IA	1971	932.0	1534368	1380803	3385	1689.00	0.3632	1841680	1050.0	410585	7701	17851	144887	2859	980.0
139	IA	1972	968.0	1615383	1436851	3696	1727.00	0.3723	1917075	1063.0	459300	14908	18876	144887	2884	980.0
140	IA	1973	956.0	1778515	1566149	4673	1781.00	0.3845	1978631	1057.0	489037	15874	19454	144887	2863	1007.0
141	IA	1974	968.0	1653232	1440441	4721	1843.00	0.5117	2033686	1061.0	518331	17316	19002	144887	2856	1004.0
142	IA	1975	978.0	1670668	1460109	5258	1884.00	0.5732	2099336	1068.0	547375	18835	19633	144887	2870	1030.0
143	IA	1976	996.0	1809567	1561841	5499	1959.22	0.6033	2185752	1072.7	583598	19456	20647	144887	2870	1049.0
144	ID	1966	210.0	314011	291811	2179	419.00	0.3507	445823	104.4	138215	6625	3931	214133	701	227.0
145	ID	1967	213.0	332865	309727	2317	429.00	0.3498	454572	106.3	140250	7410	4096	214133	688	231.0
146	ID	1968	220.0	346835	319865	2406	473.00	0.3407	470930	108.2	146958	8158	4214	214133	695	237.0
147	ID	1969	219.5	373235	345212	2675	474.00	0.3457	476637	110.1	148654	9232	4397	214133	707	237.5
148	ID	1970	219.0	402535	376634	2892	484.00	0.3507	473873	112.0	141353	7230	4741	214133	713	238.0
149	ID	1971	232.5	418618	385529	3043	501.00	0.3498	509203	117.0	153194	7692	4930	214133	736	265.0
150	ID	1972	246.0	456869	422820	3322	508.00	0.3511	549834	120.0	165941	5463	5271	214133	755	265.0
151	ID	1973	248.0	473312	424843	3939	539.00	0.3995	590126	127.0	178518	6407	5455	214133	776	275.0
152	ID	1974	257.0	453666	411452	4487	554.00	0.5334	632103	131.0	225859	6795	5657	214133	797	290.0
153	ID	1975	266.0	484309	433904	4523	523.00	0.5982	647446	137.0	238114	7389	5873	214133	813	463.0
154	ID	1976	273.0	521776	479012	4964	600.03	0.6222	681587	139.7	253267	7447	6395	214133	831	311.0
155	IL	1966	3283.0	3878030	3636786	3099	5821.00	0.3323	4704624	8663.2	564039	9395	48566	144387	10792	3587.0
156	IL	1967	3322.0	3998771	3739872	3237	5801.00	0.3399	4818259	8761.4	596458	11556	49858	144387	10947	3626.0
157	IL	1968	3383.0	4224347	3931594	3421	5972.00	0.3471	4990073	8859.6	614226	16441	52139	144387	10995	3659.0
158	IL	1969	3442.5	4418060	4097656	3624	5689.00	0.3595	5162398	8957.8	635147	19052	53873	144387	11039	3771.0
159	IL	1970	3502.0	4548033	4223506	3817	5752.00	0.3862	5237876	9056.0	660450	22781	55313	144387	11114	3883.0
160	IL	1971	3597.0	4673175	4292857	4129	5903.00	0.3760	5417021	9017.0	691738	24867	57390	144387	11191	4036.0
161	IL	1972	3692.0	5075195	4656554	4338	6004.00	0.3636	5643853	9076.0	721021	28884	59383	144387	11244	4036.0
162	IL	1973	3674.0	5302382	4807790	4908	6124.00	0.4061	5951948	9101.0	811629	32625	60772	144387	11176	4093.0

STATISTICAL ANALYSIS SYSTEM

OBS	ST	YEAR	HH	HWF	HWGAS	PCDI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPOP	A2
163	IL	1974	3716.0	5094444	4573296	5321	6300.00	0.5474	6173638	9092.0	893917	37402	59210	144387	11160	4117.0
164	IL	1975	3745.0	5243371	4759415	5848	6390.00	0.5860	6343875	9083.0	968908	41224	60943	144387	11145	4191.0
165	IL	1976	3824.0	5484163	4947920	6369	6548.67	0.6090	6676583	9130.0	1135151	53440	64409	144387	11229	4298.0
166	IN	1966	1484.0	2159021	1985648	2654	2752.00	0.3332	2550539	3274.0	470288	9664	26408	93491	4976	1669.0
167	IN	1967	1510.0	2233650	2046934	2743	2661.00	0.3473	2631944	3314.0	495665	11177	27399	93491	5053	1699.0
168	IN	1968	1544.0	2386098	2173794	2927	2572.00	0.3490	2739206	3354.0	524531	12445	29550	93491	5093	1728.0
169	IN	1969	1576.5	2492288	2260178	3132	2840.00	0.3665	2806206	3394.0	541154	14345	30617	93491	5143	1778.0
170	IN	1970	1609.0	2627339	2365800	3233	2699.00	0.3723	2817991	3434.0	505274	16661	32578	93491	5194	1828.0
171	IN	1971	1665.0	2762917	2467832	3511	2804.00	0.3757	2868016	3381.0	574088	19002	34292	93491	5242	1917.0
172	IN	1972	1721.0	2961899	2621031	3726	2936.00	0.3556	3064376	3409.0	591317	27099	36785	93491	5286	1923.0
173	IN	1973	1718.0	3120797	2732472	4272	2959.00	0.3926	3232321	3498.0	690400	31744	38727	93491	5304	1964.0
174	IN	1974	1742.0	2976988	2597773	4478	3185.00	0.5317	3268516	3502.0	712980	33555	36993	93491	5313	2000.0
175	IN	1975	1755.0	3017213	2644285	4887	3338.00	0.5908	3315371	3504.0	735754	35635	37359	93491	5313	2024.0
176	IN	1976	1782.0	3209748	2778791	5362	3445.29	0.5970	3450535	3596.3	782612	38907	39886	93491	5302	2050.0
177	KS	1966	712.0	1001915	936487	2607	1364.00	0.2873	1405256	936.6	381634	7747	11900	211828	2264	757.0
178	KS	1967	718.0	1041470	971245	2736	1410.00	0.2961	1440595	946.7	395145	8644	12315	211828	2197	759.0
179	KS	1968	734.0	1113530	1031954	2906	1396.00	0.3290	1463618	956.8	418769	9634	12578	211828	2216	771.0
180	KS	1969	730.5	1165623	1076556	3080	1436.00	0.3465	1514935	966.9	400033	11359	13177	211828	2236	773.0
181	KS	1970	727.0	1183003	1086950	3341	1453.00	0.3298	1547643	977.0	415733	12288	13376	211828	2249	775.0
182	KS	1971	751.0	1214393	1106509	3577	1496.00	0.3298	1599109	1856.0	438933	14095	13861	211828	2259	805.0
183	KS	1972	775.0	1328874	1201252	3935	1565.00	0.3240	1691501	1864.0	466001	11256	14696	211828	2268	805.0
184	KS	1973	771.0	1347654	1201360	4597	1594.00	0.3778	1777799	980.0	505656	12243	15402	211828	2264	830.0
185	KS	1974	783.0	1317201	1173597	4825	1642.00	0.5117	1785237	975.0	527887	13172	15203	211828	2266	839.0
186	KS	1975	790.0	1370652	1228179	5231	1672.00	0.5732	1805434	973.0	559182	14338	15485	211828	2267	849.0
187	KS	1976	820.0	1477521	1326321	5569	1718.25	0.6133	1873574	1057.5	585020	15005	16501	211828	2310	883.0
188	KY	1966	907.0	1172941	1100840	2026	1383.00	0.3340	1574632	1436.2	314469	2684	15604	102694	3184	1091.0
189	KY	1967	922.0	1248482	1169760	2165	1442.00	0.3290	1632380	1454.9	329085	3164	16626	102694	3172	1108.0
190	KY	1968	944.0	1335206	1244323	2335	1477.00	0.3407	1690646	1473.6	352974	3566	17729	102694	3195	1130.0
191	KY	1969	964.0	1417683	1316032	2477	1572.00	0.3573	1712829	1492.3	363115	4118	18871	102694	3198	1126.5
192	KY	1970	984.0	1502081	1391541	2685	1609.00	0.3665	1762517	1511.0	380667	8000	19960	102694	3219	1123.0
193	KY	1971	1025.5	1620079	1492756	2884	1626.00	0.3748	1859987	1471.0	407513	8550	21500	102694	3278	1184.0
194	KY	1972	1067.0	1730819	1582949	3087	1684.00	0.3728	1967620	1479.0	444419	12038	23000	102694	3306	1184.0
195	KY	1973	1062.0	1830895	1653995	3510	1722.00	0.4031	2090748	1553.0	484323	13116	24395	102694	3328	1214.0
196	KY	1974	1082.0	1780680	1625278	3882	1742.00	0.5383	2164060	1562.0	531404	14649	23811	102694	3354	1239.0
197	KY	1975	1102.0	1843676	1690036	4232	1910.00	0.5820	2245138	1572.0	562631	16113	24688	102694	3387	1276.0
198	KY	1976	1134.0	1962492	1788590	4667	1956.94	0.6125	2350146	1560.0	616088	18210	26240	102694	3428	1313.0
199	LA	1966	598.0	1248642	1177434	2097	1595.00	0.3065	1555655	2150.0	309526	7041	13549	116369	3627	1241.0
200	LA	1967	1015.0	1306286	1229899	2273	1622.00	0.3190	1633802	2177.5	317418	8398	14639	116369	3581	1263.0
201	LA	1968	1047.0	1397568	1311291	2450	1677.00	0.3240	1661572	2205.0	334587	9332	15352	116369	3603	1292.0
202	LA	1969	1049.5	1462648	1370799	2529	1723.00	0.3390	1702076	2232.5	349543	10996	16172	116369	3619	1281.5
203	LA	1970	1052.0	1530902	1431718	2730	1782.00	0.3573	1742351	2260.0	365228	11908	16838	116369	3643	1271.0
204	LA	1971	1099.0	1600726	1487078	2909	1813.00	0.3557	1822285	2292.0	386559	12434	17615	116369	3696	1337.0
205	LA	1972	1146.0	1760676	1627902	3121	1917.00	0.3406	1942263	2322.0	411859	12825	18660	116369	3738	1337.0
206	LA	1973	1141.0	1867614	1714938	3476	2016.00	0.3648	2057279	2356.0	446181	13920	19320	116369	3746	1372.0
207	LA	1974	1161.0	1851456	1687086	3878	2033.00	0.4974	2134526	2370.0	503905	16185	19545	116369	3762	1395.0
208	LA	1975	1183.0	1944602	1777329	4316	2122.00	0.5609	2187521	2389.0	510480	16826	20326	116369	3791	1431.0
209	LA	1976	1219.0	2111905	1918614	4723	2152.85	0.6040	2342251	2428.8	634055	25862	21310	116369	3841	1471.0
210	MA	1966	1605.0	1783690	1709910	2771	2739.00	0.3048	2172767	5319.4	218213	5086	21673	20269	5370	1783.0
211	MA	1967	1624.0	1844203	1763767	2964	2791.00	0.3232	2223472	5370.3	214755	5639	21769	20269	5594	1790.0
212	MA	1968	1648.0	1961892	1872033	3171	2850.00	0.3332	2223472	5421.2	225509	6237	23223	20269	5618	1793.0
213	MA	1969	1704.0	2047389	1948581	3377	2901.00	0.3465	2426096	5472.1	237466	7376	25378	20269	5650	1879.5
214	MA	1970	1760.0	2174347	2071772	3666	2588.00	0.3573	2574838	5523.0	255344	12175	26072	20269	5689	1966.0
215	MA	1971	1822.0	2255736	2144951	3878	3060.00	0.3657	2699793	5594.0	260795	11942	28030	20269	5768	2063.0
216	MA	1972	1884.0	2391692	2276622	4065	3141.00	0.3598	2821411	5611.0	270597	21015	29442	20269	5796	2063.0

STATISTICAL ANALYSIS SYSTEM

OBS	ST	YEAR	HH	HWF	HWGAS	PCDI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPOP	A2
217	MA	1973	1879.0	2493501	2352302	4442	3209.00	0.3907	2951795	5616.0	290559	26675	29291	20269	5799	2123.0
218	MA	1974	1907.0	2380939	2246586	4776	3567.00	0.5240	3041952	5594.0	307482	24785	28237	20269	5793	2143.0
219	MA	1975	1936.0	2412546	2279427	5213	3554.00	0.5598	3107051	5611.0	321815	26666	29100	20269	5818	2197.0
220	MA	1976	1971.0	2500313	2365167	5608	3643.69	0.5823	3200503	5594.8	325173	27489	29973	20269	5809	2233.0
221	MD	1966	956.0	1264247	1202026	2661	1793.00	0.3257	1533643	3047.4	185721	3206	17317	25618	3618	1309.0
222	MD	1967	1018.0	1328139	1260557	2813	1867.00	0.3347	1611986	3124.8	197603	3576	17823	25618	3757	1335.0
223	MD	1968	1041.0	1423031	1348839	3041	1925.00	0.3423	1703846	3202.2	204895	3860	18788	25618	3815	1342.0
224	MD	1969	1108.0	1530420	1448438	3265	2016.00	0.3490	1795263	3279.6	219679	4661	19497	25618	3868	1398.5
225	MD	1970	1175.0	1633223	1545748	3563	2054.00	0.3565	1871834	3357.0	237504	4762	20492	25618	3992	1455.0
226	MD	1971	1228.0	1728041	1634180	3822	2073.00	0.3607	2002976	3428.0	262884	5031	22215	25618	4001	1544.0
227	MD	1972	1281.0	1857284	1752535	4083	2151.00	0.3765	2130458	3473.0	289654	14639	23630	25618	4048	1544.0
228	MD	1973	1282.0	1926461	1809456	4528	2218.00	0.3923	2258772	3483.0	315202	16066	25543	25618	4074	1570.0
229	MD	1974	1306.0	1874434	1748537	4900	2359.00	0.5121	2346033	3490.0	335142	17605	23896	25618	4089	1608.0
230	MD	1975	1324.0	1934062	1811816	5397	2441.00	0.5670	2422724	3494.0	339336	18283	25186	25618	4122	1639.0
231	MD	1976	1367.0	2029484	1908460	5833	2487.37	0.5848	2505062	3523.7	355551	18837	26194	25618	4144	1693.0
232	ME	1966	284.0	402214	384245	2224	474.00	0.3148	433891	301.0	82620	1277	5064	80083	987	316.0
233	ME	1967	287.0	413878	393979	2313	485.00	0.3332	452083	302.5	88027	1520	5224	80083	1004	317.0
234	ME	1968	291.0	437864	416025	2513	491.00	0.3432	480270	304.0	93023	1689	5540	80083	994	317.0
235	ME	1969	297.0	455911	431839	2680	497.00	0.3615	495760	305.5	95630	1946	5786	80083	992	323.0
236	ME	1970	303.0	482492	454685	2916	513.00	0.3773	510001	307.0	107189	1841	6108	80083	994	329.0
237	ME	1971	313.0	510639	479670	3038	540.00	0.3898	536815	289.0	103208	2044	6435	80083	1010	354.0
238	ME	1972	324.0	545081	508742	3278	557.00	0.3740	564782	291.0	111928	4114	6699	80083	1026	354.0
239	ME	1973	332.0	566388	524885	3667	595.00	0.4015	596345	320.0	119976	4415	6930	80083	1039	358.0
240	ME	1974	339.0	551548	508825	3996	651.00	0.5418	637155	322.0	137073	5214	6713	80083	1049	371.0
241	ME	1975	345.0	565959	523286	4246	628.00	0.5682	648131	324.0	146555	5557	6916	80083	1058	382.0
242	ME	1976	356.0	599229	554270	4764	647.36	0.5873	699096	324.1	140574	5623	7500	80083	1070	392.0
243	MI	1966	2434.0	3422775	3292382	2922	4418.00	0.3288	4024120	6988.4	496134	10160	43940	147156	8500	2852.0
244	MI	1967	2490.0	3527133	3384062	3021	4514.00	0.3395	4133428	7079.8	533564	11899	45054	147156	8630	2915.0
245	MI	1968	2540.0	3797527	3633835	3247	4573.00	0.3503	4316967	7171.2	569641	13299	48047	147156	8696	2945.0
246	MI	1969	2556.5	4030800	3843017	3452	5009.00	0.3415	4488463	7262.6	602138	16336	50905	147156	8781	3030.0
247	MI	1970	2653.0	4096749	3907313	3553	5127.00	0.3382	4569319	7354.0	637655	18407	53148	147156	8875	3115.0
248	MI	1971	2746.5	4281578	4062973	3855	5213.00	0.3435	4739639	7307.0	673908	19960	55557	147156	8961	3307.0
249	MI	1972	2840.0	4586688	4337556	4159	5312.00	0.3423	5010537	7350.0	731756	27010	57817	147156	9013	3307.0
250	MI	1973	2845.0	4810238	4523949	4667	5436.00	0.3953	5239792	7436.0	790430	29263	58478	147156	9061	3351.0
251	MI	1974	2904.0	4599375	4323852	4976	5533.00	0.5386	5400904	7465.0	850594	32483	55749	147156	9117	3439.0
252	MI	1975	2947.0	4650037	4386506	5330	5950.00	0.5942	5545460	7481.0	903159	35467	58173	147156	9111	3531.0
253	MI	1976	2953.0	4942724	4639871	5978	6049.94	0.5765	5701372	7412.8	961333	38955	61817	147156	9104	3579.0
254	MN	1966	1045.0	1458924	1376972	2488	2036.00	0.3223	1942781	4026.2	355985	7100	17688	205359	3588	1119.0
255	MN	1967	1068.0	1521373	1428961	2626	2074.00	0.3482	1996925	3623.9	372826	8052	18661	205359	3659	1151.0
256	MN	1968	1096.0	1615292	1510694	2822	2078.00	0.3507	2085639	3221.6	396234	8982	19899	205359	3703	1179.0
257	MN	1969	1125.0	1720098	1605810	3020	2221.00	0.3590	2143744	2819.3	416507	10635	20793	205359	3758	1232.5
258	MN	1970	1154.0	1810493	1686418	3292	2310.00	0.3715	2206624	2417.0	441876	11561	22380	205359	3805	1286.0
259	MN	1971	1200.0	1930372	1786946	3470	2368.00	0.3707	2293478	2449.0	466813	13571	23404	205359	3854	1383.0
260	MN	1972	1246.0	2016627	1863856	3647	2336.00	0.3706	2368127	2448.0	484698	15870	24878	205359	3877	1383.0
261	MN	1973	1244.0	2133246	1944833	4381	2384.00	0.3903	2452616	2461.0	527239	17241	25160	205359	3890	1414.0
262	MN	1974	1273.0	2034665	1851312	4579	2403.00	0.5217	2532219	2481.0	575596	19360	24588	205359	3904	1455.0
263	MN	1975	1252.0	2053941	1868092	4915	2417.00	0.5835	2524517	2490.0	559696	19430	25624	205359	3921	1490.0
264	MN	1976	1325.0	2144389	1939399	5156	2571.54	0.6173	2768430	2541.2	680998	23508	26956	205359	3965	1540.0
265	MO	1966	1443.0	1947130	1815038	2533	2296.00	0.3223	2147531	2902.0	439024	3886	22175	178697	4551	1498.0
266	MO	1967	1458.0	2019013	1875324	2698	2500.00	0.3373	2211187	2937.0	448578	4404	23777	178697	4539	1511.0
267	MO	1968	1466.0	2167061	1998304	2901	2450.00	0.3390	2320150	2972.0	478700	4949	24791	178697	4568	1532.0
268	MO	1969	1503.5	2297230	2113760	3007	2528.00	0.3465	2313005	3007.0	474138	5546	25460	178697	4640	1556.5
269	MO	1970	1521.0	2419868	2227939	3255	2569.00	0.3407	2407687	3042.0	510465	5865	25785	178697	4677	1581.0
270	MO	1971	1567.0	2576890	2360427	3471	2719.00	0.3615	2497950	2179.0	539232	7325	27077	178697	4734	1667.0

STATISTICAL ANALYSIS SYSTEM

OBS	ST	YEAR	HM	HWF	HWGAS	PCDI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPOP	A2
271	MO	1972	1613.0	2727251	2490077	3661	2775.00	0.3565	2618164	2178.0	582235	18749	29248	178697	4747	1667.0
272	MO	1973	1617.0	2772296	2492880	4135	2875.00	0.3920	2744553	3062.0	641489	20704	30748	178697	4768	1690.0
273	MO	1974	1638.0	2702321	2431851	4323	2909.00	0.5217	2809846	3057.0	673789	22412	29710	178697	4772	1733.0
274	MO	1975	1649.0	2744108	2486080	4778	2972.00	0.5765	2866219	3045.0	679706	23198	30675	178697	4763	1761.0
275	MO	1976	1681.0	2918456	2629283	5187	3033.75	0.5948	2941091	3330.7	699195	24592	32501	178697	4778	1803.0
276	MS	1966	617.0	862514	797539	1675	871.00	0.3306	956842	502.2	247311	6099	9315	122497	2340	774.0
277	MS	1967	626.0	918780	840206	1818	972.00	0.3311	1012166	512.4	254919	6962	9821	122497	2228	784.0
278	MS	1968	638.0	982398	892709	1986	1010.00	0.3307	1061292	522.6	262964	7525	10598	122497	2219	796.0
279	MS	1969	637.5	1063296	957084	2136	1320.00	0.3430	1085452	532.8	278548	8960	11185	122497	2220	762.5
280	MS	1970	637.0	1085392	1002860	2311	1237.00	0.3548	1117311	543.0	290301	7446	11627	122497	2217	729.0
281	MS	1971	663.0	1156926	1055970	2533	1339.00	0.3752	1175836	466.0	302185	8600	12283	122497	2241	771.0
282	MS	1972	689.0	1274322	1156143	2791	1382.00	0.3491	1249152	473.0	320781	8961	13122	122497	2256	771.0
283	MS	1973	657.0	1316706	1181449	3180	1379.00	0.3848	1312445	594.0	347093	9686	13754	122497	2317	792.0
284	MS	1974	709.0	1293333	1155579	3369	1378.00	0.5209	1341245	608.0	368453	10606	13916	122497	2334	822.0
285	MS	1975	719.0	1280166	1148946	3616	1456.00	0.5417	1376510	616.0	378375	11182	14358	122497	2346	841.0
286	MS	1976	736.0	1354443	1205046	4033	1505.97	0.5715	1446036	623.0	401101	12441	15329	122497	2354	858.0
287	MT	1966	213.0	339912	296659	2352	394.00	0.3382	439146	162.2	143500	1769	3838	377070	704	227.0
288	MT	1967	214.0	340860	300192	2425	391.00	0.3444	451337	163.9	149561	1870	4080	377070	701	227.0
289	MT	1968	218.0	367185	321429	2558	392.00	0.3423	463344	165.6	157695	2017	4150	377070	700	226.0
290	MT	1969	217.5	392822	342954	2708	398.00	0.3582	478134	167.3	164385	2353	4439	377070	694	228.5
291	MT	1970	217.0	410790	352654	3035	409.00	0.3636	484990	169.0	170587	5268	4867	377070	694	231.0
292	MT	1971	227.5	433465	372174	3125	421.00	0.3657	510696	174.0	180993	5570	5079	377070	710	251.0
293	MT	1972	238.0	463527	394482	3508	444.00	0.3523	538524	177.0	207683	3602	5373	377070	716	251.0
294	MT	1973	241.0	505226	432272	4127	462.00	0.3995	567056	178.0	208950	3613	5689	377070	730	256.0
295	MT	1974	247.0	484955	412004	4355	495.00	0.5317	585320	180.0	220488	3935	5823	377070	737	265.0
296	MT	1975	253.0	477535	404957	4705	514.00	0.5942	601957	182.0	230202	4220	5723	377070	746	275.0
297	MT	1976	260.0	536143	449092	4772	535.00	0.6085	638953	183.2	245738	4479	6128	377070	753	281.0
298	NC	1966	1358.0	1961087	1840582	2069	2430.00	0.3248	2307008	2119.0	453580	16149	22511	126387	4994	1846.0
299	NC	1967	1397.0	2072717	1541466	2233	2512.00	0.3377	2423241	2160.5	482197	19895	24629	126387	4952	1896.0
300	NC	1968	1441.0	2195453	2047423	2397	2548.00	0.3365	2572949	2202.0	517375	24675	26112	126387	5004	1940.0
301	NC	1969	1475.5	2367449	2200881	2600	2635.00	0.3573	2717076	2243.5	552473	25111	27816	126387	5031	1925.0
302	NC	1970	1510.0	2491413	2314451	2819	2743.00	0.3532	2825801	2285.0	578302	29784	29624	126387	5082	1910.0
303	NC	1971	1580.5	2629422	2425055	3027	2835.00	0.3736	3001520	2320.0	615609	35168	31378	126387	5158	1997.0
304	NC	1972	1651.0	2872824	2642131	3309	2919.00	0.3731	3219776	2355.0	667365	31517	34031	126387	5221	1997.0
305	NC	1973	1659.0	3020481	2743015	3724	3060.00	0.3932	3445377	2403.0	728757	35534	35798	126387	5302	2040.0
306	NC	1974	1703.0	2971177	2701591	3999	3161.00	0.5199	3569769	2444.0	772811	37735	35000	126387	5375	2103.0
307	NC	1975	1743.0	3009525	2748125	4333	3294.00	0.5676	3699569	2471.0	806999	40764	36400	126387	5441	2166.0
308	NC	1976	1755.0	3200647	2896613	4723	3403.21	0.6042	3890854	2480.6	864978	44931	38600	126387	5469	2198.0
309	ND	1966	180.0	251555	225954	2170	360.00	0.3207	406420	71.2	138245	1591	3476	179417	649	207.0
310	ND	1967	179.0	257952	232781	2276	333.00	0.3295	404886	71.9	141512	1684	3444	179417	626	202.0
311	ND	1968	180.0	272489	244626	2366	333.00	0.3007	413824	72.6	146605	1829	3549	179417	621	200.0
312	ND	1969	181.0	278355	249745	2613	329.00	0.3382	419773	73.3	151883	2127	3654	179417	621	201.0
313	ND	1970	182.0	300443	264391	2714	331.00	0.3552	428081	74.0	158208	2591	3807	179417	618	202.0
314	ND	1971	190.0	314708	278751	3085	341.00	0.3715	444066	76.0	164214	2909	3955	179417	629	217.0
315	ND	1972	198.0	340822	302658	3572	347.00	0.3223	453622	77.0	172174	2659	4116	179417	634	217.0
316	ND	1973	197.0	367582	320175	5186	354.00	0.3896	490442	79.0	184646	2671	4300	179417	635	224.0
317	ND	1974	200.0	342292	301499	4966	362.00	0.5229	526574	79.0	204143	3134	4371	179417	637	227.0
318	ND	1975	202.0	372324	324566	5019	373.00	0.5832	550827	81.0	218213	3496	4502	179417	637	229.0
319	ND	1976	210.0	358903	346903	4551	385.66	0.6223	563391	145.6	226007	3742	4783	179417	643	237.0
320	NE	1966	444.0	659161	610322	2608	902.00	0.3432	870439	599.0	224251	3664	8450	198091	1443	450.0
321	NE	1967	447.0	677564	625268	2686	918.00	0.3573	887809	609.5	233749	4028	8707	198091	1457	454.0
322	NE	1968	457.0	720266	662313	2770	886.00	0.3573	909123	618.0	242088	4375	8953	198091	1467	464.0
323	NE	1969	465.5	754161	690121	3081	898.00	0.3508	929236	627.5	249156	5068	9200	198091	1474	480.5
324	NE	1970	474.0	789482	718788	3285	934.00	0.3782	974158	637.0	260122	5672	9600	198091	1484	497.0

STATISTICAL ANALYSIS SYSTEM

OBS	ST	YEAR	HH	HWF	HWGAS	PCCI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPOP	A2
325	NE	1971	494.5	829508	746981	3488	1033.00	0.3740	1032693	656.0	282186	7280	9903	198091	1508	532.0
326	NE	1972	515.0	911350	812564	3831	1007.00	0.3748	1080885	671.0	299970	12187	10798	198091	1528	532.0
327	NE	1973	512.0	972040	856313	4571	1087.00	0.4003	1096840	679.0	308995	12557	11153	198091	1533	549.0
328	NE	1974	522.0	892851	777085	4603	1044.00	0.5317	1144678	686.0	334457	14018	10940	198091	1537	558.0
329	NE	1975	528.0	902152	790840	5333	1064.00	0.5940	1177845	686.0	350494	15088	11211	198091	1544	569.0
330	NE	1976	540.0	959418	837001	5356	1025.99	0.6315	1293369	694.2	380481	16515	11843	198091	1553	582.0
331	NH	1966	200.0	261925	254524	2483	379.00	0.3148	334052	328.6	53598	930	3665	23380	677	227.0
332	NH	1967	205.0	276225	268352	2649	371.00	0.3332	348717	337.2	55500	1070	3650	23380	697	234.0
333	NH	1968	212.0	303669	293581	2850	390.00	0.3432	352806	345.8	53379	1186	3931	23380	709	239.0
334	NH	1969	218.5	325446	313931	3022	402.00	0.3565	355770	354.4	57717	1448	4198	23380	724	247.5
335	NH	1970	225.0	350719	338173	3214	427.00	0.3640	361711	363.0	57098	1605	4436	23380	738	256.0
336	NH	1971	234.5	375483	360455	3426	441.00	0.3823	406699	236.0	60291	1748	4835	23380	758	278.0
337	NH	1972	244.0	398128	381755	3551	461.00	0.3765	436158	238.0	67143	3719	5076	23380	774	278.0
338	NH	1973	254.0	411508	393313	4059	505.00	0.4007	462140	392.0	75211	4224	5235	23380	794	290.0
339	NH	1974	261.0	398983	379948	4383	525.00	0.5448	490303	401.0	85214	4853	5078	23380	808	302.0
340	NH	1975	266.0	407492	389555	4718	534.00	0.5648	485306	406.0	79465	4615	5290	23380	812	312.0
341	NH	1976	275.0	435523	415056	5212	561.20	0.5940	527277	412.1	81944	4911	5676	23380	822	318.0
342	NJ	1966	2022.0	2475188	2295753	3120	3529.00	0.3148	3122876	6376.4	325054	6032	34521	19479	6894	2400.0
343	NJ	1967	2053.0	2550052	2360627	3308	3597.00	0.3298	3200454	6471.3	328746	6566	35573	19479	6928	2425.0
344	NJ	1968	2102.0	2704305	2496057	3537	3733.00	0.3482	3333523	6566.2	340452	7028	37717	19479	7005	2460.0
345	NJ	1969	2160.0	2803760	2584111	3755	3869.00	0.3665	3489789	6661.1	349829	8055	39116	19479	7095	2467.5
346	NJ	1970	2218.0	2969322	2736672	4065	4029.00	0.3740	3585637	6756.0	358574	8891	41463	19479	7168	2475.0
347	NJ	1971	2296.5	3089867	2843883	4358	4074.00	0.3807	3737308	6863.0	368222	9336	43289	19479	7296	2594.0
348	NJ	1972	2375.0	3377996	3114393	4556	4124.00	0.3632	3858631	6900.0	384233	33523	47082	19479	7349	2594.0
349	NJ	1973	2365.0	3470875	3180680	4955	4342.00	0.3857	4073749	6821.0	392511	34020	48167	19479	7325	2621.0
350	NJ	1974	2386.0	3384810	3097073	5388	4217.00	0.5230	4168451	6798.0	404820	35924	47244	19479	7322	2638.0
351	NJ	1975	2408.0	3475998	3209825	5893	4323.00	0.5473	4154542	6772.0	407355	36661	48445	19479	7316	2670.0
352	NJ	1976	2458.0	3605313	3309663	6352	4215.81	0.5565	4257205	6771.0	414517	37055	50081	19479	7336	2720.0
353	NM	1966	266.0	513062	453763	2059	534.00	0.3290	549206	310.2	138790	4868	5961	314457	1011	335.0
354	NM	1967	266.0	525761	462761	2163	549.00	0.3365	571239	315.9	146064	5317	6121	314457	1000	332.0
355	NM	1968	272.0	550542	484638	2321	540.00	0.3448	589489	321.6	152276	5814	6478	314457	994	327.0
356	NM	1969	280.5	591299	518542	2445	553.00	0.3573	610733	327.3	167180	7195	6935	314457	1011	344.0
357	NM	1970	285.0	620990	542098	2650	577.00	0.3673	637371	333.0	178903	7003	7463	314457	1016	361.0
358	NM	1971	312.0	674269	589395	2826	600.00	0.3690	661129	346.0	192665	7246	8015	314457	1053	390.0
359	NM	1972	335.0	728144	632650	3046	637.00	0.3648	695114	359.0	207998	5789	8853	314457	1076	390.0
360	NM	1973	333.0	776779	673934	3405	666.00	0.3829	725637	371.0	218751	6593	9468	314457	1099	412.0
361	NM	1974	345.0	751086	644276	3702	702.00	0.5265	763452	381.0	227403	7232	9438	314457	1119	423.0
362	NM	1975	358.0	791551	681720	4180	735.00	0.5898	826568	388.0	268387	8505	9921	314457	1144	438.0
363	NM	1976	370.0	852659	725552	4544	753.58	0.5953	883646	388.2	287264	8064	10524	314457	1168	453.0
364	NV	1966	133.0	257234	229932	2911	287.00	0.3323	279000	321.2	68091	2141	2820	284613	435	164.0
365	NV	1967	134.0	261478	234959	3019	338.00	0.3507	266637	339.4	69709	2299	3062	284613	449	164.0
366	NV	1968	140.0	289034	256322	3226	327.00	0.3690	303403	357.6	73964	2548	2999	284613	464	168.0
367	NV	1969	150.0	303968	268685	3472	335.00	0.3740	328929	375.8	78726	3077	3095	284613	480	178.0
368	NV	1970	160.0	337189	299423	3822	337.00	0.3823	354590	394.0	87773	3290	3460	284613	489	188.0
369	NV	1971	174.0	357477	316868	4123	354.00	0.3740	372730	413.0	93343	3535	3623	284613	511	202.0
370	NV	1972	188.0	395619	351201	4282	369.00	0.3902	399046	427.0	100337	2225	3889	284613	533	202.0
371	NV	1973	188.0	422255	373682	4817	389.00	0.4173	436978	444.0	110229	2463	4281	284613	551	213.0
372	NV	1974	200.0	418361	363430	5164	398.00	0.5438	456051	463.0	116875	2695	4195	284613	574	222.0
373	NV	1975	209.0	447272	393872	5730	419.00	0.5903	463835	478.0	117155	2766	4439	284613	590	358.0
374	NV	1976	217.0	463045	412052	6256	449.76	0.5908	508405	492.3	132322	2969	4890	284613	610	243.0
375	NY	1966	5662.0	4702732	4546235	3026	7609.00	0.3153	6005132	15761.8	622095	19925	57778	123882	17942	6190.0
376	NY	1967	5631.0	4841102	4669888	3203	7903.00	0.3309	6060491	15894.1	623924	21762	60731	123882	17935	6047.0
377	NY	1968	5745.0	5022106	4838851	3445	7983.00	0.3449	6310107	16026.4	634411	23208	62326	123882	18051	6129.0
378	NY	1969	5831.5	5429746	5213634	3662	7991.00	0.3580	6504997	16158.7	651237	26659	58695	123882	18105	6263.5

STATISTICAL ANALYSIS SYSTEM

OBS	ST	YEAR	HH	HWF	HWGAS	PCCI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPOP	A2
379	NY	1970	5914.0	5533754	5251069	3935	8056.00	0.3664	6718026	16291.0	687721	26378	59405	123882	18241	6398.0
380	NY	1971	6056.0	5858953	5607418	4185	8278.00	0.3773	6890944	14270.0	697557	23650	62952	123882	18384	6594.0
381	NY	1972	6198.0	6054788	5787529	4359	8450.00	0.3936	7006452	14249.0	707098	38876	65102	123882	18367	6594.0
382	NY	1973	6182.0	6281262	5980989	4732	8546.00	0.4190	7319493	16181.0	757546	41827	67586	123882	18214	6641.0
383	NY	1974	6235.0	5713265	5430173	5106	8731.00	0.5757	7457918	16066.0	789525	44840	65262	123882	18103	6665.0
384	NY	1975	6313.0	5727762	5457762	5576	8832.00	0.5990	7591358	16067.0	824934	48393	65124	123882	18076	6754.0
385	NY	1976	6381.0	6208314	5914850	5989	8935.09	0.6176	7650669	16005.6	886232	51452	67962	123882	18084	6832.0
386	OH	1966	3057.0	3937077	3639296	2757	5511.00	0.3273	5238498	8255.6	540689	6871	48273	106125	10403	3510.0
387	OH	1967	3110.0	4054699	3748167	2861	5726.00	0.3332	5305391	8340.7	559018	8093	49722	106125	10414	3571.0
388	OH	1968	3187.0	4322481	3959274	3060	5860.00	0.3440	5441963	8425.8	579255	8806	52834	106125	10516	3640.0
389	OH	1969	3238.0	4573747	4174695	3272	5828.00	0.3565	5739576	8510.9	623893	10635	55821	106125	10563	3685.0
390	OH	1970	3289.0	4758622	4363168	3459	6105.00	0.3665	5973901	8596.0	650256	13305	56014	106125	10652	3730.0
391	OH	1971	3379.0	4925210	4479124	3701	5948.00	0.3790	6043109	8909.0	680256	16411	61051	106125	10724	3892.0
392	OH	1972	3469.0	5236301	4741368	3912	6141.00	0.3790	6414345	8938.0	717966	46044	63505	106125	10722	3892.0
393	OH	1973	3473.0	5532281	4568581	4345	6294.00	0.3865	6643998	8615.0	820742	52835	65171	106125	10743	3932.0
394	OH	1974	3515.0	5346260	4783729	4691	6781.00	0.5336	6965481	8609.0	846399	56104	63084	106125	10745	4001.0
395	OH	1975	3554.0	5390402	4866000	5044	7545.00	0.5719	7178933	8608.0	868927	59021	64134	106125	10759	4084.0
396	OH	1976	3593.0	5653149	5049558	5523	8107.18	0.5753	7145834	8538.8	943888	64788	67019	106125	10690	4127.0
397	OK	1966	803.0	1171395	1083638	2242	1421.00	0.3223	1495620	1318.8	405675	12792	14657	178145	2479	850.0
398	OK	1967	822.0	1215084	1122775	2397	1465.00	0.3373	1541907	1342.1	424321	14397	15139	178145	2489	878.0
399	OK	1968	845.0	1288566	1187034	2567	1461.00	0.3340	1610387	1365.4	449405	15970	16049	178145	2503	894.0
400	OK	1969	848.0	1368311	1258493	2696	1492.00	0.3473	1650182	1398.7	467492	18599	16837	178145	2535	890.0
401	OK	1970	851.0	1451169	1332674	2953	1621.00	0.3507	1712522	1412.0	490815	20119	18011	178145	2559	886.0
402	OK	1971	887.5	1528246	1355873	3122	1657.00	0.3507	1789483	1435.0	517176	20723	18627	178145	2600	938.0
403	OK	1972	924.0	1644961	1492018	3311	1631.00	0.3473	1887210	1456.0	553923	36420	20083	178145	2633	938.0
404	OK	1973	926.0	1731125	1557849	3794	1674.00	0.3753	1984145	1479.0	600722	39522	21672	178145	2669	963.0
405	OK	1974	942.0	1684312	1506886	4150	1712.00	0.5033	2040649	1486.0	637196	43155	21494	178145	2681	998.0
406	OK	1975	959.0	1758817	1579239	4596	1720.00	0.5644	2112733	1503.0	671959	46727	22724	178145	2712	1010.0
407	OK	1976	991.0	1879598	1676387	4909	1785.55	0.5946	2214092	1528.2	705834	46457	24296	178145	2766	1051.0
408	OR	1966	638.0	902917	826376	2521	1087.00	0.3207	1167112	1183.8	211780	8840	11055	249117	1968	667.0
409	OR	1967	646.0	933421	852727	2651	1100.00	0.3248	1190006	1208.1	214327	9620	11565	249117	1979	674.0
410	OR	1968	665.0	982883	891904	2816	1157.00	0.3315	1242368	1232.4	229164	10782	12034	249117	2004	687.0
411	OR	1969	678.5	1047995	942243	2947	1176.00	0.3348	1334521	1256.7	240253	12671	12700	249117	2062	703.0
412	OR	1970	692.0	1112041	1003143	3152	1304.00	0.3532	1369233	1281.0	246439	12692	13527	249117	2091	719.0
413	OR	1971	733.0	1189971	1067651	3411	1360.00	0.3582	1431732	1300.0	259416	13577	14380	249117	2135	786.0
414	OR	1972	774.0	1278441	1141417	3649	1513.00	0.3548	1496115	1318.0	263227	11563	15233	249117	2185	786.0
415	OR	1973	773.0	1367614	1191108	4103	1497.00	0.3839	1605880	1344.0	290356	18609	15962	249117	2219	817.0
416	OR	1974	800.0	1289789	1135783	4528	1533.00	0.5170	1579736	1362.0	291801	19210	15223	249117	2255	848.0
417	OR	1975	815.0	1346727	1172395	4914	1551.00	0.5550	1627592	1377.0	300760	20276	15938	249117	2288	871.0
418	OR	1976	844.0	1433585	1259721	5363	1601.45	0.5723	1790746	1407.6	351899	25604	17096	249117	2329	901.0
419	PA	1966	3467.0	3795990	3513473	2640	6301.00	0.3132	5196174	9400.0	636337	8660	51332	116462	11664	3856.0
420	PA	1967	3514.0	4010141	3695727	2819	5913.00	0.3148	5335237	9445.5	655443	10132	52123	116462	11681	3879.0
421	PA	1968	3586.0	4278720	3923644	2985	6076.00	0.3265	5546819	9491.0	683215	11113	56874	116462	11741	3927.0
422	PA	1969	3645.5	4396876	4003253	3173	6217.00	0.3473	5759552	9536.5	718766	13123	55148	116462	11741	3933.5
423	PA	1970	3705.0	4551783	4127715	3417	6213.00	0.3648	5818553	9582.0	743865	13748	56677	116462	11794	3940.0
424	PA	1971	3811.5	4869303	4409564	3651	6313.00	0.3723	6023575	9650.0	789005	15870	61499	116462	11888	4099.0
425	PA	1972	3918.0	5346049	4805233	3842	6532.00	0.3674	6311330	9658.0	829742	61136	67520	116462	11905	4099.0
426	PA	1973	3906.0	5359840	4761950	4265	6574.00	0.3790	6674740	9582.0	906539	66386	67694	116462	11862	4147.0
427	PA	1974	3946.0	5055693	4427221	4661	6660.00	0.5288	7175045	9558.0	927501	69886	63853	116462	11842	4181.0
428	PA	1975	3980.0	5043674	4461074	5142	6861.00	0.5390	7659305	9527.0	1045387	81429	63702	116462	11829	4247.0
429	PA	1976	4062.0	5524049	4882205	5569	6938.42	0.5673	8127455	9547.1	1154255	85902	69769	116462	11862	4332.0
430	RI	1966	270.0	291863	278380	2663	434.00	0.3048	423433	823.8	46067	1207	4020	2717	895	307.0
431	RI	1967	272.0	300778	285162	2888	469.00	0.3232	434362	831.6	47000	1340	4161	2717	909	309.0
432	RI	1968	278.0	320666	302527	3083	480.00	0.3382	452336	839.4	49504	1483	4357	2717	922	309.0

STATISTICAL ANALYSIS SYSTEM

OBS	ST	YEAR	HH	HWF	HWGAS	PCDI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	OTRUCK	TVMT	AREA	TPOP	A2
433	RI	1969	285.0	330474	312116	3212	496	0.3565	469805	847	52005	1765	4508	2717	932	322.0
434	RI	1970	292.0	352107	333883	3434	504	0.3623	488277	855	54052	1650	4602	2717	950	335.0
435	RI	1971	303.5	364156	343355	3640	527	0.3690	509047	776	56590	1895	5038	2717	958	348.0
436	RI	1972	315.0	384938	361138	3857	538	0.3615	536284	783	60013	5154	5414	2717	969	348.0
437	RI	1973	312.0	385652	361125	4179	558	0.3832	562830	869	64380	5546	5473	2717	967	352.0
438	RI	1974	307.0	380500	356898	4603	555	0.5257	567851	858	67005	6079	5544	2717	938	332.0
439	RI	1975	307.0	389815	369848	5151	528	0.5590	562641	851	62944	5714	5660	2717	931	332.0
440	RI	1976	316.0	386063	365558	5642	596	0.5857	585441	846	71932	6226	5761	2717	927	340.0
441	SC	1966	678.0	970608	913347	1886	1188	0.3248	1147120	1147	197395	3835	12432	78283	2607	955.0
442	SC	1967	698.0	1026233	960057	2029	1244	0.3215	1190392	1166	208655	4288	13086	78283	2533	984.0
443	SC	1968	721.0	1113107	1037172	2214	1326	0.3332	1250002	1185	222071	4798	14191	78283	2559	1009.0
444	SC	1969	727.5	1194766	1110805	2401	1377	0.3473	1311384	1204	237320	5747	15512	78283	2570	983.5
445	SC	1970	734.0	1276298	1182637	2614	1403	0.3432	1359811	1223	250518	6647	16559	78283	2591	958.0
446	SC	1971	775.5	1374473	1268488	2769	1460	0.3573	1382965	1250	255239	7523	17764	78283	2639	1015.0
447	SC	1972	817.0	1503127	1378293	2994	1564	0.3665	1497389	1267	285704	12002	19472	78283	2688	1015.0
448	SC	1973	816.0	1591355	1443958	3419	1416	0.3840	1601114	1303	312091	15247	20428	78283	2724	1051.0
449	SC	1974	841.0	1557573	1410119	3768	1463	0.5288	1671008	1340	327536	16488	20012	78283	2775	1093.0
450	SC	1975	852.0	1608738	1461709	4032	1566	0.5439	1772362	1363	362558	12453	20603	78283	2818	1118.0
451	SC	1976	857.0	1721204	1555872	4446	1585	0.5790	1770198	1375	356910	17483	21961	78283	2848	1147.0
452	SD	1966	157.0	297247	276741	2230	400	0.3065	401189	92	118300	1374	4046	196723	681	206.0
453	SD	1967	195.0	305490	284040	2344	404	0.3427	406961	93	122466	1455	4143	196723	671	202.0
454	SD	1968	198.0	320389	296994	2529	398	0.3490	411007	93	124775	1557	4310	196723	669	203.0
455	SD	1969	199.5	324338	296921	2650	401	0.3575	417954	94	128289	1810	4361	196723	668	207.0
456	SD	1970	201.0	351749	321227	2806	411	0.3715	426397	95	133449	2368	4689	196723	666	211.0
457	SD	1971	205.0	379636	345484	2994	419	0.3623	441689	96	140181	2651	4818	196723	675	226.0
458	SD	1972	217.0	421660	363971	3435	424	0.3248	462613	97	148829	3236	5038	196723	680	226.0
459	SD	1973	216.0	425869	376855	4504	417	0.3853	486059	98	161053	3516	5140	196723	682	232.0
460	SD	1974	220.0	408256	361160	4327	411	0.5223	506924	99	174046	3926	5093	196723	681	235.0
461	SD	1975	222.0	421386	375028	4421	418	0.5940	520896	100	182765	4234	5060	196723	681	239.0
462	SD	1976	228.0	449343	398553	4217	473	0.6098	541663	101	195906	5503	5503	196723	686	244.0
463	TN	1966	1113.0	1513884	1417671	2045	1905	0.3315	1757575	2385	325679	8981	17267	107040	3881	1378.0
464	TN	1967	1146.0	1606355	1499481	2180	2060	0.3332	1869918	2413	340198	10590	18002	107040	3859	1414.0
465	TN	1968	1169.0	1698342	1570402	2349	2010	0.3448	1906774	2441	356389	11646	18824	107040	3878	1427.0
466	TN	1969	1161.0	1822708	1675629	2542	2013	0.3540	1971160	2469	380788	13983	19236	107040	3897	1417.5
467	TN	1970	1213.0	1890806	1727989	2722	2078	0.3557	2049992	2497	404292	15495	20719	107040	3924	1408.0
468	TN	1971	1274.5	2048350	1855602	2964	2088	0.3548	2135635	2335	424352	17076	27224	107040	3988	1485.0
469	TN	1972	1326.0	2257277	2029809	3240	2159	0.3548	2293635	2354	466906	19636	25830	107040	4072	1485.0
470	TN	1973	1327.0	2461785	2199125	3672	2245	0.3748	2466821	2585	520290	21969	32513	107040	4095	1544.0
471	TN	1974	1359.0	2382234	2116329	3988	2371	0.5051	2568381	2620	572585	24901	31442	107040	4149	1563.0
472	TN	1975	1383.0	2485364	2221267	4344	2430	0.5717	2725569	2646	624270	27916	32926	107040	4188	1608.0
473	TN	1976	1418.0	2647439	2342448	4789	2532	0.5965	2804840	2658	642213	28761	35073	107040	4214	1640.0
474	TX	1966	3154.0	4927565	4607154	2333	5553	0.3018	5711263	8019	1229814	33931	54397	678927	10703	3782.0
475	TX	1967	3205.0	5168740	4817042	2518	5601	0.3090	5893582	8185	1293686	39905	59002	678927	10599	3832.0
476	TX	1968	3300.0	5581458	5186039	2700	5627	0.3115	6179683	8352	1372631	44852	62188	678927	10819	3907.0
477	TX	1969	3367.0	5952115	5534310	2882	5860	0.3193	6506385	8518	1475259	54077	66075	678927	11045	3984.5
478	TX	1970	3434.0	6294098	5841071	3146	6380	0.3323	6693280	8684	1544104	40563	68031	678927	11197	4062.0
479	TX	1971	3605.0	6715212	6192379	3289	6595	0.3421	6984269	8868	1624858	46751	71889	678927	11416	4348.0
480	TX	1972	3764.0	7290467	6694102	3554	6790	0.3380	7315711	9050	1737651	55008	76581	678927	11604	4348.0
481	TX	1973	3793.0	7820718	7111664	4041	6973	0.3485	7815645	9235	1909305	59323	80507	678927	11828	4470.0
482	TX	1974	3908.0	7592639	6885193	4416	7288	0.4748	8053269	9421	2019718	60491	78691	678927	12017	4623.0
483	TX	1975	4011.0	8006190	7260853	4931	7509	0.5396	8396489	9606	2149675	72031	84582	678927	12236	4757.0
484	TX	1976	4155.0	8563561	7734510	5437	7870	0.5650	8969754	9821	2351570	79774	91964	678927	12487	4932.0
485	US	1966	58232.0	74664492	65973025	2622	100959	0.3208	94192599	141071	15516895	365205	927899	9160454	195923	67252.0
486	US	1967	59245.0	77730668	72680934	2774	103172	0.3316	96944876	143260	16192776	416454	966005	9160454	197374	67933.0

STATISTICAL ANALYSIS SYSTEM

OBS	ST	YEAR	HH	HWF	HWGAS	PCDI	CRIVER	PRGAS	VREG	SMSA	TRUCKS	OTRUCK	TVMT	AREA	TPOP	A2
487	US	1968	60726.0	82949441	77258786	2972	105392	0.3371	100884786	145449	16994615	466055	1019726	9160454	199312	69437.0
488	US	1969	62088.0	88135102	81805024	3162	108295	0.3480	105096603	147637	17870987	547180	1066108	9160454	201306	70561.0
489	US	1970	63450.0	52329056	85598364	3397	111543	0.3569	108375423	149826	18748421	572266	1114098	9160454	203302	71685.0
490	US	1971	65291.0	57558586	89984705	3627	114426	0.3643	112988119	148689	19837063	627589	1183524	9160454	206212	75534.0
491	US	1972	67132.0	105062178	96542738	3856	118414	0.3613	118782023	149431	21239163	903053	1264614	9160454	208230	75540.0
492	US	1973	68737.0	110472881	100636235	4328	121628	0.3882	125669992	154046	23232872	1004998	1316207	9160454	209844	77252.0
493	US	1974	70255.0	106300765	96504515	4677	125427	0.5241	129933169	155039	24589078	1085399	1282790	9160454	211381	78994.0
494	US	1975	71537.0	108984347	96353593	5106	129814	0.5722	132950410	156098	25775715	1170720	1330074	9160454	213592	81175.0
495	US	1976	73253.0	115700156	104978219	5534	134156	0.5947	138549263	143	27719597	1291764	1409163	9160454	214658	82838.0
496	UT	1966	283.0	418629	381714	2204	550	0.3090	543991	779	122306	3516	5079	212629	1010	346.0
497	UT	1967	285.0	430666	391336	2258	558	0.3198	547658	795	126049	3842	5260	212629	1019	354.0
498	UT	1968	293.0	469067	425282	2418	513	0.3248	571336	811	121936	4408	5539	212629	1029	358.0
499	UT	1969	295.5	509878	463109	2530	527	0.3423	601436	827	131750	4550	5802	212629	1047	369.5
500	UT	1970	298.0	547153	497692	2768	615	0.3432	664404	843	144242	4917	6108	212629	1059	381.0
501	UT	1971	318.5	580675	530236	2966	572	0.3498	711267	872	196411	4894	6544	212629	1094	420.0
502	UT	1972	335.0	640514	579535	3212	650	0.3556	721600	894	200704	7294	6969	212629	1127	420.0
503	UT	1973	337.0	674991	602787	3595	665	0.3737	777370	911	209859	7594	7274	212629	1150	439.0
504	UT	1974	345.0	660825	587754	3886	721	0.5017	809625	933	219829	8262	7457	212629	1179	450.0
505	UT	1975	358.0	684671	610772	4281	729	0.5632	844974	953	256761	9951	7942	212629	1203	468.0
506	UT	1976	365.0	723640	644161	4708	759	0.5845	877390	968	271182	10355	8420	212629	1228	481.0
507	VA	1966	1224.0	1658385	1520593	2321	2186	0.3157	1874779	2813	284152	3732	21754	103030	4483	1670.0
508	VA	1967	1252.0	1748407	1599204	2501	2230	0.3149	1932478	2878	295307	4225	22641	103030	4508	1713.0
509	VA	1968	1290.0	1890433	1724993	2713	2307	0.3321	2047557	2943	314326	4721	24547	103030	4558	1737.0
510	VA	1969	1340.5	2085253	1903323	2876	2388	0.3473	2161278	3008	335669	5657	26951	103030	4614	1757.5
511	VA	1970	1391.0	2202594	2008791	3145	2246	0.3557	2262721	3073	359090	5955	28419	103030	4648	1778.0
512	VA	1971	1450.0	2371619	2156079	3417	2492	0.3523	2410216	3059	387464	7274	30504	103030	4715	1853.0
513	VA	1972	1505.0	2552093	2314066	3694	2670	0.3690	2602773	3083	425733	18687	32717	103030	4765	1853.0
514	VA	1973	1518.0	2705457	2446136	4153	2856	0.3948	2990592	3187	489646	21674	34664	103030	4844	1890.0
515	VA	1974	1555.0	2626012	2374772	4517	2944	0.5273	3171744	3229	504703	22964	33634	103030	4909	1965.0
516	VA	1975	1592.0	2652810	2450382	4947	3017	0.5723	3250861	3261	530304	24794	34641	103030	4966	2017.0
517	VA	1976	1655.0	2867873	2600073	5332	3069	0.6007	3302252	3299	526585	25288	36710	103030	5032	2075.0
518	VT	1966	118.0	167802	163163	2279	213	0.3332	186600	0	31923	592	2096	24002	413	134.0
519	VT	1967	122.0	180399	175236	2403	219	0.3432	194120	0	33589	645	2265	24002	423	139.0
520	VT	1968	126.0	191171	185247	2605	224	0.3623	206607	0	34622	685	2452	24002	430	145.0
521	VT	1969	129.0	200895	194584	2747	246	0.3765	214539	0	35086	769	2555	24002	437	150.0
522	VT	1970	132.0	221004	208961	2929	253	0.3865	228796	0	38246	1592	2687	24002	445	155.0
523	VT	1971	138.5	236318	221932	3183	268	0.3998	237153	0	42374	1744	3018	24002	453	168.0
524	VT	1972	145.0	252571	237794	3260	280	0.4023	261600	0	45408	2015	3253	24002	460	168.0
525	VT	1973	146.0	259165	240300	3674	293	0.4173	274563	0	48906	2169	3338	24002	466	172.0
526	VT	1974	145.0	250312	230145	3951	303	0.5568	282279	0	53913	2465	3101	24002	468	177.0
527	VT	1975	152.0	254727	233592	4292	310	0.5840	287109	0	52638	2461	3314	24002	472	182.0
528	VT	1976	157.0	270903	248648	4745	302	0.5965	304929	0	59673	2651	3416	24002	476	187.0
529	WA	1966	970.0	1242698	1174907	2885	1606	0.3198	1756294	2307	353804	8806	16670	172416	3075	1029.0
530	WA	1967	1025.0	1331999	1250777	3025	1705	0.3382	1851761	2353	388610	9914	17741	172416	3174	1124.0
531	WA	1968	1073.0	1432564	1346369	3237	1788	0.3490	1987376	2399	419987	11323	19023	172416	3270	1480.0
532	WA	1969	1085.5	1512352	1419749	3413	1904	0.3556	2109232	2445	457389	13576	19989	172416	3343	1355.0
533	WA	1970	1106.0	1571457	1473663	3532	1920	0.3640	2101961	2491	474023	13817	20711	172416	3409	1230.0
534	WA	1971	1135.0	1624014	1518737	3715	1966	0.3665	2163117	2504	497585	13989	21860	172416	3435	1275.0
535	WA	1972	1172.0	1700364	1579757	3942	2003	0.3615	2242060	2491	529641	16524	22363	172416	3418	1275.0
536	WA	1973	1173.0	1800628	1654715	4451	2145	0.3925	2370610	2469	575707	17725	23457	172416	3431	1296.0
537	WA	1974	1217.0	1751500	1607339	4889	2122	0.5247	2444446	2511	607638	19273	22585	172416	3500	1341.0
538	WA	1975	1246.0	1821447	1675091	5473	2177	0.5693	2539764	2536	645386	21319	24023	172416	3547	1396.0
539	WA	1976	1294.0	1960985	1781207	5865	2289	0.6000	2694903	2582	696211	22865	25932	172416	3612	1453.0
540	WI	1966	1206.0	1555763	1477282	2536	2185	0.3157	1998875	2556	304559	5739	20574	141062	4181	1322.0

STATISTICAL ANALYSIS SYSTEM

OBS	ST	YEAR	HH	HWF	HWGAS	PCDI	DRIVER	PRGAS	VREG	SMSA	TRUCKS	DTRUCK	TVMT	AREA	TPOP	A2
541	WI	1967	1224.0	1596723	1510804	2636	2280.00	0.3157	1954112	2590.1	314363	6477	20931	141062	4303	1137.0
542	WI	1968	1246.0	1694534	1597587	2802	2361.00	0.3265	2027121	2624.4	323850	6892	22189	141062	4345	1353.0
543	WI	1969	1287.5	1826602	1712837	2948	2458.00	0.3348	2104702	2658.7	329739	7874	23885	141062	4378	1416.5
544	WI	1970	1329.0	1923830	1799007	3221	2463.00	0.3315	2181510	2693.0	350399	8576	24563	141062	4418	1480.0
545	WI	1971	1388.0	2021458	1879074	3406	2465.00	0.3448	2230174	2604.0	349647	9989	25856	141062	4471	1582.0
546	WI	1972	1447.0	2168623	2005482	3610	2523.00	0.3373	2359679	2628.0	398709	17997	27566	141062	4526	1582.0
547	WI	1973	1436.0	2266814	2077189	4087	2594.00	0.3837	2472201	2747.0	405412	18323	28699	141062	4539	1634.0
548	WI	1974	1470.0	2221868	2020626	4448	2664.00	0.5213	2577547	2765.0	436535	20356	27965	141062	4565	1663.0
549	WI	1975	1467.0	2270399	2065268	4844	2721.00	0.5815	2590709	2784.0	454936	21753	28584	141062	4589	1714.0
550	WI	1976	1529.0	2403132	2163193	5350	2773.78	0.5840	2648897	2770.1	439450	22800	30221	141062	4609	1749.0
551	WV	1966	528.0	604745	551552	2005	823.00	0.3190	730880	670.9	144080	1720	7488	62341	1817	601.0
552	WV	1967	536.0	621858	567725	2145	855.00	0.3273	765347	669.1	148124	1851	7851	62341	1769	604.0
553	WV	1968	550.0	658820	600415	2234	828.00	0.3354	804860	667.4	161076	2112	8225	62341	1763	619.0
554	WV	1969	548.5	686612	622350	2373	861.00	0.3540	836254	665.7	170659	2534	8713	62341	1746	598.5
555	WV	1970	547.0	739446	659747	2647	913.00	0.3573	800933	664.0	173437	2635	8401	62341	1744	578.0
556	WV	1971	568.5	779824	691471	2844	982.00	0.3773	826154	668.0	199828	3165	8735	62341	1776	610.0
557	WV	1972	550.0	808827	716166	3103	1016.00	0.3840	873606	666.0	202025	7388	9808	62341	1795	610.0
558	WV	1973	589.0	875759	769631	3465	1051.00	0.3956	911005	664.0	223949	8216	10203	62341	1788	622.0
559	WV	1974	595.0	843001	757392	3861	1079.00	0.5123	935397	659.0	229910	9103	10118	62341	1784	628.0
560	WV	1975	604.0	898139	805192	4293	1262.00	0.5757	966009	665.0	228981	8873	10570	62341	1803	641.0
561	WV	1976	615.0	942547	862246	4660	1324.00	0.5907	994675	660.9	232645	9033	11075	62341	1821	658.0
562	WY	1966	58.0	207796	179789	2436	221.00	0.3082	223993	0.0	75368	2126	2605	251756	322	101.0
563	WY	1967	55.0	217659	186937	2531	221.00	0.3373	226403	0.0	77278	2348	2582	251756	322	102.0
564	WY	1968	102.0	232597	197931	2655	215.00	0.3223	225601	0.0	77486	2480	2797	251756	324	104.0
565	WY	1969	103.5	247334	211299	2870	222.00	0.3440	237841	0.0	83211	3203	2902	251756	329	109.0
566	WY	1970	105.0	261095	220892	3212	229.00	0.3615	246661	0.0	87375	3172	3045	251756	332	114.0
567	WY	1971	110.5	267031	226396	3231	232.00	0.3673	257337	0.0	91686	3481	3198	251756	340	124.0
568	WY	1972	116.0	294830	247735	3624	217.00	0.3440	273608	0.0	98237	3701	3369	251756	346	124.0
569	WY	1973	116.0	319853	266255	4164	224.00	0.3912	293912	0.0	107724	5040	3459	251756	353	130.0
570	WY	1974	121.0	319985	254619	4672	257.00	0.5317	306796	0.0	116878	5631	3452	251756	362	134.0
571	WY	1975	126.0	344479	279950	5117	280.00	0.5932	336824	0.0	132548	6571	3682	251756	376	142.0
572	WY	1976	133.0	381810	301847	5633	300.44	0.6144	360888	0.0	144632	6806	4277	251756	390	151.0

HH -- number of households
HWF -- annual highway motor fuel consumption
HWGAS -- annual highway gasoline consumption
PCDI -- per capita disposable income
DRIVER -- licensed drivers
PRGAS -- price of regular gasoline, current dollars
VREG -- total vehicle registrations
SMSA -- total population living in SMSAs
TRUCKS -- total registered trucks
DTRUCK -- total diesel-powered registered trucks
TVMT -- annual VMT
AREA -- state land area in square miles
TPOP -- state population
A2 -- population 18-44 years of age

Table 14. Cross-Sectional Data Base for State Effects Model - Variables*

OBS	STATE	TOTVMT	URBVMT	SMVMT	UPOP	ULAND	SMALPOP	SMALLAND	TPERS	TMIPERS	FCAR	TUTCAF	PCFOR	CPOP70	CPOP73	FLEET	TERRAIN					
1	AK	6692	1890	415	164	33	49	13	29	275	21096	96401	0.218836	0	0	2911	1					
2	AL	68441	32007	8361	1976	1966	509	673	210	2056	139348	1491214	0.093446	762	776	13422	0					
3	AR	38346	14154	7497	944	755	549	472	144	1260	67383	767086	0.087844	132	142	8306	0					
4	AZ	43667	22678	2321	1636	1635	233	229	193	2103	108593	768171	0.141366	845	945	22961	1					
5	CA	349600	237220	18680	18543	5863	1385	1031	1065	9974	1951153	9540172	0.204520	7330	7443	327453	1					
6	CO	45501	22776	3076	1940	747	327	170	173	1795	172156	1042906	0.165074	650	692	20562	1					
7	CT	49956	33906	902	2324	1317	85	72	49	417	222131	1433744	0.149710	670	644	62696	0					
8	DC	8435	8435	0	722	61	0	0	2	22	34709	293756	0.118156	757	734	49315	0					
9	DE	6912	4909	601	394	130	34	25	17	188	32088	290513	0.110454	0	0	7849	0					
10	FL	105470	61272	6812	6583	4330	829	766	254	2649	472506	3876604	0.121887	1707	1806	74234	0					
11	GA	120932	50867	13075	2713	2246	698	705	239	2208	234514	2137859	0.109696	891	840	46104	0					
12	HI	11360	7725	1398	652	232	178	95	18	165	103044	353670	0.291357	325	338	9170	1					
13	IA	53481	21586	7502	1474	1079	634	472	110	958	91013	1345570	0.067639	312	309	11587	0					
14	ID	16090	4236	2843	375	214	267	130	70	618	41447	289939	0.142951	0	0	35760	1					
15	IL	166774	108435	5720	9124	2955	1034	521	214	1933	430383	5724205	0.075186	3641	3443	139627	0					
16	IN	95930	47135	10938	3241	2043	821	693	182	1553	166976	2489160	0.067108	1471	1466	4490	0					
OBS	TROMI	URDMI	SMRDMI	LTS	LTMI	MEDS	MEOMI	LHS	LHMI	HFS	HHMI	TTR72	P1	P2	P4	MCL1	DRIVE	PASS	TRANSIT	TAXI	OTHER	NONAG
1	9762	448	120	38	355	6	46	1	10	2	33	48	27	133	59	1.36	51.4	9.0	1.2	0.2	38.2	161.8
2	86154	12535	4246	306	3434	99	1225	11	127	26	1090	441	212	1134	1093	0.91	70.3	15.3	2.4	0.5	11.5	1155.4
3	72130	6113	3736	272	2850	24	240	4	70	20	310	320	114	637	658	0.95	69.6	13.0	1.3	0.4	15.7	623.8
4	51602	8283	1421	245	2817	35	335	6	94	11	329	297	130	700	651	1.81	76.2	10.3	1.2	0.1	12.3	729.1
5	168547	57776	8378	1631	16542	298	3925	41	595	95	3952	2055	1250	7199	6350	1.81	74.8	8.7	5.3	0.1	11.1	7829.3
6	78091	8216	1736	287	3020	62	591	8	70	17	699	374	165	891	676	0.97	71.9	9.8	2.8	0.2	15.3	946.6
7	18937	5823	405	105	1171	19	183	6	71	17	402	146	170	999	1004	1.69	70.2	12.3	6.9	0.2	10.3	1223.4
8	1101	1101	0	8	84	5	65	1	11	1	13	15	45	257	212	1.62	37.4	11.7	35.6	2.2	13.1	576.5
9	5044	1302	216	34	377	5	57	2	20	10	697	51	37	193	165	1.82	75.0	12.3	0.6	0.2	10.9	229.9
10	90932	33024	7105	425	5060	133	1319	19	276	45	2133	622	439	2430	3151	0.89	72.1	12.7	1.6	0.2	13.4	2750.1
11	100517	13655	5991	431	4709	68	689	23	302	37	1433	500	298	1653	1344	0.89	68.7	15.0	4.1	0.6	11.6	1755.7
12	3606	1130	439	34	324	9	81	1	10	3	49	48	62	300	222	1.20	65.2	13.6	6.1	0.2	14.9	342.8
13	112354	8577	4016	306	2656	48	469	23	276	28	1075	405	161	969	947	1.00	61.3	10.7	1.6	0.3	25.7	993.1
14	57265	1957	1382	124	1159	9	54	6	41	11	231	151	50	252	240	1.01	63.9	7.9	2.0	0.1	21.1	273.0
15	130146	26167	5503	488	4473	76	662	60	570	70	2015	595	629	3562	3463	1.02	59.6	11.8	15.3	0.4	12.9	4418.9
16	89402	15580	5398	315	2954	140	1225	46	335	52	1729	553	315	1709	1578	1.02	70.3	13.6	2.8	0.3	13.0	1941.7
OBS	AREA	ALT	FREIGHT	UPRHWY	URBINTER	TOTINTER	AGEMP	B1	B2	B3	B4	B5	JANTEMP	FREEZE	SNOW	TRAVEL	EFFECT					
1	1467055	0	0.00	0	0	0	0.8	153	393	392	25	33	23.5	152	106.3	324.5	.					
2	131334	0	620.32	129	103	904	91.0	155	1043	807	15	6392	51.2	20	0.4	581.4	0.06125					
3	134538	0	377.49	79	56	521	98.0	39	339	1460	11	5514	39.5	65	5.6	586.9	0.09384					
4	293750	2	1786.17	59	54	1205	22.2	311	270	197	250	2081	51.2	15	0.0	855.4	0.04753					
5	404575	0	3312.24	1584	672	2302	311.0	3350	6533	2888	132	8039	48.3	5	0.0	8158.2	-0.16197					
6	269754	5	94.37	192	108	949	59.0	71	399	894	31	3658	29.9	166	58.7	1551.5	-0.13828					
7	12553	0	431.58	362	197	338	14.3	162	1533	5223	2	562	24.8	139	56.3	697.5	-0.17722					
8	159	0	0.00	35	13	30	0.0	292	1792	33	159	190	35.6	80	17.5	607.6	-0.21085					
9	5123	0	111.64	42	34	31	6.8	25	274	1013	0	92	32.0	103	21.3	174.6	-0.09026					
10	140063	0	0.00	483	213	1495	95.0	128	2333	1020	54	14592	62.0	2	0.0	5575.6	-0.09061					
11	150409	1	208.31	287	221	1197	98.0	120	1077	2684	30	9233	42.4	60	1.6	1373.1	0.16073					
12	16641	0	0.00	43	17	49	.	593	1033	502	4	120	72.3	0	0.0	897.0	.					
13	144667	1	903.44	85	85	903	213.0	90	399	779	4	7393	19.4	140	32.3	566.8	-0.10706					
14	214123	3	42.58	14	14	615	42.0	58	273	351	141	1906	29.0	126	21.5	357.8	-0.05777					
15	144367	1	2688.46	429	342	1812	163.0	1650	4700	11900	31	6311	24.0	125	33.0	2747.0	-0.11045					
16	93461	1	2132.58	277	210	1145	134.0	324	3034	4234	24	6681	27.9	122	20.4	1071.6	0.06159					

* See p. 123 for an explanation of variable names.

ORS	STATE	TOTVMT	URBVMT	SMVMT	UPOP	ULAND	SMALPOP	SMALLAND	TPEAS	TMPERS	FCAR	TOTCAR	PCFDR	CPOP70	CPOP73	FLEET	TERRAIN
17	KS	42414	17878	5667	1405	773	613	385	143	1123	95637	1097151	0.087168	570	570	11529	0
18	KY	67638	24805	9625	1598	371	438	46	143	1453	106026	1288832	0.082265	469	521	12486	0
19	LA	55688	22905	4042	2505	1144	466	213	131	2117	141268	1509437	0.093500	941	931	19291	0
20	MA	79726	61458	5606	5177	2536	379	411	33	643	338163	2481903	0.136253	1184	1144	54916	0
21	MD	66830	49054	3783	3335	1052	320	154	113	1112	231967	1978059	0.117270	906	878	56201	0
22	ME	18547	6025	3467	538	416	352	178	44	380	56019	415454	0.134837	0	0	4161	0
23	MI	159372	101120	10498	6352	2710	615	608	323	3685	295323	5225882	0.056703	2427	2281	236981	0
24	MN	74540	36941	8420	2500	1257	463	305	133	1162	130053	1785251	0.072848	845	767	87912	0
25	MO	83740	43549	5132	3413	1055	538	293	214	2043	172421	2139020	0.080607	1361	1288	38327	0
26	MS	39337	10053	5177	1049	696	614	458	114	1329	73366	800641	0.091633	154	164	4688	0
27	MT	14809	3850	2161	364	207	210	125	63	321	35572	293069	0.124790	0	0	2718	1
28	NC	95726	36836	12584	2234	1493	931	531	240	2315	225607	2143477	0.105253	640	714	38734	0
29	ND	13074	3036	2338	759	145	193	115	23	226	17669	278619	0.063417	0	0	2951	0
30	NF	30715	10962	2382	921	354	289	123	33	497	54612	693326	0.078769	497	540	8426	0
31	NH	14465	5205	2545	424	259	223	155	23	232	64959	394689	0.164584	0	0	3521	0
32	NJ	127558	58494	2164	6630	2257	140	135	100	939	425406	3591751	0.118440	1109	1080	132606	0

ORS	TRDMI	URDMI	SMRDMI	LTS	LTMI	MEDS	MEDMI	LHS	LHMI	HFS	HHMI	TR72	P1	P2	P4	MCLI	DRIVE	PASS	TRANSIT	TAXI	OTHER	NONAG
17	131441	7346	3534	306	2609	65	462	48	281	23	333	442	141	708	743	1.00	69.7	9.9	1.2	0.3	18.9	801.2
18	70131	6371	3290	323	3193	48	510	21	197	30	347	422	199	1077	1040	0.94	70.6	15.2	1.0	0.1	13.1	1064.3
19	54657	5208	2628	300	3638	63	908	8	94	19	327	370	234	1197	1043	0.91	65.1	12.1	7.7	0.5	14.6	1249.5
20	32825	18501	2382	162	1869	39	455	10	129	38	873	249	346	1951	1901	1.13	62.1	12.9	11.2	0.7	13.1	2272.4
21	27514	5528	2118	164	2223	29	310	15	150	32	733	259	246	1193	1172	1.02	72.4	14.6	1.1	0.2	11.7	1482.3
22	21563	1906	1040	79	820	15	141	2	29	3	273	194	51	321	342	1.02	64.4	15.0	1.6	0.6	18.4	356.9
23	115952	24662	5391	455	5597	115	1490	20	252	47	1033	677	559	2972	2614	0.99	74.0	11.1	4.4	0.2	10.2	3136.1
24	123745	11491	2791	386	2554	36	371	17	224	25	1093	466	236	1254	1173	1.02	62.6	11.6	5.1	0.2	20.5	1474.2
25	118268	15173	3296	289	2635	170	1579	47	410	53	1307	500	276	1485	1562	0.99	67.7	13.2	4.9	0.5	13.8	1718.5
26	67477	5442	3853	252	3044	20	290	7	81	21	379	300	142	699	678	0.91	64.4	18.2	0.8	0.1	15.8	692.3
27	70341	2290	1383	128	1113	22	151	20	94	12	173	185	44	231	228	1.01	64.0	7.7	0.8	0.3	27.2	238.1
28	50805	15102	7234	462	4809	54	767	28	400	56	2333	500	340	1826	1571	0.96	70.2	18.6	0.7	0.2	10.4	1966.1
29	85148	1111	861	60	589	39	190	38	164	19	233	165	40	189	199	1.00	53.1	8.8	0.5	0.4	34.2	203.6
30	94740	4050	1743	188	1592	72	490	7	88	17	313	385	92	477	496	1.00	65.1	9.9	0.1	0.0	25.9	557.8
31	13738	1906	1120	44	466	5	34	2	25	6	133	37	45	267	247	1.02	67.1	15.4	1.4	0.5	15.6	292.6
32	33010	15034	688	231	2328	31	352	19	193	55	1433	335	376	2294	2433	1.03	63.5	10.6	14.1	0.3	11.4	2700.2

ORS	AREA	ALT	FREIGHT	URHWY	URBINTER	TOTINTER	AGEMP	B1	J2	B3	B4	B5	JANTEMP	FREEZE	SNOW	TRAVEL	EFFECT
17	211828	1	151.92	156	100	806	103.0	20	431	891	5	3550	31.3	114	14.9	566.1	-0.21599
18	102664	1	211.75	127	101	717	138.0	270	393	749	53	5049	33.3	95	18.3	868.1	0.02647
19	116369	0	654.85	102	96	578	68.0	122	320	11244	13	3447	52.9	12	0.2	1021.0	0.00499
20	20269	0	240.53	420	302	522	19.0	432	3.33	5510	3	453	29.2	103	42.8	1835.7	-0.05312
21	25618	0	500.63	289	181	362	33.0	200	1897	5398	44	3039	33.4	101	23.5	1037.2	-0.01098
22	40083	0	0.00	14	9	314	20.3	20	134	492	5	1415	21.5	161	77.0	595.5	0.15700
23	147156	1	294.74	499	314	1170	110.0	753	1391	3531	15	8492	20.0	150	50.0	2600.2	0.05015
24	205359	1	26.47	256	154	917	193.0	220	1473	3839	11	6884	10.0	174	55.0	1943.7	-0.02330
25	178657	0	1461.62	360	220	1112	204.0	54	711	2739	51	5597	29.0	104	13.0	1433.2	0.06363
26	122457	0	368.28	52	42	676	00.0	214	337	2012	54	5154	47.1	50	1.2	469.4	0.17646
27	377070	5	345.26	17	17	1193	33.0	222	147	727	40	549	20.5	155	56.5	440.0	-0.08573
28	126357	0	400.51	206	101	868	150.0	315	1333	5161	20	14275	41.0	80	6.5	1251.4	0.09838
29	179417	1	0.00	8	9	582	57.0	51	3	441	39	1220	8.2	186	39.1	268.6	-0.30661
30	198051	1	1026.53	35	34	483	115.0	50	333	633	5	1953	22.6	139	32.0	533.8	-0.09712
31	23350	0	0.00	35	11	215	5.0	38	113	803	1	202	20.6	174	65.2	451.7	0.08493
32	19479	0	1714.81	457	221	368	21.0	234	3343	4332	29	3543	32.7	115	17.2	2010.7	-0.09354

OBS	STATE	TOTVMT	URRVMT	SMVMT	UPOP	ULAND	SMALPOP	SMALLAND	TPERS	THIPERS	FCAP	TOTCAR	PCFDR	CPOP70	CPOP73	FLEET	TERRAIN					
33	NM	27170	10616	4618	776	526	406	323	113	1078	59087	445954	0.130241	244	274	5886	0					
34	NV	12152	6069	632	427	251	56	42	52	498	37978	257856	0.147282	126	144	4459	0					
35	NY	217080	145328	9053	4044	3822	983	504	139	1363	807619	7409372	0.109000	9171	8841	230398	0					
36	OH	175456	102337	10521	8016	3675	1194	582	193	2149	424764	5598193	0.077115	2997	2840	107610	0					
37	OK	62257	29770	7924	1703	1333	603	677	200	2181	0	0	0.090000	698	709	23379	0					
38	OR	43491	17634	3804	1535	737	437	217	120	1030	118433	992783	0.139803	383	378	26515	1					
39	PA	190646	108913	13019	8178	2840	1232	513	259	2779	534597	5025045	0.106386	2812	2679	110838	1					
40	RI	15507	13111	415	900	675	54	18	17	134	55095	474706	0.132453	179	170	6207	0					
41	SC	56448	19306	6080	1220	684	470	257	117	1145	111234	1084660	0.102579	114	112	14561	0					
42	SD	13893	2179	1557	263	161	182	119	37	276	17703	278119	0.063652	0	0	2089	0					
43	TN	87753	36803	12055	2787	1905	1009	792	133	1991	160317	1725309	0.092921	1366	1428	21214	0					
44	TX	131820	130267	21901	8466	8439	3024	1615	777	9300	511983	5451241	0.093921	4295	4505	114441	0					
45	US	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.					
46	UT	22053	12263	774	946	533	88	73	122	1093	62076	434289	0.142937	176	169	11903	1					
47	VA	101348	52623	4935	3202	1721	513	252	107	1523	249981	2036139	0.122772	1211	1205	35314	1					
48	VT	5080	1542	1542	153	95	153	95	15	153	37464	214540	0.174302	0	0	1202	1					
OBS	TPDMI	URDMI	SMDMI	LTS	LTMI	MEDS	MDMI	LHS	LHMI	HFS	HMMI	TR72	P1	P2	P4	MCLI	DRIVE	PASS	TRANSIT	TAXI	OTHER	NONAG
33	49556	4505	2771	164	1767	22	234	4	44	6	144	136	74	364	298	0.94	73.8	9.7	2.1	0.2	14.2	370.2
34	40810	1658	255	75	756	10	86	2	17	2	43	39	33	200	165	1.01	68.7	7.1	1.2	0.3	22.8	263.1
35	107744	33667	4452	462	4684	97	319	19	194	81	1301	659	961	5793	6027	1.12	45.9	8.6	32.2	0.7	12.6	6834.1
36	110060	27469	5055	446	4800	131	1323	31	317	60	2343	308	539	3445	3275	1.03	78.4	10.7	0.5	0.1	10.3	4016.2
37	109355	5949	4106	358	4171	95	855	34	231	50	2119	327	157	853	905	0.90	73.5	10.4	1.5	0.6	13.9	899.7
38	93967	7515	2472	158	1536	62	488	11	95	22	375	233	129	742	735	1.03	73.0	9.4	3.3	0.1	14.2	837.4
39	118032	27217	5422	545	5453	71	603	39	450	111	3013	735	648	3590	4116	0.99	62.0	11.9	11.9	0.2	13.9	4435.7
40	5210	3639	181	41	413	6	65	2	27	7	233	56	52	280	320	1.09	68.6	13.9	2.0	0.0	15.5	349.2
41	60945	6619	3016	201	2253	36	375	8	128	12	331	257	183	935	756	0.93	66.4	21.9	0.6	0.2	10.9	982.6
42	72283	1118	927	58	903	32	229	4	47	5	213	139	43	196	223	1.03	54.5	7.1	0.6	0.2	37.6	209.3
43	81271	5684	5069	348	3509	36	320	9	152	31	1423	424	277	1371	1287	0.91	69.4	14.7	3.9	0.4	11.5	1505.7
44	256636	45557	11767	1431	18152	87	1032	35	358	99	3733	1644	743	4014	3467	0.90	72.5	11.9	3.3	0.2	12.0	4462.9
45	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
46	45404	3511	461	171	1580	17	195	6	56	10	403	203	85	393	288	0.99	73.2	12.9	1.6	0.1	12.2	440.3
47	62381	11045	1675	704	3063	31	374	24	290	35	1223	375	321	1696	1412	1.04	65.6	20.7	1.7	0.3	12.1	1778.7
48	13841	650	650	70	322	3	33	6	43	5	140	43	30	152	139	1.02	66.2	15.6	0.5	0.3	17.5	162.1
OBS	AREA	ALT	FREIGHT	URHHWY	URBINTER	TOTINTER	AGFMP	B1	B2	B3	B4	B5	JANTEMP	FREEZE	SNOW	TRAVEL	EFFECT					
33	314457	5	1788.47	41	41	999	22.0	125	429	2424	324	301	35.2	120	9.7	482.6	0.30048					
34	294613	4	815.97	31	19	535	5.0	25	140	95	44	728	31.9	188	26.2	951.0	0.17554					
35	123882	0	650.25	1140	463	1460	100.0	780	12343	5613	35	12519	25.0	138	67.3	4049.4	-0.19399					
36	106125	1	4532.17	815	584	1541	150.0	1358	4043	3069	29	13452	28.4	124	28.5	2295.3	-0.07602					
37	178145	1	1120.95	187	95	801	105.0	25	233	1507	64	6410	36.8	82	9.4	775.7	-0.05699					
38	249117	0	323.40	128	75	732	53.0	31	337	1514	37	4229	38.1	44	9.2	1025.7	-0.07330					
39	116462	0	4235.37	596	326	1585	116.0	932	7437	11750	41	4742	30.0	115	26.0	2707.4	-0.21353					
40	2717	0	46.04	69	44	105	2.3	22	231	545	1	121	28.4	127	40.1	170.3	-0.18678					
41	78283	0	154.22	80	75	772	74.0	89	797	1435	9	6096	45.4	65	1.2	973.7	0.21372					
42	196723	2	263.47	18	14	708	71.0	37	229	421	43	1340	14.2	172	40.3	294.3	-0.02990					
43	107040	1	568.54	214	164	1015	138.0	120	1375	1321	35	5452	39.5	81	9.0	1053.6	0.09176					
44	678527	1	1276.45	1181	648	3236	255.0	453	2374	12159	112	14242	47.0	35	2.0	3396.2	0.12524					
45	9150454	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.					
46	212629	4	407.41	87	51	923	21.8	29	302	71	43	635	28.0	137	56.3	675.8	0.07145					
47	103030	0	1107.15	271	169	1044	90.0	207	1333	30	59	8372	39.0	70	10.0	1279.6	0.10233					
48	24002	0	0.00	0	0	321	14.5	30	04	403	0	594	15.8	168	77.9	312.1	0.20680					

OBS	STATE	TOTVMT	URBVMT	SMVMT	UPOP	ULAND	SMALPOP	SMALLAND	TPERS	T41PERS	FCAR	TOTCAR	PCFOR	CPDP70	CPDP73	FLEET	TERRAIN					
49	WA	65816	37852	6125	2630	1467	503	364	299	2702	236039	1360233	0.173528	857	826	29547	1					
50	WI	78312	38745	8749	2758	1348	766	466	84	331	129194	1901532	0.367937	890	861	38740	0					
51	WV	26613	13455	2946	623	374	240	133	111	923	68478	714373	0.095857	0	0	10096	1					
52	WY	10091	2004	2004	237	124	237	124	43	337	16951	151533	0.111862	0	0	2364	1					
OBS	TRDMI	URDMI	SMRDMI	LTS	LTMI	MEDS	MEDMI	LHS	LHMI	HHS	HHMI	TTR72	P1	P2	P4	MCLI	DRIVE	PASS	TRANSIT	TAXI	OTHER	NONAG
49	84315	14132	3321	410	3959	71	620	12	107	14	342	308	212	1184	1064	1.03	75.0	8.8	0.9	0.1	15.2	1218.3
50	104716	11525	4154	150	1423	131	954	17	185	37	1207	335	275	1439	1420	1.04	63.3	11.6	5.1	0.2	19.7	1676.8
51	34817	3161	1327	165	1506	13	113	7	85	16	401	234	35	546	614	0.95	67.9	13.6	3.2	0.4	14.8	574.7
52	31606	1017	1017	70	703	14	124	3	23	5	156	92	23	119	110	1.01	65.2	8.2	0.9	0.0	25.7	145.9
OBS	AREA	ALT	FREIGHT	UPBHWY	URBINTER	TOTINTER	AGEMP	B1	B2	B3	B4	B5	JANTEMP	FREEZE	SNOW	TRAVEL	EFFECT					
49	172416	0	345.87	331	168	771	83.0	100	316	3677	112	6902	33.0	50	25.0	1394.0	-0.20275					
50	141062	1	492.58	167	75	576	199.3	142	1327	4951	11	3169	19.4	149	43.7	1567.2	0.00000					
51	62341	1	170.33	104	67	575	43.7	53	755	7	7	1544	34.5	100	29.2	574.8	-0.07590					
52	251756	6	955.23	0	0	918	15.3	74	552	158	3	922	26.6	173	51.7	313.1	0.27950					

TOTVMT - annual VMT, all roads

URBVMT - daily VMT, urban roads only (population of 5,000 or more)

SMVMT - daily VMT, cities (5,000-49,999 population only)

UPOP - population of cities 5,000 or greater

ULAND - land area of cities of 5,000 or greater

SMALPOP - population of cities 5,000-49,999

SMALLAND - land area of cities 5,000-49,999

TPERS - number of trucks used predominantly for personal transportation

TMIPERS - total annual VMT by trucks used predominantly for personal transportation

FCAR - estimated number of foreign cars in operation

TOTCAR - estimated number of automobiles in operation

PCFOR - percent automobiles which are foreign cars

CPOP70 - population in cities of 100,000 or greater, 1970

CPOP73 - population in cities of 100,000 or greater, 1973

FLEET - number of automobiles in fleets of 10 or more

TERRAIN - terrain factor, 1 = mountainous, 0 otherwise

TRDMI - total mileage of all roads

URDMI - urban paved roads (places with 1970 census population of 5,000 or more)

SMRDMI - urban paved roads (population of 5,000-49,999)

LTS, MEDS, LHS, HHS - numbers of light, medium, light heavy, and heavy-heavy trucks

LTMI, MEDMI, LHMI, HHMI - average annual miles of travel per vehicle for light, medium, light heavy, and heavy-heavy trucks

TTR72 - total trucks in operation, 1972

P1, P2, P4 - population in age groups 18-20, 21-44, 45 and over

MCLI - state cost of living index

DRIVE, PASS, TRANSIT, TAXI, OTHER - journey-to-work modal split: percent driving cars, passengers in cars, taking public transit, taxi, and all other possibilities including walking and working at home

Continued on p. 124.

NONAG — nonagricultural employment
 AREA — land area in square miles
 ALT — altitude index in 10^3 feet
 FREIGHT — a measure of through freight traffic (not used)
 URBHWY — freeways and expressways in places of 5,000 or greater population
 URBINTER — urban interstate highway miles in places of 5,000 or greater population
 TOTINTER — total interstate highway miles
 AGEMP — employment in agriculture
 B1 — commercial gasoline-powered buses
 B2 — commercial diesel-powered buses
 B3 — commercial school buses
 B4 — federal buses
 B5 — public school buses
 JANTEMP — historical mean January temperature
 FREEZE — historical mean days below freezing in a year
 SNOW — average annual snowfall in inches
 TRAVEL — annual expenditures by overnight travellers
 EFFECT — state intercept calculated in LSDV demand model (10^3 gallons)

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