Maximum Potential Energy Savings Resulting From a Cessation of Federal Aid to Urban Highway Construction

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Evidence indicates that a cessation of federal capital assistance to urban highway construction would not contribute significantly to the conservation of energy used for urban highway travel. The effect of such a policy would be weakened by four factors: (a) Additional facilities built with federal grants would not significantly affect highway capacity; (b) federal grants have not been as effective in stimulating urban highway construction as their matching requirements would suggest; (c) off-peak travel, which constitutes most of the total urban vehicle kilometers of travel, would not be significantly affected; and (d) increased congestion would reduce vehicle operating efficiency and thus increase energy consumption. Direct actions to reduce the demand for vehicle travel in metropolitan areas and to improve the fuel efficiency of automobiles will be much more effective than indirect programs such as attempts to restrict highway capacity.

Federal capital grants and other related policies have an effect on the size of the transportation sector and the allocation of demand among modes. Because the transportation sector is a major source of demand for energy, especially for petroleum products, considerations of energy conservation must enter into the determination of federal policies on capital grants to transportation and other related policies.

A recent analysis by Charles River Associates of the impact of federal capital-grant policies (1) concentrated on the energy consequences of federal programs that were judged to have the greatest potential for affecting energy consumption. This paper focuses on an analysis of federal aid to urban highway construction. Limitations of space preclude an analysis here of the other programs, but the Charles River Associates analysis produced results for other programs similar to those for the urban highway program.

The reduction in urban highway construction that would result from the elimination of future federal aid to highway construction has three potential effects on energy consumption:

1. Energy consumed in building highways would be reduced.
2. The resulting reduction in urban highway capacity, by decreasing the peak-period performance characteristics of highways, would lead to a reduction in demand and therefore in peak-period vehicle kilometers traveled. This reduction would lower total fuel consumption by automobiles if the demand were not merely diverted to the off-peak.
3. Increases in peak-period congestion brought about by the deterioration of the highway system would raise fuel consumption per vehicle kilometer driven.

This paper deals primarily with the change in automobile fuel consumption. The direction of the net overall change in fuel consumption in response to a reduction in highway capacity depends on the comparative percentage reduction in vehicle kilometers traveled and the percentage increase in fuel consumption per vehicle kilometer.

This paper uses a sensitivity analysis to evaluate public policy. Rather than producing a "best estimate" of energy savings, it makes simplifying assumptions favorable to energy savings. For example, the additional energy consumption caused by increased highway congestion is not considered. If the resulting energy savings under these assumptions are not appreciable, it is reasonable to assume that energy policy should concentrate on other options.

The maximum potential energy savings that would result from cessation of federal aid to urban highway construction were estimated by using upper bound assumptions on the reduction in urban highway peak-period travel caused by a given reduction in urban highway capacity. Even when these extreme assumptions are used, calculations show only a 1.3 percent nationwide reduction in 1989 urban automobile energy consumption in response to an elimination of the entire urban federal-aid highway program between 1974 and 1989. An analysis by Charles River Associates (1), which was expanded by Toder (4), made a best estimate of energy impact that considered the net effect of energy losses and savings. Reducing urban highway capacity, according to this analysis, would lead to a slight increase in automobile fuel consumption because the energy loss caused by increased congestion would more than offset the energy savings caused by reduced travel.

The findings imply that decisions on the magnitude of federal capital grants to highways should be based on considerations other than direct effects on fuel consumption. The problem of the high fuel consumption that results from automobile travel on congested highways can best be attacked by more direct measures, such as congestion tolls or other highway-entry controls, in selected urban areas that are characterized by the most severe congestion, and improved automobile fuel efficiency, if higher fuel prices are ruled out as a policy alternative.

REVIEW OF PAST RESEARCH ON EFFECTS OF FEDERAL AID ON HIGHWAY CONSTRUCTION

Sherman Model

Sherman (2), in a study sponsored by the U.S. Department of Transportation, studied the effects of federal highway grants on state highway expenditures based on data from each of the 48 contiguous states over a 14-year period from 1957 through 1970. Sherman conducted separate analyses for the three categories of federal-aid highway grants: Interstate, primary, and secondary.

Interstate System

Although the federal assistance program for the Interstate highway system caused a decrease in expenditures on non-Interstate highway systems, it apparently created an incentive for the states to increase their total highway expenditures. According to Sherman's estimates, long-run total state capital expenditures (including the federal portion) on the Interstate system increased by $1.57 for each incremental dollar of federal aid for Interstate highway construction. To some extent, this increase was at the expense of other highway systems; capital expenditures for primary-system roads dropped by $0.05 and those for secondary-system roads by $0.03 for each dollar of federal aid. Capital expenditures on non-federal-aid roads increased by $0.03, however, so that net state capital expenditures on all categories of roads increased by $1.52 for every dollar of federal Interstate aid. Total highway expenditures including maintenance and other miscellaneous expenses increased somewhat more, by $1.62 for every dollar of federal aid received.

Primary System

Primary-system grants were less successful than Interstate grants at stimulating highway investment. Although matching requirements call for states to put up a dollar of their own funds for each dollar of primary-system aid received, Sherman's model indicates that a $1 increase in primary-system grants actually increased total state capital expenditures for the system (both federal and state shares) by only $1.72. Moreover, primary-system grants had a depressing effect on all other categories of highway expenditures. The sum of the effects on all categories of expenditures indicates a negligible change in total highway expenditures. Investment in total highway infrastructure did increase but by only $1.04 for every dollar of federal aid. The net impact of these grants thus appears to be to cause states to substitute funds within their highway programs—that is, increase primary-system investment at the expense of other highway programs and presumably use the federal funds to reduce state highway taxes.

Secondary System

The same general pattern of effects emerges for secondary-system grants as for primary-system grants except that this program, overall, stimulated the aided system in particular and total capital investment in general even less. The net impact of federal grants on total highway expenditures again appears to be negligible. Even within the aided category, a dollar increase in federal aid caused an increase in state capital expenditures of only $1.04. The effect on capital expenditures for all categories of highways was even less: Each dollar of federal aid increased state expenditures by only $0.63. Sherman's results indicate that states used secondary-system grants in the same way they used primary-system grants—primarily to reduce taxes earmarked for highway expenditures—and that the slight stimulation to secondary-system expenditures came at the expense of other highway expenditures.

Summary of Past Findings

Although the effect of each of the federal-aid grant programs during the study years was to increase state capital expenditures for the aided highway system in particular and for all highway systems in general, only the Interstate grants stimulated total highway expenditures. Because increases in capital expenditures on the non-Interstate systems reflected decreases in other, noncapital expenditures without substantially affecting states' total highway expenditures, these findings suggest that ending federal aid may cause both (a) a diversion of state funds away from construction to other highway expenditures and (b) an increase in total state commitments to highway expenditures that will make up for much of the lost federal aid.

EFFECTS ON STATE URBAN HIGHWAY CONSTRUCTION AND ENERGY CONSUMPTION OF ENDING FEDERAL AID

Estimating the effects of a cessation of federal aid to urban highway construction from 1974 to 1989 involves three steps:

1. Estimate the effects on state urban highway expenditures from 1974 to 1989,
2. Apply this estimate to reasonable assumptions about the mix and the capacity of highways to be built by 1989 and calculate the reduced highway capacity, and
3. Estimate the effect of that reduced capacity on urban highway travel and energy consumption.

Effect of Cessation of Federal Aid on Highway Expenditures

Sherman's findings may be used to determine the impact on capital expenditures for urban highways of ending federal aid. Under existing federal funding programs, state and local governments would be granted $11.08 billion of federal aid for urban segments of the Interstate system from 1972 through 1979 (1, 3) and $17.6 billion for other urban highways from 1974 to 1989. Sherman's results indicate that states would reduce their total capital expenditures (federal and state portions) for urban highways by $0.87 (a weighted average of $0.63 and $1.04) for every dollar of primary- and secondary-system aid lost and by $1.52 for every dollar of Interstate aid lost. These figures yield the following total reduction in capital expenditures over the 1974-1989 period (in constant 1973 dollars):

$$(\$11.08 \text{ billion} \times \$1.52) + (\$17.6 \text{ billion} \times \$0.87) = \$32.15 \text{ billion} \quad (1)$$

Effect of Reduced Highway Expenditures on Highway Construction

The cost per kilometer of urban highway construction must be estimated if the dollar decrease in capital expenditures for urban highways is to be converted into an estimate of the resultant decrease in kilometers of urban highway construction. In 1973, the total expenditure by all levels of government for the construction of federally assisted urban highways was $1.56 million/km ($2.5 million/mile), including the cost of capital improvements to existing facilities as well as the costs of entirely new facilities (3, p. 259). If the mix of urban highways built or improved in the 1974-1989 period is assumed to be the same as that in 1973, then the failure to spend $32.15 billion over that period represents at most ($32.15 billion ÷ $1.56 million/km) = 20 605 km (13 861 miles) of urban highways that will not be built by 1989 as a result of the elimination of federal aid to urban highway construction.

Table 1. Increase in peak-hour traffic flow on urban highways by 1989 as result of federal aid to urban highway construction.

Highway Type	Assumed Average Number of Lanes[a]	Capacity (vehicles per hour per lane)[b]	Additional Kilometers (new and improved)	Peak-Hour Travel on Additional Kilometers[c] (vehicle·km)
Divided				
Full access control	7	1700	5 979	71 150 100
Partial access control	6	1350	698	5 656 230
No access control	5.5	1000	2 817	15 495 700
Undivided				
Four or more lanes	5	850	3 076	13 074 700
Three lanes	3	850	404	1 029 945
Two lanes	2	850	7 718	13 121 280
Total			20 693	119 530 000

Note: 1 km = 0.62 mile.

[a] Selected to represent upper bound.
[b] Intermediate figures based on several surveys because of variance in capacity estimates for different types of highways.
[c] Average number of lanes x capacity x additional kilometers.

Effect of Reduced Highway Capacity on Urban Highway Travel

In attempting to predict the effect of reduced highway capacity on urban highway travel, the issue is how much new travel demand would be created by the new facilities that could be built with the highway aid. Consider two extreme examples of peak-hour demand response to new highways:

1. No new vehicle kilometers of travel may be generated by the new facilities. The only effect of improved highway services during peak hours is a narrowing of the peak as more people find that they can make their trips at the same time. In this extreme case, some off-peak travel shifts to the peak periods but there are no new trips. The result may be a net energy savings attributable to the new facilities if a reduction in peak-hour congestion occurs that is not offset by the increased congestion experienced by diverted traffic.
2. Increased service levels during peak periods may divert riders from transit and otherwise generate a significant number of new or longer trips rather than merely shift demand from the off-peak. In this case, the construction of new highways could be the more energy-saving option only if more energy is consumed without the new highways (because of congestion) than is consumed in the case of improved service levels (because of generated traffic).

If it is assumed that peak-hour levels of service are those primarily affected and that during the peak any new facilities are filled to capacity by new travel, an upper bound effect on urban highway travel of a cessation of federal aid to urban highway construction can be estimated. Specifically, the facilities that would be created by a continuation of federal grants are assumed to be used to capacity in one direction during the two morning and two evening peak hours of each workday, and all traffic served by the additional capacity is assumed to be new traffic generated by construction of these federally aided facilities. Because of the special assumptions of 2-h morning and evening peaks, complete capacity utilization on all new facilities, and entirely new traffic, this estimate should represent an extreme upper bound. Although some additional increased traffic may be expected because of improved off-peak service, it is not likely to be large relative to the generated peak demand.

Table 1 gives the estimated kilometers of various types of highways that would be built with federal aid during the 1974-1989 period as well as the average number of lanes assumed for each type of facility and the capacity of that facility. Capacity figures are instrumental in converting incremental kilometers of highway into incremental vehicle kilometers of travel. The Highway Capacity Manual defines capacity as "the maximum number of vehicles per unit of time that can be handled by a particular roadway component under the prevailing conditions" (5, p. 1). Maximum average speed and average density (vehicles per lane kilometer) on the highway depend on capacity and may be used to derive vehicle kilometers traveled per unit of time on a given facility; that is,

$$(km/h)\cdot(v/lkm) = [(vkm/lkm)/h] = (v/h)/l \quad (2)$$

where

km = kilometers,
h = hours,
v = vehicles,
l = lanes,
lkm = lane kilometers, and
vkm = vehicle kilometers.

Additional kilometers of highway in Table 1 were derived by deducting the 4142 km (2574 miles) of urban Interstate highways to be built as of 1973 (4, p. 221) from the total 20 693 km (12 861 miles) of highways that would be built as a result of federal aid and assuming that the remaining 16 551 km (10 287 miles) would be divided among the various types of highways in the same proportion as are the existing kilometers of non-Interstate, federal-aid primary and urban systems (4, pp. 245-246). The 4142 km of Interstate highways were then similarly divided among highway categories according to existing highway kilometers (4, p. 264). Data by number of lanes and degree of access control are not available for kilometers of federal-aid secondary highways. Thus, the figures for additional kilometers may be concentrated too heavily in the high-performance highway categories, which may result in an overestimate of increased capacity.

The number of vehicle kilometers traveled in both directions on each type of highway given in Table 1, during each hour of complete capacity utilization, can be obtained by multiplying lane-capacity figures for each type of highway by the number of lane kilometers for each type. That is,

$$[(v/h)/l]\cdot l\cdot km = km/l \quad (3)$$

The sum of vehicle kilometers traveled on each type of highway yields total vehicle kilometers traveled per hour of complete capacity utilization on all additional kilometers of highway.

If it is assumed that 20 percent of the additional kilometers of highway comprise entirely new facilities and the remaining 80 percent are capital improvements to old facilities that increase capacity by 20 percent (i.e., new vehicle kilometers of travel are 16 percent of total vehicle kilometers of travel after the improvement), then new peak-hour vehicle kilometers of travel would be 20 percent of the total traveled on all additional kilometers of highway plus 16 percent of the remaining 80 percent, or

$$\frac{1}{3} \times 119\,530\,000 \text{ km} = 39\,445\,000 \text{ km} \quad (4)$$

Multiplying this total by two (4 peak hours per day with one-way full-capacity utilization) and by 250 for the number of workdays per year (260 weekdays minus 10 holidays) gives 19.7 billion km (12.4 billion miles), an annual total of new vehicle kilometers of travel attributable to the continuation of federal aid to urban highway construction by 1989. This figure represents 1.3 percent of the projected 1572.6 billion vehicle kilometers of travel on urbanized-area highways in 1989 (6, p. V-15). If the effects of increased congestion on automobile fuel efficiency are ignored, the effect on energy consumption can be assumed to be of a similar magnitude.

Sensitivity Tests

Estimated Effect on Highway Capacity of Cessation of Federal Aid

Because the sample period used by Sherman (2) ends in 1970, his results cannot be brought to bear directly on the numerous significant changes in the federal-aid highway program since that time. The upward revision of the primary- and secondary-system matching ratios in fiscal 1974, the creation of the urban system in 1970 and of three new general highway programs in 1973, and the availability beginning in 1974 of highway funds for mass transit improvements all represent structural changes in the program relative to the period Sherman analyzed. These and other considerations probably cause actual energy savings to be less than forecasts based on Sherman's analysis.

There is some question whether Sherman's findings on the effects of small increases in federal funding may be validly applied to a large decrease. The analysis assumed that the average and marginal effects are the same, i.e., that the relationship is linear so that the first and last federal dollars have the same impact. The actual impact on highway construction of such a large diminution of federal funds would likely be substantially less than the effects of the small changes used in Sherman's analysis. The cessation of federal aid would have to cause a substantial decline in the level of service of automobile travel if it were to appreciably affect travel demand. Such a decline in highway service levels would cause considerable pressure on state and local governments to make up for the loss of federal funding, especially if the federal gasoline tax were also reduced.

Sherman's model did not consider separately the effects of federal aid on urban and rural highways but assumed that urban and rural effects are the same and that the analysis results apply equally well to both urban and rural highways. The general deemphasis on rural and the increased emphasis on urban transportation reflected in the Federal-Aid Highway Act of 1973, however, may reflect changing priorities of state and local governments. If the reduction in urban highway capacity estimated here resulted in a large increase in peak-hour congestion, state and local governments might be pressured to make up for the loss of federal funding by shifting funds from rural to urban highway projects. On the other hand, increased resistance to new highway developments from urban environmentalists might more than compensate for the increased pressure from highway users. In both cases the estimated reduction in urban vehicle kilometers of travel would be too large, in the first case because the reduction in urban highway capacity resulting from an end of federal aid would not be as great as that assumed here and in the second case because the highways would not be built even if federal aid continued.

Since 1970 the federal-aid highway program has been relaxed considerably to permit restricted use of highway funds for mass transit improvements. For example, since fiscal 1974, under certain conditions states may exchange Highway Trust Fund money allocated for a nonessential segment of the Interstate system in an urbanized area of more than 50 000 population for an equal amount from general funds to be used for the construction or purchase of facilities for public transportation. Although the construction and operation of mass transportation facilities also consume energy, this mode is, under certain occupancy and operating conditions, more energy efficient than the private automobile. The extent to which these new provisions will be applied is difficult to predict. However, to the extent that they would be applied, the energy savings resulting from a cessation of federal aid to urban highways would be reduced.

Another consideration that may prevent the energy savings that would result from a cessation of federal aid from being as large as might otherwise be expected is the possibility that large maintenance expenses may consume an inordinately large portion of highway capital expenditures. If federal highway grants have in the past caused an overcapitalization of the highway system at the expense of noncapital needs such as maintenance, these delayed expenses may catch up and create severe pressures for eliminating the requirement that federal funds be used for construction. In the future, the stimulating effect of federal aid may be considerably reduced because the states can no longer neglect noncapital expenditures. Again, to the extent to which these expenditures represent money that would not be spent on new highway construction in any case, the estimates of the reduction in highway capacity and energy consumption are too high.

Some of the evidence cited by Sherman suggests that the federal-aid program had virtually no impact on states' decisions to invest in highways: Namely, states spent more than the minimum required to qualify for the maximum aid available. Matching requirements do not necessarily ensure that the recipients will spend more than they otherwise would have on the subsidized program because recipients can merely substitute federal funds for funds they would have spent anyway. For example, with a 50 percent matching ratio, the recipients' incremental investment per incremental dollar of federal aid should fall between zero and $2.00.

Because states are required to put up only $0.11 for every dollar of federal aid received under the Interstate program (specifically, $0.10 for every $0.90), the rational maximum by which states should increase Interstate capital expenditures in response to an additional dollar of federal aid is $1.11. Sherman estimated that the actual increase was $1.52. Sherman's finding that states actually provided more than the minimally required matching funds may contradict the conclusion that the program stimulated state investments because the cost of incremental highways could not have been affected by the grants.

One explanation is that federal highway grants do not cover all costs associated with building highways. This qualification would be particularly important for the limited-access Interstate system, for which a significant number of kilometers of feeder and access streets may be required to complement the main system. Because accounting procedures are not standardized, many states may include these expenses as well as others associated with capital maintenance activities in their cost figures for Interstate highway construction.

Providing further evidence for this hypothesis, Sherman estimated the responses to the level of federal funding of short-run, project-selection decisions within a fixed budget as well as long-run, expenditure-level decisions. He found that, in the short-run allocation process, states allocated exactly the requisite amount, or $1.11, to Interstate construction projects for every dollar of federal grant money received for Interstate construction. It seems possible that the greater state capital expenditures on the Interstate system in relation to the level of federal funding may in the long run be accounted for by state expenditures complementary to the federally assisted portion of Interstate system construction.

The paradox is that Sherman's empirical results indicate that states not only spent more than the minimum amount required to receive the federal aid (which implies that additional construction may not have been stimulated by the aid program because states paid the full cost of additional facilities) but also shifted funds to favor the aided program. One explanation for this economically irrational decision is the "bias effect": The mere offer of aid will cause more to be spent on the aided program than can be explained by the economic incentives of the grant alone.

Estimated Effect of Reduced Highway Capacity on Urban Highway Travel and Energy Consumption

Several factors may cause the actual energy savings resulting from a cessation of federal aid to be less than the upper bound estimate.

1. Many federal-aid highway expenditures, particularly those in smaller cities, would not appreciably affect urban highway congestion and travel demand both because some of the new facilities will not be used to capacity even in the peak hours and because some of the investments would not be for the high-volume facilities assumed in the calculations.
2. Many of the peak-hour trips served by the new facilities are likely to be diverted from the off-peak rather than to represent entirely new trips or trips diverted from mass transit. Scheduling a trip to avoid rush-hour traffic is probably more common than giving up the trip altogether. The likelihood that ending the federal program will cause trips to be diverted to transit is reduced by the fact that the level of bus service will also suffer during the peaks. According to preliminary figures of the American Public Transit Association (7, p. 16), buses carried approximately 71 percent of total transit passenger traffic in the United States in 1974 and 69.7 percent in 1973.
3. Conserving energy by restricting highway capacity and service levels involves an inherent contradiction: If the decline in highway performance is severe enough to discourage trip making, it will adversely affect the energy efficiency of automobiles by creating high congestion levels.
4. If the peak-hour automobile trips eliminated because of reduced federal aid were diverted to transit, the transit sector would use more energy.
5. Ending federal grants for urban highways would result in severe pressures for ending federal user taxes. States might in turn increase their taxes to keep total user charges constant.

On the other hand, certain assumptions in the analysis could be modified to produce somewhat higher energy savings.

1. Total energy savings might be slightly increased because of a saving of highway-construction energy (though the resources conserved may be diverted to other energy-intensive activities). Hirst (8) has estimated that highway construction accounts for 6.59 percent of all direct and indirect energy requirements for automobile use and about 11.11 percent of direct energy use (gasoline consumption by automobiles). If so, a 1.3 percent reduction in urban vehicle kilometers of travel as a result of fewer highways would approximately equal a 1.44 percent reduction in energy use ($1.3 + 1.3 \times 0.1111$) if operating fuel efficiency is unchanged and if resources not used in highway construction do not otherwise consume any energy.
2. More funds might be used for the construction of entirely new facilities than were assumed. However, the estimate of the reduction in vehicle kilometers of travel on urban highways is not highly sensitive to the assumption that only 20 percent of urban highway construction represents entirely new facilities. If as much as 50 percent of total urban highway construction represents new facilities, 58 percent of total vehicle kilometers of travel on all additional kilometers of highway would be new [$0.50 + (0.16 \times 0.50) = 0.58$], and the total expected reduction in urban vehicle kilometers of travel in 1989 would rise to 2.2 percent. The expected reduction becomes as great as 3.8 percent if all highway construction represents entirely new facilities.
3. Improved highway facilities could prompt urban location decisions that increase travel demand by encouraging urban decentralization. The effect of lengthening work trips is included in the analysis of induced peak-hour automobile demand. Although some off-peak, non-work-trip demand might be generated because of the effects of improved highways on residential location, initial, less than conclusive studies of the effect of automobile level of service on trip length (9; 10; 11; 12; 13; 14, p. 5) do not show a strong impact.

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Policy Preferences for Conservation of Transportation Energy in Case of Fuel Shortage

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The attitude and behavior of travelers during the oil embargo of the winter of 1973-1974 were analyzed. Immediately after the embargo period, questionnaires containing forced-choice pairs of combinations from a set of 10 possible transportation-related energy-conservation policy actions were mailed to 2323 households in regions of Iowa that did not contain a city of 50 000 or more population. Tabular analysis of the data indicated that respondents overwhelmingly favored policies of uniform speed regulation and voluntary participation and were strongly opposed to increased prices as a conservation policy. Analysis of the data by means of paired-comparison scales indicated that the aggregate sample was more concerned about the degree of constraint and its effect on life-styles than about the type of conservation policy (pricing versus rationing). Young adults favored severe rationing or severe price increases less than other groups. Persons earning high incomes favored voluntary participation more than speed-limit regulation, and low- and middle-income groups felt the opposite. Regions with few high-speed highways favored the 88.5-km/h (55-mph) speed limit significantly more than did other areas. Public acceptance of any future transportation-related energy policy appears to be strongly related to the perceived distribution of available transportation options.

The oil embargo imposed by the Middle Eastern petroleum-exporting nations from November 1973 through March 1974 created a situation in which transportation-related energy conservation policies could be evaluated. The embargo affected manufacturing processes that depended on relatively cheap fuels, agricultural fertilizer production, homes heated by oil, and those portions of the power industry that used oil-fired furnaces to generate electricity. But the impacts on automobile transportation were the most dramatic and pervasive. The general public, legislative and executive governmental processes, and the market economy were subjected to three conditions:

1. Gasoline shortage—Available gasoline supplies were significantly short of demand in some areas, which produced long lines at service stations;
2. Price rise—The pump price for gasoline approximately doubled in most areas during the embargo period; and
3. Conservation debate—A highly publicized debate developed about the various social and economic aspects of conservation policies.

Several research activities resulted that were designed to examine fuel consumption levels and public perception of the long- and short-term impact of policy alternatives (1, 2, 3). The research reported here is one such study.

CONTEXT OF THE RESEARCH

The original research dealt with 59 Iowa counties in nine multicounty planning regions that do not contain cities of 50 000 or more population as regional centers (Figure 1). A random sample of 2323 households was selected from cities ranging in size from 32 366 (Burlington, 1970 census) to 599 (Titonka, 1970 census) to individual rural residences to represent the approximately 1 200 000 persons residing in the 59 counties.

A questionnaire designed to determine individual preferences for policy alternatives and other data to be correlated with the preferences was initially mailed to all sample households. The first mailing was followed up with a postcard—a combination reminder-thank you—7 d later. A second mailing to all nonresponding households about a month later and subsequent telephone contacts brought the total returns to 1837 questionnaires (83.7 percent of the original sample). A total of 1398 questionnaires were completed and analyzed. Deceased persons and untraceable bad addresses accounted for 127 questionnaires, and 3.8 percent of the households refused to participate in the survey. The response rate is attributed to the systematic approach to both the design of the questionnaire and to distribution procedures as well as extensive media efforts to keep the public in-