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Reducing Work Trip Length Through Home Mortgage Subsidy Incentives

ALAIN L. KORNHAUSER, THOMAS M. ASH, AND CAROLYN A. RINDERLE

This paper presents research in progress at Princeton University that examines the potential of geographically restricted mortgage subsidies to encourage people to live closer to work and thus reduce work trip travel and automobile-related energy consumption and air pollution. A preliminary analysis is made of the effect of a mortgage-subsidy program at Princeton University. The Princeton plan offers a 1.5 percent mortgage subsidy to eligible employees of Princeton who buy a home within an 8-mile radius of campus. Preliminary analysis indicates that the mortgage subsidy has produced significant reductions in work trip travel in comparison with employee work trips of similar employers in the Princeton area. Implementation of mortgage subsidies in the private sector is also investigated. We propose that the U.S. Environmental Protection Agency's emissions offset policy can provide industry with a financial incentive for implementing geographically restricted mortgage-subsidy programs. This policy is proposed as a means of increasing an industry's flexibility in meeting pollution regulations. It also provides the benefit of significant energy conservation.

This paper reports preliminary results of research in progress at Princeton University that examines the potential of geographically restricted mortgage subsidies to reduce vehicle miles of travel (VMT) in urban areas. At Princeton, mortgage subsidies are available to eligible employees who are willing to live within a specified distance of the work place. This research examines the effect of the Princeton University mortgage-subsidy program in reducing the length of employee work trips. Work trip comparisons are made between employees at Princeton and employees of three other major employers in the area.

At this point in the research the data are highly aggregated. This limitation is currently being overcome by collecting data via a detailed questionnaire. However, the preliminary analysis suggests that the Princeton plan has been effective in reducing Princeton employees' work trip VMT significantly.

This paper presents the benefits of a geographically restricted mortgage loan policy and the theoretical support for such a policy. The initial empirical results of the Princeton plan are given. We propose that the U.S. Environmental Protection Agency's (EPA) regulatory policies be used as incentives to induce participation of the private sector in providing geographically restricted mortgage-subsidy programs.

PROBLEM DEFINITION

The problems of excessive energy consumption and air pollution emerged during the last decade as major facets of the urban transportation problem. Automobile travel is a major contributor to both energy consumption and air pollution. Automobile travel accounts for about 40 percent of the U.S. consumption of oil, two-thirds of which is consumed in urban areas (1). Pollutant emissions from mobile sources produced 75 percent of the ambient carbon monoxide (CO), 55 percent of the ambient hydrocarbons (HC), and 50 percent of the ambient nitrogen oxides (NO_x) in urban areas in 1973. Reduction in these levels of energy consumption and air pollution has been mandated by legislation such as the 1975 Energy Policy and Conservation Act and the Clean Air Act of 1970, as amended. However, large-scale solutions by the public sector to these problems appear to be decreasingly feasible as the public increasingly embraces fiscal austerity and rejects governmental regulation of private industry.

To date, the approaches to solving the problems of excessive energy consumption and air pollution from mobile sources have been characterized by both a technical dimension and a political dimension. The technical dimension distinguishes between transportation supply and transportation demand solutions. Supply solutions include the construction of new mass transit facilities or the increasing of the capacity of existing transit facilities and improvement of the fuel efficiency and emissions levels of automobiles. Supply solutions generally try to accommodate existing or projected demand for transportation; they represent the traditional approach of transportation planners and engineers to transportation problems.

On the other hand, demand solutions focus on the reduction or redistribution of VMT, which in turn reduces or redistributes vehicular emissions and reduces energy consumption. Demand solutions include automobile and gasoline taxes, staggered work hours, increased parking fees, congestion pricing, and influencing the location of travel-producing or travel-attracting activities. This last option may offer the greatest potential for reducing automobile-related energy consumption and air pollution, but it is difficult to implement due to American traditions in land use development (2). Demand solutions have gained popularity in recent years, at least within the academic community.

Potential solutions can also be categorized along a political axis. The political dimension distinguishes between distributive and restrictive solutions, to borrow Altshuler's useful dichotomy (1).

Distributive solutions are those that confer financial or other benefits to various groups in order to implement transportation proposals. Restrictive solutions constrain choice and include such measures as regulation of product performance, consumer regulations such as gasoline rationing, and pricing measures to reduce VMT or gasoline consumption. In general, distributive measures are feasible politically but are expensive to implement; restrictive measures involve less direct expense but are politically difficult to implement.

Any particular solution participates in both dimensions at once. For instance, construction of a new transit facility is a supply-oriented, restrictive measure. Demand-oriented, distributive measures, which are potentially the most-effective combination, have not as yet been proposed. Our intention here is to make a preliminary case for one such measure--mortgage subsidies to households that are willing to live close to work.

Future efforts to reduce automobile-related air pollution and energy consumption will probably focus on improved vehicular efficiency and reduction of VMT. With regard to improved automobile performance, the federal government has made full use of its regulatory powers. The machinery has been set in motion, and, with vigilance, the automobile fleet will become more energy efficient and less polluting.

Little, however, has been done with respect to VMT reductions. Carpooling and transit have so far failed to produce significant reductions in VMT. This indicates that other nontransportation measures to reduce VMT should be considered.

Transportation seeks to eliminate the spatial separation of people and activities. By shortening the journey-to-work, which accounts for 40-60 percent of urban travel, spatial separation is decreased and VMT reduced. If people could be induced to live closer to work, this objective could be realized. The potential energy savings from such a policy would outweigh the effect of any other policy except for the utopian carpooling policy.

Evidence suggests that for the past 25 years transportation has placed little constraint on the major household decision of housing location. Although accessibility of the work place and urban rent structure are theoretically and empirically related, most researchers have found that other factors, such as cost, dwelling unit aspects, and neighborhood quality, are more important factors than distance to work in individual decisions about housing location.

As a result, the work trip can be quite long. One Chicago survey, for instance, found that the mean maximum acceptable length of the work trip was 58 min (3). Furthermore, work trip length seems to be increasing over time (4).

These increasing work trip lengths are symptomatic of the sprawl that has characterized metropolitan areas since the 1950s. Without redirection, this sprawl will probably continue. Given the extraordinarily high mobility of the U.S. population, policies that encourage people to voluntarily choose housing closer to where they work could be effective in reducing transportation needs.

Offering lower-interest home-mortgage loans to home buyers willing to live within a specified distance of their work places is an attractive policy for accomplishing this goal. Just as home-mortgage policies contributed to decentralization and overconsumption of transportation in the 1950s and 1960s, the above mortgage policy could lead to reduced energy consumption and strong economic growth in the 1980s and 1990s. Such a policy has a number of advantages:

1. It provides incentives rather than disincentives,
2. It tends to result in conservation and to complement programs that seek greater fuel efficiency and less pollution,
3. It provides long-term results with continuing benefits,
4. It does not necessarily imply highor low-density land use,
5. It produces land use patterns conducive to transit and carpooling, and
6. It is demand-oriented and distributive.

THEORETICAL DEVELOPMENT

A review of the literature concerning residential location revealed no previous theoretical analysis of the effects of a mortgage subsidy in reducing work trip length. However, two related areas of study are applicable to this topic: (a) trade-off theories of urban land rent and (b) residential mobility and migration studies. A brief examination of this literature supports the conclusion that a geographically restricted mortgage subsidy could result in reduced work trip VMT.

Trade-Off Theories of Land Rent

Trade-off theories of urban land rent (5-8) are based on the assumption that housing and accessibility to work are purchased jointly. These models assume a hypothetical city on a flat, homogeneous plane where all employment is concentrated at the center. The price any urban location commands is solely a function of its accessibility to the city center. Due to the cost of traveling, which is assumed to increase with distance from the city center, central locations command a higher unit price than do less central locations. Thus, the model derives a declining unit land rent curve for the urban area, which has the highest land rents at the point of greatest accessibility [the central business district (CBD)].

Households maximize their utility by trading off higher commuting costs for lower unit rents. Households that prefer lower-density housing, for instance single-family, detached houses, will travel farther in order to purchase housing at a lower unit price (9). The land rent model suggests that (assuming that higher-income households have a higher preference for land than for accessibility) households that can afford to do so will consume more housing, locate where unit prices are lower, and commute farther to work (10).

The land rent model has been the subject of much empirical analysis in the 1960s and 1970s. Most empirical studies have found site rent to be highly correlated with some aggregate measure of accessibility (11), although a number of researchers disagree (10,12-13). However, it seems clear that higher-income households (such as homeowners) consume less accessibility and more space (14) and tend to commute farther (9).

The trade-off rent models support the assertion that a geographically restricted mortgage policy could result in VMT reductions. Were a household to receive a mortgage subsidy without a geographical restriction, the household would buy more housing. How much more housing, and whether the household moves closer to the work place, stays at the same distance, or moves farther away will depend on the household's relative preferences for housing and accessibility. However, if the subsidy is restricted to sites within a given distance of the work place, the model suggests that at least some

households will be better off by relocating closer to work, assuming that the mortgage subsidy does not affect the market rent curve.

Residential Mobility and Migration Studies

The literature on residential mobility and migration examines factors that influence the choice of housing at particular locations and conceptualizes the mobility process for individual households and aggregates of households. Trade-off models consider only generalized work place accessibility, household income, and lot size in developing an aggregate urban land rent curve. Given this land rent curve, how individual households select housing depends on a number of factors, including

1. Locational attributes, such as neighborhood quality and demographic composition, local taxes, public services, and parking availability;
2. Housing attributes, such as age of structure, dwelling quality, garage, structure type, and lot size;
3. Spatial attributes, such as accessibility to work and family, friends, shopping, and other nonwork destinations; and
4. Socioeconomic characteristics, such as household income, race, household size, number of workers, education, and marital status (15).

The relative importance of the journey to work as a factor in the housing decision seems to be small. Recent studies have concluded that convenience to work is only of marginal importance in the location decision (14,16,17) and that the journey to work is becoming less important as a determinant of residential location (4). Thus, the desire to save commuting costs no longer appears to be an important incentive to live close to the work place. The mortgage policy proposed in this paper supplants this incentive with a more potent financial incentive to live close to work.

Availability of mortgage funds and affordability of housing also affect the housing choice. However measured, the percentage of families able to afford a median-priced new home is decreasing (18). One study, based on 1976 data, found that between 17.5 and 40 percent of families could afford a median-priced new home, when affordability was based on current income. When current home equity was included in family income, 60 percent of the families could afford a new home (18). This percentage is probably lower in today's economy. By making housing affordable to more families, it therefore seems that the effectiveness of a mortgage subsidy in influencing household location is further reinforced.

Conceptualizations of the mobility process (19-21) typically use a cost-benefit approach to moving from one location to another. In these approaches, households consider moving due to dissatisfaction. Dissatisfaction occurs when a perceived gap appears between actual and optimal levels of housing satisfaction (22). Thus, dissatisfaction could occur due to the availability of a mortgage subsidy at a location other than the current household location. Dissatisfaction does not necessarily result in household relocation, however, because moving entails substantial search and relocation costs. Households move when the expected benefits (monetary and nonmonetary) from a new location exceed the moving costs (monetary and nonmonetary) of moving to that location. Thus, if the benefits that accrue from a mortgage subsidy are greater than the moving costs entailed in qualifying for that subsidy, at least a significant percentage of households should move to subsidized locations.

Although current research has not yet allowed us to measure these benefits and costs, we hope that these can be measured through a survey currently being administered. In the findings presented, only the percentage of subsidy and the corresponding amount of VMT are known; individual household benefits and costs are unknown.

EMPIRICAL ANALYSIS OF THE PRINCETON PLAN

Description

The Princeton University mortgage loan program, "The Princeton Plan", is part of the university's effort to provide close, affordable accommodations for its employees. The plan's objective is to ensure that Princeton University remain a residential university by offering incentives to faculty and senior-level staff to purchase a home in the vicinity of Princeton. The plan offers home-mortgage loans at an annual percentage rate approximately 1.5 points below the prevailing local commercial interest rate for home-mortgage loans at the time written application is made. To qualify, an eligible university employee must buy a house located within 8 miles of the central campus.

Begun in 1958, the plan applies to first mortgages only on homes purchased to be the principal residence of the eligible employee and his or her family. Refinancing of existing mortgages, second-mortgage loans, and home-improvement loans are not allowed. The effect of these restrictions is to associate the mortgage program directly with the housing-location decision.

The primary incentive offered by the plan is the reduced mortgage rate. However, other incentives provided by the plan are a lower down payment (10 percent) and a longer payback period (40 years). Also, the very availability of mortgage funds in a tight market situation is an incentive to eligible home buyers to participate in the program.

About 40 percent of all eligible employees hold home mortgages obtained through the Princeton mortgage-loan program. When only professors, associate professors, and assistant professors are considered, participation increases to 55 percent. About 70 percent of full professors participate in the program.

Plan-Induced VMT Reductions

The impact of Princeton University's home-mortgage loan program on residential location and work trip length has been assessed by comparing work trip length distributions between (a) university employees eligible to participate in the program and those who are ineligible and (b) Princeton employees and comparably salaried employees of other institutions and corporations in the area. Evaluation of these distributions allows a preliminary assessment of the effects of the Princeton plan. More rigorous evaluation of the impact of the Princeton plan in reducing VMT will be based on the results of the detailed survey currently being conducted.

Rutgers University, the Squibb Corporation, and the Educational Testing Service (ETS) were selected to provide comparisons of work-trip length distributions with Princeton University. Both Squibb and ETS are located close to Princeton and employ workers whose socioeconomic characteristics are similar to those of Princeton employees. Rutgers was selected for comparison because it is the closest major university to Princeton. Rutgers is located in New Brunswick, New Jersey, approximately 20 miles from Princeton.

It was necessary to generate dichotomous employee groups at Rutgers, ETS, and Squibb comparable to the eligible and ineligible dichotomy at Princeton. Consequently, a salary level of $25 000 was chosen as an approximate dividing line between those employees eligible for Princeton's loan program and those not eligible. Thus, an employee whose salary is more than $25 000 at Rutgers or ETS corresponds to an employee at Princeton eligible for the mortgage program. Due to data restrictions, the employee sample from Squibb is divided at $20 000 rather than $25 000.

Length of the work trip was calculated on a straight-line basis rather than on a road-mileage basis. Employees were aggregated by zip code area and were assumed to live at the centroid of the zip code area. Although these simplifications reduce the precision of the model, this level of detail was considered sufficient for preliminary comparisons of distributions of work trip length.

Figures 1-3 present cumulative work-trip length distributions for groupings of Rutgers, Squibb, and ETS employees comparable to the eligible and ineligible groups of Princeton employees. Figure 4 presents cumulative distributions of work trip length for eligible and ineligible Princeton employees. If, for example, there is a cumulative percentage of 40 at 10 miles, this indicates that 40 percent of the employees in that salary range live within 10 miles of work.

Inspection of these plots supports the hypothesis that Princeton's mortgage loan program is successful

Figure 1. Cumulative work trip length distributions for Rutgers University employees.

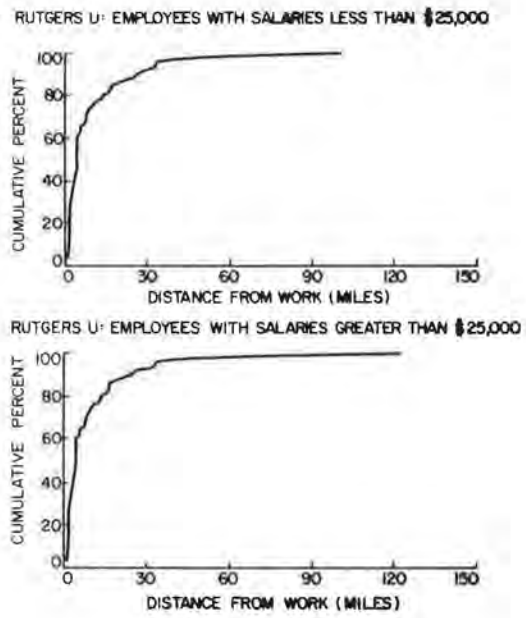

Figure 2. Cumulative work trip length distributions for Squibb employees.

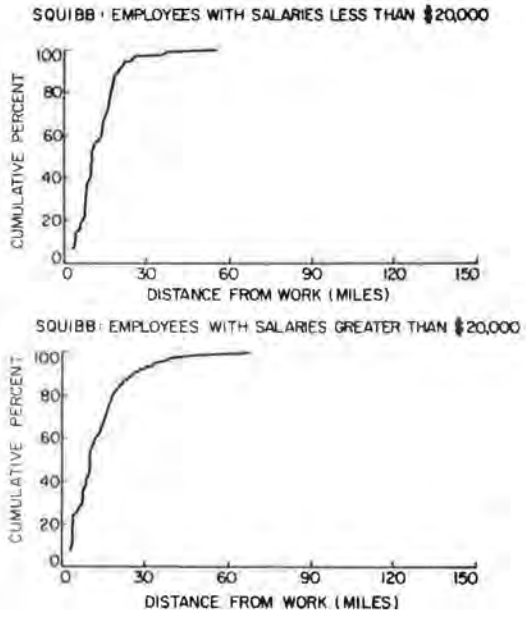

Figure 3. Cumulative work trip length distributions for ETS employees.

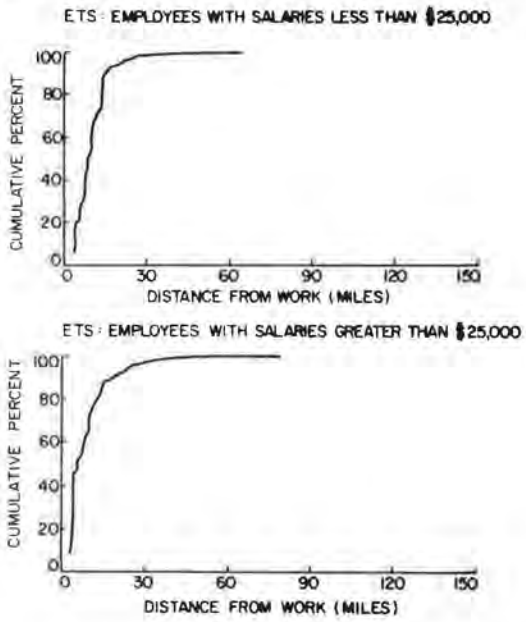

Figure 4. Cumulative work trip length distributions for Princeton University employees.

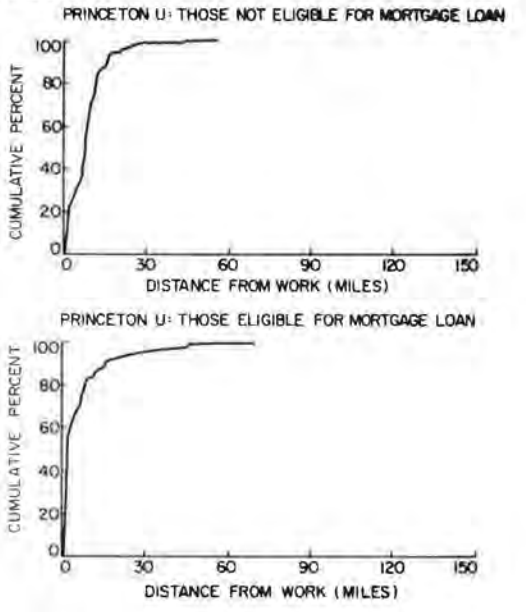

Table 1. Work trip length means and standard deviations.

Employer	Employee Salary Category	No. of Employees	Mean	SD
Rutgers	<$25 000	1953	9.4	12.6
Rutgers	>$25 000	3817	9.3	12.8
Squibb	<$20 000	357	12.4	7.5
Squibb	>$20 000	546	13.3	10.2
ETS	<$25 000	1791	10.1	6.2
ETS	>$25 000	405	9.3	8.6
Princeton	Not eligible for loan	2174	8.9	6.6
Princeton	Eligible for loan	2138	6.8	9.6

in inducing employees to live closer to the work place. Rutgers' distributions for low and high-salaried employees appear almost identical to each other. The Squibb and ETS distributions appear less alike, but only Princeton's work-trip length distributions appear greatly different. This indicates that there is little difference in the distributions of work-trip length of high- and low-salaried employees, except at Princeton, which has a mortgage-loan program for its high-salary personnel.

Table 1 presents sample sizes, mean work-trip lengths, and standard deviations for employee group pairs at Rutgers, Squibb, ETS, and Princeton. Within groups, both the high-salary (eligible) groupings and the low-salary groupings (ineligible) are significantly different at the 95 percent confidence level. The ETS groups are significantly different at the 95 percent level but not at the 99 percent level. The Princeton distributions, however, are significantly different at all confidence levels up to 99.9 percent. The distributions of work trip length for the employees eligible for the program and those who are ineligible can, therefore, be declared significantly different. Comparably salaried groups at Rutgers and Squibb showed no significant difference in trip length; comparable groups at ETS showed only marginal differences. These results indicate that the mortgage-loan program at Princeton does entice eligible employees to live closer to work.

Weighted averages were used to compare the distribution of work trips of Princeton employees who participate in the mortgage program with the distributions of comparably salaried employees at Rutgers and ETS. This revealed that the Princeton employees live approximately 2.5 miles closer to their work place than do their counterparts. In this initial analysis, the difference in commuting distances is attributed to the mortgage subsidy. Consequently, the Princeton plan is responsible for reducing annual VMT for the 2138 participants by approximately 3.2 million miles. (This figure is based on assumptions of a 300-workday year and twice daily commuting trips.)

This reduction in work trip VMT results in a conservation of energy and reduction of air pollution. Approximately 200 000 gal of gasoline are conserved annually as a result of the subsidy-induced VMT reduction. This estimate is based on a fleet fuel-economy average of 14.2 miles/gal, extrapolated from the Transportation Energy Conservation Data Book (23). In addition, the reduced VMT that accrues from the Princeton plan results in annual reductions of emissions of approximately 150 tons CO, 19 tons HC, and 10 tons NO_x. [These figures are derived from the Mobile Source Emission Factor Tables (24) for 21 percent cold starts, 53°F, and 25 mph.]

Although the objective of the Princeton plan is to encourage a residential university community, these figures demonstrate that the plan also induces significant savings in both energy consumption and vehicular emissions. In order to assess the feasibility of implementing this type of program on a more widespread level, the issue of costs must be addressed. As a starting point, the costs of the Princeton plan were estimated.

The Princeton mortgage program is financed through the university endowment. As of 1979, $26 837 000 was held in outstanding loans to faculty and staff, almost all of which was in the form of mortgage loans. In 1979 alone, the university invested $3 322 000 in the mortgage program. The plan has a default rate of virtually zero, and administrative costs are low. Thus, the cost of the program to Princeton University is essentially just the opportunity cost of directing funds to the mortgage-loan program rather than to some alternative investment opportunity.

We assume that, in the absence of the mortgage program, the university would diversify its portfolio in much the same manner. That is, the university would invest a comparable amount in long-term, low-risk investments through a commercial institution. Thus, the opportunity cost to the university of providing the mortgage subsidy is estimated as the amount of the mortgage investments multiplied by the differential interest rate.

Although the Princeton mortgage rate has since been capped at 10.5 percent, at the time the data were collected the interest rate was set at 1.5 percentage points below the prevailing local commercial interest rate. Since approximately $27 million was invested in the program in 1979, the opportunity cost to the university for that year was approximately $400 000. The inclusion of $25 000 annual administrative costs for the program brings the total cost of the mortgage-subsidy program in 1979 to approximately $425 000.

IMPLEMENTATION OF MORTGAGE SUBSIDIES

Although the Princeton plan induces a significant reduction in employee work trip VMT and associated fuel consumption, these benefits are achieved at a significant cost. Consequently, in this time of fiscal austerity and deregulation, implementation of such a mortgage policy through the public sector is probably infeasible. In addition, Princeton's rather unique motivation for implementing a geographically restricted mortgage-subsidy program would not be widely shared throughout the private sector.

We propose, however, that an important financial incentive for implementation by the private sector of geographically restricted mortgage-subsidy programs does exist. This incentive has been provided by the EPA's emissions offset policy.

Emissions Offsets

By using this policy, industries can trade-off part of their mandated emissions reductions at the plant for emissions reductions that accrue from subsidy-induced VMT reductions. Thus, industry can use this type of subsidy program to increase flexibility in finding the most cost-effective means of pollution control. In the process, significant energy savings can be realized.

The failure of the Clean Air Act to provide for new sources of industrial pollution in areas that had not attained the national ambient air quality standards (NAAQS) effectively put a stranglehold on major industrial development in many urban areas. As a result, a 1976 interpretive ruling on section 110 of the Act provided for economic development in nonattainment areas under certain stringent conditions. The ruling allowed a new source of pollu-

tants to locate in a nonattainment area if its emissions would be more than offset by concurrent reductions of emissions from existing sources in the area. This became the heart of the emissions-offset policy, or simply the offset policy.

The same ruling also addressed the problem of new sources that cause a previously clean area to violate federal air quality standards. Under these conditions, a potential source of pollutants was required to obtain offsets in an amount sufficient to prevent violation of the NAAQS.

The offset policy can only be applied to the same types of air pollutants, and, in addition, the limitations on the geographic source of offsets depend on the type of pollutant involved. For example, hydrocarbon or nitrogen oxide emissions offsets could be obtained from anywhere in the broad vicinity of the new source, but other pollutant offsets would have to be obtained from a more limited area because they are more site dependent.

The 1977 Clean Air Act Amendments expressly approved the emissions-offset interpretive ruling, and on December 29, 1978, EPA announced a revised emissions-offset policy. The most important feature of the revised policy was EPA's provision for the banking of emissions offsets.

The approval of offset emissions banking provided the key to the organizational problem of coordinating pollution offsets. An offset banking system can facilitate the trading of offsets by certifying that the promised pollution reductions have been made and by keeping track of available offsets within the region. Banking enables the pollution offsets to be traded, sold, or saved.

The emissions offset and banking policies provide industry with an important financial incentive to implement geographically restricted mortgage-subsidy programs. By using these policies, industries may offset increased pollution at the plant with decreased emissions from shorter employee work trips. Thus, industries are provided with a larger spectrum of feasible solutions to pollution abatement from which they can find the most cost-effective means of control. In particular, an industry does not have to shorten its own employees' trips; the banking policy allows the same benefit in reduced pollution controls to be obtained by purchasing reduced employee emissions from other firms in the area.

In comparing the costs of pollution control via mortgage subsidies with the cost of industrial pollution abatement measures, it is important to use the marginal cost of control in the evaluation. The marginal cost of industrial pollution abatement typically increases with increasing levels of control. Consequently, if pollution offsets obtained through mortgage subsidies are to be traded with the last X percent of regulated industrial control, the cost of the subsidy program should be compared with the cost of that last increment of abatement.

Mortgage-Subsidy Programs

Many mortgage-subsidy programs currently exist in the private sector. The two most common are direct mortgage financing and mortgage interest-rate-differential programs (MID programs). Although only a small percentage of these is geographically restricted, the existence of these programs suggests their potential feasibility on a more widespread level. In particular, it suggests that it would not be a radical step to modify these programs to be geographically restricted, such as by offering an increased subsidy that is restricted to a specified geographic area.

The first type of mortgage subsidy is the direct mortgage financing program. Through this program, eligible employees can obtain mortgages, often at an interest rate below the prevailing commercial rate. Financial benefits accrue to the participating employee through both the lower interest rate and actual availability of a loan in a tight money market.

Direct mortgage programs are offered primarily through academic institutions, but several businesses also provide such programs. A sample of those that offer direct subsidy programs includes the University of Michigan, Columbia, Harvard, the University of California, Carnegie-Mellon, Yale, and the Gulf Oil Corporation. According to a 1980 Merrill Lynch survey of major corporations, 7 percent of the respondents (40 firms) indicated that they provide mortgages directly to their employees, and 22 percent (18 firms) of the banking, financial, and insurance corporations interviewed provide such programs. Another trend revealed by the survey is that the percentage of companies that have mortgage-financing programs increases with their propensity to transfer employees (25).

Several of the academic mortgage programs restrict participation to homeowners who live within a specified geographic area. This has generally been done to further such objectives as offering a recruitment aid and establishing a proximate residential community, but the success of these programs suggests that geographically restricted mortgage-subsidy programs could be used to achieve other objectives as well.

The second common type of mortgage-subsidy program is the MID program. Under this policy, reimbursement is made to eligible employees according to a formula based on the interest rates of the new and old mortgages. The same Merrill Lynch study found that 27 percent of the interviewed firms (164 firms) have MID programs. Companies that provide MID programs include Digital Equipment, B.F. Goodrich, Anheuser Busch, Anchor Hocking, Eli Lilly, and Celanese Corporation.

Although none of these programs is restricted geographically, implementation of such a policy would be feasible. Future research will examine the impact geographically restricted MID programs can have on influencing residential location.

CONCLUSIONS

The intention of this paper has been to report research in progress on the feasibility of geographically restricted mortgage-subsidy programs to reduce employee work trip VMT, energy consumption, and vehicle emissions. Future research is planned to analyze in more detail several aspects of the mortgage subsidy. A questionnaire is being distributed to provide much needed disaggregate data. These data will aid measurement of the sensitivity of residential location decisions to MID programs and direct mortgage subsidies. These data will also help determine the effect of geographically restricted mortgage subsidies on total household VMT and travel patterns.

This paper reported only general conclusions on the cost to industry of a mortgage-subsidy program. In order to determine more fully the financial incentive to private industry of implementing such a program, the costs of both mortgage-subsidy programs and industrial pollution abatement will be documented more completely.

The results of research to date, however, indicate that geographically restricted mortgage-subsidy programs can be feasibly implemented in the private sector as a means of reducing VMT, and, consequently, of reducing excessive energy consumption and vehicular emissions. Linkage of mortgage subsi-

dies to EPA's emissions offset policy can provide industry with a financial incentive to provide such programs. This linkage forms a policy that provides industry with the means of achieving more cost-effective pollution control while realizing significant savings in energy consumption.

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Transportation-Related Impacts of Compressed Workweek: The Denver Experiment

TERRY J. ATHERTON, GEORGE J. SCHEUERNSTUHL, AND DOUG HAWKINS

This paper summarizes results of an evaluation of the federal employee compressed workweek experiment in the Denver area. In this experiment, more than 7000 federal employees changed from standard work schedules to either a four-day workweek or nine workdays in a two-week period. Emphasis is placed on transportation impacts related to air quality and energy issues, with particular attention given to quantifying the more-indirect impacts of compressed work schedules on overall weekly household travel patterns. The analysis approach developed to evaluate these issues essentially involves the measurement of a number of travel-related impacts prior to implementation of the compressed workweek and again one year later. Also involved is the use of experimental and control groups to isolate those impacts attributable to the compressed workweek from other impacts from factors exogenous to the experiment, such as changes in the price and availability of gasoline. The findings indicate that compressed work schedules lead to a reduction in weekly household vehicular travel. Further, reductions are observed not only for work travel but for nonwork travel as well. Results also suggest that the compressed workweek can be compatible with other regional transportation actions such as ridesharing and transit. Although not demonstrated conclusively in the Denver experiment, the compressed workweek also appears to have the potential for improving traffic flow conditions by reducing peak-hour traffic volumes.

The compressed workweek, a form of alternative work schedules in which employees work a full 40-h week in less than the standard five days, became popular