Making the Concept of Equity Operational

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In an effort to improve communication among transportation planning professionals and with the public, definitions of "equity"—a term commonly used by professionals, politicians, and citizens in discussion of planning issues—and related concepts are proposed. Two examples are offered to show how horizontal and vertical equity can be made operational. Supposed trade-offs in transportation between efficiency and equity are also explored, and it is concluded that, contrary to conventional wisdom, they are more often complementary than conflicting.

Rather than invent entirely new words to round out their jargon, technical professions often borrow common words that have meanings somewhat related to the technical concept in need of a name. One of the problems in doing this is that a word such as "equity" is used by many people in discussing the same issue but with little overlap in meaning and, hence, limited communication. For many people, equity refers to their own (often private) definition of fairness, whereas for others equity may mean equal treatment or the distribution of income. Because equity has become such a popular word in transportation planning, some efforts at presenting an operational form of the concept seem justified.

In this paper, some definitions are first proposed, and then two examples are presented and discussed. The first example compares alternative policies for allocating gasoline during a shortage, and the second estimates empirically the vertical impact of financing rail rapid transit construction out of property and sales taxes, as was done in San Francisco. The conclusion is drawn that inequities in the transportation sector are the result of inefficiencies rather than a consequence of the conflict between efficiency and equity.

DEFINITIONS OF HORIZONTAL AND VERTICAL EQUITY

Equity generally refers to the distribution of something that has value—i.e., costs or benefits—among entities—i.e., people, regions, or factors—and whether that distribution is good or bad or better or worse. Part of the problem in the use of the term is that equity is both descriptive (what the distribution is) and normative (whether it is good or bad).

Many of the standard works on public finance (2, 9, 10) include brief sections on definitions and alternative concepts of equity. Current literature is sometimes helpful (7), but more often it is directed at remote theoretical points. Although an occasional extended empirical work (6) will include transportation as one component, applications in the transportation field are limited (1, 3, 4, 5, 11). An extensive literature treats the shifting and incidence of the property tax. The definitions offered below are generally consistent with this literature although there is considerable disagreement and ambiguity within it. A first step toward a definition of equity is to group applications of the equity concept under two main headings:

1. Horizontal equity—In formal terms, this is the equivalent treatment of individuals in equal circumstances and relates most directly to popular notions of fairness. Suppose, for example, a large transportation investment creates benefits to landowners according to the schedule shown in Figure 1 but taxes are levied uniformly within the two jurisdictions benefited. It can be seen that (a) some persons in each jurisdiction pay for benefits they do not receive while others receive more than they pay and (b) one jurisdiction is paying more than its share of the total bill.

2. Vertical equity—The other side of equity refers to the distribution of income between different classes of incomes. Views on this subject tend to reflect one of two lines of thought: (a) The existing income distribution is unacceptable and another is preferred, usually one that is more egalitarian, or (b) the present distribution is tolerable, but the effects of proposed programs and policies should be evaluated to be sure they at least do not worsen the situation. The second approach is the one taken here, but roughly the same analytic skills are required in either case. This means that we are primarily interested in equity impacts, i.e., the incremental change in the aggregate distribution of income that results from a project.

Two types of criteria are used to evaluate impacts of vertical equity. One assumes that the size of the pot is fixed (there are no efficiency impacts) and the result of the policy is labeled either favorable (low incomes gain at the expense of high), unfavorable (high incomes gain at the expense of low), or neutral (there are no net redistributive effects). The other type of criterion is more general, applies to the distribution of costs, benefits, and net benefits, and is measured in proportion to income: Costs (taxes) that increase faster than income as a proportion of income are progressive as are benefits that increase less than proportionately; costs that increase less than proportionately or benefits that increase faster than income are regressive; and costs or benefits that are a constant proportion of income are neutral.

Three examples are shown graphically in Figure 2. Empirical estimates of these distributions will be less smooth (because of grouping of data by income class) and less monotonic than the diagrams shown.

EFFICIENCY CRITERION

Maximum social welfare is obtained when, for all outputs, the marginal social benefit of the last unit is equal to the marginal social cost in terms of what society must give up in order to obtain that unit of output. In a perfectly functioning market, benefits are reflected by willingness to pay and can be represented diagrammatically by a demand curve; social opportunity costs are similarly represented by the supply curve, and the intersection—the optimum level of output and price—results automatically from the market processes. In economic theory, this is what is known as efficiency. Horizontal equity is satisfied because equal payment is made for equal use, and vertical equity is neutral as long as the initial distribution of income is acceptable.

No actual markets function perfectly, so the policy

question becomes that of determining what kinds of market failure exist and what public intervention is warranted. Despite the pervasive presence of the public sector in transportation, the types of market failure that justify public intervention (notably, the natural monopoly characteristic of a large capital investment in a network) are few in number. In particular, there is no reason why users of the systems should not pay the full social costs of constructing and operating those systems. Although there are those who argue otherwise, it is assumed here that transportation does not create external benefits. External costs such as pollution and noise are ignored.

INEQUITY OF EFFICIENT PRICING

Some persons object to efficient pricing because it is claimed to be inequitable. Of particular concern are those potential system users who are dissuaded by the level of the user charge. Clearly, many persons who would like to use a transportation facility and who choose not to in the face of the high price may be of lower than average income. The claim may be made that it is the poor who are "tolled off" the facility. The reasoning for this argument can be stated as follows: For any good or service that is in the broad category of being a necessity or is simply generally consumed, the amount spent for this item by each household will rise with the income of the household (overall, wealthier households will spend more for the item), but the proportion of income spent will decline. An increase in price, then, will operate like an excise tax, falling more heavily on lower income households as a proportion of income.

An example of the effects of correct pricing is shown in Figure 3. Indeed, the increase in price, by itself, is regressive. This observation should, however, be placed in context:

1. Equity impacts cannot be estimated without specifying the null alternative. When the price to users is below cost, then the deficit must be made up by a transfer from some group of taxpayers to the group of consumers. If, for example, the burden of the subsidy falls as shown by line AB in Figure 3, shifting the full cost burden onto consumers would result in a net improvement in equity. In the no-free-lunch real world, equity is determined not by whether the user pays or not but by how things are paid for by users and nonusers together.
2. If the higher price is the correct (i.e., efficient) one, then the welfare gains exceed the costs to consumers, and it is possible to make everyone better off as a result. This can be done through the generation of income, if private markets are functioning properly, or through direct government action. If the correct price is achieved by a tax, then the revenues can be used to provide a rebate to low-income households, to improve service to persons most adversely affected by the higher price (e.g., better commuter bus service), to construct new facilities where the demand warrants, or all of the above. In most policy contexts there are several feasible ways to at least approximate neutral or favorable equity and at the same time improve efficiency, and these actions should be taken in conjunction with each other.
3. If the user is to be undercharged because it is more equitable, then the question becomes, How much subsidy? Once a major component of the system is subsidized, it becomes harder to deny subsidies to others; city bus companies and railroads have joined the ranks at the trough in the last decade or so, and the taxicabs and intercity bus companies are now starting to get hungry.

It is preferable, then, to separate—analytically—equity and efficiency and not attempt to achieve equity by sacrificing efficiency. Typically, the gains will be overwhelmed by the losses when, with a little care, it is quite possible to achieve both.

Figure 1. Horizontal equity between jurisdictions.

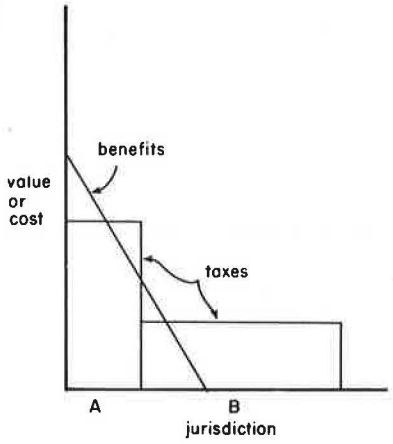
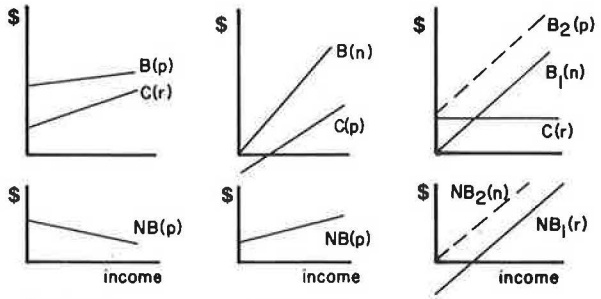


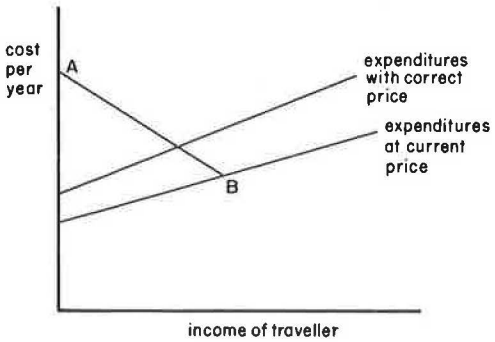
Figure 2. Possible cost and benefit distributions by income.



B = benefit
C = cost
NB = net benefits

n = neutral
r = regressive
p = progressive

Figure 3. Equity effects of correct pricing.



EXAMPLES

Response to a Gasoline Shortage

Three alternative policies for dealing with the situation in which there is excess demand for gasoline at prevailing (controlled) prices have been selected from among those discussed, proposed, or placed in practice. They have been simplified somewhat for discussion purposes,

and no attempt has been made to test empirical assumptions used in evaluating the three alternatives.

1. Plan A imposes a tax on the price of gasoline that is large enough to reduce demand to the level of supply and uses the revenues to provide a tax rebate on the basis of income (no other test, such as automobile ownership, is considered).
2. Plan B allocates available supplies to regions according to previous consumption levels. Within those regions, the stock of gasoline is allocated to those willing to pay the controlled price plus wait in line for the gasoline.
3. Plan C issues rationing stamps to all licensed drivers according to need, the total number of stamps being equal to the total supply of gasoline. Need is hard to define precisely, but it appears to include such notions as the lesser need for gasoline among persons living in areas served by transit, greater need among persons who live far from where they work, and need based on automobile ownership and previous consumption.

The three plans are listed in decreasing order of efficiency (net social benefits). Plan A directs supplies to those who benefit most as expressed by willingness to pay; plan B includes a time price, which is a less efficient rationing device; and plan C is least efficient because it both creates heavy transaction costs and tends to encourage at least some inefficient consumers to maintain their previous levels of consumption.

Horizontal Equity

If persons who consume equal amounts of gasoline make equal sacrifices, then horizontal equity is served; in other words, persons should pay in accordance with the amount consumed. Plan A would be the most equitable, then, because it would require each consumer to sacrifice in accordance with the amount of gasoline consumed. Plan B is less equitable because consumers in equal circumstances (i.e., who consume equal amounts of gasoline) will sacrifice varying amounts in terms of time and inconvenience depending on such factors as region, location within region, time schedule, and availability of stand-ins such as wives and children. But at least the costs are fully borne by consumers of gasoline. Plan C has the effect of creating income (the stamps have a value approximately equal to the optimal tax in plan A) for a particular group of consumers (those with automobiles, high gasoline consumption, and without access to transit) in a way that is arbitrary from the standpoint of horizontal equity; plan C is, in fact, perverse because it rewards those who are least deserving from the standpoint of horizontal equity (not necessarily the same as vertical).

Vertical Equity

Plan B has the most favorable impact on vertical equity, but the reasons are somewhat unattractive. If it is assumed that persons with higher incomes also generally place a higher value on their time, then the time component of the price of gasoline extracts a greater sacrifice from them than from those with lower incomes; in other words, vertical equity is achieved by making everyone worse off but those with higher incomes more worse off than those with lower incomes. Both efficiency and equity can be improved somewhat by allowing persons with higher than average values of time to hire persons with lower than average values to stand in line for them. This becomes, in effect, a transfer payment from higher income to lower income people as a function of how much time those with lower incomes are willing to waste waiting in line.

Plan A also has a favorable vertical equity impact because high- as well as low-income people pay the higher price but only those with lower incomes receive the rebate. Depending on how the surplus revenues (above the amount of the rebate) are used, the vertical equity impact could be improved or worsened.

Plan C again has the least favorable impacts. The extent to which the distribution of income would be worsened by this plan depends on the distribution of income of needy persons (those with automobiles, a driver's license, or high previous consumption) versus the distribution of income of nonneedy persons. Whether the result would be favorable or unfavorable requires matching empirical information with a precise definition of need, but it appears plausible that most of the needy would be affluent suburban commuters. In addition, persons who do not have a driver's license (the poor and the elderly) are more likely to come from low-income than high-income households.

The efficiency of plan C could be improved slightly by allowing recipients to sell their stamps, which would permit a household with high consumption to decide whether to maintain previous levels of consumption or sell the stamps and consume less, but the equity impact would be unaffected by this transaction. Selling the stamps simply means that the income in kind (gasoline) can be exchanged for money income, and the distribution of income is unchanged.

A summary comparison of how the three plans rank in dealing with gasoline shortages is given below:

Ranking	Efficiency	Horizontal Equity	Vertical Equity
Best	A	A	B
Second best	B	B	A
Worst	C	C	C

In comparing the three plans for dealing with gasoline shortages, a conflict or trade-off between efficiency and equity appeared only once, and that was where vertical equity could be enhanced by making everyone worse off. In general, the efficient plan was the most equitable or could be made the most equitable by imposing modest side constraints. Planners should be looking for ways to impose these constraints on efficient solutions rather than attempting to redistribute income through transportation policy.

Vertical Impact of Bay Area Rapid Transit Financing

The cost of constructing the Bay Area Rapid Transit (BART) system was paid for primarily from two local general revenue sources: a property tax with an effective rate of about 0.13 percent and a sales tax of $0.005 that exempts groceries. Given information about the income-related characteristics of taxpayers and users of the system, estimating the magnitudes of flows of costs and benefits between income groups requires four steps [the empirical information used in discussing this example is derived from Hoachlander (8)].

Direct Incidence

Ideally, the property tax paid by each property owner in each income class would be calculated by applying the tax rate to the value of the owner's property, and sales taxes would be calculated by applying the sales tax rate to annual local expenditures. A number of difficulties

make the reality considerably more crude, but only the more important ones will be described. First, data are grouped into large classes by income, and average values of income and property must be used. Second, the original source of the information was the 1970 U.S. Census, and property and income data are only provided for residential property so that the distribution of the impact of the property tax on commercial and industrial property is assumed to be the same as the distribution on residential property. Third, spill-ins and spill-outs (e.g., sales taxes paid by tourists) are assumed to be negligible or no different from the estimated distribution of impact based on local residents.

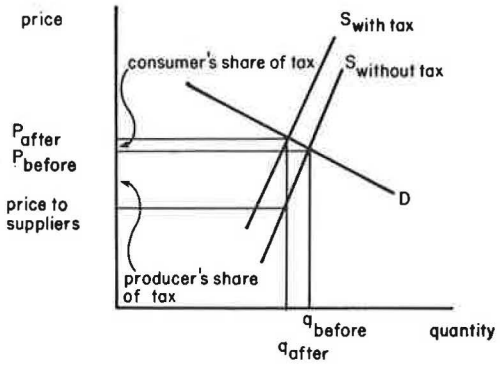
Market Adjustments

In many situations, the imposition of the tax will cause a change in behavior on the part of those on whom the tax is levied. If the policy change were a price increase, then consumers could be expected to adapt in various ways so as to lessen the impact of the higher price or take advantage of a lower price. Sales and property taxes can cause consumers to shop in jurisdictions where the tax is lower, and property taxes can encourage households and firms to locate in other jurisdictions. Although this would be possible in the Bay Area case, the tax rates are low enough that substantial attempts to escape them were probably not made. Of course, if the estimates are being made retrospectively, then the actual distributions of households after the tax was levied can be used.

Tax Shifting

The extent to which the burden of a tax falls on consumers versus producers (or landlords versus renters) depends on the relative elasticities of supply and demand. One example in which supply is fairly inelastic and demand is elastic is shown in Figure 4. In this situation, the tax falls more heavily on producers because consumers drop out of the market with even small increases in price but producers cannot so easily adjust supply. If things were the other way around—inelastic demand and elastic supply—then consumers would bear most of the burden of the tax. It is important to note that it is not on whom the tax is levied but market conditions that determine incidence. For the conditions shown in the diagram in Figure 4, the tax could have been charged to consumers (a sales tax) instead of producers (an excise tax quoted in the price), and the results would still be the same.

Figure 4. Incidence of tax on consumers and producers.



Hoachlander assumed that homeowners absorb the full burden of the tax on owner-occupied property, that the tax on rental property is fully shifted forward onto tenants, and that sales taxes are fully borne by the consumer (he used the Internal Revenue Service estimates tabled for purposes of itemizing income-tax deductions), and the estimates for the cost burden given in Table 1 (8) reflect these assumptions. On the benefits side, because only users (or their households) are assumed to benefit, the passenger kilometer was chosen as a measure of benefit. By using recent ridership surveys and thus distribution of patronage and average trip length, an index of aggregate passenger kilometers of travel by income class can be constructed. For convenience, total benefits (net of fares) are assumed to be equal to the total taxes contributed, so the passenger-kilometer index was scaled to give the same total as that for costs. This allows the costs and benefits for each class to be compared on the basis of relative gain or loss (zero sum). The results of estimating benefits and also of subtracting costs are given in Table 2 (8).

Interpretation

A good way to represent the distributional results in graphic form is to measure costs or benefits per household on the vertical scale and let the width of each band be proportional to the size of the income class. In Figure 5, it is clear that high-income groups have gained at the expense of low-income groups, but the magnitudes are placed in perspective because the area of each segment indicates the amount of the transfer into or out of each income class.

Several points should be kept in mind in interpreting these results:

1. Benefits calculated per trip (instead of per kilometer) would appear to be less redistributive but nonetheless unfavorable.
2. Property taxes are not generally fully shifted and, to the extent that this is true, estimates of the cost burden are biased downward; i.e., higher income groups actually pay more tax than that shown.
3. As noted, the estimates of costs are based on residential property taxes only, which make up about 53 percent of BART property taxes. To the extent that the distribution of costs initially levied on commercial and industrial property differs from the distribution of costs levied on residential property, the cost estimates are inaccurate.

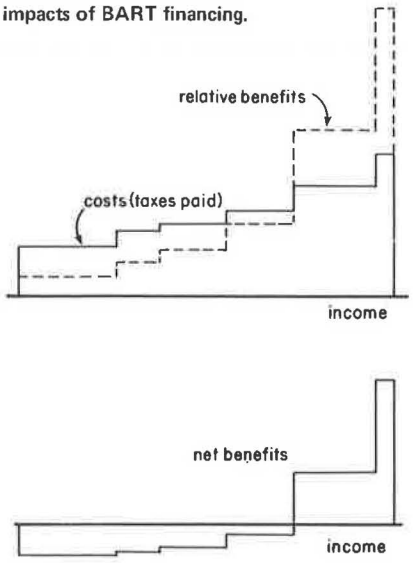
Table 1. BART taxes by income class.

Income Class ($)	Tax on Homeowners ($)		Tax on Renters ($)		Total ($)	Households		Tax per Household ($)
	Property	Sales	Property	Sales		Number	Percent	
0-5 000	1310	498	2367	1555	5 730	206 915	27	28
5 000-7 000	609	290	1068	795	2 762	83 502	11	33
7 000-10 000	1432	770	1508	1216	4 926	132 348	17	37
10 000-15 000	3351	1938	1525	1313	8 127	180 632	23	45
15 000-25 000	3501	2373	828	856	7 558	129 139	17	58
≥25 000	1381	916	213	220	2 730	37 139	5	73
Total					31 833	769 675	100	

Table 2. BART benefits by income class.

Income Class ($)	BART Ridership (¢)	Average Trip (km)	Passenger-Kilometer Benefits ($000)	Benefits per Household ($)	Net Benefits per Household ($)
0-5 000	10.5	2.75	2 267	11	-17
5 000-7 000	6.8	2.82	1 502	18	-15
7 000-10 000	12.6	3.38	3 338	25	-12
10 000-15 000	21.6	4.32	7 321	40	-4
15 000-25 000	30.6	4.74	11 370	88	29
≥25 000	17.8	4.32	6 033	162	89
Total	100		31 833		

Figure 5. Vertical equity impacts of BART financing.



4. The conclusion that BART created an unfavorable income redistribution in the Bay Area cannot be accepted without establishing what would have occurred otherwise. Previous investments in highway capacity had drawn from similar sources in similar proportions and to the benefit of similar groups. It is quite likely that the unfavorable equity impacts of BART are not much, if at all, worse than the impacts of a corresponding investment in highways; BART only looks bad in comparison with an ideal sector that is equitably priced and financed.

5. In principle, fares for the high-quality service used by higher income travelers could be set at a level somewhat above costs as a bias toward progressivity. In the case of BART, however, these same travelers have available to them the most heavily subsidized alternative—commuting to and from the suburbs by automobile. BART could probably raise its fares by a modest amount, but it is severely constrained by prices set on competing modes.

COMPLEMENTARITY OF EQUITY AND EFFICIENCY

If the characteristics of a good or service are such that (a) benefits of consumption are entirely captured by users (and perhaps passed on along with costs) and (b) the existing distribution of income is generally acceptable, then equity and efficiency can both be served most easily by charging full costs to users in accordance with use. Accomplishing this with complete accuracy in transportation would require that user fees at least vary by network segment, time of day, and type of vehicle. The system would be entirely self-supporting (covering all opportunity and administrative costs) and would contribute to sales and property tax revenues.

Such, of course, is not the case. In general, the transportation user underpays, and the underpayment is erratic but tends to be greater the higher the cost of the service is. Facilities for which demand is either very high or very low are especially underpriced. Moreover, inefficiencies in resource allocation and utilization also lead to undesirable equity impacts, such as the following:

1. The shortfall must be made up from some other source—normally a general revenue instrument, usually the property tax. This violates horizontal equity (nonusers pay for services that do not benefit them) and may have unfavorable vertical impacts as well.
2. The nature of the service offered—such as the balance between modes—is biased toward higher income users. Suburban commuters receive large subsidies per trip, whereas transit-dependent travelers receive far less service than they would get if all subsidies were eliminated.
3. Minor cross subsidies that might be desirable (e.g., for the elderly or school children) are impossible because all users underpay.
4. Attempts to correct inequities on one mode are frustrated by the ease with which the relatively affluent can escape higher user charges by shifting to another mode.

Certainly, it is not a simple task to evaluate the various kinds of equity impacts, but the methods and concepts are available and they are no harder to use than those related to efficiency. Much improvement in the state of the art needs to be made, but in the effort it might be discovered that, far from having sacrificed equity to efficiency, we have achieved neither.

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Who Favors Work-Schedule Changes and Why

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Factors that influence attitudes of white-collar employees toward alternative work-schedule changes are examined to determine whether the desire to avoid traffic congestion is a primary determinant of such attitudes. A random sample of 110 employees from the main office of the New York State Department of Transportation in Albany, New York, were given a short questionnaire on travel patterns, attitudes toward components of work schedules, and perceptions of impacts of work-schedule changes on family life, travel patterns, and working environment. An attitude scaling technique known as trade-off analysis was used to determine the most preferred programs and the characteristics of those in favor of and those opposed to schedule changes. Results showed the basic motivation behind favoring work-schedule changes is the employee's desire to introduce flexibility into family, leisure, and work activities; the desire to avoid traffic congestion is a contributing, but not a major, factor. The most preferred arrangements are 5-d variable hours, 4-d variable hours, and 5-d individual-specific hours, all with over 65 percent support. Support was strongest among younger employees who had children in school and weakest among single and older employees and car poolers. The policy implications for transportation planning are discussed.

Considerable research has been published on the application of staggered work hours as a device to relieve commuter congestion in public transit facilities (1, 2, 3, 4). The conclusion of these studies is that peak demands in transit facilities can be reduced by 10 to 30 percent through widespread use of such policies. Studies of the impacts of the 4-d workweek on highway congestion (5, 6, 7, and a paper elsewhere in this Record by Tannir and Hartgen) and other studies (8, 9) support variable work hours and 4-d workweek policies as a possible policy for low-cost shifting of travel to reduce traffic congestion. All of these studies, however, have concentrated on large metropolitan areas.

The impacts of staggered work hours and 4-d workweek schedules on firms and their employees have been studied and generally found to be positive (10, 11, 12, 13). General benefits include improvement in employee morale and productivity, reduction in absenteeism and overtime, better use of capital assets, extended hours of service to clients, improved driving conditions during the trip to work, and, under certain conditions, reductions in energy consumption.

DATA AND METHOD

The New York State government offices located at the State Campus in Albany, New York, were selected to be surveyed in this inquiry. The site is located approximately 6.4 km (4 miles) west of downtown Albany in a predominantly residential area, and there are approximately 10 042 employees. The campus is accessible by way of a highway network of local streets, major arterials, and expressways. New York State is the only employer on the campus, employment density is high, and public transportation does not play a major role in the daily movement of employees to and from their jobs. White-collar workers constitute the majority of these employees.

Employees on the State Campus were surveyed to determine employee characteristics, attitudes toward changes in work schedules, and perceived impacts. For several reasons, the main office of the New York State Department of Transportation (NYSDOT) was selected as the focal point for the employee survey. First, it is located on the State Campus. Second, the department population is generally representative of the entire campus population. Third, it was convenient because the researchers were familiar with the organizational structure and functional units of the department. And, finally, permission to conduct such a survey was obtainable from management and employee representatives of NYSDOT.

A random sample of 140 employees from the NYSDOT main office staff of 1771 were selected and contacted. Of these, 110 completed returns were used in the analysis. The returned sample was representative of the main office population (Table 1). Respondents were administered a questionnaire that covered travel and demographic characteristics, general attitudes toward work-schedule changes, perceived impacts of these