INCOME DISTRIBUTION EFFECTS OF THE ATLANTA TRANSIT SYSTEM

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This paper reports on a pilot study to evaluate the income-distribution effects of the proposed Atlanta transit system. The incidence of benefits and costs to each of 8 traffic zones is estimated. The zones have annual incomes per family varying between $5,000 and $18,000. Benefits accruing to each zone as a result of savings in time, vehicle ownership and operating costs, transit fares, parking, and accidents are estimated and compared to transit fares and additional sales taxes that must be paid by the residents of that zone. The net benefits accruing to each zone seem to be more, both per family and per trip, in zones where family incomes are lower. This pattern, however, is strongly influenced by both the location of the zone relative to the closest transit station and the level of interaction between the zone and the central business district. Other factors affecting the distribution of income in the Atlanta metropolitan area are also discussed.

•DURING the last 10 years public investment in urban transit systems has increased considerably and has evoked charges that transit systems favor white middle-class suburbanites over central city, blue-collar workers. In November 1971, the voters of Atlanta approved a $1.4-billion transit system. This new system has also been criticized on the grounds that it favors the nonpoor and thus does not help to compensate for the income distribution biases of public highway investments. The system is supposedly biased to favor the central business district worker who is predominantly white and in the middle-income bracket. In addition, the system is being paid for by a 1 percent sales tax in the 2 counties that are building the transit system, and the use of this regressive tax has heightened the controversy over the possible income biases of the Atlanta system.

The Urban Mass Transportation Act of 1970 provides a federal grant of two-thirds of the capital cost. The 1 percent sales tax covers the remaining one-third of the capital cost and will heavily subsidize the operating cost of the system. Because the fares will be subsidized and because the rail and bus lines will not serve all areas of Atlanta equally, the new system could indeed have a considerable distributive effect on incomes in Atlanta.

This paper examines the possible distributive effects of the Atlanta system in a particular year after the system is completed to determine whether there is an income-group bias. It reports on a pilot study in 8 of the 399 traffic zones into which the metropolitan area is subdivided. The 8 zones were chosen primarily because data were readily available for them and because they represent a wide range of family incomes, residential densities, and automobile ownership characteristics (Tables 1 and 2). Figure 1 shows the relative location of the study zones with respect to the proposed rapid transit system.

1983 was chosen as the year in which to predict the system's distributive effects primarily because of data availability. Many of the computer programs that have been used in planning the Atlanta system are simulations of the transportation network that is supposed to exist in 1983. Many of the data necessary for this study have come from these programs. Throughout this paper the rapid transit system is compared with a 1983 expressway transportation network that would include only the present Atlanta bus system for public transit. The incremental investment in transit above the amount invested in expressways will give rise to incremental cost and benefits for

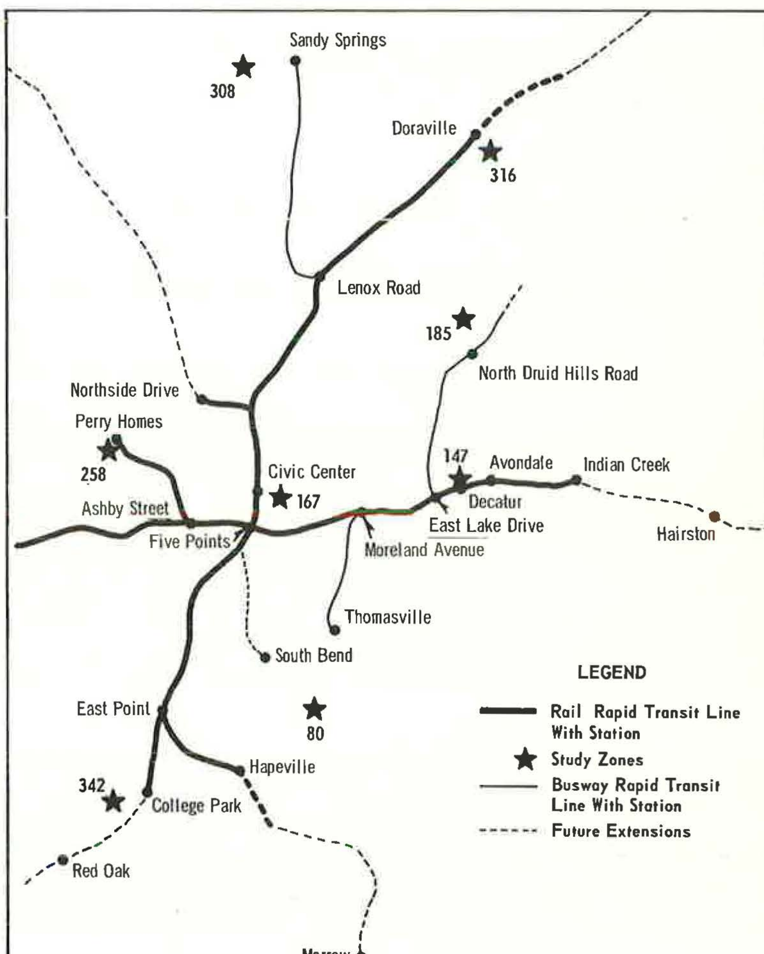
Table 1. 1983 socioeconomic data.

Zone	Average Family Income (dollars)	Persons in Labor Force	Families	Passenger Cars	Land Area (acres)
80	11,683	404	240	381	5,462
147	8,771	1,468	771	982	1,755
167	6,353	1,812	996	692	1,397
185	18,595	703	453	951	4,306
258	5,396	2,580	1,037	895	3,218
308	18,173	4,091	4,021	8,424	89,780
316	10,308	1,175	1,063	2,026	61,370
342	8,838	2,539	1,432	2,358	22,820

Table 2. 1983 transportation data.

Zone	Daily Trips	Distance to Transit Station (miles)	Automobiles per Family	Distance From CBD (miles)	Percentage of Trips to CBD
80	2,163	2.7	1.58	5.4	24.9
147	6,623	0.3	1.27	5.2	21.8
167	5,799	0.9	0.69	1.4	67.7
185	4,748	0.8	2.09	6.7	17.1
258	7,292	0.5	0.86	4.3	48.2
308	42,723	1.4	2.09	11.3	12.9
316	10,646	0.9	1.90	13.7	13.0
342	13,006	1.4	1.64	8.5	19.4

Figure 1. Atlanta rapid transit system.



the city. Furthermore, it is assumed that approximately the same total investment in highway facilities will occur in the study area, with or without rapid transit. This assumption will be justified later in the discussion of transportation networks and the effects networks have on land use development patterns.

The incremental costs and benefits that will accrue to each of the 8 study zones are measured, and the distributive nature of the rapid transit system is examined. The procedures outlined in this paper could be extended to the entire area and could thus provide policy-makers and voters with more evidence on which to base decisions pertaining to choices among alternative transportation systems.

COMPARISON OF ALTERNATE SYSTEMS

A comparison of the costs and benefits of a certain transportation strategy requires that the transportation planning process be carried out for 2 transportation systems: the highway system only and the mixed highway-rapid transit system. The following notation is used to identify the 2 systems:

S1983* = 1983 transportation network with rapid transit (dual-mode system), and
S1983 = 1983 highway transportation network without rapid transit (single-mode system).

The complete transportation planning process was carried out for system S1983*, but not for S1983.

Different systems obviously induce different urban growth patterns; therefore, only a new forecast can adequately reflect the dispersed pattern of urban development that will arise from an all-highway system. In addition, new trip generation predictions are necessary for each transportation zone because all zones will display different development densities if they are served by a highway network rather than a highway-transit network. Likewise, new trip-distribution predictions are necessary for S1983.

For example, a zone in Atlanta's CBD would attract more trips under a rapid transit-highway system than an all-highway system because of the accessibility the rapid transit system would provide to central business district zones. Levels of traffic congestion and travel times would vary considerably on portions of the highways that might be common to both transportation alternatives. Expressways in the CBD might, for example, be less congested in the all-highway network than in the highway-public transit network because the CBD would have a considerably higher employment density and would thus have more trips both by rail and by car attracted to it with a rapid transit system than with an all-highway system.

Since the planners have not analyzed an all-highway system for 1983, some assumptions had to be made in order to derive the necessary data for S1983 from the 1970 Atlanta highway system (S1970). It was assumed that 1970 automobile travel times would continue to prevail in 1983 in the central area of Atlanta for the S1983 system. If public investment in transportation continued only in highways, these new roads would be built almost exclusively in the periphery of Atlanta. This would cause Atlanta to continue to grow in a dispersed, low-density land development pattern similar to that of other automobile-oriented cities such as Los Angeles. This dispersed growth pattern has already revealed itself along Atlanta's recently completed perimeter expressway, where at a great distance from the CBD suburban office parks, apartments, and shopping centers are springing up in response to this form of transportation investment. Consequently, if no rapid transit system were built to redensify the central portions of Atlanta, most of the growth between 1970 and 1983 would occur in the outer suburbs of Atlanta and the CBD would remain approximately the same size.

The assumption that 1970 travel times will persist in 1983 is supported by the fact that only 2 major new expressways are planned for 1983 to serve the downtown area. Therefore, whether the downtown can continue to grow is doubtful. Hence, with only slow growth in the CBD and with the accessibility provided by the 2 new expressways, the assumption that the 1983 CBD will attract approximately the same number of trips as it did in 1970 and travel times will be approximately the same is not unreasonable. In addition, in an all-highway system, many of the trips that originate at the periphery and are generated by either system would be bound for destinations in the outer ring of new development rather than for the CBD, which would be their probable destination if rapid transit were built.

BENEFITS OF THE RAPID TRANSIT SYSTEM

The proposed system will yield 3 main benefits to individuals in the Atlanta area: (a) savings in net travel times; (b) savings in vehicle operating and capital costs, including parking, accidents, and insurance costs; and (c) increases in trips. Although the first 2 benefits are dealt with extensively, the third benefit is not accounted for in the urban transportation planning process, which assumes that the same number of trips will be generated by a zone regardless of the system that serves it. Total annual benefits are given in Table 3.

Time Savings Benefits

Travel times from each of the 8 study zones to each of the other 399 zones in the Atlanta area for S1983 were derived by using actual measured 1970 automobile travel data (1). As discussed earlier, the underlying assumption is that, without a rapid transit system, 1970 automobile travel times will persist until 1983 in the central portion of Atlanta.

The available sample of 1970 automobile travel times, however, is not large enough to cover all possible trip routes in the all-highway system of 1983. To extend the 1970 automobile travel times to that system, adjustment factors were developed that converted the 1983 highway travel times for S1983* to the 1983 highway travel times for S1983.

$$(T^*_{ijk})(F_{i\ell}) = T_{ijk} \tag{1}$$

where

T_{ijk} = travel time in both 1970 and 1983 on the Atlanta highway system from origin i to destination j (i = 1, . . . , 8 and j = 1, . . . , 399) by mode k (k = 1 for automobile and 2 for transit);

T^*_{ijk} = travel times on S1983*;

$F_{i\ell}$ = adjustment factor that converts T^*_{ijk} to T_{ijk} (i = 1, . . . , 8) and (ℓ = 1, . . . , 5).

For each of the 8 study zones, 5 adjustment factors were developed, 1 to each quadrant and 1 to the CBD. Thus, a trip originating in a study zone would have its 1983 highway travel time in S1983* converted according to the location of its eventual destination. There were 40 factors developed in all, 5 for each of the 8 zones.

To compute the factors, we compared 1970 travel times on the highway system and travel times on S1983* for each of 40 origin-destination pairs representing all 4 quadrants and the CBD. The former travel times had to be derived from 1970 data, which were obtained by the Georgia State Highway Department. These data were in the form of measured speeds on selected roads and expressways. The speeds were measured by test vehicles traveling on 57 subsections of 6 major freeways and 6 major arterials surrounding Atlanta. The freeway subsections totaled 86 miles (138 km) in length and had an average daily traffic volume of 76,962 vehicles. The arterial subsections totaled 24 miles (39 km) in length and had an average daily volume of 20,230 vehicles. Travel speeds were measured on the subsections at 3 or 4 times during each of the 2 peak periods and were measured either once or twice during the off-peak period. Figure 2 shows the location of the expressways. Corresponding 1983 highway travel times from 1 zone to another for the highway-transit system were based on the least time path between a pair of zones.

Whenever a 1970 subsection did not have a corresponding 1983 link, a 1970 travel time was assigned to a 1983 link on the basis of the link's location in the city and its classification as either a freeway or an arterial link. For example, a trip originating in origin zone 80 and bound for a destination zone in quadrant 2 of the city would take

Table 3. Total annual benefits.

Zone	Amount (dollars)	Zone	Amount (dollars)
80	57,215	258	1,084,409
147	903,386	308	1,262,062
167	875,311	316	461,885
185	307,163	342	210,905

Figure 2. 1970 Atlanta expressway system.

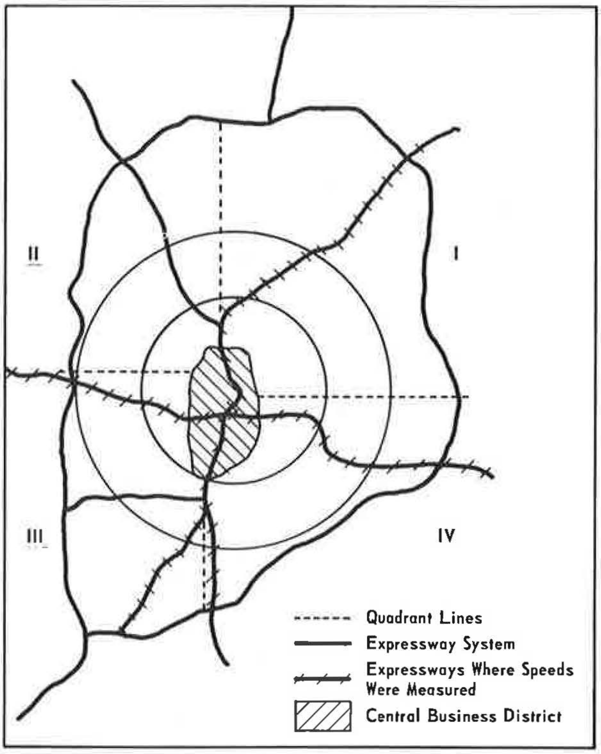


Table 4. Annual benefits from time saved.

Zone	Time Saved (min/trip/day)	Average Increment of Time Saved	SRI Time Value (dollars/hour)	Annual Time Saving (hours/year)	1983 Value of Time Saved (dollars/year)
80	2,059.9	1.06	0.95	17,809	16,918
147	56,711.9	10.23	1.45	491,503	712,679
167	21,683.6	4.16	0.65	187,924	122,150
185	16,510.5	3.83	1.36	143,086	194,596
258	48,433.1	7.48	0.63	419,753	264,444
308	35,626.3	0.94	1.36	308,761	419,904
316	20,377.8	2.12	0.95	176,607	167,776
342	-7,690.5	-0.66	0.79	-66,651	-52,654

Table 5. Annual benefits from private vehicle operating and capital costs.

Zone	Operating Cost		Capital Cost		
	Daily Vehicle-Miles Not Traveled	Annual Saving (dollars)	Cars No Longer Needed: Number[a]	Cars No Longer Needed: Percent	Annual Saving (dollars)
80	138.6	3,834	33	43	16,644
147	442.6	12,244	154	48	86,708
167	1,003.0	27,748	753	49	432,978
185	847.4	23,444	143	33	55,353
258	2,418.8	66,914	619	50	363,043
308	9,840.5	272,229	900	33	348,381
316	3,316.3	91,742	275	45	145,158
342	1,655.8	45,807	218	48	122,742

[a](S1983* trips - S1983 trips)/1.38, where 1.38 = avg automobile occupancy.

an expressway in the 1983 highway network on which no 1970 travel times were measured. To assign a 1970 travel time to the links on that expressway, we grouped the links into 3 categories, which were determined by their location within 1 of 3 concentric rings centering on the CBD. The average 1970 travel times on the 2 nearest expressway links by both quadrant and concentric ring were applied. The concentric rings were used because travel times generally increase on expressways and arterials as distance to the CBD decreases. Travel time comparisons were made only for links that were of the same street classification.

Once the necessary factors, $F_{i\ell}$, were obtained for each of the 40 origin-destination pairs, they were used to provide a trip-time matrix (8 × 399) for S1983. Similar trip-time matrices for S1983* were provided by the Georgia Department of Transportation. A transit travel-time matrix was provided by the Metropolitan Atlanta Rapid Transit Authority (2, 3). The Georgia Department of Transportation also provided a total person-trip interchange matrix. A modal-split analysis was performed on this matrix. In the case of S1983, this was simply a matter of subtracting the old bus system patronage estimates from total person trips made by automobile. A modal-split analysis was performed for S1983* on the basis of the diversion curves used by the consultants.

Net time savings for trip-makers in zone i due to the proposed system can now be readily computed from the equation

$$X_i = \sum_{k=1}^{2} \sum_{j=1}^{399} (T_{ijk} - T^*_{ijk}) N_{ijk} \tag{2}$$

where

X_i = net time savings for trip-makers in zone i resulting from the investment in transit, in minutes per trip per day; and

N_{ijk} = total number of trip-makers using mode k between origin zone i and destination zone j.

The values obtained are given in Table 4. These values are converted to annual time savings by multiplying by the number of working days per year and by doubling the figures to allow for 2-way trips. Only working days are considered because the origin-destination study on which the study was based does not consider weekend trip patterns. Time savings were in turn converted to dollar savings; monetary time values obtained by Thomas and Thompson (4) were used. A specific value of time was found for each of the 8 study zones on the basis of average zonal family income and the average length of zonal time savings per trip. These values were applied to the time savings of each zone, and monetary values of time saved by virtue of the proposed transit system were obtained.

Savings in Operating and Capital Costs

The next series of benefits to be estimated are savings in private vehicle capital and operating costs. These savings are based on the number of commuters who divert to rapid transit from the highway system. A person who diverts to the rapid transit system no longer incurs the automobile cost of the trip.

Operating costs considered in this study are gas, oil, tires, and maintenance costs. Operating costs per mile, which were given by the Bureau of Public Roads and used by the consultant (5), have been used in the following equation:

$$OC_i = \sum_{i=1}^{399} \left(\frac{N_{ij1} - N^*_{ij1}}{1.38} \right) (D_{ij})(C) \tag{3}$$

where

OC_i = operating cost saving to origin zone i,
D_{ij} = distance in miles from origin i to destination j, and
C = cost of automobile operation per mile.

N_{ij1} and N^*_{ij1} were defined above; the subscript 1 indicates the automobile mode, and the denominator 1.38 refers to the average car occupancy in Atlanta.

Some of the trip-makers who divert to rapid transit will no longer need a second automobile because of the rapid transit system. Estimating the proportion of diverted trip-makers who will no longer need a second car in 1983 is at best a precarious task. Nonetheless, the consultant compared frequency of second car ownership in major cities both with and without transit to predict how many diverted trip-makers in Atlanta would no longer need a car. They decided that roughly 50 percent of diverted trip-makers would divest themselves of a car if a rapid transit system were built in Atlanta. The authors feel, however, that income would enter into a trip-maker's decision to keep a car, and that 50 percent was too high for high-income zones. Therefore, zone 258, which has the lowest family income, was assigned the 50 percent rate; but zone 185, which has the highest income, was assigned 33 percent. Linear interpolations between these 2 extremes yielded values for zones with intermediate incomes. Zonal capital cost savings were obtained from the use of a value of $1,173 as the annual capital cost of owning an automobile. Annual operating and capital cost savings are given in Table 5.

Savings in Parking and Accident Costs

Another benefit of the rapid transit system is the savings in parking fees that accrue to transit-diverted trip-makers who travel to the CBD, this being the only area where monthly parking fees are consistently charged. Based on an average monthly charge of $20, savings in parking costs that accrue to trip-makers in each of the 8 study zones were found. The diversion of vehicles from the highway to the transit mode is also expected to reduce the number of accidents on the road. The number of accidents is a function of the distance traveled and the type of road. Unfortunately no data exist on what types of roads diverted transit commuters would no longer travel on, so an accident cost per vehicle-mile had to be applied to all mileage not traveled regardless of road classification. Accident costs were estimated to be $1,987,700 per 100 million vehicle-miles of travel per year. Annual parking and accident cost savings are given in Table 6.

Insurance Cost Savings

Daily commuters pay an insurance premium, in addition to normal insurance costs, on the cars they travel to work in. According to the project consultants, this premium averages $27.50 per year for an automobile used for commuting in Atlanta (5).

The major difficulty in estimating this benefit is that no data exist on how many of the transit-diverted trip-makers would be making work trips because the automobile trips are not stratified by trip purpose for S1983. It was assumed that diverted ridership would be distributed among the trip purposes in the same proportion as all transit ridership by trip purpose. For example, 60 percent of all transit riders from zone 80 make work trips. Therefore, it was assumed that 60 percent of the former automobile users who diverted to rapid transit would be making work trips. This assumption probably yields a conservative work-trip estimate because typically transit systems attract mainly commuting rather than shopping or school trips. Nonetheless, this procedure was followed because it gives the probable minimum number of diverted home-based work trips. Table 6 gives the results of this benefit computation.

Fare Savings

Under the old bus system, the transit fare in Atlanta was 40 cents 1 way, plus 5 cents for a transfer. Consequently, a typical bus work trip in Atlanta in 1971 costs

Table 6. Annual benefits from parking, accident, and insurance costs and transit fare savings.

Zone	Parking Cost: CBD Diverted Cars	Parking Cost: Annual Saving (dollars)	Accident Cost: Daily Vehicle-Miles Not Traveled	Accident Cost: Annual Saving (dollars)	Insurance Cost: Percentage of Transit Work Trips	Insurance Cost: Annual Saving (dollars)	Transit Fare: Captive Transit Riders	Transit Fare: Annual Saving (dollars)
80	30.5	7,315	138.6	145	0.60	546	53	11,713
147	97.0	23,286	442.6	455	0.77	3,261	293	64,753
167	725.6	174,144	1,003.0	1,034	0.55	11,389	479	105,859
185	111.4	26,732	847.4	879	0.75	2,949	10	2,210
258	378.2	90,778	2,418.8	2,532	0.63	10,724	1,294	285,974
308	801.3	192,310	9,840.5	10,171	0.73	18,067	0	0
316	198.2	47,576	3,316.3	3,432	0.82	6,201	0	0
342	192.4	46,182	1,655.8	1,716	0.67	4,017	195	43,095

Table 7. Annual costs.

Zone	Sales Tax: 0.5 Percent Sales Tax on Gross Income	Sales Tax: 1983 Gross Income (dollars)	Sales Tax: Tax Contribution per Family (dollars)	Sales Tax: Annual Contribution (dollars)	Transit: Transit Patronage	Transit: Annual Fare Contribution (dollars)	Annual Cost (dollars)
80	0.344	11,683	40.18	9,643	94	14,664	24,307
147	0.366	8,771	29.47	22,720	48	75,036	97,756
167	0.379	6,353	24.10	24,000	1,436	224,016	248,016
185	0.230	18,595	42.76	19,270	207	32,292	51,566
258	0.432	5,396	23.31	24,172	1,927	300,612	324,784
308	0.280	18,173	41.79	168,037	1,241	193,596	361,633
316	0.333	10,308	34.32	36,482	380	59,280	95,762
342	0.384	8,838	33.93	48,647	480	74,880	123,527

Table 8. Net annual benefits.

Zone	Family Income (dollars)	Net Annual Benefits Less Costs (dollars)	Net Annual Benefits per Family (dollars)	Net Annual Benefits per Daily Trip-maker (dollars)	Distance to Transit Station (miles)
258	5,396	759,625	733	104	0.5
167	6,353	627,295	630	108	0.9
147	8,771	805,630	1,044	122	0.3
342	8,838	87,123	61	7	1.4
316	10,308	366,123	344	35	0.9
80	11,683	32,908	137	15	2.7
308	18,173	900,429	224	21	1.4
185	18,595	255,597	562	54	0.8

Table 9. Person trips between zones and quadrants.

Zone	CBD	Quadrant 1	Quadrant 2	Quadrant 3	Quadrant 4
80	539	162	105	432	925
147	1,448	3,852	255	143	925
167	3,931	976	405	202	285
185	812	3,489	246	72	129
258	3,520	782	2,179	544	267
308	5,525	18,422	16,966	1,013	797
316	1,385	8,098	632	172	359
342	2,529	724	1,207	6,168	2,378

80 to 90 cents a day. The bus system has now been sold to MARTA, whose board of directors decided on a uniform 1-way rate structure, regardless of the distance traveled, the number of transfers, or the time of day at which the trip was made. The fare was set at 15 cents for the first 7 years of operation and 30 cents in the tenth year; "thereafter the fare to be charged [is] maintained, in accordance with the policy of the Board, at as low a rate as is possible, considering all other relevant matters" (2). A captive bus or transit rider could thus save an average of 25 cents per day in fares if the old Atlanta bus fares were to persist in 1983. 1971 bus fares could rise before 1983. In view of estimation difficulties, however, the average daily fare of 85 cents was assumed to persist, with the understanding that this is a very conservative estimate, which reduces the benefits of low-income zones, in which most captive riders live.

The consumption of this benefit raises some accounting difficulties. Rather than subtract the MARTA 60-cent daily fare paid by captive ridership from the average 85-cent bus fare, we included the MARTA fares later as zonal costs. Fare savings are best viewed as fares no longer paid to the old bus system by captive transit riders. These savings are given in Table 6.

COSTS OF THE RAPID TRANSIT SYSTEM

The measurable cost to each zone of the rapid transit system is its sales tax contribution to MARTA and the fare revenues each zone generates through patronage. From estimates of these 2 values, a total zonal cost can be obtained and compared with the total zonal benefit estimated above. The incidence of costs on each of the 8 study zones is given in Table 7.

Sales Tax Contribution

In the land use forecast for 1983, average family income was estimated for each zone in the city by the Atlanta Regional Commission (7). This projected zonal average family income and Bureau of Labor Statistics data on the consumption habits of southern urban families were used to estimate a total sales tax contribution for each zone. In 1960 the Bureau of Labor Statistics performed an extensive survey of consumption habits of families stratified by income group, family size, race, and geographic location (8). Because all of these stratifications were part of the land use forecast for 1983, it was possible to impute specific consumption patterns to each of the study zones. From these patterns, a value for total taxable consumption was obtained for each zone, and the MARTA 1983 sales tax rate of 0.5 percent was applied to this value.

Total taxable consumption was obtained by subtracting from current expenditures (BLS data cross classified by average zonal income, family size, and race) the dollar amount spent on goods and services exempt from taxation under Georgia law. These exempt goods and services include tuition fees, water service, phone service, professional services, transit fares, and holy scriptures (9). Then the MARTA sales tax rate, which is set by law to be 0.5 percent in 1983, was applied to total taxable consumption to obtain the dollar sales tax contribution of an average family within the zone. Because zones were drawn to make the families as homogeneous as possible with respect to zonal socioeconomic characteristics, error introduced by using an "average" family as the unit for computing the zonal tax contribution is minimized.

A possible income distribution effect of the sales tax is the diversion of retail trade away from the counties that levy the MARTA tax over and above the regular Georgia Retailers' and Consumers' Sales and Use Tax. Counties in California in which additional 0.5 percent sales tax was levied experienced a loss of sales, and consumers residing in these counties often attempted to avoid the tax, no matter how small (10). Although no evidence is available on the possible magnitude of trade diversion, owners of commercial property involved in retail sales just inside the county line will likely lose trade and owners of retail establishments just outside the line will gain by more than the amount of trade that their geographic market area would normally warrant. This loss of trade could eventually transmit itself into shifting property values and encourage the location of new suburban shopping centers outside the city limits (11). Persons living just inside the county line will easily avoid the tax on many items, thus making them better off than other residents within the 2 MARTA counties. No attempt is made in this paper to quantify all of these diversionary effects and to rigorously evaluate their income distribution implications.

Fare Contribution

The Atlanta modal-choice model predicts the total transit patronage for each zone in the study area. These patronage estimates for each of the 8 study zones and the MARTA fare structure described above (30 cents for 1-way trips, no transfer cost) were used to estimate the second component of cost incurred by each zone.

COSTS VERSUS BENEFITS

Table 8 gives the results of comparing each net zonal benefit with the average family income in that zone.

The 3 lowest income zones have the 3 highest net benefits. A more striking statistic is the zonal benefit per daily trip-maker, which illustrates how much zonal net benefit arising from transportation investment accrues to each trip-maker in a zone. The lower income trip-maker receives 2 to 4 times the benefit that the upper income trip-maker receives from transit system investment on an annual basis. The data also point out the increased mobility provided by the new system to the lower income zones. The lower costs per trip originating in these zones will invariably increase the number of trips generated in them. This is a fact that is not allowed for in the traditional transportation planning process, but does point to the potential increase in mobility for lower income groups.

Representativeness of 8 Study Zones

Before any general conclusions can be drawn about the income distribution effects of the entire system, the 8 study zones must be carefully analyzed to determine the extent of their being representative of other zones with similar income. Zones with the same family income may vary considerably in their geographic location and socioeconomic characteristics, and it is difficult to generalize on the basis of these 8 zones. The following observations, however, may help the reader to critically review the findings of this study.

All the zones except zone 80 are within 2 miles (3 km) of a transit station. Accordingly, zone 80 does not stand to benefit much from the system. It has the second lowest net benefit per family and net benefit per trip-maker. All the other zones enjoy considerable transit accessibility, and the 2 highest net family benefit zones are both located on a transit line. The net benefit of a zone is thus strongly correlated with its location relative to a transit line, regardless of its income. Of the 2 highest income zones, zone 185 has more than twice the zonal net benefits of zone 308 and is about half as far from a transit station. Both zones have about the same per family income. This suggests that net zonal benefits can be estimated as a function of both family income and distance to the closest transit station.

Zone 342 is probably an aberration relative to its income group because it is the only zone that had a negative net time savings benefit. The data given in Table 9 show that a large number of trips originating in zone 342 are bound for areas that are not readily accessibly by transit, notably in quadrant 4 of the city. The transit lines serve zone 342 trip-makers well if they are bound for the CBD; but to reach quadrant 4, they must first go to the CBD. The negative net time savings of zone 342 and the resulting low benefits per family and per trip show that net zonal benefits are strongly affected by the extent of the zone's interaction with the central business district, which is the focal point of the transit system.

Other Income Distribution Effects

This study was directed at a small sample of traffic zones in the Atlanta area and concentrated on direct user private costs and benefits. There are, however, other factors that are related to the transit system and are expected to have income distribution effects in metropolitan Atlanta. The rapid transit system will provide increased accessibility, and highly concentrated growth will continue in Atlanta's CBD and benefit downtown business managers and property owners. Many downtown interests have given vigorous support to the rapid transit system throughout the 1960s primarily because they will gain a great deal from the proposed system. Atlanta would continue to grow rapidly with or without rapid transit, but the growth would occur in different areas altogether, depending on the nature of the transportation system. Because of the rapid transit system, land values will increase for property owners in the CBD at the expense of owners in the suburbs. The extent of this CBD gain at suburban expense will probably be massive. Estimating the magnitude of such shifts and identifying their recipients are not attempted in this paper.

Also, property values will likely rise significantly along the new rapid transit lines (12). Thus, everywhere within the city, property owners near the new transit lines will enjoy considerable increases in property values while owners with less strategically located property will be at a comparative disadvantage.

In a more general sense, the investment in rapid transit in Atlanta will raise nearly everyone's income above what it would have been without the system because of multiplier effects on the local economy of the massive federal expenditure. The two-thirds federal funding will inject approximately $1 billion into the local economy during a period of about 10 years, and Atlantans will have paid only a small portion of that two-thirds funding through their own federal tax contribution. Consequently, one would expect incomes to rise in Atlanta, especially for persons employed directly or indirectly in the building of the system.

The local sales tax could cause certain border effects that would alter personal incomes. The trade diversion effects of the sales tax could cause both property values and sales volumes to rise just outside the county lines where the tax is in effect and to fall just inside these lines.

CONCLUSIONS

This paper has attempted to present a pilot study of the income distribution effects of the proposed Atlanta transit system. The benefits and costs of the system have been calculated for 8 of the 399 geographic traffic zones. Although some trends have emerged, factors such as the distance of the zone from the nearest proposed transit station and the extent of its dependence on and interaction with the CBD have a significant determining influence on the magnitude of the benefits of the system accruing to that zone. The extent of these influences cannot be determined without the benefit of a larger sample of zones. Nevertheless, zones that have an average family income of less than $9,000 and a significant amount of interaction with the CBD seem to benefit most from the system. Distance from a transit station or lack of interaction with the CBD or both disrupt this pattern for low-income zones. A family living in zone 167 and receiving an average family income of $6,353 can expect to benefit almost twice as much as a family living in zone 316 and having an average family income of $10,308. Both zones are 0.9 miles away from a transit station and have about 90 percent of their trips destined to the CBD or some intermediate location. The benefits per trip-maker are 3 times higher in zone 167 than in zone 316. Net zonal benefits per family are considerably higher in zone 316, where average incomes are $10,318, than in zone 308, where average incomes are $18,173, but are are considerably lower in zone 258, where average incomes are $5,396. All 3 zones are comparable in terms of transit accessibility and orientation to the CBD. From this, one could surmise that, for comparable levels of transit accessibility and CBD orientation, a zone's net benefits from the system decrease as income increases.

These findings are based on a limited sample and only one type of costs and benefits with distributive implications. Similar studies, which cover all traffic zones in an urban area and which would consider the distributive impact of factors such as rising and falling land values, spatial redistribution of residential and employment centers, and spatial redistribution of the demand for goods and services, could shed a very useful light on the problem of the income distribution effect of transportation investments.

An extended study that would cover all traffic zones could provide planners, policy-makers, and residents with an additional tool for the evaluation of alternative transportation systems. Future improvements in simulation models and refinements of the methods of analysis suggested in this paper could provide both voters and policy-makers with a clear, reasonably reliable picture of the costs and benefits of the system to small geographic subdivisions of an urban area. The weaknesses of aggregate benefit-cost studies can be avoided by an analysis of the impact of proposed public systems in a disaggregate fashion. The analysis of the income distribution effects of large public works investments should become a standard part of the design and evaluation phases of the planning process.

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