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ANALYSIS AND EVALUATION OF THE RAPID TRANSIT EXTENSION TO CLEVELAND'S AIRPORT

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• DURING the late 1960s, one of Cleveland's two rapid transit lines was extended by slightly more than 4 miles to the airport. Two of the three new stations (including one at the airport) were opened on November 15, 1968, and the third one (Brookpark) was opened on April 20, 1969. The three stations, including the connecting trackage, rights-of-way, and transit cars, were added to the system at a total capital outlay of about $18.4 million. The rolling stock for extension service accounts for $3.4 million of the total. Federal funds covered two-thirds of the total capital costs; the remainder was paid out of city and county funds.

Now, based on 3 full years of actual operating experience, what can be said about the impact of the line on the general public and on users? Also, what inferences can be made about similar proposals in other cities?

It should be emphasized that the analyses, findings, and conclusions of this report are based on limited experience, on sample survey data, and on data collected during years of some rather extraordinary change. As a consequence, they are somewhat tentative, though as complete, accurate, and reasonable as possible.

AIRPORT AND RAPID TRANSIT USE

The small 19-mile Cleveland rapid transit line is owned by the city of Cleveland and includes the airport extension that runs for 4 miles between the Westpark and airport stations. (This does not include the 16-mile Shaker Heights line, which is not part of the city-owned rapid transit system.) The total airport line extends about 11 miles southwesterly from a downtown terminal, the only downtown station, and interconnects not only with the eastern rapid transit line but also with the Shaker Heights system. During 1969, there were approximately 2.5 million passenger enplanements at Hopkins International Airport, about one-fifth the number at Chicago's O'Hare Airport. According to Federal Aviation Administration (FAA) estimates, Hopkins will have 4.8 million in 1975 and 8.1 million in 1980 (1, p. 15). Current figures rank Hopkins Airport as the 18th busiest terminal in the United States, a low figure when compared with Cleveland's position as the 10th largest standard metropolitan statistical area (SMSA) in 1970 population. As given in Table 1, estimated enplanements at Cleveland during 1970 were down about 4 percent from those in 1969 as compared to a national drop of about 1.3 percent.

Passenger volume on the rapid transit system rose during its first 2 full years after the opening of the original 11 stations in 1955 but then fell until two additional stations were opened in 1958. Similarly, after 2 full years of operation, passenger volume again began to decrease on the 15-mile system and steadily declined until 1969, the first full year of operation after the opening of the first two airport extension stations. System ridership decreased sharply during 1970 because of a decrease in air movement, a fare increase, a 17-day transit strike, and continued secular declines. This experience, taken together with that recorded on other North American rapid transit systems, suggests that, in the absence of further extensions (or serious improvements or sizable fare reductions), ridership generally will decrease or, at best, remain fairly level and that decreases in ridership will begin a couple of years following an improve-

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ment or extension. Although these general trends will be offset at least partially by increasing airport usage in future years, they may and probably will be accentuated by increasing affluence and usage of taxis or rental cars.

EFFECT OF EXTENSION ON RAPID TRANSIT RIDERSHIP

The actual ridership data for the Cleveland rapid transit system are shown in Figure 1. Plotted alongside these data are two trend or projection lines that may be used to estimate the extra volumes that resulted from the airport line extension. Without the airport extension, for instance, it could be assumed that the 1969 rapid transit ridership would have remained at the 1968 level, roughly 16.167 million riders. But, with further and normal declines, it would have fallen to a level as low as 15.950 million riders. In turn, the additional ridership attributable to or caused by the airport extension can be estimated as the difference between the actual 1969 ridership (16.490 million) and the two preceding figures. Thus, at the most, we may estimate that the extension increased the 1969 annual passenger volume by about 550,000 and at a minimum by about 350,000. However, because neither of these estimates accounts for the additional riders added in late 1968 (after the November opening of the airport extension) or for the fact that the third station was not opened until mid-April 1969, they should each be increased by about 50,000. The final estimate of increased annual passenger volume as a result of the extension ranges between 400,000 and 600,000 for 1969. (The projection lines shown in Fig. 1 include the joint effects of fare increases and secular declines; admittedly, this makes the 1969 projection estimate somewhat tenuous.)

Although the projection-line technique does have the advantages of being simple and direct, its validity can be questioned. For instance, one may argue that, without the extension, the 5-cent increase that took place in March 1969 would have decreased system patronage more than that indicated by the downward sloping projection line; this argument (which has considerable merit) suggests, then, that the extension resulted in patronage increases higher than the 600,000 figure, during 1969 at least. Moreover, analysis of the data provided (1, Table II-1) suggests that during 1969 the extension resulted in an additional 1.9 million rapid transit riders at the airport station alone. Although this latter figure is somewhat compelling, one nevertheless should keep in mind that this figure is based on comparative before-and-after survey data taken during only 2 weeks, one in September 1968 and the second in September 1969. The "after" data of the second survey probably include some extraordinary riders who were simply testing the system or exploring some of its technical features.

If we consider all of the preceding factors, it seems reasonable to estimate that the airport extension attracted approximately 1 million extra riders during 1969. On the other hand, the 1970 and 1971 passenger decreases for both the system and extension stations (as given in Table 1) lead me to conclude that the extra ridership figure will decline each succeeding year.

Virtually all the analyses, findings, and conclusions given here are based on annual rather than average weekday patronage figures and estimates. By using the former procedure, estimates of both the weekday patronage and the annual expansion factor are simultaneously subjected to scrutiny and tested. Contrarily, studies that simply compare actual and estimated average weekday ridership figures fail to account for any differentials and errors stemming from utilization of inaccurate annual expansion factors and thus can lead to different and sometimes improper conclusions.

Finally, a recent conversation with Cleveland Transit System (CTS) personnel (one occurring after preparation of the bulk of my analysis) suggests that even the 1-million extra-rider figure may be an underestimate. For instance, the CTS research director cited the results of a late 1971, 1-day mail survey that had a 54 percent response rate and that was conducted at the Brookpark and Puritas airport extension stations; 46 percent of the survey respondents said that they were new rapid transit riders. The latter percentage, if assumed to be unbiased with respect to the responses and to weekday-versus-weekend ridership differentials, would suggest that these two airport extension stations alone contributed about 1.26 million extra riders in 1971. Further, the CTS research director said that the CTS had estimated that about 70 percent of the airport station patronage (or about 70 percent of a total of 0.886 million in 1971) were new or extra riders, bringing their estimate of extra riders to a total of 1.88 million in 1971.

Clearly, then, the range of estimates for new riders is wide. Moreover, the problem is even more difficult when trying to estimate the extra ridership figures for future years, regardless of whether the effects of secular declines, future fare increases, and service changes are included. Some attempt at narrowing the gap seems worthwhile (though perhaps daring). The most important statistic suggesting that a lower estimate is closer to the truth is the fact that both the system and airport station patronage fell substantially in 1970 and 1971; airport station patronage dropped more during 1971 because of the surcharge imposed on airport station patrons. These declines, about 20 percent for the airport station in both years and about 14.5 and 5.7 percent in 1970 and 1971 respectively for the system, dwarf the almost negligible decreases in the patronage using the three new airport extension stations. Put together, it would be difficult to argue that the new riders attracted to the rapid transit system are a group that is less affected by fare increases and secular declines than were previous riders; in fact, the contrary would seem closer to the truth.

AIRPORT EXTENSION COSTS

It has been pointed out that the initial capital outlays were about $18.644 million, approximately $3.434 million of which was expended for 20 additional rapid transit cars. Since that time, another $2.5 million has been spent for an additional 10 rapid transit cars for the line. If we assume a 30-year service life for transit cars, a 50-year period for the remaining capital items, and an opportunity cost of 6 percent per year, the annualized debt service for the capital outlays will total approximately $1.4 million a year. (These assumptions probably understate the costs to society because the capital outlays are treated as if they were committed in 1969 rather than in 1966.)

One may examine these data from two perspectives. First, the extra resource expenditures may have been made solely or principally to increase volume. Under this assumption, the additional outlays of $1.4 million per year resulted in an annual increase of 1 million to 1.8 million riders. Thus, there were capital outlays of $0.75 to $1.40 to gain each extra 1969 airport extension rider. In addition, the extra maintenance and operating costs probably range from $0.27 to $0.50 per extra extension rider, bringing the total costs per extra rider to something in the order of $1.02 to $1.90 per trip (2, p. 1). Obviously, these unit costs only apply to 1969 data, and if patronage on the extension continues to decline (as it has even in its early years), these unit costs will increase.

Second, the extra resource expenditures may have been incurred both to increase passenger volume and to improve the services available to former system users. (This accounts for the benefits accruing to former system users who, after the extension was built, switched to a more convenient or accessible station.) If we use this assumption, the extra capital, operating, and maintenance costs can be spread over the total number of riders using the three stations. Thus, the average costs to the general public per trip would be about 50 cents, some 74 percent of which is attributable to capital costs. The application of these two sets of incremental cost calculations will become more apparent in the next section.

FINANCIAL FEASIBILITY OF AIRPORT EXTENSION

Financial as opposed to economic feasibility can be established by determining whether the incremental revenues for the total extension outweigh the extra costs stemming from the improvement and its operation. As noted earlier, the incremental capital costs, when annualized at 6 percent for the estimated service lives, amount to approximately $1.4 million per year. The additional annual operating and maintenance costs are more difficult to obtain because most of the operation and maintenance functions for the extension are not priced separately from those for the total rapid transit system. The preconstruction analysis made by W. C. Gilman and Company estimated that the extension would result in 800,000 extra car-miles per year and an annual increase in maintenance and operating expenses of $0.5 million. [It is difficult to ascertain whether this estimate is either higher or lower than actual extra costs. It was based on an expected total extension patronage that was about 10 percent higher than the actual 1969 and 1970 volume and on a car-mileage figure that apparently was about 7 percent higher than the 1969 amount (1, p. 1; 12). Also, because the maintenance and operation cost estimate was based on 1964 operating cost data for the CTS rapid transit, the estimate was overstated because the extension way and equipment in 1969 and 1970 were newer than that for the CTS rapid transit system in 1964; it was understated because the wage and material costs in 1969 and 1970 were higher than in 1964. Finally, the extra car-mileage and cost estimates were those anticipated for 20 extra cars for the extension, a number that since has been increased to 30.] If this maintenance and operation cost figure is regarded as a reasonable estimate, the total incremental cost will be $1.9 million a year.

Estimating the incremental revenues stemming from the extension is more difficult but can be done reasonably well. However, the extension passenger volume figure (3.7 million a year) definitely should not be used as the basis for the incremental revenue and, in turn, financial feasibility calculations. For instance, those riders who merely shifted from another close-in station to one of the three extension stations obviously did not increase the system revenue total. The obvious exception to this would be shifts to the airport station, which, after November 1970, incurred a 25-cent surcharge. Thus, incremental revenues attributable to the extension resulted only from (a) extra riders (those who were newly attracted to the system as a result of the extension or those riders who otherwise would have stopped using the transit system without the extension) and (b) the surcharge levied on the airport station users.

A simple way of computing the incremental extension revenues would be (a) to multiply the annual 1.00 to 1.88 million extra ridership by the 50-cent basic fare and (b) to add the surcharges obtained at the airport station (overlooking the fact that some airport station patrons pay less than the 25-cent surcharge). [This appears to be a generous way of computing the incremental revenues because the extra-rider figures were based on 1969 data when the (weighted) fare level was about 39 cents rather than 50 cents; even if the extra-rider estimates are considered to hold for 1970 as well, the (weighted) fare for that year was 44 cents, a fare level still below the 50-cent figure.] For the first item, the product would be $0.50 to $0.94 million in extra annual revenues; for the reward item, the total would be equal to about $0.222 million in extra revenues. In sum, the incremental revenues accrued from the airport extension would be equal to a figure between $0.722 and $1.162 million a year, assuming that both of the preceding conditions are valid and that there are no further passenger volume decreases or fare increases.

All things considered, it may be asserted that the airport extension is far less than financially feasible, at least at current fare and service levels. In fact, the extra costs of $1.9 million a year are from 63 to 163 percent higher than the incremental revenues, which at best approach $0.720 to $1.162 million a year.

In addition, it will be helpful to know whether this deficit can be reduced or even eliminated. Definite answers cannot be given to such questions, but some estimates can be made of the financial conditions under different price or fare levels; for this purpose, I will make use of the fare and ridership data at the airport station. For instance, it can be shown that, for the lower pre-1971 fare levels (as given in Table 2), total airport station revenues were less than those occurring after the November 1970 fare increase. (The total revenue levels did not show a consistent increase with fare increases during the 1968 to 1971 period; this variability could have stemmed from various fluctuations in demand, or because of the way in which the "weighted average fare" was computed, or some combination of factors.) Because the price elasticity over the total range of the 35- to 75-cent fare increase was -0.73 (i.e., demand is price-inelastic) and because it has been -0.46 since the November 1970 increase, we can say in general that total revenues can be increased by increasing fare levels and that the fare raises have tended to lessen the financial deficits. (To say that the demand is price-inelastic means that a 1 percent increase in fare will result in less than a 1 percent decrease in passenger volume.) Also, because total costs will decrease as fares increase (because volume levels will drop to some extent), we can say that fare increases will lead to net revenue increases when the demand is price-inelastic. However, to extrapolate either of these two elasticities (-0.73 or -0.46) beyond the range of data on which they were based and especially to suggest that either will apply to even higher fares is not necessarily valid. Put differently, we would like to know which fare change, an increase or a reduction, would increase net revenues and thus reduce financial deficits. If the demand were price-inelastic, as seemingly indicated by the -0.46 elasticity figure accompanying the last fare increase, a further increase might be in order. But because that index represents a rough average for a wide range of fare levels (from 44 to 75 cents), we cannot be entirely certain whether demand is price-inelastic. For instance, if the demand is assumed to be linear and to go through the 1971 data point (Fig. 2), then the demand at the current fare level would be price-elastic, rather than price-inelastic, as indicated by the data given in Table 2. More specifically, the price elasticity at the 1971 data point (for the case of linear demand as shown) would be about -1.05 or higher than unit elasticity. In this case, a small price reduction would increase total revenues, though it would also increase total ridership and total costs; in a similar vein, a price increase would reduce both total revenues and total costs. In both cases, the net could be either positive or negative in contrast to the situation where fares are increased in the inelastic region of the demand function. Thus, in this instance (that is, when the demand is linear and when the fare level is in the elastic region), the analyst cannot ascertain the net effects of a fare change without having more knowledge of the accompanying cost changes. [Specifically, information about the marginal cost function is required. If the marginal cost were reasonably high (relative to the present fare level), a fare increase probably would reduce financial deficits and a reduction would do the opposite. With very low marginal costs, a small fare reduction might improve the financial picture; however, from the standpoint of minimizing deficits or maximizing profits, the fare should not be reduced below the unit elastic point.]

A few final comments seem appropriate with respect to estimates of the change in net revenues stemming from fare changes. First, recall that the previous sets of elasticities were computed solely from airport station data and thus may not be directly applicable to the other two extension stations. In fact, I would judge that airport station patrons tend to be considerably more price-inelastic than other extension riders because so many (about 60 percent) of the airport station patrons are air travelers, a group whose incomes are considerably higher than the usual resident or transit rider. As a consequence, one might suspect that the demand for the two other extension stations at which the fare is only 50 cents per trip is not as price-inelastic as indicated by the data shown in the Figure 2 demand function. Thus, one might also suspect that fare increases above 50 cents for other than airport station patrons would not increase gross and net revenues to the extent that they apparently did for the airport station.

ECONOMIC FEASIBILITY OF THE AIRPORT EXTENSION

To determine economic feasibility, we must ascertain whether the extra benefit or value resulting from the extension outweighs the additional costs. On the benefit side, our attention is not on extra revenues only as it was with the financial feasibility calculations. Here, it is on how much extra benefit or value travelers do obtain from the extension, regardless of whether they pay for that benefit. Put in another way, how much would travelers be willing to pay at a maximum rather than forego the trip or switch to another mode or station? Some travelers would be willing to pay more than others, the exact amounts depending on the trip purpose, on incomes, on preferences, and so forth. Such knowledge depends on accurate estimates of demand for all levels of price and service. Because the available demand data are restricted to only present-day price and service levels, little can be said about the difference between the maximum amount each individual (and the group collectively) would pay and the amount he (and the group) actually does pay. But if the differences were known, it would be possible to estimate the extent to which the incremental benefits are greater than the incremental revenues and thus to determine the economic feasibility of the extension.

From available demand and cost data, one cannot say with any assurance whether the improvement was economically feasible. However, because the incremental costs

Table 1. CTS rapid transit ridership data.

Calendar Year	Total Annual Passengers (millions): New Stations[a]	Airport Station	All Rapid Transit Stations	Total Annual Enplanements at Hopkins Airport (millions)
1968	0.326[b]	0.176[b]	16.167	2.432
1969	3.676	1.400	16.490	2.572
1970[c]	3.668	1.130	14.088	2.475[d]
1971	3.634	0.886	13.288	2.356[d]

Note: The figures for all three new stations and the airport station only were obtained by doubling the actual turnstile counts (outgoing passengers are not counted at individual stations).

[a]Two of the three stations were opened on November 15, 1968; the third was opened April 20, 1969.

[b]These figures were recorded during the 6 weeks following the November 15, 1968, opening date.

[c]The transit system was closed for 17 days during July 1970 because of a strike.

[d]Estimated by the Federal Aviation Administration.

Figure 1. Rapid transit line ridership.

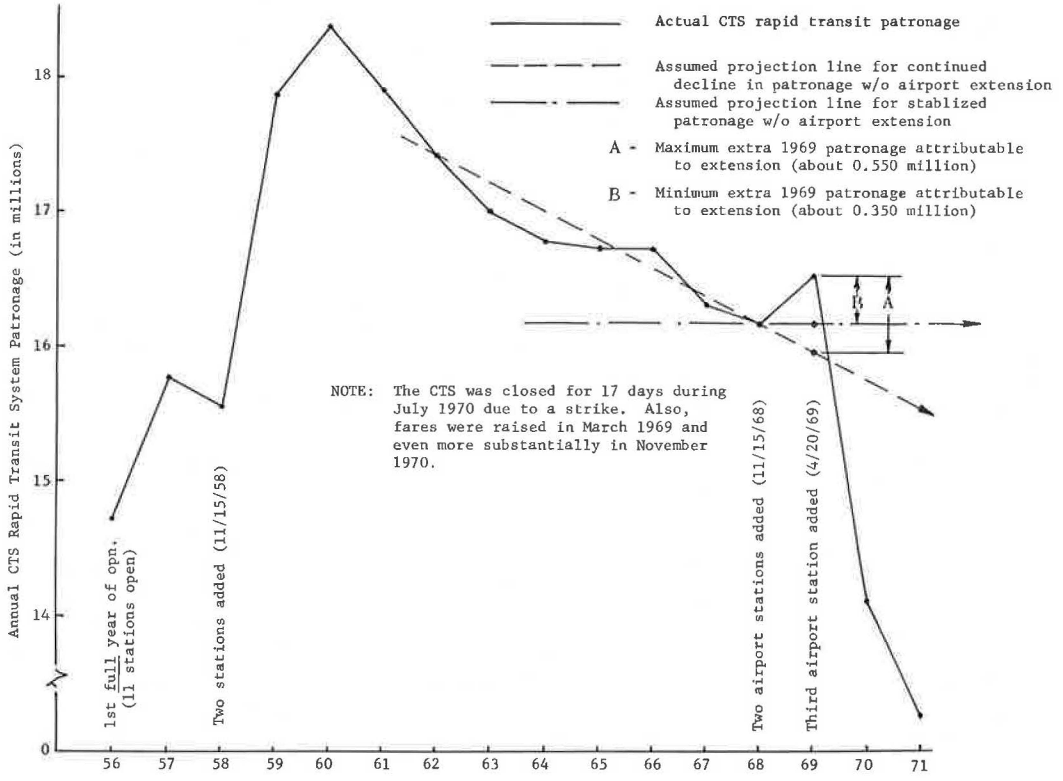

Table 2. Average fare, patronage, and revenue data for airport station.

Calendar Year of Extension Operation	Average Daily Riders Boarding or Alighting at Airport Station[a]	Weighted (by month) Average Fare (cents)	Price Elasticity Over the Range of Fare Increase[b]		Total Annual Revenues From Airport Station (dollars)
1968	4,180	35			534,000
			-0.78 (1968–1969)		
1969	3,840	39			547,000
			-1.77 (1969–1970)	-0.73 (1968–1971)	
1970	3,100[c]	44			498,000
			-0.46 (1970–1971)		
1971	2,430	75[d]			664,500

Note: Demand is price-inelastic when the elasticity or index is between 0 and -1, unit-elastic when it is exactly -1, and elastic when it is less than -1. When demand is elastic, price reductions will increase total revenue; when demand is inelastic, fare increases will raise total revenue.

[a]The number of extra riders attracted by the total extension is assumed to be equal to these figures; judging from the figures given in Table 1, the assumption appears to be reasonable.

[b]Price elasticity is the percentage of change in volume or patronage accompanying each 1 percent increase in price or fare; in making these computations, the base on which the percentages are computed is the average volume or fare over the range considered. All of the patronage reduction is attributed to just the fare increase (rather than fare increase, secular declines etc.), an assumption that doubtless has led to overestimated price or fare elasticities.

[c]Adjusted to account for effect of strike.

[d]This figure does not include reduced rate surcharge passes.

of the extension are from 63 to 163 percent higher than the incremental revenues, some doubt must be expressed whether current riders find the service so attractive that they would rather pay the difference than forego the service. At one extreme, we can ask the following question: Would each "average" extension rider (a composite of new riders and former riders who merely switched from closer-in stations) pay an extra 20 to 32 cents (over and above current fares) rather than give up the extra benefits? At the other extreme, we can assume that the extra benefits received by former riders who merely switched from closer-in to farther-out airport extension stations are so small that the riders would be unwilling to pay very much extra for this improved service. (The data given in Table 1 tend to support this assumption. For instance, the volume of total patronage at the three extension stations remained reasonably steady following the implementation of the system-wide November 1970 fare increase and the airport station surcharge, whereas ridership at the airport station fell considerably; this indicates that those who shifted to the airport station from closer in stations prior to November 1970 and then shifted back to closer in stations afterwards found the extra benefit worth less than 25 cents.) This implies that virtually all the extra benefits are received by new riders. If we adopt this assumption and use the annual 1.00 to 1.88 million extra ridership estimate, it can be seen that the airport extension would be economically feasible only if the new riders are willing to pay from 74 to 190 percent more than the current fare, or from $1.00 to $1.90 more per trip, on the average, rather than forego the service. This seems unlikely, and thus it is difficult to conclude that the airport extension is economically feasible, even when "consumers' surpluses" for current riders are incorporated.

Importantly, though, this conclusion is partially dependent on current fare and patronage levels, both of which affect the costs and benefits resulting from the extension. Other fare levels, for example, may result in larger net benefits and thus improve the chances for economic feasibility. It is almost impossible to assess the effects of different fare levels, however, without having information about the costs of the levels of usage of the extension. Should the current fare be higher than the marginal cost (for the current volume level), then the conditions for economic feasibility will be enhanced by reducing the fare until it just equals the marginal cost (3). Contrarily, when the marginal cost is higher than the fare, a fare hike would improve the chances for economic feasibility. But, unfortunately, there is no way of knowing which of these conditions now exists for the Hopkins extension.

Also, what might be learned from alternative travel mode data for extension riders at the airport station? Most new airport station riders shifted primarily from limousine usage (about 700 per day) or from private automobile usage (about 600 per day) and secondarily from taxi usage (just more than 300 per day) (1, Table III-15). These shifts represented a 50 percent decrease in limousine ridership, a 25 percent decrease in taxi patronage, and an 8 percent drop in private automobile usage. The decrease in limousine usage seems most understandable because most of the trips started or ended in the downtown area, the service was not particularly preferable to that of the rapid transit system, and the $1.60 downtown-to-airport limousine ride was about four times more costly than a similar rapid transit ride. Further, it does not seem strange that the percentage of decrease in taxi usage was less than that for the limousine. If taxi riders had been especially concerned about the high cost of cabs (about $6 to $7 from downtown to the airport), more would have used limousines previously. Even so, it is obvious that, by adding a dollar to the differential between the taxi and the alternative public mode fares, some riders were induced to make the switch. The third group, those switching from the automobile, mostly included residents of well-to-do communities that are east of Cleveland's downtown and have easy access to rapid transit stations. Prior to the extension, these people simply did not have either a reasonably priced or a convenient alternative to the automobile.

Finally, it should be noted that analyses that fully incorporate consumers' surpluses into incremental benefit totals will thereby take full account of the value of travel time savings and such other benefits accruing to transit users. However, such benefits as time savings accruing to highway users as a result of reduced congestion (when some former highway users shifted to the airport extension) can be regarded as external benefits and should be included in the incremental benefit totals in addition to the other aspects mentioned. Some estimates of the magnitude of these external benefits are provided in the following sections.

EXTERNAL BENEFITS AND COSTS

The Hopkins extension has had other impacts, both positive and negative. Among the more obvious are revenue losses for bus, limousine, and taxi operators, at least some (if not all) of which can be offset by reductions in operating and possibly capital costs stemming from smaller passenger loads and reduced frequency; the loss in traveler benefits for former bus, limousine, and taxi patrons; worse service for the remaining bus and limousine users due to reduced schedules; increased noise for firms and residents abutting the transit extension; reduced congestion, air, and noise pollution; "windfall" gains for some owners of close-by property; and social (or economic) disruption for some of those displaced or inconvenienced by the extension and its parking lots. (Some analysts have suggested that the financial and economic feasibility analyses given earlier should have included the bus, limousine, and taxi cost savings as financial and economic gains stemming from the extension; however, this would not be correct unless we also took account of the concomitant reductions in revenues and traveler benefits, and so forth.)

In a similar vein, airport extension riders enjoy a higher quality and more accessible rapid transit service, but one that is subsidized. Most of the capital outlays are funded out of city, county, and federal revenue sources rather than charged to the riders because the incremental revenues cover operating costs and only 16 to 46 percent of the remaining capital outlays. It seems appropriate, then, to ask who the riders are, at least in terms of income characteristics, and to compare them with others in the Cleveland area. (Obviously, this comparison does not account for tax transfers.) Table 3 summarizes the few data that are available on this score. It is apparent that the airport station riders who make use of the extension are, as a group, considerably more affluent than the average Cleveland citizen (4, 5). This is especially true, of course, for the passengers who ride the line and who constitute almost 60 percent of the airport station patrons and about 20 percent of all extension riders. Although these few data permit no definitive answers, they do suggest that subsidization of the Hopkins extension represents an income transfer from poor to well-to-do citizens.

EFFECT ON TRAFFIC CONGESTION

Another aspect given prominent attention when discussions of airport extensions take place is that of the reduction of traffic congestion when automobile drivers are diverted to transit facilities. Although no exact measures of the effect of the Hopkins extension are available, some approximations can be made and should be helpful to such an assessment.

As noted earlier, only 1.00 to 1.88 million riders of the 4 million annual extension riders represent additional CTS riders; the others merely shifted from closer-in to one of the three new extension stations. The congestion reduction from those shifting from one transit station to another is probably small because the traffic movement takes place some 7 to 11 miles from the central business district. Clearly, those shifting from other modes to the transit extension are the much more significant group. For the analysis of traffic congestion as affected by the extension, the following assumption will be made: Because the 1969 airport station patronage was 1.4 million, or about 0.8 million higher than anticipated, it will be assumed that virtually all new riders who were using the extension in 1969 (prior to the 1970 fare increase and airport station surcharge) got on and off at the airport station. Thus, inferences about former modal choices and so forth can be made from the data given in another report (1, Tables III-15, IV-24, V-18, VI-1), which deals only with airport station riders.

In calculating the modal shifts and the resultant reduction in highway travel, we will deal with air passengers, air passenger-related visitors, employees, and casual visitors separately. It is doubtful that the extension led to any extra air travel. Finally, it will be assumed that the 1969 air passengers who did use the transit extension would have made the same modal choices without the airport extension as did the 1968 trip-

Figure 2. Price elasticity of rapid transit line.

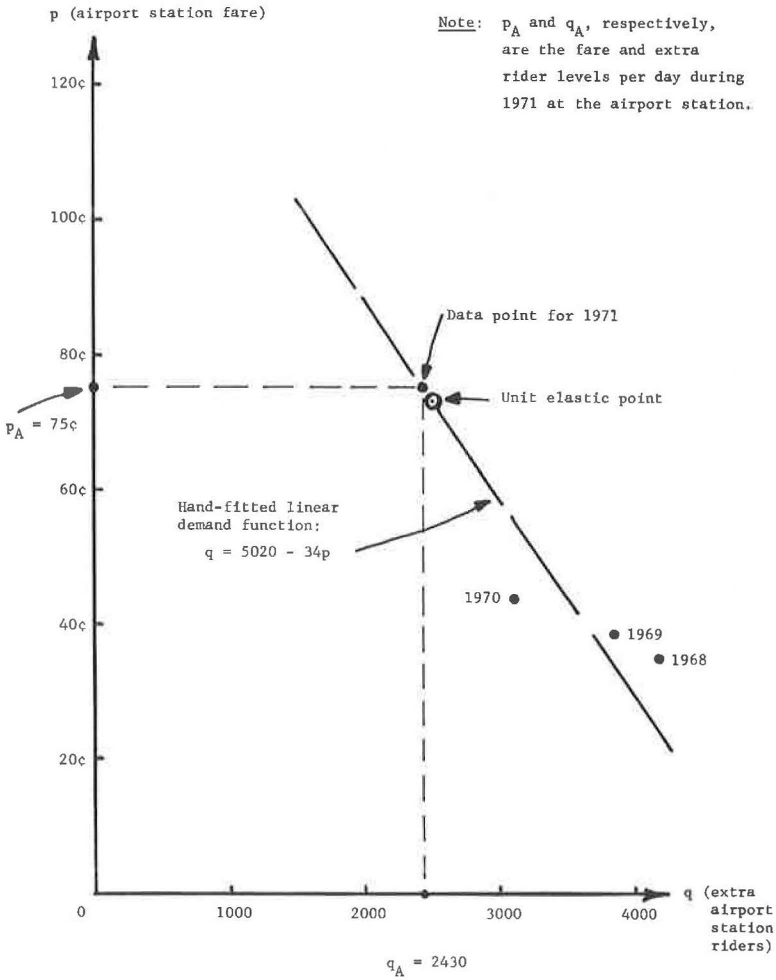

Table 3. Family income characteristics of extension riders.

Family Income (dollars)	Hopkins Airport Station Rapid Transit Riders[a] (percent)			Cleveland SMSA Families
	Air Travelers[b]	Travelers' Visitors[c]	Casual Visitors[d]	
Less than 5,000	4.1	9.6	19.0	NA
5,000 to 10,000	13.1	19.4	33.0	NA
10,000 to 15,000	21.6	31.0	30.0	NA
More than 15,000	61.2	40.0	18.0	NA

Note: The 1969 estimated median family income for air travelers is $16,400; for travelers' visitors it is $13,400; for casual visitors it is $9,700; and for Cleveland SMSA families it is $11,000.

[a]For all these riders, who made up about 85 percent of the airport station rapid transit riders in September 1969, the (weighted) median family income is estimated as $14,700 (1, Tables III-5, IV-9, VI-10). No data were available for employees using the airport station (who represent 14.9 percent of the rapid transit passengers boarding or alighting at the airport station).

[b]This group makes up about 57.6 percent of the rapid transit passengers boarding or alighting at the airport station. Also, 39.9 percent of this group has family incomes of $20,000 or more.

[c]This group makes up about 10.5 percent of the rapid transit passengers boarding or alighting at the airport station.

[d]This group makes up about 17.0 percent of the rapid transit passengers boarding or alighting at the airport station.

makers before the extension opened. Following these assumptions, it can be shown that the maximum daily reduction in private car and taxi trips has been 7,000 and that there have been almost 1,300 fewer public bus person trips per day and just over 5,000 fewer bus-limousine person trips per day (1, Table III-15). It is doubtful, though, that the reduction in bus and bus-limousine person trips led to a significant reduction in vehicular trips. To determine the reduction in congestion, especially rush-hour congestion, we must convert these daily vehicular trip figures to hourly figures by using peaking factors. Peaking for air travelers is generally less than that for other transport groups, and the percentage of the daily Cleveland air passenger trips made during the peak hour (5 to 6 p.m.) ranges from 12 to 14 percent (1, Table III-10). As a consequence, approximately 1,000 vehicular trips may have been removed from the surrounding roads and streets during the peak hour. As many as 700 vehicles per hour may have been taken off the highways during two other hours (one of which is during the morning rush period), but during most of the daylight hours fewer than 500 an hour would have been removed.

Similar calculations for passenger-related visitors, for casual visitors, and for employees reveal that the extension caused no decrease in the number of private automobile trips for casual visitors but led to increased casual trip-making to the airport, most of which took place by rapid transit (1, Table V-1). Also, the extension reduced the number of private automobile trips made by passenger-related visitors by some 1,500 trips a day (1, Table IV-24). Because these visitors follow the same peaking pattern as air passengers, there are at most only 200 fewer vehicular trips made on the adjoining roads and streets during the peak hour and fewer than 100 an hour during most hours of the day. Also, approximately 200 fewer employees made private automobile and taxi trips to and from work, thus reducing automobile trips by the same number (at a maximum) during the peak hour for air passengers.

In total, then, it may be estimated that, during the peak hour, no more than 1,400 automobiles and taxis and fewer than 100 buses and limousines were removed from adjoining roads and streets as a result of the extension. However, given the diversity of origins and destinations of these three groups, it is very difficult to estimate how much this reduced traffic congestion. The wide variety of origins and destinations for air passenger trips, which would constitute the bulk of vehicular trip reductions, is given elsewhere (1). It would be most helpful to know how many of these trips were diverted from the downtown and more congested end of I-71, an expressway that roughly parallels the airport extension and the west-side rapid transit line (1). As an approximation, it could be estimated that at most no more than 2,500 (or 35 percent) of the 7,000 fewer air passenger automobile trips made daily would have made use of the expressway if the extension had not been built. This assumes that almost 80 percent of the air passengers who have Cuyahoga origins or destinations (or about 50 percent of all air passengers) would have used the expressway if the extension had not been built. By combining these data with those for passenger-related and casual visitors, we can estimate that evening peak-hour traffic on the expressway has been reduced by some 500 vehicles an hour. Most of this traffic moves in the outbound or major flow direction during the 5 to 6 p.m. peak hour. At the downtown end of the expressway, where there are four lanes in each direction, there will be some reduction in congestion but hardly a major amount because the total flow is reduced at most by 125 vehicles per lane per hour. This reduction, however, is less than 10 percent of the current rush-period volume levels on this roadway, which range from 1,500 to 2,000 vehicles per lane per hour. Thus, the peak-hour speeds may have been increased by a couple of miles per hour for this section of the expressway, saving no more than ½ minute per trip (6). At the airport end of the expressway, where there are only three lanes in each direction but much smaller total flows, the reduced volumes of about 170 vehicles per lane per hour will have little effect. The per-lane peak-hour flows, approximately 1,200 to 1,300 vehicles, are currently well below critical levels.

Under the best of conditions and most liberal assumptions, then, it is difficult to attribute any significant gains in reduced congestion and pollution to the airport extension. Small increases in speed and reductions in congestion and pollution have been achieved, but even these are limited to 2 or 3 hours a day (with the maximum effect occurring during the 5 to 6 p.m. peak hour). These external benefits may be considered as offsetting some of the apparent economic and financial deficits enumerated earlier, though it is difficult to believe that these external benefits could constitute a major consideration.

IMPLICATIONS FOR OTHER AIRPORT EXTENSIONS

What are the implications of the Cleveland extension for other cities? To begin, in Cleveland the airport is responsible for only a small portion of the rapid transit patronage and the extension volume. Although airport passengers, visitors, and employees using the rapid transit extension represent about 92 percent of the airport station's patrons, this same group of airport users totals only 35 percent of the extension's users and less than 8 percent of the rapid transit patronage. Moreover, the new riders attracted by the extension, most of whom are air passengers who formerly traveled to the airport by other modes, represent only 7 to 14 percent of the total rapid transit system patronage.

Several reasons account for low utilization of the Cleveland airport extension. One, Hopkins is not a heavily used airport; at least 17 other U. S. airports currently have heavier patronage. Chicago's O'Hare, the busiest airport, has approximately 5 times more passenger enplanements, Kennedy has about 4½ times as many, and Los Angeles has about 4 times as many (7). Two, for a city of its size and density, the Hopkins International Airport is located a great distance from the city center. For instance, Hopkins is roughly the same distance from downtown, 14 miles, as are the New York Kennedy, San Francisco, and Los Angeles airports and only 3½ miles less than O'Hare is from downtown Chicago (8). Also, peak volumes, for airports generally and for Cleveland particularly, are low when compared with the high passenger-carrying capacity of rapid transit lines. In 1970, for example, O'Hare had approximately 12,000 passengers (by all modes) during its peak hour; Kennedy about 10,000; Los Angeles about 9,000; and Cleveland only 2,800. Finally, for Cleveland (and elsewhere) the origins or destinations of the airport passengers, visitors, and employees are diverse and not concentrated in the central business district (1, p. 38). At best, only 30 to 40 percent of air passenger travel moves to or from the downtown in most cities, except in New York where approximately 45 percent of current air travelers move to or from Manhattan. Because fixed rail rapid transit facilities rarely provide adequate service to other than close-in downtown areas, the potential passenger volume for fixed rail facilities is quite low—currently some 5,000 passengers maximum during the peak hour at the largest U. S. airport. (Even this figure, and certainly not Cleveland's 2,800, is insignificant when compared with rail transit capacities that can exceed 40,000 an hour.)

Cleveland is atypical in two major respects. First, Cleveland has a small downtown area, and only 10 percent of its air passengers start or finish their trips in the central business district (1, p. 30). This percentage is far lower than that experienced by New York, Chicago, Washington, Boston, and San Francisco even though they have no direct airport extension. This suggests, then, that extensions in other cities would fare better than Cleveland's. Second, Cleveland probably can better serve other-than-downtown travelers. One unique feature of Cleveland's system is that it has increased its utility and patronage beyond that which could be anticipated in other cities. The areas generating most resident-made air travel are directly connected to the airport by the CTS and Shaker Heights rapid transit lines, are east of the downtown core, are laid out on an east-west axis, require long and arduous cross-town trips, and thus are well served by the east-west rapid transit lines. Shaker Heights, Cleveland Heights, University Heights, East Cleveland, and University Circle, for example, generate heavy air travel and lie on a straight-line path that requires a lengthy and congested 15-mile trip through the central core of the city to the airport. As a result, people living in such areas can avoid the long and uncomfortable downtown trip by car. They can get to the airport directly by taking the rapid transit line and can avoid airport parking charges. (These may be offset, at least partially, by parking fees or feeder service costs at the other end of the trip.) And they do make heavy use of the service (relative to most other residents).

Only 29 percent of the air passengers having a Cleveland (central city) origin or destination, the area having highest density and closest proximity to most stations, use the airport extension. This figure compares with 52 percent in East Cleveland, 46 percent in Cleveland Heights, 35 percent in University Heights, 32 percent in South Euclid, and 25 percent in Shaker Heights. The communities are all more distant from the airport than is the Cleveland central city area and have many well-to-do residents that are directly served by rapid transit service. By contrast, it seems doubtful that the New York and Chicago airport extensions, for example, would be able to serve adequately more than a handful of trips having other than strictly downtown origins or destinations. For instance, travelers not bound for or coming from downtown would have to gain access to the facility at the originating end of the trip, travel downtown, and then transfer to another outbound line to reach their destination, making a very circuitous, inconvenient, and time-consuming trip. Most bedroom communities in these and other large cities would not be on a direct and fairly straight rapid transit route with an extension to the airport and thus would be worse off than Cleveland in this respect.

CONCLUSIONS

All things considered, can the Hopkins Airport extension be described as a success or as a failure?

According to some proponents, it is a success. For instance, Secretary Volpe (9) in speaking for the Department of Transportation, the principal funding agency for the Hopkins extension, said that "Cleveland's experience with its airport-to-downtown rail rapid transit link over the past 2 years has been very heartening," and he generally seemed to indicate that the extension had been a success. Subsequently, a newspaper article (10) exaggerated the comments of Secretary Volpe by stating that "The Department of Transportation reports that the results of a study published October 8 show that Cleveland's airport-to-downtown airport service has proved to be an unqualified success." And, not too surprisingly, the Cleveland Transit System General Manager, in a New York Times interview, summed up his views about the extension by saying it is very successful.

However, in view of these data, findings, and considerations, one must wonder about the validity of these or other such unconditional endorsements.

First, the incremental costs for the extension are from 63 to 163 percent greater than the incremental revenues received from its new riders and from the airport surcharge, the deficit being in the range of $0.738 to $1.178 million a year for current fare levels and volumes. At present, then, the extension must be regarded as a distinct financial failure. Not only that, but there seems little hope for significantly reducing, much less eliminating, the deficits resulting from the extension. For instance, the earlier analysis indicated that the current fare demand is (probably) slightly price-elastic and that deficit reductions can be accomplished (if at all) only by utilizing a monopolistic pricing policy. But even monopolistic prices would do little to decrease the deficit if the marginal costs (i.e., the extra costs incurred to handle an extra extension passenger) are quite low or at least substantially lower than the current average variable costs. For volume levels and load factors as low as those on the Hopkins extension, the marginal costs probably are low (both absolutely and relative to average variable costs). Thus, one might conclude that the deficits are about as low as is possible.

Second, the extension appears to be economically as well as financially infeasible. Put differently, even if consumers' surpluses (that is, the amounts current riders would be willing to pay over and above what they now pay rather than switch to other modes or forego trips) were added to their revenues and if the total was balanced against the extra costs, there seems to be little chance that the total would be high enough to "tip the scales." As noted earlier, the "average" patron would have to be willing to pay an extra 20 to 32 cents; put differently, each rider would have to pay a fare that is almost 40 to 60 percent higher than the current one (without switching modes or foregoing the trip) in order for the consumers' surpluses to outweigh the current deficits. This appears to be an unlikely possibility, especially because fares on the CTS transit lines are already very high (compared to other rapid transit lines).

Third, although slightly more than 2,000 air passengers (about 14 percent of Hopkins' air passengers) and about 10,000 passengers in total use the extension daily, these can hardly be regarded as significantly large volumes—certainly not, at least, for a high-capacity rail rapid transit line. Nor can the diversion of even as many as 3,000 passengers a day from automobiles be considered a significant (if even measurable) reduction in traffic congestion; realistically, only a small reduction in congestion has resulted from the extension because, at best, only 125 vehicles have been removed from each lane of the most congested Cleveland expressway during the peak hour. If, moreover, we consider the fact that this subsidized airport extension is heavily used by people considerably more affluent than most Cleveland residents, some doubt must be raised about the extension's success when judged on equity or "fairness" grounds.

There are two final points I would like to make. One, the Cleveland experience underlines the importance of conducting good feasibility studies in advance of such improvement programs. These studies should be comprehensive, incorporating both financial and economic feasibility analyses. They should analyze the sensitivity of the ridership to different fare levels and service conditions. Such preliminary investigations should do more than "talk about" supposed congestion and pollution reduction; they should consider as well the effect of such programs on the citizens involved. Further, it is necessary not only to look at the potential users, and the source of any subsidies to them, but also to consider whether it is equitable to extend a transit line with public funds without compensating private taxi and limousine operators and others for any losses they may sustain as a result. Two, it appears that rapid transit extensions to airports are not "the" answer to ground access problems and will not generate massive or even moderately heavy usage (11). To the contrary, large capital outlays will be required in order to finance a premium service to be used heavily, if not mainly, by a small number of very well-to-do urban air travelers.

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