A Methodology for Assessing Effects of Federal Subsidy Reductions on Transit Fare and Service

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A simple elasticity-based model is described that was developed to define the sizes of either fare increases or service decreases required to offset possible reductions in federal operating subsidies for transit systems in Indiana. The development of this model is part of a larger study at Purdue University to examine alternative strategies for the distribution of the state's public mass transportation (PMT) funds. The relative significance of the projected fare and service changes on the four categories of transit systems in Indiana and the implications of changes in state PMT funding policy in response to reductions in federal subsidies are discussed.

The federal programs for assistance to urban transit systems are currently in an uncertain state. Present levels of federal operating subsidies may not continue. In an effort to reduce federal deficits, many domestic programs, including transportation, are expected to be cut back. It is argued that the responsibility of operating transit systems primarily lies with the state and local governments.

Revenue for transit operation in Indiana is derived from three basic sources: federal and state subsidies and locally derived income (LDI). The present function of state transit subsidies is to match local funds for federal grants. With a possible reduction in federal funding, the state's role cannot continue to be secondary. State transit funding now will take a more dominant role in addressing the state's transportation and economic development objectives, rather than merely being a matching program for federal assistance.

A study *(1)* has recently been completed at Purdue University to develop alternative procedures for the allocation of state public mass transportation (PMT) funds to the various transit systems in Indiana. This study proposed a system of clustering the transit agencies with similar operational characteristics, providing a basis for a formula distribution of state funds. Currently, this study is being extended to consider the effects on state funding policy of a reduction in federal subsidy.

In particular, the following questions are being addressed: how are the available limited state PMT funds to be distributed? and should the state continue to distribute the funds among all systems proportionately or should the situation be taken as a case of triage, in which only systems with the highest chance of survival in terms of ridership and local support should be funded? The current research addresses these issues and is expected to provide guidelines for subsidy allocation and other aspects of state transit funding.

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OUTLINE OF THE METHODOLOGY

As part of this large study, it was necessary to develop a methodology to examine the effects on fare and service structure of reductions in federal transit operating subsidies. The intention of the methodology was only to define the limits of the effects of subsidy cuts. For simplicity, the effects of subsidy cuts on fares and service are modeled separately. Optimum balances between fare increases and service cuts for each system have not been identified.

The model is based only on broad economic and financial indicators of transit system performance. Individual routes were not considered separately. The projected changes in fares and service should be taken as indicative only.

GROUPING OF INDIANA TRANSIT SYSTEMS

As a result of the recent Purdue study *(1)*, the Indiana transit systems have been divided into four groups for the purpose of allocating state PMT funds. These groups cluster the transit systems such that systems within a group are nearly homogeneous (similar) and the systems of different groups are heterogeneous (dissimilar). The division of systems into groups was based on population, peak hour fleet, average operating speed, wage rate, and type of service, with the expectation that systems within a group could then be compared equally.

This analysis resulted in four general groups, which are shown in Table 1. Group 1 includes the relatively large systems; Group 2 consists of medium-sized systems; Group 3 includes small, fixed-route, fixed-schedule systems; and Group 4 comprises all demand-responsive systems, some of which are county-wide and primarily intended for elderly and handicapped people.

These groupings are approximate only, as each system has its own set of operating characteristics. For example, the NICTD rail system is a unique operation with speed and other characteristics highly different from any other system. As its characteristics are closest to Group 1, it was included in that group. The Madison County system was not a state-supported system in 1984 when the Purdue study was conducted, but it has since become eligible for state support and was included in Group 4 in 1985.

TABLE 1 INDIANA TRANSIT SYSTEMS (1985 DATA)

SYSTEM	POPULATION	ANNUAL REV. VEH. HRS	ANNUAL EXPENDITURE $	FARE+OTHER REVENUE $	FEDERAL SUBSIDY $	OPERATING RATIO *
GROUP 1:						
FT. WAYNE	236 479	123 926	4 266 981	910 141	1 165 093	0.54
GARY	151 953	121 136	5 615 338	2 347 244	1 256 401	0.63
INDIANAPOLIS	711 539	442 784	19 214 946	8 097 601	5 750 666	0.53
NICTD	171 371	42 237	15 521 035	6 121 300	2 173 060	0.42
SOUTH BEND	149 928	136 057	5 144 776	1 172 560	1 229 244	0.62
TOTAL/AVERAGE	1 421 270	866 140	49 763 076	18 648 846	11 574 464	0.52
GROUP 2:						
ANDERSON	66 910	30 296	1 035 815	105 782	464 030	0.25
BLOOMINGTON	52 044	30 089	870 799	151 091	331 041	0.37
EVANSVILLE	130 496	54 040	1 397 277	615 575	443 277	0.47
HAMMOND	93 714	26 760	891 042	147 494	371 774	0.35
LAFAYETTE	91 380	64 614	1 834 531	428 012	700 215	0.49
MUNCIE	77 216	51 635	1 923 140	487 722	623 388	0.51
SO. INDIANA	73 487	11 781	608 414	72 170	268 122	0.27
TERRE HAUTE	63 931	46 513	909 452	179 482	364 985	0.33
TOTAL/AVERAGE	649 178	315 728	9 756 692	2 187 328	3 566 832	0.41
GROUP 3:						
BEDFORD	14 410	6 770	154 380	16 652	68 864	0.26
COLUMBUS	30 614	17 730	287 292	50 470	118 411	0.31
EAST CHICAGO	39 787	21 136	673 463	0	294 400	0.27
LAPORTE	21 796	17 074	324 411	60 203	132 104	0.36
MARION	35 874	10 041	305 222	31 865	136 678	0.25
MICHIGAN CITY	36 850	13 950	365 570	73 166	146 202	0.33
MITCHELL	4 641	1 124	44 615	4 204	20 206	0.25
NEW CASTLE	20 056	12 126	315 408	27 938	139 975	0.29
RICHMOND	41 349	16 498	306 945	91 023	107 961	0.41
WASHINGTON	11 325	2 520	33 535	7 355	13 090	0.35
TOTAL/AVERAGE	256 702	118 969	2 810 841	362 876	1 177 891	0.31
GROUP 4:						
GOSHEN	19 665	1 858	24 353	5 765	9 294	0.36
KIRPC	76 239	6 437	180 451	6 605	85 916	0.21
KOSCIUSKO CO.	59 556	14 507	353 030	53 365	149 833	0.29
LCEOC	51 422	40 227	567 002	157 334	204 834	0.44
MADISON CO.	72 426	685	34 868	2 486	16 191	0.23
MONROE CO.	51 114	10 475	300 386	15 594	142 396	0.21
TRADE WINDS	51 422	42 237	553 363	265 308	167 823	0.50
UNION CO.	6 860	4 547	68 826	5 678	31 574	0.24
TOTAL/AVERAGE	388 703	120 973	2 082 279	512 135	807 861	0.37

$$\text{* OPERATING RATIO} = \frac{\text{FARE, CHARTER AND OTHER REVENUES + LOCAL ASSISTANCE}}{\text{OPERATING EXPENDITURE}}$$

DESCRIPTION OF MODEL

An aggregate model was developed to consider fare and service changes necessary to offset possible federal subsidy reductions. The model is based on demand elasticities and the details are presented in the following paragraphs.

Fare Changes

The fare change module calculates the increase in fare required to offset the decrease in available funds due to a given percentage of reduction in federal subsidy. The steps are as follows:

- Calculate the value of the given percentage of reduction in federal subsidy for each transit system.
- Calculate the average fare given by total fare revenue divided by total ridership.
- Calculate the increase in fare required at current ridership to offset the subsidy cut.
- Calculate the decrease in ridership arising from the fare increase.
- Calculate the net increase in revenue arising from the fare increase and decrease in ridership. For the elasticity values assumed in Table 2, the increase in revenue will be insufficient to offset the subsidy cut.

TABLE 2 FARE AND SERVICE ELASTICITIES

GROUP	FARE	SERVICE
1 Large fixed route	Average= -0.33 Range= -0.25 to -0.5	Average= 0.7 Range= 0.5 to 0.9
2 Medium fixed route	Average= -0.36 Range= -0.25 to -0.5	Average= 0.8 Range= 0.6 to 1.0
3 Small fixed route	Average= -0.42 Range= -0.3 to -0.6	Average= 0.9 Range= 0.7 to 1.1
4 Demand-responsive	Average= -0.2 Range= -0.1 to -0.35	Average= 0.6 Range= 0.4 to 0.8
TOTAL	(a) Simpson-Curtin Rule = -0.33 (1) (b) APTA = -0.3 (2) 50% range= -0.2 to -0.46 75% range= -0.12 to -0.55	Average= 0.8 Range= 0.6 to 1.0

- Select a larger fare increase. For second and subsequent iterations, the model assumes fare increases to give multiples of the required revenue increase at current ridership.
- Recalculate the net increase in revenue arising from the fare increases and associated decreases in ridership.
- Interpolate linearly between the net changes in revenue for multiples of the required revenue increase to obtain net change in revenue equal to federal subsidy decrease.
- Obtain the fare increase required to give the required net change in revenue.

Service Changes

This module calculates the decrease in service required to offset the reduction in federal subsidy. In the model, service is measured in annual revenue vehicle-hours provided by the system. It could equally be measured by annual revenue-miles or average headway.

- Calculate the value of the given percentage reduction in subsidy for each transit system.
- Calculate the variable operating cost as a proportion of total expenditure. The definition of variable operating cost is discussed in the next section.
- Calculate the decrease in service required at current ridership to offset the subsidy cut.
- Calculate the decrease in ridership arising from the service decrease.
- Calculate the resulting reduction in fare revenue due to the decreased ridership. This additional reduction in revenue will require a matching additional decrease in expenditure.
- Calculate the reduction in additional expenditure and consequent decrease in service necessary to offset the combined effect of the initial decrease in service and ridership. Continue this iterative process until the loss of fare revenue from decreases in ridership between successive iterations is small. The model uses a difference of 10 percent or less.
- Calculate required service reduction as percentage of that existing.

ASSUMPTIONS

The objective of the model was to indicate trends in fare and service changes arising from cuts in federal subsidies. Absolute accuracy in forecasting changes in specific systems was not as important as identifying differences between groups and their relative significance for system viability.

A number of simplifying assumptions were made, consistent with the macroscopic nature of the model and also the limited availability of system data.

• All routes within a system are considered to be equally affected by changes in ridership or service. No attempt has been made to isolate specific effects of individual routes or services.

• Fare and service changes were considered separately. The findings of the model only define the limits of available alternative policies, but the implications of combinations of fare and service changes are discussed in the next section.

• Changes in fares or service were assumed to occur incrementally. Fare collection or scheduling considerations that may constrain systems to make changes in steps were not considered. No allowance was made for capital gains from the possible sale of rolling stock that may be made redundant by service reductions.

• Fare and service elasticities were assumed to be constant for each group and not to vary with the size of subsidy cuts. This simplification may tend to underestimate the effects of large subsidy reductions, but little evidence has been found to quantify changes in elasticity with magnitude of change. Elasticities are discussed further in the next section.

• The average fare was determined by dividing annual fare revenue by annual ridership. It does not necessarily correspond to the normal adult fare. For systems where no fare is charged (East Chicago in Group 3, Lake County Economic Opportunity Council and Trade Winds in Group 4), a base fare of 40 cents was assumed. This is of the order of the minimum nonzero fares within these groups and was only used for the purpose of calculating group average percentage fare increases. This assumption was not necessary for calculating real fare increases, which are therefore a more accurate indication of the effect of subsidy cuts on fares.

• Annual expenditure was divided into two components: fixed and variable costs. Cuts in federal subsidy were reflected as cuts in variable cost, which was assumed proportional to the extent of service provided. Variable costs were taken as

Operators' salaries, wages, and fringe benefits;
Maintenance and other services;
Fuels and lubricants;
Tires and tubes;
Other materials and supplies;
Purchased transportation; and
Leases and rentals.

All other costs were taken as fixed costs.

• Annual revenue hours of operation were assumed to be 256 weekdays, 52 weekends, and 5 holidays. Peak weekday service was assumed to be 6 hr per day.

Although these assumptions may be simplistic, they are sufficient to indicate the significance, if not the actual effect, of the subsidy reductions.

ELASTICITIES

If the effects of subsidy cuts were only to increase fares or decrease service by amounts necessary to offset the loss in revenue, the calculation of the size of the effects would be simple. However, the secondary effect of subsidy cuts, the reduction in ridership and consequent loss of fare revenue arising from fare increases or service reductions, must also be considered.

Transit demand elasticity is the proportional change in the amount of ridership resulting from a proportional change in a system variable. The fare elasticity is the percentage change in ridership for a 1 percent change in fare. Similarly, the service elasticity is the percentage change in ridership for a 1 percent change in service. All elasticities used are arc elasticities. Table 2 presents the fare and service elasticities used in the model.

Fare Elasticities

The Curtin rule *(2)*, widely used in the transit industry, states that an overall fare increase of 1 percent will shrink ridership by approximately 1/3 of 1 percent. This corresponds to an arc elasticity of –0.33. The Curtin rule is considered appropriate for predicting ridership losses from fare increases on typical, predominantly line-haul, local bus operations *(3)*, such as those included in Groups 1–3.

The American Public Transit Association (APTA) has also analyzed the effect of fare increases on ridership, using data reported by transit managers between 1950 and 1967 *(4)*. This study estimated arc elasticities for over 100 American cities ranging in population from less than 50,000 to more than 1,000,000. The average arc elasticity was found to be –0.33, similar to that derived by Curtin's rule, but in only 12 percent of the cases was the elasticity between –0.31 and –0.35.

Although these estimates are imprecise, the message is clear: the use of average values alone may be misleading. The wide variation in values between different systems must also be considered. For the purpose of the present macroscopic study, a range of elasticity values was selected. This corresponds to the 50 percentile range, as determined from the APTA study.

The APTA study also considered the effects of city size, initial fare, and magnitude of fare increase on observed elasticities. The absolute value of the average arc elasticity increased as the population decreased, indicating that fare increases tend to have greater effects in smaller cities. These average values for given sizes of cities were adopted for the present study with ranges as for the overall average. As the APTA study indicated that neither the magnitude of the average fare before the fare increase nor the percentage increase in the average fare (up to 50 percent) had any discernible relation to the size of the elasticity, these effects were not considered.

Another study that provided evidence to define the range of elasticity values was undertaken in Iowa *(5)*. This study found that the fare elasticity varies considerably, depending primarily on the quantity of transit service. At high levels of service, elasticity is about –0.3 to –0.4, depending on city size. However, absolute values were considerably higher at low levels of service. On the basis of the Iowa definition of level of service (bus-miles per capita), Group 1 and 2 systems have medium to high levels of service. Group 3 has medium to low levels of service and therefore could exhibit higher elasticities. As Group 4 is not fixed route–fixed schedule, no comparison was made.

Elasticities for demand-responsive systems (Group 4) were not readily available but were based on the assumptions that a large proportion of the ridership are elderly or handicapped people who are more dependent on these systems. In addition, the demand-responsive nature implies a higher quality of service than fixed-route systems. Consequently, it was assumed that Group 4 systems are less sensitive to changes in fare. The Iowa study supports in general terms the ranges of elasticities presented in Table 2.

Service Elasticities

Less information is available on the ranges of service elasticities, but it is clear that ridership is more sensitive to service than to fare changes. A 1973 study *(6)* derived service elasticities for 17 transit systems, based on population and level of service (bus-miles per capita). A summary of transit service headway elasticities was also given by Carstens and Csanyi *(5)*. Average service elasticities for each group were obtained on the basis of available information. A range of ±0.2 was assumed to represent the 50 percentile spread in the absence of any more specific data. Service elasticities for Group 4 systems were considered to be smaller than for the fixed-route systems, as the quality of service in demand-responsive systems is inherently higher.

FINDINGS AND IMPLICATIONS

A number of important trends are apparent from the results of the analysis. These trends are discussed in the following paragraphs.

Relative Effect of Subsidy Cuts on Groups

Fare increases and service decreases become larger with increasing group size. Group 1 is the least sensitive and Group 4 the most sensitive to subsidy reductions. On average, Group 1 systems increase fares approximately in proportion to subsidy cuts and decrease service at approximately one-half the subsidy rate. Groups 2 and 3 are sensitive, increasing fares by four and six times the rate of subsidy decrease, respectively, and both decrease service at approximately two-thirds the subsidy rate. Group 4 is more sensitive still, with fares increasing at approximately eight times the subsidy rate and service decreasing approximately in proportion to the subsidy rate.

The explanation of this increasing sensitivity with group number can be explained by examining the relative sizes of revenue available to each group. Figure 1 compares the 1985 operating ratios of the four groups. The definition of operating ratio used in this study is consistent with the earlier study *(1)*, in which operating ratio was represented as a measure of local support for a transit system and computed locally derived income (the sum of fares, charter and other revenues, and local subsidies) divided by operating expenditure. A review of Table 1 would indicate that larger systems have higher operating ratios, whereas smaller systems tend to have lower ratios, reflecting the increasing dependence on nonlocal revenue (i.e., federal and state subsidies) with increasing group number.

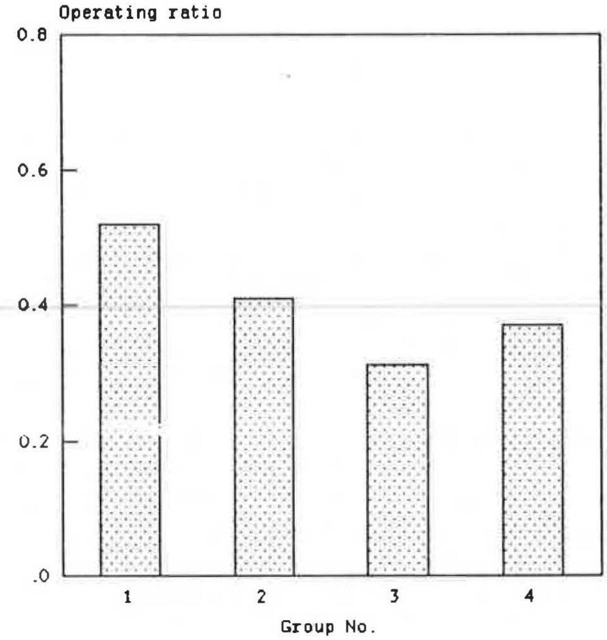

FIGURE 1 1985 operating ratios (group averages).

Consequently, the relative significance of a given cut in subsidy will increase as the dependence on the subsidy increases.

Sensitivity of Fares and Service to Subsidy Cuts

Fares appear to be more sensitive than service to subsidy cuts. For example, a subsidy cut of 30 percent requires fare increases from 40 percent for Group 1 to more than 200 percent for Groups 3 and 4, whereas a service reduction of only 13 to 25 percent is needed between Groups 1 and 4. This sensitivity of fares to subsidy cuts reflects the fact that except for Group 1, fare revenue is smaller than subsidy revenue. Consequently, for

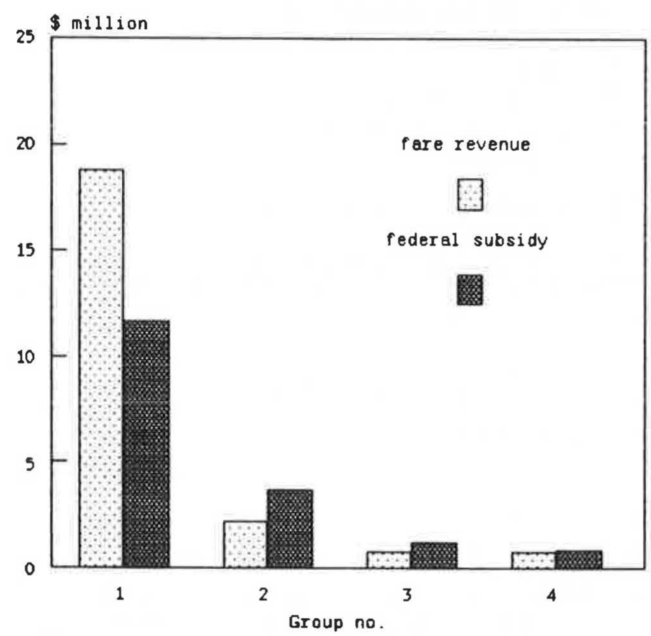

FIGURE 2 1985 fare revenues and federal subsidies (group totals).

a given percentage subsidy cut, the required percentage fare increase must be larger to make up the shortfall in revenue. The relative sizes of fare and federal subsidy revenues are shown in Figure 2.

In addition, the average federal subsidy for each group is smaller than the estimated variable operating cost, which was assumed proportional to service in the model. Therefore the required percentage reduction in service will be smaller than the percentage subsidy cut, reflecting the ability of service cuts to absorb subsidy cuts better than fare increases. Figure 3 shows the federal subsidy for each group as a percentage of variable operating costs.

Significance of Fare and Service Changes

Table 3 presents the significance of effects of subsidy cuts on fare and service. The criteria chosen were a doubling of fare as an upper limit of feasible fare increase and a 50 percent reduction in revenue vehicle-hours as an upper limit on service cuts. In addition, the level of subsidy cuts necessary to require an 80 percent reduction in service is presented as an indication of the level of federal subsidy cuts that would mean virtual elimination of transit service under the existing financial environment.

Again, the lower sensitivity of Group 1 compared with the other groups is apparent. If a policy of equivalent effect is adopted, then it appears that Group 1 systems can accommodate approximately two to three times the level of subsidy cuts of the other groups. In addition, if these criteria are accepted as practical limits to the extent of subsidy cuts for each group, the maximum total subsidy cut would be approximately $9.3 million for fare increases only or $15.9 million for service reductions only. This represents an average subsidy cut of 50 percent for fare increases and 90 percent for service decreases, respectively.

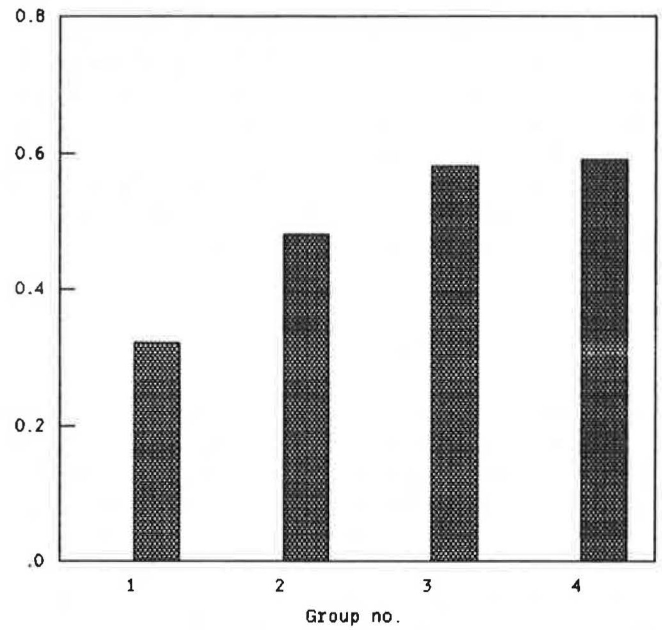

FIGURE 3 Ratios of federal subsidies to variable operating costs (1985 group averages).

TABLE 3 EFFECT OF SUBSIDY CUTS (GROUP AVERAGES)

Group No.	Operating Ratio	Size of subsidy cuts required to achieve stated criteria: 2 x Fare	50% Service Reduction	80% Service Reduction
1	0.52	70%	100%	100%
2	0.41	25%	80%	100%
3	0.31	15% (1)	75%	100%
4	0.37	12% (1)	60% (2)	95% (3)

NOTES

(1) East Chicago (Group3), and LCEOC and Trade Winds (Group 4) do not charge fares. An average fare of 40 cents was assumed only for use in calculating group average percentage increases in fares.

(2) This value is an estimate only as Madison County has reduced services to zero above a 60 percent subsidy cut.

(3) This value is an estimate only as Monroe County has reduced services to zero above a 90 percent subsidy cut.

Variation Within Groups

The variation in effect within each group is large, and the average group effects should not be taken as indicative of the performance of all systems within a group. For example, a 20 percent subsidy cut in Group 1 requires an average fare increase of 16¢, but individual systems have fare increases from 9¢ to 27¢. Similarly, the group average service cut is 9 percent, but individual system decreases range from 7 to 13 percent.

This variation in effect is even larger for other groups. For Group 4 in particular, larger subsidy cuts (more than 50 percent) appear to reduce service below the limits of viability for at least one system, although the group average reduction is more modest. For example, a 50 percent subsidy cut would reduce the Group 4 average service by 42 percent, but one system would be reduced by over 85 percent.

Sensitivity to Elasticity

A detailed sensitivity analysis was conducted to assess the effect of assuming the low, average, and high elasticity values for fare and service charges. For each group, fare increases appear to be more sensitive to changes in elasticity than service decreases. The sensitivity to changes in elasticity also appears to decrease with increasing group number. This decrease is due to the increasing size of the fare increase or service decrease by increasing group number for a given subsidy cut. The secondary effect of revenue losses from reductions in ridership arising from the fare increases or service cuts therefore decrease as a proportion of total revenue reduction with increasing group number.

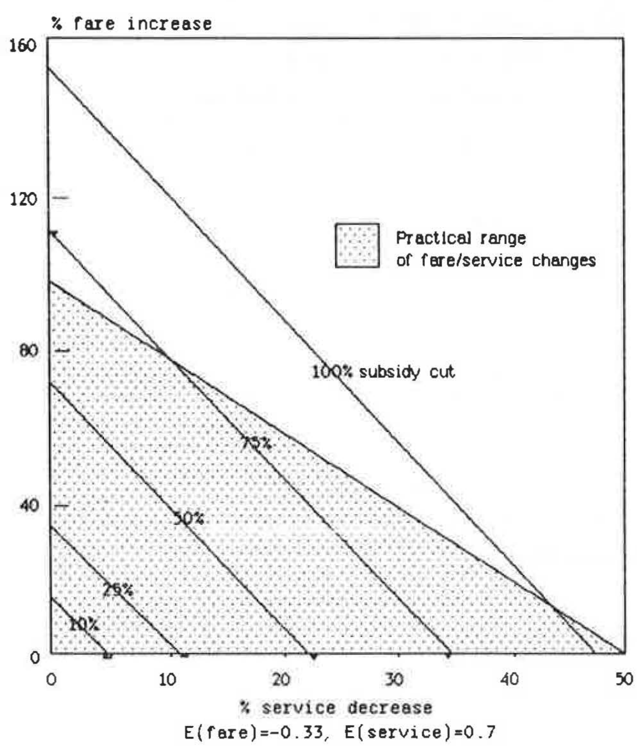

FIGURE 4 Effects of subsidy cuts (Group 1).

Combinations of Fare and Service Changes

Figures 4–7 show possible equivalent combinations of fare and service changes for a given subsidy cut. Although the model was established to consider fare and service changes separately, these indifference curves were developed on the assumption of constant marginal exchange for the purpose of identifying trends only.

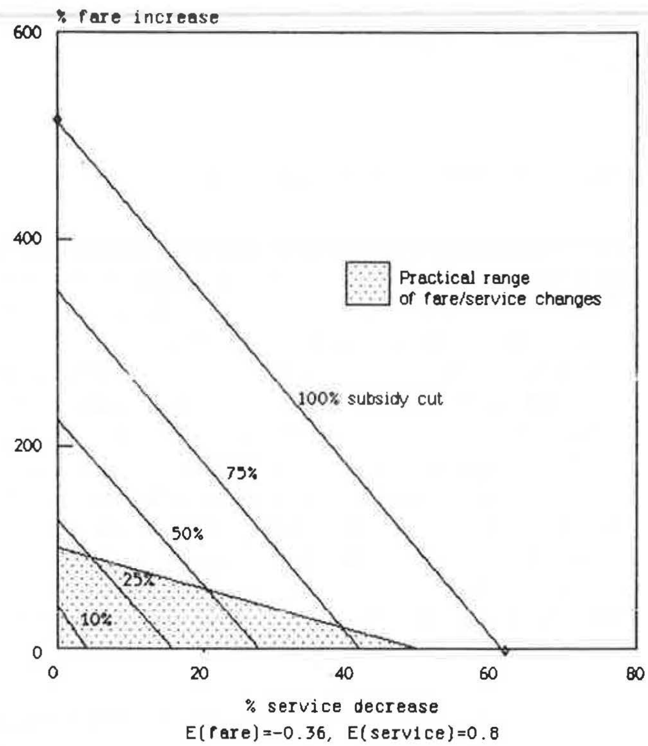

FIGURE 5 Effects of subsidy cuts (Group 2).

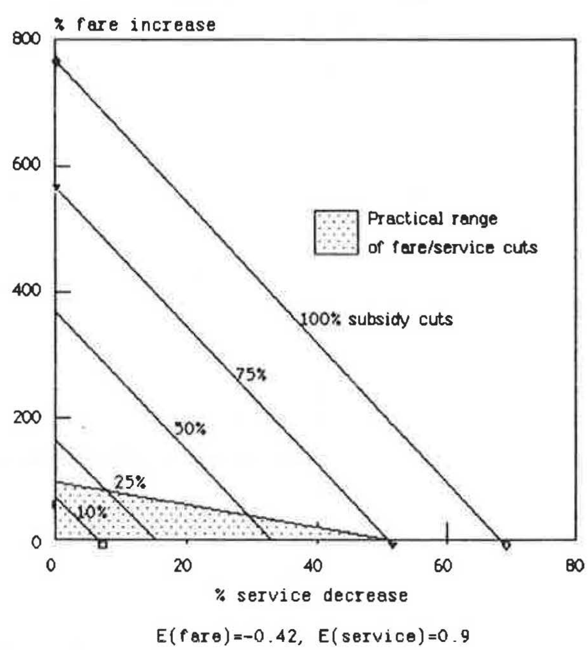

FIGURE 6 Effects of subsidy cuts (Group 3).

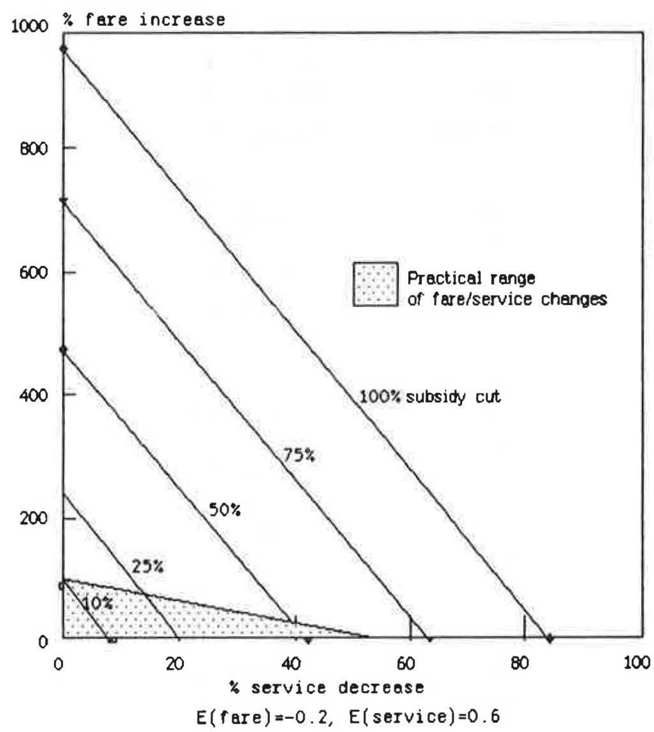

FIGURE 7 Effects of subsidy cuts (Group 4).

As mentioned previously, a doubling of fare was assumed to be an upper limit of possible fare increase and a 50 percent reduction in revenue vehicle-hours as an upper limit on service cuts. The limits of the practical extent of combinations of fare and service changes are shown as the shaded areas in Figures 4–7. The effects of various levels of federal subsidy cuts can be better recognized by examining the indifference curves in relation to the shaded areas. For example, Group 1 can withstand a 50 percent subsidy cut by increasing fare (less than 80 percent) or by reducing service (less than 25 percent), but a 50 percent subsidy cut for Group 2 cannot be matched by fare increase (more than 200 percent). A feasible level of service reduction (less than 30 percent), however, is possible for Group 2 at 50 percent subsidy cut. Similar observations can be made for other groups and other levels of subsidy cuts.

Effects on Individual Systems

An example of the possible effects of federal subsidy reductions on individual systems is presented in Table 4. This example shows the size of subsidy cuts that would make the systems double their average fare or reduce their service by half.

In considering the levels of the existing average fare in Group 1, Fort Wayne, Gary, and Indianapolis can be compared. Gary shows the best ability to absorb subsidy cut through increased fare revenue, whereas Fort Wayne shows the least ability. On the other hand, although even a complete removal of federal subsidy is not sufficient to cause the NICTD to double its fare, the existing average fare level at the NICTD is already high, and its doubling may not be a practical solution. South Bend's situation is the opposite. Its existing average fare is rather low, indicating a high degree of concessional fares. Consequently, South Bend can withstand a considerably high level of subsidy cut through increased fare revenue.

If subsidy cuts are to be compensated for by increased fare revenue, Fort Wayne and possibly NICTD are the most vulnerable systems in Group 1. On the other hand, if service reduction is taken as the criterion, Indianapolis is less robust than the other systems in its peer group.

The same type of evaluation can be made for systems in other groups. For example, in Group 4 as far as the fare revenue is concerned, Goshen, LCEOC, and Tradewinds appear to be more stable than the rest of the systems. However, Goshen already charges 76¢ per trip, whereas for LCEOC and Tradewinds, the doubling of fare revenue would mean the imposition of 40¢ average fare in place of the existing zero fare. On the other hand, Madison County appears to be most vulnerable, as it already charges a high average fare and even a relatively low federal subsidy cut of 15 percent would require its average fare to double.

If service reduction is considered, KIRPC, LCEOC, and Tradewinds indicate a higher degree of resilience than the other systems. The most vulnerable, however, appears to be Madison County, where a 30 percent subsidy cut would require the vehicle-hours be cut by half.

CONCLUSIONS AND RECOMMENDATIONS

A study has been undertaken to evaluate possible state subsidy policies in response to reduction in federal assistance to Indiana transit systems. A methodology was developed to assess the impacts of possible reductions in federal transit operating subsidies on fare and level of service. The results presented involved effects primarily in terms of system groups. However, an analysis was also made to estimate effects on individual systems. On the basis of the results, the following conclusions can be made.

1. If revenue shortfalls due to reductions in federal assistance are to be balanced by increase in locally derived income, either local assistance or fare revenue has to be increased. Otherwise the revenue shortfall must be accommodated by reduction in operating cost through service cuts. In the present paper, only fare and service changes as they are related to operation are considered. An increase in local assistance can be estimated directly as equal to the expected revenue shortfall. However, in view of the general public attitude towards tax increase, it is unlikely that any significant increase in local assistance for transit operation will be forthcoming for most Indiana transit systems.

2. The analysis indicated that, in general, there is a greater flexibility in reducing service than in increasing fare to accommodate revenue shortfalls. However, beyond a certain level of revenue shortfall, the necessary amounts of fare increase or service cut become unrealistically high. These revenue shortfall levels varied from system to system within a group. These cutoff levels can be used in determining what systems should continue to receive state subsidy.

3. The systems in Group 1 indicated a greater capacity to absorb subsidy cuts compared to other groups for the same levels of fare increase and service cut. Other groups are highly dependent on federal subsidy, and their operations become vulnerable even at a relatively small level of revenue shortfall.

TABLE 4 EFFECT OF SUBSIDY CUTS (INDIVIDUAL SYSTEMS)

System	Average Fare	Size of subsidy cuts required to achieve stated criteria		
		2 x Fare	50% Service Reduction	80% Service Reduction
GROUP 1:				
Ft. Wayne	0.51	45%	100%+ (2)	100%+ (2)
Gary	0.53	95%	100%+ (2)	100%+ (2)
Indianapolis	0.49	80%	75%	100%+ (2)
NICTD	2.49	100%+ (2)	100%+ (2)	100%+ (2)
South Bend	0.26	55%	100%+ (2)	100%+ (2)
GROUP 2:				
Anderson	0.27	15%	80%	100%+ (2)
Bloomington	0.27	20%	100%	100%+ (2)
Evansville	0.37	65%	90%	100%+ (2)
Hammond	0.38	25%	100%	100%+ (2)
Lafayette	0.36	35%	75%	100%+ (2)
Muncie	0.32	40%	95%	100%+ (2)
So. Indiana	0.39	20%	80%	100%+ (2)
Terre Haute	0.35	30%	70%	100%+ (2)
GROUP 3:				
Bedford	0.32	10%	70%	100%+ (2)
Columbus	0.27	25%	90%	100%+ (2)
East Chicago	0.40 (1)	95%	70%	100%+ (2)
LaPorte	0.57	25%	90%	100%+ (2)
Marion	0.23	15%	70%	100%+ (2)
Michigan City	0.32	25%	70%	100%+ (2)
Mitchell	0.47	15%	60%	95%
New Castle	0.24	10%	75%	100%+ (2)
Richmond	0.45	45%	80%	100%+ (2)
Washington	0.33	30%	85%	100%+ (2)
GROUP 4:				
Goshen	0.76	50%	55%	85%
KIRPC	0.23	10%	90%	100%+ (2)
Kosciusko Co.	0.44	25%	70%	100%+ (2)
LCEOC	0.40 (1)	60%	95%	100%+ (2)
Madison Co.	2.09	15%	30%	50%
Monroe Co.	0.37	10%	50%	80%
Trade Winds	0.40 (1)	50%	100%+ (2)	100%+ (2)
Union Co.	0.41	15%	70%	100%+ (2)

(1) 40 cent average fare assumed where no fare charged.
(2) Indicates complete removal of subsidy is insufficient to meet criterion.

4. Small-percentage subsidy cuts in Group 4 and other small systems will decrease the adverse effects of the cuts substantially but will have little effect on the total subsidy cut.

5. The results of the analysis presented in this paper are dependent on the assumed elasticity values. These results can be used only as a guide, along with other information, to make decisions as to the state transit subsidy allocation policies in response to federal subsidy cuts.

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