Selection of a County Distribution Formula for State Road Assistance In Mississippi

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This paper describes the method employed by the Mississippi highway finance study staff to determine the formula recommended by it to the legislature for distributing State assistance for road purposes to the counties. The 20-yr annual average total cost of county roads in each county was accepted as a measure of need. Although need per se was rejected as a basis for distributing State assistance, a distribution formula based on other factors but one which, on the average, most nearly would equate proportionwise road cost (needs) and State assistance, was considered desirable.

Five factors most frequently used by States for distributing motor fuel taxes to local units of government were tested, singly and in all possible combinations. They ranked from best to worst as follows: (a) road mileage, (b) area, (c) equal division, (d) population, and (e) motor vehicle registrations. Moreover, combinations of factors do not appear to secure better results by compensating extremes. The single factor of road mileage was found superior under Mississippi conditions to any other factor or combination of factors.

The superiority of the mileage formula was further verified by distributing various amounts of assumed State assistance and analyzing the results. Another statistical measure used in this connection was the sum of deficits of counties having deficits, smallness of deficit sums being indicative of formula efficiency.

•THIS PAPER is concerned primarily with the method employed by the Mississippi highway finance study staff to determine the formula recommended by it to the legislature for distributing State assistance for road purposes among the counties. Adoption of a proper distribution formula for such State assistance is a prerequisite to a necessary reallocation of highway responsibilities and/or highway revenues between the State and its local units of governments if an adequate system of highways in the State is to be realized.

The highway finance study (1), from which this paper is extracted for the most part, was made by the University of Mississippi for the Legislative Highway Planning Committee as a companion study to an engineering evaluation made by the Automotive Safety Foundation (2). This connection is important inasmuch as the approach to the problem of distributing State assistance among the counties was made within the framework of the engineering study. The latter provides 20-yr cost estimates for the upgrading and maintenance of Mississippi's network of roads and streets to acceptable standards. (The study provides three alternate programs with regard to the time period

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necessary to bring all highways, roads, and streets up to adequate standards. The programs are for 10-yr, 15-yr, and 20-yr catch-up periods, respectively. Only the financing of the 20-yr catch-up period was developed by the finance study staff.)

Program costs were developed in detail for the State highway system, the county road systems, and municipal street systems under each of three different assumptions as to the mileages to be included in each system. The assumptions were designated as A, B, and C, respectively. Under assumption A, the currently-designated State highway system is to be developed as proposed, and existing routes paralleling both the Interstate system and the proposed major thoroughfares are to be continued as a part of the State system. The ultimate mileage in the State system under this assumption would be 12,111 miles. Under assumption B, certain categories of highways would be transferred from the State system to the counties and municipalities. These categories would include (a) the parallel routes just mentioned, (b) designated but non-State-maintained highways, and (c) State highways with discontinuous system or maintenance responsibility. The ultimate mileage in the State system under this assumption would be 8,466 miles. Under assumption C, the State highway system would be further reduced in size to a recommended 6,500 miles.

To the estimated program costs, the highway finance study staff added estimated costs of debt service (principal and interest) on outstanding highway, road, and street debt. All costs were stated in terms of annual averages. The staff also made estimates of all revenues that will be available under current law to finance the highway, road, and street needs previously outlined. These likewise were reduced to annual averages.

THE PROBLEM

For the purpose of emphasizing the overall view and pointing the direction of needed adjustments among the State, counties, and municipalities, each of these levels of government is considered as a single administrative unit. That is, all State Highway Department revenues are considered available for expenditure on State highways on a needs basis without regard to highway districts; all road revenues of all the counties collectively are considered to be available for expenditure on county roads on a needs basis without regard to county lines; and all street revenues of all municipalities collectively are considered to be available for expenditure on a needs basis regardless of the municipalities within which the streets are located. These assumptions do not accord with the facts but they do serve a useful purpose.

Table 1 gives the projected annual average highway costs and highway revenues from current sources for each level of government under each assumption (A, B, and C) as to mileage responsibility. These data identify clearly and unmistakably the major highway finance problem in Mississippi; i.e., the existing imbalance between the highway responsibilities of the different units of government and the revenues available to the latter for meeting these responsibilities. As serious as the overall deficiency in highway revenues admittedly is, the misallocation of available funds relative to needs is even more so. Additional revenue is not the only answer. Revenues and responsibilities of the different governmental units must be brought more nearly into balance.

Under assumption A (Col. 1, Table 1), under the present assignment of responsibilities and revenues, the State highway system will require $82.9 million annually but will receive only $61.3 million, leaving an annual average deficit of $21.6 million. On the other hand, counties as a group will require $42.8 million and will receive $59.7 million, leaving a statistical surplus of $17.0 million. (When discussing the surplus or deficit relationship of revenue to cost for counties collectively or for municipalities collectively or for all units of government combined, the qualifying term "statistical" is used to refer to the algebraic sum of surpluses and deficits of all counties, or of all municipalities or of all units, respectively.

Of particular significance in this connection is the fact that only 21 percent of estimated county road revenues is from locally levied taxes. (Even this figure overstates the local contribution because it includes an indeterminable amount of homestead exemption reimbursement payments made by the State to the counties.) The municipalities as a group will require $14.0 million and will receive $13.5 million, leaving a statistical deficit of $0.6 million. All units combined will require $139.7 million and

TABLE 1

PROJECTED HIGHWAY COSTS[1] AND HIGHWAY REVENUES[2] FROM CURRENT SOURCES, MISSISSIPPI: 1963-1982 ANNUAL AVERAGES[3,4]

System and Item	Automotive Safety Foundation Assumption[5] ($ x 10^3)		
	A	B	C
All units:			
Cost	139,724	139,724	139,724
Revenue	134,491	134,491	134,491
Deficit	-5,233	-5,233	-5,233
State:			
Cost	82,908	71,096	63,964
Revenue	61,287	61,287	61,287
Deficit	-21,621	-9,809	-2,677
County:			
Cost	42,767	52,355	58,547
Revenue	59,741	59,741	59,741
Surplus	16,974	7,386	1,194
Municipal:			
Cost	14,049	16,273	17,213
Revenue	13,463	13,463	13,463
Deficit	-586	-2,810	-3,750

[1] 20-yr program costs plus debt service on highway debt outstanding as of June 30, 1961, for State and as of September 30, 1959, for counties and municipalities.
[2] Net of collection expense.
[3] Detail figures shown may not add to totals due to rounding.
[4] Source: Table 99 (1).
[5] Program costs under A, B, and C based on State highway system of 12,111, 8,466, and 6,500 miles, respectively.

will receive $134.5 million, leaving a statistical deficit of only $5.2 million. The amounts for all units combined remain the same under assumptions A, B, and C.

Under assumption B, a considerably improved relationship would be achieved between assigned responsibilities for providing highway services and revenues available under current law. Under this assumption, the annual average cost of the shortened State highway system would decline to $71.1 million, and the State deficit would be reduced to $9.8 million. The counties would find the cost of their road responsibilities increased to $52.4 million and their statistical surplus reduced to $7.4 million. The municipalities would find the cost of their street responsibilities increased to $16.3 million with a corresponding increase in their statistical deficit to $2.8 million.

Under assumption C, the annual average deficit of the State would decline to $2.7 million. The counties as a group would just about break even with a statistical surplus of $1.2 million. The municipalities as a group would find their annual average statistical shortage of street revenues increased to $3.7 million.

These data suggest that much can be done toward financing the modern highway program recommended for Mississippi without any increase in taxes. To accomplish this, however, a substantial reassignment of highway responsibilities and/or highway revenues will be required among the State, counties, and municipalities to bring about a better balance between responsibilities and revenues. The most obvious interlevel

shift is between the State and the counties. But economic as well as political difficulties would be involved in such shifting, because when individual county statistics are studied, it becomes apparent that not all counties share proportionately in the statistical surpluses of $17.0 million, $7.4 million, and $1.2 million found under assumptions A, B, and C, respectively.

Indeed, not all counties will have a surplus. Even under assumption A, the most favorable from the counties' standpoint, 17 counties will have estimated deficits totaling $0.7 million. Under assumption B, 47 counties will have an estimated combined deficit of $4.6 million. Under assumption C, 56 counties are found to have estimated deficits totaling $8.9 million. It appears clear that a different method of allocating State assistance (which constitutes approximately 80 percent of estimated county road revenues) among the counties is a prerequisite to any reassignment of responsibilities and/or revenues among the State, counties, and municipalities.

SELECTION OF FORMULA

If all counties made the same relative effort tax-wise and managed their road affairs equally well, a strong case could be made for the proposition that the most efficient and equitable distribution of State assistance would be strictly on a needs basis. However, not all counties make the same relative tax effort nor manage their road affairs equally well. Moreover, needs would be difficult to measure in a politically acceptable manner through the years. Therefore, a distribution formula that on the average most nearly equates proportion-wise total road costs and State assistance was accepted as a desirable goal. Such a formula, though basically reflecting needs, would not penalize individual counties that may have exerted extra efforts in their road programs or may have been favored by the current distribution formula.

In seeking such a formula, the five factors most frequently used by States for distributing motor fuel taxes to local rural units of government were tested singly and in all possible combinations. These factors (Table G-106, 3) were (a) motor vehicle registrations (used by 14 States), (b) miles of road (13 States), (c) area (12 States), (d) population (12 States), and (e) equal division (11 States). There are 31 possible combinations of these factors.

Other factors used less extensively are sales of motor fuel (used by 3 States), assessed valuation (3 States), vehicle-miles (2 States), needs (2 States), and other factors (8 States). The number of factors used by individual States range from 1 to 5. They are used in various combinations and an individual State may use more than one formula. The data are as of January 1, 1959.

Mississippi values used for the three factors that will vary with time were motor vehicle registrations (estimated number in 1972); miles of road (ultimate mileage as furnished by Automotive Safety Foundation); and population (average of 1960 and estimated 1970).

Technical Procedures

The testing method was as follows. It was assumed that a total amount of State assistance equal to the annual average total cost of all county roads in the State was to be distributed. The amount which each county would receive under each formula was stated as a percentage of its road cost, and the percent of surplus or deficit it would experience was computed. (Thus, a county that would receive 115 percent of its road cost would have a 15 percent surplus, whereas a county which would receive 85 percent of its road cost would have a 15 percent deficit.) The average deviation of these percentage surpluses and deficits was computed for each formula. The formula giving the smallest average deviation would, on the average, most nearly equate proportion-wise road costs and any given amount of State assistance. This procedure was carried through for costs under assumptions A, B, and C.

The results given in Table 2 point clearly and persuasively to road mileage as being superior to any other factor or combination of factors. The single factors rank from best to worst as follows: (a) road mileage, (b) area, (c) equal division, (d) population, and (e) motor vehicle registrations. Moreover, combinations of factors do not appear

TABLE 2

TEST OF DISTRIBUTION FORMULAS[1]
(average deviation of surpluses and deficits as percent of road cost)

Distribution Formula[2]	Automotive Safety Foundation Assumption[3]		
	A	B	C
R	63	65	66
A	20	19	21
P	53	54	55
M[4]	8	9	9
E	25	25	27
RA	33	34	35
RP	57	59	59
RM	32	33	33
RE	33	34	35
AP	28	28	29
AM[5]	12	12	13
AE	20	19	21
PM	27	28	27
PE	28	29	30
ME[5]	14	14	15
RAP	38	39	39
RAM	22	23	24
RAE	25	26	27
RPM	38	39	40
RPE	38	38	39
RME	23	23	24
APM[6]	19	20	20
APE	22	23	24
AME[5]	14	14	15
PME[6]	19	20	21
RAPM	29	29	30
RAPE	29	30	31
RAME[6]	19	20	21
RPME	28	29	29
APME[6]	17	18	19
RAPME	24	24	26

[1]Source: Table 131 (1).
[2]R = registrations; A = area; P = population; M = road mileage; E = equal division.
[3]Program costs under A, B, and C based on State highway system of 12,111, 8,466, and 6,500 miles, respectively.
[4]Recommended.
[5]Runners-up.
[6]Also further tested.

TABLE 3

AVERAGE DEVIATIONS OF COUNTY SURPLUSES AND DEFICITS AS PERCENTAGES OF ROAD COSTS UNDER VARIOUS ASSUMPTIONS AS TO AMOUNT OF STATE ASSISTANCE AND DISTRIBUTION FORMULA[1]

Automotive Safety Foundation Assumption[2]	Amount of State Assistance ($1,000)	Average Deviation of Surpluses and Deficits as Percent of Road Costs When State Assistance Distributed by							
		Mileage	Mileage and Area	Mileage and Equal	Mileage, Area and Equal	Mileage, Area and Population	Mileage, Equal and Population	Mileage, Area, Equal and Registration	Mileage, Area, Equal and Population
A	45,371	36	38	41	41	39	41	40	40
	41,061	27	29	31	31	34	35	34	34
	38,909	23	26	27	28	32	32	32	31
	36,756	20	23	24	25	31	31	30	29
	34,604	19	21	23	23	30	30	29	28
	32,451	19	21	21	22	31	31	29	28
	30,299	20	22	21	22	32	31	30	29
B	45,371	17	20	21	21	28	29	28	27
	41,061	17	19	20	20	29	29	28	27
	38,909	18	20	20	21	30	29	28	27
C	45,371	16	20	20	21	29	29	28	27
	47,523	15	20	20	21	29	29	28	26
	49,676	16	20	20	21	29	29	28	26

[1]Source: Mississippi Highway Finance Study Staff.
[2]Program costs under A, B, and C based on State highway system of 12,111, 8,466 and 6,500 mi, respectively.

to secure better results by compensating extreme values. The influence of the better factors can be discerned in the various combinations.

Despite the persuasiveness of the preceding evidence, it was not accepted as being

conclusive. From the 31 formulas, the eight having the lowest average deviations, as previously described, were selected for further examination and analysis:

1. Mileage.
2. Mileage and area.
3. Mileage and equal division.
4. Mileage, area, and equal division.
5. Mileage, area, and population.
6. Mileage, equal division, and population.
7. Mileage, area, equal division, and registrations.
8. Mileage, area, equal division, and population.

Each formula was tested pragmatically to determine how the various counties would fare if the formula were used to distribute State road assistance. The testing was done by distributing varying amounts of assumed State assistance under each assumption as to allocation of highway responsibility. The test amounts distributed were determined on the basis of various assumptions as to the division to be made between the State and the counties of estimated road revenues available under current law from State-levied taxes and Federal aid. (Some adjustments not pertinent to the present discussion were made in the average amount of estimated road revenues available under current law from State-levied taxes and Federal aid. Then, a series of assumed changes from current law in the State-county assignment of these revenues was made. Under assumptions A and B, the estimated sum assignable to the counties under current law was reduced successively, first by the truck and bus privilege (license) tax and then by $0.0025 decrements of gasoline tax, until the balance remaining plus local revenue was roughly equal to the estimated all-county road cost. Under assumption C, two increments of $0.0025 of gasoline tax were added to the estimated sum assignable to counties under current law.)

(The use of such a range of amounts of State assistance was dictated in large part by the fact that these same data also were used in reconciling the conflicting claims of the counties and the State to the road revenues available from State-levied taxes and Federal aid.)

Altogether 104 sets of assumptions as to (a) highway responsibility (i.e., assumption A, B, or C), (b) the amount of State assistance, and (c) distribution formula were tested. Under each assumption the following values were computed for each county: (a) the amount of State assistance it would receive, (b) the amount of its total road revenues including local sources, (c) the amount of its road surplus or deficit, and (d) the road surplus or deficit as a percent of its total road cost. Frequency distributions of the last were made and carefully analyzed; their average deviations are given in Table 3.

TABLE 4

STATISTICAL SURPLUS OR DEFICIT[1] AND SUMS OF DEFICITS[2] COMPARED: ESTIMATED COUNTY AVERAGES (1963-1982) UNDER VARIOUS ASSUMPTIONS AS TO ASSIGNMENT OF RESPONSIBILITY, AMOUNT OF STATE ASSISTANCE, AND ALLOCATION FORMULA[3] ($ × 10^3)

Automotive Safety Foundation Assumption[4]	Amount of State Assistance	Statistical Surplus or Deficit (-)[1]	Sum of Deficits[2] When State Aid Distributed by							
			Mileage	Mileage and Area	Mileage and Equal	Mileage, Area and Equal	Mileage, Area and Population	Mileage, Equal and Population	Mileage, Area, Equal and Registration	Mileage, Area, Equal and Population
A	45,371	15,752	-72	-64	-102	-81	-809	-772	-582	-491
	41,061	11,442	-261	-412	-350	-407	-1,853	-1,829	-1,610	-1,441
	38,909	9,290	-527	-628	-721	-842	-2,580	-2,526	-2,257	-2,087
	36,756	7,137	-1,035	-1,359	-1,344	-1,433	-3,430	-3,370	-3,083	-2,822
	34,604	4,985	-1,828	-2,098	-2,149	-2,240	-4,433	-4,367	-4,051	-3,735
	32,451	2,832	-2,930	-3,170	-3,127	-3,210	-5,582	-5,486	-5,184	-4,862
	30,299	680	-4,254	-4,511	-4,315	-4,434	-6,870	-6,751	-6,461	-6,163
B	45,371	6,164	-1,633	-2,008	-2,019	-2,071	-4,674	-4,736	-4,295	-3,948
	41,061	1,854	-3,709	-4,092	-4,116	-4,245	-7,097	-7,027	-6,654	-6,266
	38,909	-298	-5,130	-5,466	-5,444	-5,616	-8,442	-8,275	-7,946	-7,574
C	45,371	-28	-5,016	-5,818	-5,707	-5,975	-8,852	-8,763	-8,411	-8,015
	47,523	2,124	-3,655	-4,619	-4,391	-4,700	-7,659	-7,533	-7,128	-6,709
	49,676	4,277	-2,541	-3,484	-3,290	-3,583	-6,504	-6,353	-5,945	-5,526

[1]Algebraic sum of surpluses and deficits of all counties. [2]Sum of deficits of counties having deficits. [3]Source: Table 132 (1).
[4]Progam costs under A, B, and C based on State highway system of 12,111, 8,466, and 6,500 mi, respectively.

TABLE 5

STATISTICAL SURPLUS OR DEFICIT[1] AND NUMBER OF COUNTIES HAVING DEFICITS UNDER VARIOUS ASSUMPTIONS AS TO AMOUNT OF STATE ASSISTANCE AND DISTRIBUTION FORMULA[2]

Automotive Safety Foundation Assumption[3]	Amount of State Assistance ($1,000)	Statistical Surplus or Deficit (-)[1] ($1,000)	Number of Counties Having Deficits When State Assistance Distributed by							
			Mileage	Mileage and Area	Mileage and Equal	Mileage, Area and Equal	Mileage, Area and Population	Mileage, Equal and Population	Mileage, Area, Equal and Registration	Mileage, Area, Equal and Population
A	45,371	15,752	2	4	2	3	19	18	17	14
	41,061	11,442	7	13	9	12	30	27	26	25
	38,909	9,290	15	19	17	19	36	33	30	29
	36,756	7,137	24	24	26	25	40	41	38	34
	34,604	4,985	38	33	32	34	50	46	45	43
	32,451	2,832	47	50	38	38	55	51	52	51
	30,299	680	56	55	50	52	58	57	57	57
B	45,371	6,164	29	34	28	30	48	48	43	42
	41,061	1,854	51	48	47	50	57	51	53	51
	38,909	-298	60	58	52	52	61	57	57	56
C	45,371	-28	54	49	52	50	57	54	55	56
	47,523	2,124	48	44	43	45	52	51	53	51
	49,676	4,277	39	42	38	39	49	50	48	49

[1]Algebraic sum of surpluses and deficits of all counties. [2]Source: Highway Finance Study Staff.
[3]Program costs under A, B, and C based on State highway system of 12,111, 8,466, and 6,500 mi, respectively.

TABLE 6

STATISTICAL SURPLUS OR DEFICIT[1] AND AVERAGE DEFICITS OF COUNTIES HAVING DEFICITS UNDER VARIOUS ASSUMPTIONS AS TO AMOUNT OF STATE ASSISTANCE AND DISTRIBUTION FORMULA[2] ($ × 10^3)

Automotive Safety Foundation Assumption[3]	Amount of State Assistance	Statistical Surplus or Deficit (-)[1]	Average Deficit of Counties Having Deficits When State Assistance Distributed by							
			Mileage	Mileage and Area	Mileage and Equal	Mileage, Area and Equal	Mileage, Area and Population	Mileage, Equal and Population	Mileage, Area, Equal and Registration	Mileage, Area, Equal and Population
A	45,371	15,752	36	16	51	27	43	43	34	35
	41,061	11,442	37	32	39	34	62	68	62	58
	38,909	9,290	35	44	42	44	72	77	75	72
	36,756	7,137	43	57	52	57	86	82	81	83
	34,604	4,985	48	64	67	66	89	95	90	87
	32,451	2,832	62	63	82	84	101	108	100	95
	30,299	680	76	82	86	85	118	118	113	108
B	45,371	6,164	56	59	72	69	97	99	100	94
	41,061	1,854	73	85	88	85	125	138	126	123
	38,909	-298	86	94	105	108	138	145	139	135
C	45,371	-28	93	119	110	120	155	162	153	143
	47,523	2,124	76	105	102	104	147	148	134	132
	49,676	4,277	65	83	87	92	133	127	124	113

[1]Algebraic sum of surpluses and deficits of all counties. [2]Source: Computed from Tables 4 and 5.
[3]Program costs under A, B, and C based on State highway system of 12,111, 8,466, and 6,500 mi, respectively.

In computing surplus or deficit, estimated total road revenue (State assistance plus local sources) was used. Also, the total statistical surplus or deficit for all counties combined and the total of deficits for those counties having deficits were computed and analyzed (Table 4). Tables 5 and 6 give, respectively, the number of counties having a deficit and the average deficit of deficit counties under each assumption.

CONCLUSION

On the basis of the previous analysis, it was concluded that only the first four of the eight formulas merit any consideration and that, on balance, the single factor of road mileage is the best. (The detailed results of the first four formulas were presented in the report to the committee. Any one of the four would be far superior to the currently-used formula; and one of the other three might prove to be politically more acceptable than road mileage alone.) Selection of this factor does not deny that the mileage formula may appear to be particularly unfortunate to a very limited number of counties. But if the objective is to provide the most completely developed statewide system of

county roads possible with a given amount of State assistance, the mileage formula is superior to all other tested formulas.

Moreover, if all State assistance to counties were distributed on the basis of road mileage, a considerable reduction could be made in the amount of such assistance without impairing in any way the overall program of county road development. For example, under assumption A average State assistance could be reduced by $6.5 million (i.e., by the truck and bus privilege tax and $0.0025 of motor fuel tax) without increasing the number of counties that would have a deficit under existing distribution formulas or the total deficits of such counties. The particular counties involved, however, would be different. This is not to suggest that $6.5 million is the proper amount of reduction in State assistance to counties, but it is illustrative of the advantages to be derived from use of a better allocation formula.

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