that growing international awareness, both within the European Community and across the Atlantic, can make a significant contribution to their solution.

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Highway Investment and the National Economy

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ABSTRACT

Analyses conducted by the FHWA have estimated empirical relationships between levels of highway expenditures; the condition of the nation's highways; and highway users' speeds, operating costs, and fuel consumption. In this paper these analyses are extended to explain and quantify the impacts of deterioration of highway performance on (a) the macroeconomic behavior of the U.S. economy and (b) specific industry sectors. The estimated macroeconomic and interindustry impacts are consequences of departures from a base-case, multiyear program of highway expenditures that, by 1995, would restore the physical and operating characteristics of highways to what they were in 1978. Against this base case, this study estimates the consequences of a program of much lower highway expenditures that corresponds closely to FHWA's projections to 1995. The movement from the 1978 service level base case to the low-investment scenario is described in terms of lower highway expenditures and taxes and estimated resultant changes in industrial productivity, motor vehicle depreciation, and highway use. The base case and low-investment scenario are then simulated and compared by a long-term macroeconomic model and by a dynamic input-output model. The macroeconomic impacts are higher prices and lower levels of production, employment, disposable income, consumption, saving, and productivity. Projected impacts on particular industries are diverse. The most adversely affected sectors are for-hire trucking and highway construction firms and their suppliers. Several consumer-oriented industries are also projected to decline because of the weakened state of the overall economy. Several industries closely related to highway use are expected to experience growth in output. These include truck, bus, and trailer bodies; metal stampings; tires; petroleum refining; motor vehicles; and crude petroleum.

Analyses conducted by the FHWA (1) have estimated empirical relationships among levels of highway expenditures; the condition of the nation's highways; and highway users' speeds, operating costs, and fuel consumption. The FHWA Investment/Performance Impact model estimated these relationships for (a) each functional highway class, (b) rural, small urban, and urbanized areas, and (c) four vehicle types. In this paper the FHWA analyses are extended to explain and quantify the impacts of decreases in highway expenditures and highway performance on measures of macroeconomic performance of the U.S. economy. Economic impacts on specific industry sec-

tors are also analyzed. The method of analysis is to compare the levels of economic variables under two specific sets of assumptions about highway conditions. The study makes use of a long-term macroeconomic model and a dynamic input-output model. It is the direction and relative magnitude of the changes, not the estimated absolute levels that are important.

The macroeconomic and interindustry impacts examined in this paper are consequences of departures from a multiyear program of highway expenditures that, by 1995, would restore the operating characteristics of highways to what they were in 1978. As a convenient shorthand, references to this base case will be expressed hereafter in terms of the level of highway performance that existed in 1978. The specific set of changes from the 1978 level of performance, postulated year by year from 1981 to 1995, describes the movement from a 1978 service level that assumes an annual growth in vehicle miles traveled (VMT) of 2.8 percent to a low-investment scenario that corresponds closely to the revenue trend case described in The Status of the Nation's Highways: Conditions and Performance (1, Appendix B). In the low-investment scenario, VMT growth declines as a result of deterioration of highway performance.

Space limitations do not permit a review of previous empirical studies of the implications of highway performance for the national economy. Some of the formidable difficulties that an investigation of this topic entails are discussed in a recent survey paper by the Transportation Research Board (2).

SCENARIO DESCRIPTIONS

In this section the 1978-level base case and the low-investment scenario are described in terms of changes in highway expenditures, taxation, and resultant changes in industrial productivity, motor vehicle depreciation, and highway use.

Highway Expenditures

The capital and noncapital expenditure patterns for the 1978 highway performance scenario and the low-investment scenario are presented in Table 1. The 1978 service level (2.8 percent annual VMT growth) is the base case for analyzing the effects of the low-investment program, which brings about a declining annual growth in VMT because of deteriorating highway performance. The capital expenditures in the base case for the years 1981-1992 are assumed to be sufficient to maintain the 1978 performance level through 1995 if VMT grows annually by 2.8 percent. The pattern of capital expenditures for the low-investment scenario is the one reported in Table A-7 of The Status of the Nation's Highways: Conditions and Performance (1) except that actual and projected capital expenditures for 1981 and 1982 are used in place of the values in the table. The stream of noncapital spending is the same in both scenarios; it too is taken from Table A-7 of the cited report, with appropriate adjustments for 1981 and 1982 values. VMT in the low-investment scenario will continue to increase but by less than 2.8 percent a year.

TABLE 1 Expenditure Scenarios, Capital and Noncapital, 1981-1995[a]

	Constant 1978 Highway Performance (2.8% VMT growth)		Low Investment (declining VMT growth)	
Year	Capital[b]	Noncapital	Capital	Noncapital
1981	17.4	20.7	17.4	20.7
1982	15.7	19.6	15.7	19.6
1983	16.5	23.4	12.7	23.4
1984	19.8	23.5	12.1	23.5
1985	23.0	23.5	11.5	23.5
1986	26.1	23.5	10.8	23.5
1987	29.4	23.3	10.2	23.3
1988	32.7	23.1	9.6	23.1
1989	36.0	22.7	9.1	22.7
1990	39.3	22.4	8.6	22.4
1991	42.7	22.0	8.1	22.0
1992	46.1	21.5	7.7	21.5
1993	45.8	21.0	7.4	21.0
1994	45.4	20.5	7.0	20.5
1995	45.0	19.9	6.6	19.9
Total	480.9	330.6	154.5	330.6

[a]In billions of 1980 dollars.
[b]The capital expenditures for the years 1981-1992, which total $344.7 billion, are assumed to be sufficient to maintain the 1978 performance level through 1995.

Source: Federal Highway Administration and EXP Associates.

Funding Sources

In most years, the low-investment scenario represents a substantial decrease from the level of spending assumed for the 1978 highway performance base case. To obtain comprehensive estimates of the macroeconomic and interindustry implications of these decreases, it is important to account for funding changes. Historically, funding for highways has come from four sources:

1. User fees (including tolls and parking fees),
2. Nonuser taxes,
3. Investment income from highway trust funds, and
4. Bonding.

Information on the relative importance of each of these sources was provided by FHWA, and adjustments in the percentages were made as necessary to accommodate specific characteristics of the two scenarios. In the low-investment scenario, in which highway capital expenditures are cut by more than 50 percent, it is assumed that all spending reductions are matched by reductions in user and nonuser taxes.

The departures from the 1978 base case that have been discussed so far (i.e., changes in highway expenditures and funding) influence highway performance by affecting the kinds and amounts of resources that are devoted to the maintenance and improvement of the nation's roads. Changes in highway performance in turn affect the nation's economy. However, changes in highway spending and funding also influence the economy directly. A reduction in spending on highway construction, for example, will adversely affect output and employment in that industry and in industries that supply materials and services to highway construction firms. Other industries not directly related to highway construction will be negatively affected by multiplier effects. In this paper such fiscal impacts will be distinguished from economic impacts caused by changes in highway performance.

Deterioration of highway performance affects the economy primarily by influencing three variables: productivity, depreciation of motor vehicles, and VMT. In the following sections an explanation is given of how these variables are affected by declines in highway performance, how these effects are measured, and how these effects in turn produce changes in the behavior of key macroeconomic variables.

Productivity

Productivity (i.e., the ratio of outputs to inputs)

in virtually every sector of the economy is affected by the performance of the nation's highways because the performance of highways affects the efficiency with which commodities and industry personnel are carried by motor vehicles. Thus, if the low-investment scenario were realized and highways were allowed to deteriorate, transport by motor carriers would be more difficult, slower, and more costly.

The productivity adjustments made to the macroeconomic model for the movement to the low-investment case are presented in Table 2. Reachieving the 1978 highway condition and performance level by 1995 requires increased funding over the historical trend in funding extrapolated into the future (the low-investment case). The productivity values in Table 2 assume that such increases in funding could not be legislated until 1983 and that it would take 3 years of implementation before operational benefits would begin to be realized. Thus there would be no difference in labor productivity between the low-investment and base case until 1986 (values of 1.0 in the table). Using FHWA travel and speed-as-a-function-of-highway-investment forecasts, the 1995 increase in labor productivity that would result from the additional highway expenditures was computed. This 1995 value was 2.3 percent of the base case value. The intermediate 1985 to 1995 values in Table 2 are an exponential interpolation between the 1985 value of 1.0 and the 1995 value [1.0 - (2.3/ 100) = 0.977].

TABLE 2 Adjustments to Productivity and Depreciation in Going from 1978 Service Level to Low-Investment Case

Year	Adjustment	
	Productivity (weighting factor)[a]	Depreciation (billions of 1972 dollars)[b]
1981	1.0	0.0
1982	1.0	0.0
1983	1.0	0.0
1984	1.0	0.0
1985	1.0	0.0
1986	0.998	0.0
1987	0.995	0.8
1988	0.993	1.9
1989	0.991	3.0
1990	0.989	4.5
1991	0.986	6.3
1992	0.984	8.5
1993	0.982	10.8
1994	0.978	13.6
1995	0.977	16.9

[a]Data supplied by EXP Associates.
[b]Data from TSC in association with EXP Associates.

In the analysis of the effects of highway performance on productivity, it was estimated that, during 1978-1980, the number of hours spent in business travel (e.g., by truck drivers and sales persons) exceeded 11 percent of the nation's total wage hours. On the basis of forecasts of VMT, outputs of the FHWA Investment/Performance model, and other published data, labor hours in highway transit were projected for 1995 for each scenario. Differences between the low-investment scenario and the base case were then calculated. Finally, these differences were divided by projections of total U.S. labor hours in 1995 to estimate the percentage changes in overall labor productivity. Clearly, if slower speeds are a consequence of highway deterioration, as the Investment/Performance Impact model indicates, these slower speeds will adversely affect productivity in a large number of industries because more labor and truck hours will be required to accomplish the same amount of motor vehicle carriage.

Depreciation

In the macroeconomic model, the depreciation of trucks and automobiles used for business purposes is a component of a measure of total corporate depreciation. To determine the extent to which this macroeconomic variable should be changed, a series of calculations had to be carried out. First, it was determined that truck bodies, trailer coaches, and motor vehicles and parts purchased by businesses together account for 9 percent of producers' durable equipment. Based on FHWA estimates of changes in operation costs, the rate of depreciation of these vehicles in 1995 was estimated to be 22 percent higher in the low-investment scenario than it would be in the 1978 service level case. For producers' durable equipment, this means a 1995 increase of 1.98 percent in the low-investment scenario.

The dollar equivalents of these percentage changes are given in Table 2. Depreciation effects of the transition to the low-investment scenario are assumed to begin in 1987. Accordingly, the 1.96 percent increase in 1995 was scaled back to zero in 1986.

In the context of the national economy, the impacts of changes in the depreciation of motor vehicles used for transporting goods and for other business purposes can be expected to be smaller than the impacts of changes in productivity discussed previously. Higher depreciation could well result in faster replacement of vehicles and increased expenditures on maintenance, both of which would lead to higher output and employment. Though particular sectors of the economy would thus be stimulated, from a broader economic perspective this outcome is more properly viewed as an opportunity cost, that is, a diversion of resources away from the production of other goods and services.

VMT

For a given level of highway maintenance and capital investment, the level of highway performance is critically affected by the volume of traffic. For example, the faster the growth in VMT, the greater will be the deterioration of highway conditions and performance. At the same time, however, deterioration of highway performance will dampen the growth in traffic because of slower speeds and higher operating costs per mile of travel. This two-way causality was considered an important factor in the determination of the economic impacts of the movement to the low-investment scenario and was incorporated into that analysis by a two-step procedure:

1. A worst-case scenario was developed in which VMT growth would match the 2.8 percent growth of VMT in the 1978 base case, despite the lower speeds and higher operating costs caused by performance deterioration. This was done to take advantage of the Investment/Performance Impact model outputs that were generated on the assumption of a 2.8 percent annual growth in VMT. Under this assumption, operating costs in 1995 were projected to increase almost 28 percent above what they were projected to be in the base case, and average time in transit per VMT was projected to increase 21 percent. Also, the productivity weighting factors in Table 2 were lower than those given, and the increases in depreciation of motor vehicles were larger.
2. The worst-case scenario was modified on the basis of estimates of the effects of highway performance deterioration on VMT. Except for the modifications to productivity and depreciation, which are already incorporated in Table 2, feedback effects

between highway performance and VMT growth were estimated in the context of the input-output model.

Because of the two-way causality, these feedback effects were estimated iteratively. Fortunately, the estimates converged to equilibrium levels after only a few iterations. The result is a simultaneous solution for VMT growth and performance for the low-investment scenario.

THE MACROECONOMIC MODEL

A change in just one of the five variables previously discussed would perturb a complex pattern of economic relationships in ways that would be difficult to analyze and virtually impossible to estimate without the use of an econometric model of the U.S. economy. Analysis and measurement of the macroeconomic impacts of simultaneous changes in all five variables make the use of such a model essential. The macroeconomic model selected for use in this project was developed by Chase Econometrics Associates, Inc.

The Chase Long-Term Macroeconomic Model (3) consists of a set of simultaneous equations developed to predict approximately 700 economic variables. Included in the model are regression equations, identity relations, and assumption-type variables.

Simulation of the base case and the low-investment scenario required that specific variables in the macroeconomic model be modified to reflect the changes previously described. However, because VMT is not a variable in either the Chase Long-Term Macroeconomic Model or the Interindustry Forecasting Model of the University of Maryland (INFORUM), it was necessary to modify variables related to VMT in order to reflect changes in highway use. Two modifications were estimated for the INFORUM model and then aggregated for the macroeconomic model.

The macroeconomic modifications for VMT take the form of higher prices (and thus lower sales) of commodity categories that would be affected by the higher highway transport costs and slower speeds caused by deterioration of highway performance. Thus 1995 prices were increased for the following ten commodity groupings.

Commodity Group	Percent Increase
Recreational vehicles	9.6
Household operations	4.8
Other consumer nondurables	1.2
Tires and parts	1.1
Transportation services	0.8
Food and beverages	0.7
Other consumer services	0.6
Furniture and bedding	0.5
Other consumer durables	0.5
Other household services less rent	0.1

Much smaller price changes were simulated for 1986. These were then increased year by year to the 1995 levels indicated above.

Purchases by consumers of commodities directly affected by deteriorating highway performance were also modified in the macroeconomic model to reflect lower VMT. Sales in 1995 were decreased for four categories as follows:

Commodity	Decrease in Sales (%)
Gasoline and oil	11.0
New passenger car sales	8.4
Tires and parts	2.0
Transportation services	1.9

Like the commodity prices, these decreases in sales were scaled back to the much smaller changes that would be expected to begin in 1986.

After all of the modifications described in this section were effected in the macroeconomic model, the low-investment scenario was simulated by a computer routine that solved for values of all of the dependent variables in the model.

MACROECONOMIC SIMULATION OF THE LOW-INVESTMENT SCENARIO

The total effects of simultaneous changes in highway spending, taxation, productivity, depreciation of motor vehicles, and VMT were estimated for several macroeconomic variables. The effects of a reduction in highway performance from the 1978 service level to the low-investment case on six key variables are presented in Tables 3 through 8. Only columns 3 and 4, which indicate the total macroeconomic impacts, are discussed here. The portion of these impacts that represents purely fiscal effects is shown in columns 5 and 6. The remaining portion, which can be attributed to deterioration of highway performance, is shown in columns 7 and 8.

Four of the macroeconomic variables are measured in 1972 dollars. For making comparisons with the highway expenditure scenarios, which are measured in 1980 dollars, the dollar projections in Tables 3 and 8 should be multiplied by 1.786 (derived from the GNP deflator), and the dollar projections in Tables 5 and 6 by 1.970 (derived from the Consumer Price Index).

Table 3 indicates that GNP is smaller in the low-investment scenario than in the 1978 service level base case (2.8 percent growth in VMT) in every year but 1982. In 1995 the reduction in the output of goods and services is projected to be $72.31 billion, a drop of 3.2 percent. Over the entire simulation period, from 1982 through 1995, the loss is $355.68 billion (in 1972 dollars), more than one-fifth of the 1981 GNP and twice total spending by state and local governments in 1981.

Impacts on prices are presented in Table 4. By 1995 goods and services purchased by consumers will be 8 percent higher than in the base case. The implications of lower output and higher prices are given in Tables 5 and 6. Real disposable income in 1995 is estimated to be lower than in the base case by more than $90 billion, a reduction of 5.9 percent. This is equivalent to an average reduction in real disposable income of $931 per household (based on a projection of 97.3 million households in 1995 by the Bureau of Labor Statistics). Consumer spending in 1995 is estimated to decline below the base-case level by approximately $53 billion, a reduction of $541 or 3.6 percent per household. If average household disposable income and consumer spending are reduced by $931 and $541, respectively, average household saving must be reduced in 1995 by the difference, or $390.

The reduction in GNP brings with it a reduction in employment. Table 7 indicates that by 1995, the number of employed is estimated to be down by 2.66 million workers, a decline of 2.2 percent from employment in the base case. Moreover, this smaller number of employed workers perform at lower levels of productivity. Table 8 gives output per labor hour projected to be lower by 2.7 percent in manufacturing industries.

The overall macroeconomic impacts of deteriorating highway performance thus are estimated to reduce the economic welfare of the nation in terms of higher prices and lower levels of production, em-

TABLE 3 Estimated Impacts on GNP[a] of Change from 1978 Service Level to Low-Investment Case, 1982-1995

	Total Impacts				Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	1978 Service GNP	Low-Investment GNP	Impact on GNP	Percent Change	Impact on GNP	Percent of Total Impact	Impact on GNP	Percent of Total Impact
1982	1,510.58	1,513.14	2.56	0.2	2.56	100	0	0
1983	1,574.78	1,572.69	−2.09	−0.1	−2.09	100	0	0
1984	1,639.98	1,636.07	−3.91	−0.2	−3.91	100	0	0
1985	1,698.41	1,693.2	−5.21	−0.3	−5.21	100	0	0
1986	1,747.85	1,740.38	−7.47	−0.4	−6.53	87.4	−0.94	12.6
1987	1,803.00	1,792.46	−10.54	−0.6	−7.53	71.4	−3.01	28.6
1988	1,857.45	1,842.93	−14.52	−0.8	−8.37	57.6	−6.15	42.4
1989	1,912.57	1,892.2	−20.37	−1.1	−9.06	44.5	−11.31	55.5
1990	1,968.48	1,940.44	−28.04	−1.4	−9.51	33.9	−18.53	66.1
1991	2,021.43	1,985.58	−35.85	−1.8	−9.98	27.8	−25.87	72.2
1992	2,078.65	2,034.28	−44.37	−2.1	−10.03	22.6	−34.34	77.4
1993	2,135.25	2,083.14	−52.11	−2.4	−7.94	15.2	−44.17	84.8
1994	2,191.57	2,130.12	−61.45	−2.8	−6.28	10.2	−55.17	89.8
1995	2,249.04	2,176.73	−72.31	−3.2	−4.99	6.9	−67.32	93.1

[a]In billions of 1972 dollars.

TABLE 4 Estimated Impacts on Consumer Price Index[a] of Change from 1978 Service Level to Low-Investment Case, 1982-1995

	Total Impacts				Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	1978 Service CPI	Low-Investment CPI	Impact on CPI	Percent Change	Impact on CPI	Percent of Total Impact	Impact on CPI	Percent of Total Impact
1982	293.75	293.89	0.14	0	0.14	100	0	0
1983	317.15	317.12	−0.03	0	−0.03	100	0	0
1984	341.36	341.5	0.14	0	0.14	100	0	0
1985	366.71	366.82	0.11	0	0.11	100	0	0
1986	391.68	392.54	0.86	0.2	−0.08	7.8	0.94	92.2
1987	418.64	421.04	2.4	0.6	−0.39	12.3	2.79	87.7
1988	446.42	451.26	4.84	1.1	−0.8	12.4	5.64	87.6
1989	473.98	482.19	8.21	1.7	−1.35	12.4	9.56	87.6
1990	503.49	516.14	12.65	2.5	−2.03	12.1	14.68	87.9
1991	533.35	551.35	18.0	3.4	−3.03	12.6	21.03	87.4
1992	565.79	590.52	24.73	4.4	−4.21	12.7	28.94	87.3
1993	598.88	631.85	32.97	5.5	−5.39	12.3	38.36	87.7
1994	634.2	676.86	42.66	6.7	−7.01	12.4	49.67	87.6
1995	671.48	725.18	53.7	8.0	−9.0	12.6	62.7	87.4

[a]1967 = 100.

TABLE 5 Estimated Impacts on Disposable Personal Income[a] of Change from 1978 Service Level to Low-Investment Case

	Total Impacts				Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	1978 Service Income	Low-Investment Income	Impact on Income	Percent Change	Impact on Income	Percent of Total Impact	Impact on Income	Percent of Total Impact
1982	1,062.91	1,063.38	0.47	0	0.47	100	0	0
1983	1,109.12	1,108.95	−0.17	0	−0.17	100	0	0
1984	1,140.75	1,141.12	0.37	0	0.37	100	0	0
1985	1,171.21	1,172.36	1.15	0.1	1.15	100	0	0
1986	1,202.9	1,203.71	0.81	0.1	1.94	63.2	−1.13	36.8
1987	1,237.01	1,236.04	−0.97	−0.1	2.99	43.0	−3.96	57.0
1988	1,271.51	1,267.17	−4.34	−0.3	4.29	33.2	−8.63	66.8
1989	1,308.11	1,297.37	−10.74	−0.8	5.7	25.7	−16.44	74.3
1990	1,340.1	1,320.25	−19.85	−1.5	7.35	21.3	−27.2	78.7
1991	1,376.88	1,348.3	−28.58	−2.1	8.95	19.3	−37.53	80.7
1992	1,411.16	1,370.78	−40.38	−2.9	10.95	17.6	−51.33	82.4
1993	1,446.93	1,392.58	−54.35	−3.8	12.9	16.1	−67.25	83.9
1994	1,483.71	1,412.59	−71.12	−4.8	14.21	14.3	−85.33	85.7
1995	1,523.61	1,433.05	−90.56	−5.9	15.7	12.9	−106.26	87.1

[a]In billions of 1972 dollars.

TABLE 6 Estimated Impacts on Consumption[a] of Change from 1978 Service Level to Low-Investment Case, 1982-1995

	Total Impacts				Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	1978 Service Consumption	Low-Investment Consumption	Impact on Consumption	Percent Change	Impact on Consumption	Percent of Total Impact	Impact on Consumption	Percent of Total Impact
1982	975.18	975.77	0.59	0.1	0.59	100	0	0
1983	1,015.95	1,015.78	−0.17	0	−0.17	100	0	0
1984	1,056.59	1,056.56	−0.03	0	−0.03	100	0	0
1985	1,089.98	1,090.3	0.32	0	0.32	100	0	0
1986	1,122.37	1,122.17	−0.2	0	0.59	42.8	−0.79	57.2
1987	1,156.87	1,155.6	−1.27	−0.1	1.0	30.6	−2.27	69.4
1988	1,191.38	1,188.27	−3.11	−0.3	1.52	24.7	−4.63	75.3
1989	1,227.68	1,220.9	−6.78	−0.6	2.09	19.1	−8.87	80.9
1990	1,264.7	1,252.54	−12.16	−1.0	2.75	15.6	−14.91	84.4
1991	1,300.17	1,282.45	−17.72	−1.4	3.33	13.7	−21.05	86.3
1992	1,336.46	1,312.07	−24.39	−1.8	4.18	12.8	−28.57	87.2
1993	1,371.97	1,339.66	−32.31	−2.4	5.08	12.0	−37.39	88.0
1994	1,407.34	1,365.44	−41.9	−3.0	5.59	10.5	−47.49	89.5
1995	1,443.75	1,391.08	−52.67	−3.6	6.06	9.4	−58.73	90.6

[a]In billions of 1972 dollars.

TABLE 7 Estimated Impacts on Number of Employed[a] of Change from 1978 Service Level to Low-Investment Case, 1982-1995

	Total Impacts				Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	1978 Service Employed	Low-Investment Employed	Impact on Employed	Percent Change	Impact on Employed	Percent of Total Impact	Impact on Employed	Percent of Total Impact
1982	92.11	92.33	0.22	0.2	0.22	100	0	0
1983	95.41	95.37	−0.04	0	−0.04	100	0	0
1984	97.97	97.83	−0.14	−0.1	−0.14	100	0	0
1985	100.24	100.02	−0.22	−0.2	−0.22	100	0	0
1986	102.00	101.68	−0.32	−0.3	−0.33	97.1	0.01	2.9
1987	104.13	103.71	−0.42	−0.4	−0.42	100	0	0
1988	106.24	105.7	−0.54	−0.5	−0.48	88.9	−0.06	11.1
1989	108.33	107.6	−0.73	−0.7	−0.53	72.6	−0.2	27.4
1990	110.49	109.48	−1.01	−0.9	−0.59	58.4	−0.42	41.6
1991	111.93	110.6	−1.33	−1.2	−0.68	51.1	−0.65	48.9
1992	113.68	112.02	−1.66	−1.5	−0.74	44.6	−0.92	55.4
1993	115.32	113.4	−1.92	−1.7	−0.67	34.9	−1.25	65.1
1994	117.04	114.83	−2.21	−1.9	−0.64	29.0	−1.57	71.0
1995	118.68	116.02	−2.66	−2.2	−0.63	23.7	−2.03	76.3

[a]In millions.

TABLE 8 Estimated Impacts on Labor Productivity in Manufacturing[a] of Change from 1978 Service Level to Low-Investment Case, 1982-1995

	Total Impacts				Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	1978 Service Productivity	Low-Investment Productivity	Impact on Productivity	Percent Change	Impact on Productivity	Percent of Total Impact	Impact on Productivity	Percent of Total Impact
1982	9.08	9.07	−0.01	−0.1	−0.01	100	0	0
1983	9.33	9.3	−0.03	−0.3	−0.03	100	0	0
1984	9.64	9.62	−0.02	−0.2	−0.02	100	0	0
1985	10.07	10.05	−0.02	−0.2	−0.02	100	0	0
1986	10.42	10.4	−0.02	−0.2	0.0	0	−0.02	100
1987	10.74	10.68	−0.06	−0.6	0.01	12.5	−0.07	87.5
1988	11.09	11.01	−0.08	−0.7	0.01	10.0	−0.09	90.0
1989	11.46	11.34	−0.12	−1.0	0.01	7.1	−0.13	92.9
1990	11.84	11.68	−0.16	−1.4	0.01	5.6	−0.17	94.4
1991	12.28	12.1	−0.18	−1.5	0.05	17.9	−0.23	82.1
1992	12.77	12.54	−0.23	−1.8	0.05	15.2	−0.28	84.8
1993	13.22	12.95	−0.27	−2.0	0.06	15.4	−0.33	84.6
1994	13.64	13.29	−0.35	−2.6	0.06	12.8	−0.41	87.2
1995	14.06	13.68	−0.38	−2.7	0.07	13.5	−0.45	86.5

[a]Output per labor hour in 1972 dollars.

ployment, disposable income, consumption, savings, and productivity.

THE INPUT-OUTPUT MODEL

In this section, the focus of the analysis of the deterioration of highway performance shifts from macroeconomic impacts to consequences for particular industry sectors. The Chase Econometrics version of INFORUM was used to analyze these consequences.

The model used to assess the impacts of departures from the 1978 service level on particular sectors of the economy is a version of INFORUM developed by Chase Econometrics Associates (4). The Chase version of INFORUM is a 200-industry dynamic input-output model that is linked to the Chase Long-Term Macroeconomic Model. This linkage provides compatibility and consistency between the macroeconomic and industry-specific analyses.

The input-output matrices of INFORUM were modified extensively to incorporate FHWA projections of the costs of highway use in 1995 in the 1978 service level base case and in the low-investment scenario. The procedure for effecting these modifications is a series of complex and highly detailed calculations. Such an involved procedure is needed because only about one-half of total highway user costs are explicit in the matrices. The others are imbedded in the values of matrix cells.

Modification of the 1978 base case requires only that the column for highway construction in the construction sector matrix match the expenditures that were projected for this case by FHWA. The low-investment scenario requires many additional changes because only two of the 200 INFORUM sectors portray highway transportation explicitly: trucking and warehousing, and local and interurban transit. But even these inadequately reflect the condition and performance of highways alone, because the first includes warehousing and the second includes rail transit. Moreover, these two INFORUM sectors account for only a small fraction of the nation's highway travel costs.

Fortunately, an earlier study (5) estimates some relationships between highway transportation and sectors of INFORUM. Columns were developed for 13 categories of highway transportation:

1. For-hire intercity truck,
2. For-hire local truck,
3. Transit,
4. Taxi,
5. Intercity bus,
6. Private intercity freight truck,
7. Private local freight truck,
8. Private nonfreight truck,
9. Government truck,
10. Business automobile,
11. Personal automobile,
12. School bus, and
13. Other bus.

These categories account for nearly all expenditures for highway transportation.

The outputs of the FHWA Investment/Performance Impact Analysis models and FHWA's forecasts of VMT were used to estimate 1995 highway operating costs for automobiles and three truck classes for urban areas and for rural areas. Because FHWA assumed VMT growth to be 2.8 percent a year in the low-investment scenario, the initial low-investment estimates represent a worst-case scenario. This scenario was subsequently modified to reflect the negative effects of deterioration of highway performance on VMT growth. These estimates, calculated for the 1978 base case and the low-investment scenario, were translated into changes in the 13 columns named previously, after the columns were updated on the basis of recent highway revenue and expenditure data. These modified versions of INFORUM, representing the 1978 service level and the low-investment scenario, were matched with and driven by corresponding macroeconomic scenarios. Space limitations do not permit discussion of the six-step procedure that was followed to modify INFORUM. However, the steps are presented in detail in Highways and the Economy (6).

INPUT-OUTPUT SIMULATION OF THE LOW-INVESTMENT SCENARIO

The results of simulating the interindustry structure of the U.S. economy under the low-investment scenario are presented in this section along with a comparison of this simulation with its 1978 service-level base of departure. The INFORUM simulation results are measured in 1977 dollars. For making comparisons with the highway expenditure scenarios, which are measured in 1980 dollars, the dollar projections in Tables 9 through 12 should be multiplied by 1.276. Tables 9 and 10 present estimated differences in 1995 output and consumer purchases for selected industries that would be directly affected by a movement from the 1978 service level case to the low-investment scenario. The first four sectors in Table 9 are projected to incur substantial reductions in output as a consequence of lower levels of capital spending on highways and lower levels of activity in the economy generally.

The next eight sectors are directly affected by deterioration of highway performance and reductions in VMT attributable to this deterioration. The metal stampings sector is included, because it is an important supplier to the motor vehicle industry and to producers of truck, bus, and trailer bodies. The crude petroleum sector is included because of its sales to petroleum refining firms.

The increases in output of the first six of these eight sectors, though a boon to these industries, represent a social cost, because such increases divert resources away from other sectors of the economy. This diversion of resources occurs despite lower consumer purchases, which are given in Table 10. Lower consumer purchases are the direct result of reductions in VMT. Lower purchases imply that the increased outputs of these six sectors are the result of the impacts of performance deterioration on private and for-hire trucking. This waste of resources would be even greater in the absence of lower levels of macroeconomic activity, which represent social burdens of a different kind, that is, the unemployment of capital and labor.

The outputs and consumer purchases of the last two sectors in this group of eight, batteries and auto repair, are both lower than in the 1978 service level case. These reductions can be attributed to the sensitivity of VMT to increased costs of highway use and to the general decrease in the level of economic activity.

The last four lines in Table 9 indicate modal impacts of deterioration of highway performance. The easiest mode to understand is for-hire trucking, whose 1995 output is estimated to be 18 percent lower than in the 1978 service level case. First, many commodities become more expensive in the low-investment scenario. This leads to reduced sales and shipments. Second, the price of for-hire trucking increases. Finally, for-hire trucking can be expected to suffer from declines in macroeconomic activity.

TABLE 9 Industrial Sectors Significantly Affected by Movement from 1978 Service Level Case to Low-Investment Scenario: Estimated Changes in 1995 Output[a]

Sector	1978 Service Level	Low-Investment	Change	Percent Change
Related to Highway Expenditures				
Paving and asphalt	8,430.6	5,184.8	−3,245.8	−38.5
Cement, concrete, gypsum	26,732.5	19,675.1	−7,057.4	−26.4
Stone and clay mining	11,318.1	8,511.2	−2,806.9	−24.8
Other structural metal products	38,876.0	32,072.7	−6,803.3	−17.5
Related to Highway Use				
Truck, bus, trailer bodies	12,843.7	14,770.2	1,926.5	15.0
Metal stampings	22,881.7	26,108.0	3,226.3	14.1
Tires and inner tubes	16,259.9	17,560.7	1,300.8	8.0
Petroleum refining	123,131.0	128,918.0	5,787.2	4.7
Motor vehicles	191,055.0	196,978.0	5,922.7	3.1
Crude petroleum	29,302.7	29,419.9	117.2	0.4
Batteries	6,824.6	6,688.1	−136.5	−2.0
Automobile repair	80,266.0	70,874.9	−9,391.1	−11.7
Related to Other Modes				
Buses and local transit	12,224.0	13,605.3	1,381.3	11.3
Railroads	38,962.1	42,507.7	3,545.6	9.1
Airlines	51,757.8	45,495.1	−6,262.7	−12.1
Trucking	104,686.0	85,633.0	−19,052.8	−18.2

[a]In millions of 1977 dollars.

TABLE 10 Industrial Sectors Significantly Affected by Movement from 1978 Service Level Case to Low-Investment Scenario: Estimated Changes in 1995 Consumer Purchases[a]

Sector	1978 Service Level	Low-Investment	Change	Percent Change
Related to Highway Expenditures				
Cement, concrete, gypsum	4.5	3.7	−0.8	−18.3
Stone and clay mining	73.7	65.7	−8.0	−10.8
Other structural metal products	298.8	270.7	−28.1	−9.4
Related to Highway Use				
Metal stampings	1,055.7	1,013.5	−42.2	−4.0
Tires and inner tubes	17,997.9	17,152.0	−845.9	−4.7
Petroleum refining	39,616.9	35,259.0	−4,357.9	−11.0
Motor vehicles	81,522.8	74,674.9	−6,847.9	−8.4
Batteries	7,083.9	7,006.0	−77.9	−1.1
Automobile repair	40,700.7	38,625.0	−2,075.7	−5.1
Related to Other Modes				
Buses and local transit	6,798.5	7,050.0	251.5	3.7
Railroads	394.0	453.1	59.1	15.0
Airlines	20,372.6	19,191.0	−1,181.6	−5.8
Trucking	4,776.5	4,079.1	−697.4	−14.6

[a]In millions of 1977 dollars.

TABLE 11 Consumer Goods Sectors Significantly Affected by Movement from 1978 Service Level Case to Low-Investment Scenario: Estimated Changes in 1995 Output[a]

Sector	1978 Service Level	Low-Investment	Change	Percent Change
Telephone and telegraph	125,626.0	88,943.4	−36,682.9	−29.2
Drugs	19,584.9	16,040.0	−3,544.9	−18.1
Watches and clocks	2,848.5	2,407.0	−441.5	−15.5
Books	11,371.4	9,927.2	−1,444.2	−12.7
Fruits, vegetables, other crops	45,079.0	39,714.6	−5,364.4	−11.9
Poultry and eggs	11,430.8	10,242.0	−1,188.8	−10.4
Hotel and lodging places	23,727.5	21,425.9	−2,301.6	−9.7
Photographic equipment	27,039.0	24,524.4	−2,514.6	−9.3
Medical services	177,740.0	162,454.0	−15,285.6	−8.6
Canned and frozen foods	33,061.7	30,482.9	−2,578.8	−7.8
Apparel	53,988.1	50,640.8	−3,347.3	−6.2
Soft drinks and flavorings	16,233.8	15,259.8	−974.0	−6.0
Meat products	60,296.4	57,462.5	−2,833.9	−4.7
Phonograph records	2,817.8	2,707.9	−109.9	−3.9
Household furniture	18,524.6	17,839.2	−685.4	−3.7
Newspapers	20,951.9	20,281.4	−670.5	−3.2
Household appliances	21,286.5	20,796.9	−489.6	−2.3
Eating and drinking places	129,954.0	127,875.0	−2,079.3	−1.6
Alcoholic beverages	25,354.2	24,999.2	−355.0	−1.4

[a]In millions of 1977 dollars.

TABLE 12 Consumer Goods Sectors Significantly Affected by Movement from 1978 Service Level Case to Low-Investment Scenario: Estimated Changes in 1995 Consumer Purchases[a]

Sector	1978 Service Level	Low-Investment	Change	Percent Change
Telephone and telegraph	43,299.4	36,934.4	-6,365.0	-14.7
Drugs	13,799.0	12,695.1	-1,103.9	-8.0
Watches and clocks	3,014.1	2,676.5	-337.6	-11.2
Books	7,353.9	7,015.6	-338.3	-4.6
Fruits, vegetables, other crops	20,371.0	19,413.6	-957.4	-4.7
Poultry and eggs	3,905.6	3,827.5	-78.1	-2.0
Hotel and lodging places	11,877.8	11,260.2	-617.6	-5.2
Photographic equipment	5,654.4	5,196.4	-458.0	-8.1
Medical services	155,809.0	145,058.0	-10,750.8	-6.9
Canned and frozen foods	32,070.4	30,210.3	-1,860.1	-5.8
Apparel	81,003.9	78,330.8	-2,673.1	-3.3
Soft drinks and flavorings	14,125.3	13,404.9	-720.4	-5.1
Meat products	45,472.8	43,926.7	-1,546.1	-3.4
Phonograph records	4,963.0	4,794.3	-168.7	-3.4
Household furniture	26,428.3	24,499.0	-1,929.3	-7.3
Newspapers	6,907.5	6,603.6	-303.9	-4.4
Household appliances	26,033.9	25,539.3	-494.6	-1.9
Eating and drinking places	99,684.2	95,198.4	-4,485.8	-4.5
Alcoholic beverages	35,177.2	34,755.1	-422.1	-1.2

[a]In millions of 1977 dollars.

The increase in rail output is consistent with the higher costs of both private and for-hire trucking, which are substitute modes. Similarly, the increased output of bus and local transit can be explained by reductions in personal VMT, which are apparently large enough to offset the negative effects of an increase in the price of bus and local transit. The decrease in airline output could be anticipated because of the projected state of the economy in the low-investment scenario.

Tables 11 and 12 present estimated impacts on selected consumer goods industries less directly related to highway expenditures, highway use, or specific transportation modes. The more important explanatory variables for the results given in Tables 11 and 12 would appear to be aggregate disposable income and consumer spending, which, as Tables 5 and 6 indicate, decrease by 5.9 percent and 3.6 percent respectively because of the decline in the overall economy. That these macroeconomic impacts would affect some sectors more than others is evident from the variability indicated in Tables 11 and 12.

It is thus clear that although the output and sales of a few major industries would increase as a consequence of the deterioration of highway performance, most sectors of the economy would suffer declines. Industries that would experience the largest losses include for-hire trucking and highway construction firms and their suppliers.

SUMMARY

If the low-investment scenario were allowed to run its course, projected impacts on the macroeconomic performance of the economy in 1995 would include the following changes from the 1978 service level base case.

Macroeconomic Variable	Percentage Change
Gross National Product	-3.2
Consumer Price Index	+8.0
Disposable income	-5.9
Consumption expenditures	-3.6
Employment	-2.2
Labor productivity in manufacturing	-2.7

The overall macroeconomic impacts of deteriorating highway performance thus are to reduce the economic welfare of the nation in terms of higher prices and lower levels of production, employment, disposable income, consumption, and productivity.

Impacts of performance deterioration on output levels of particular industries are quite diverse. The most adversely affected sectors are for-hire trucking (-18.2 percent) and highway construction firms and their suppliers (paving and asphalt, -38.5 percent; cement, concrete, and gypsum, -26.4 percent; stone and clay mining, -24.8 percent; and other structural metal products, -17.5 percent). The automobile repair industry is projected to incur a decline of 11.7 percent as a result of the associated decrease in the growth of VMT, and the output of the airlines is estimated to fall by 12.1 percent because of lower GNP, employment, and disposable income. Several additional consumer-oriented industries could also be expected to decline because of the weakened state of the economy.

Several industries that are projected to experience growth in output are those closely related to highway use. These include truck, bus, and trailer bodies (15.0 percent), metal stampings (14.1 percent), tires and inner tubes (8.0 percent), petroleum refining (4.7 percent), motor vehicles (3.1 percent), and crude petroleum (0.4 percent). From a societal point of view, these increases in output are a burden because they represent a diversion of resources away from other sectors of the economy.

The effects felt by households are a function of household income. Under both the low-investment and the 1978 service level scenarios, average family income is forecast to grow in real terms, from $17,400 in 1982 to $21,300 in 1995 under the low-investment assumptions and to $22,700 under the 1978 service level assumptions (income and expenditure figures in 1977 constant dollars). These are equivalent to growth rates of 1.6 percent and 2.1 percent per year.

If the low-investment results were realized, households would accommodate the lower level of income by both spending and saving less. Overall, personal consumption expenditures in 1995 would be expected to be nearly $800 lower, a reduction of 3.6 percent. The input-output results indicate how this $800 is allocated across purchase groups. Significant changes are shown in the following table.

Purchase Class	Expenditure Reduction ($)
Food	76
Household furnishings	49
Clothing	36
Medical care	122
Transportation	164
Entertainment	61
Services	54

Of course these changes are relative. If compared to 1982 expenditure levels, all classes would show a positive growth.

The lower level of expenditure for transportation reflects the reduced mobility of households under the low-investment case. In the 1978 service level scenario, the typical U.S. family is projected to drive 17,226 miles in 1995. In the low-investment scenario, that family's highway VMT would be 12,786 miles, a reduction of 26 percent, or 4,440 miles. This would lead to less frequent replacement of motor vehicles and smaller expenditures on items related to automobile use. For example, the family would spend $45 less on gasoline, $21 less on automobile repairs, and $9 less on tires. On the other hand, there would be a minor increase in the use of buses, local transit, and railroads.

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Casino Bus Transportation System

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ABSTRACT

The relationship between transportation services and economic development has been well established. An interesting case study of this link is the casino bus transportation system serving Atlantic City, New Jersey. The casino buses provide a premium intercity bus service connecting numerous metropolitan areas in the Northeast Corridor with nine casinos. The casino buses bring more than ten million visitors to this resort community annually and in large measure have contributed to the economic success of legalized casino gambling. In this paper a description is presented of how the service is provided including the various subsidies and incentives provided by the casinos. Bus and passenger volumes, which indicate the dimensions of this privately operated bus service, are also presented. There is a discussion of the economic benefits of the special bus service as well as of the necessary role of government.

The need for transportation services and facilities to support economic development has been well established. Moreover, the location and pattern of industrial and commercial development within a region or state have often been influenced by existing or proposed transportation facilities. In some cases other factors such as business climate and labor force characteristics have guided development decisions. However, these situations typically call for the planning and implementation of transportation services to support development. An interesting case study of the latter situation is the casino bus operations in Atlantic City, New Jersey.