FHWA/PL/83/014
DOT-TSC-FHWA-83-1

Highways and the Economy

Transportation Systems Center
Cambridge MA 02142

November 1983
Final Report

U.S. Department of Transportation
Federal Highway Administration

Office of Program and Policy Planning
Policy Planning and Coordination Division
Washington DC 20590

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-PL-83-014		

4. Title and Subtitle	5. Report Date
HIGHWAYS AND THE ECONOMY	November 1983
	6. Performing Organization Code: TSC/DTS-42
7. Author(s) S.E. Butler, W.E. Gazda, R.J. Horn, C.G. Schneider, R.T. Smith, A.L. Webster*, H. Ismail**	8. Performing Organization Report No.: DOT-TSC-FHWA-83-1
9. Performing Organization Name and Address U.S. Department of Transportation Research and Special Programs Administration Transportation Systems Center Cambridge MA 02142	10. Work Unit No. (TRAIS): HW326/R3208 11. Contract or Grant No.:
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration Office of Program and Policy Planning Washington DC 20590	13. Type of Report and Period Covered: Final Report, Oct 1981-Jan 1983 14. Sponsoring Agency Code: HPP-20

15. Supplementary Notes

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16. Abstract

Previous analyses conducted by the Federal Highway Administration (FHWA) are used to project year-by-year economical impacts of changes in highway performance out to 1995. In the principal scenario examined, highway performance is allowed to deteriorate over time. This leads to a reduction in aggregate economic welfare in terms of higher prices and of lower levels of production, employment, disposable income, consumption expenditures, and labor productivity. The most adversely affected individual sectors are for-hire trucking and highway construction firms and their suppliers. Industries that would be helped include tires and bus, truck, and trailer bodies. Family vehicle miles traveled (VMT) is projected to decline by 26 percent in the low-investment scenario. In the scenario in which there is rapid improvement in highway performance, the projected economic changes are generally opposite to those in the low-investment scenario.

17. Key Words	18. Distribution Statement
Highway Expenditures, Highway Performance, Productivity, Vehicle Miles Traveled (VMT), Macro-economic Analysis, Input-output Analyses	DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	134	

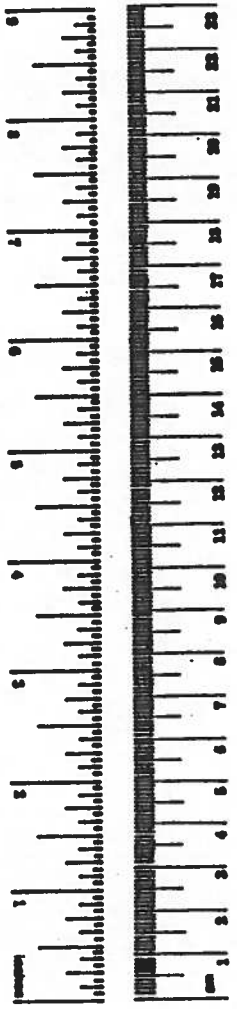
Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

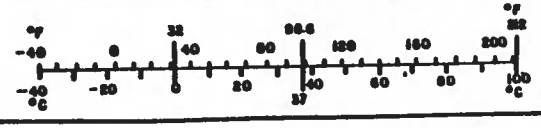
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



Preface

As part of its evaluation of the economic basis of the Nation's highway needs, the Federal Highway Administration (FHWA) has estimated empirical relationships between levels of highway expenditures, the condition of the Country's highways, and highway users' speeds, operating costs, and fuel consumption. In the present report, the results of these FHWA analyses are used to quantify the impacts of changes in highway performance -- both deterioration and improvement -- on the macroeconomic behavior of the U.S. economy and on specific industry sectors.

The research was sponsored by FHWA's Office of Program and Policy Planning in support of FHWA's on-going assessment of highway performance and its economic consequences for the Nation. The project was conducted by members of the Economic Analysis Division of the Transportation Systems Center (TSC) of the U.S. Department of Transportation (DOT). Richard J. Horn, Chief of the Economic Analysis Division, was the Project Supervisor, and Stewart E. Butler was the Technical Task Manager. The other authors were Walter E. Gazda, Catherine G. Schneider, and Rene T. Smith.

The authors gratefully acknowledge the substantive contributions of Arthur L. Webster of EXP Associates and

Hilmy Ismail of the Systems Development Corporation. In addition, the project benefitted from advice and support from FHWA's Office of Program and Policy Planning. Special thanks are extended to Harry B. Caldwell, the Program Sponsor; William F. Reulein, Chief of the Policy Development Branch; Madeleine S. Bloom, Chief of the Policy Planning and Coordination Division; and William L. Mertz, Director of the Office of Program and Policy Planning.

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Executive Summary

This report was prepared at the request of the Federal Highway Administration as a part of their development of the current biennial Highway Needs Study. It represents a continuing effort on the part of FHWA to evaluate the economic basis of highway needs.

A basic premise of this report is that two sequential links relate the level of highway spending to the economy:

(1) The level of spending affects performance characteristics of highways, e.g., user costs, speed and safety, and

(2) Changes in highway performance exert impacts on the national economy.

The first of these links has been addressed in previous and the current Highway Needs Studies and has been estimated by a complex and highly detailed set of data and models developed by the Federal Highway Administration. The purpose of this study is to begin to forge the second link in the causal chain between expenditures on highways and economic activity in order to calculate the probable economic consequences of various highway expenditure levels. Impacts are estimated both for overall, aggregate measures of economic performance and for individual industries. These are projected year by year out to the year 1995.

The base case, against which impacts of changes in highway performance are measured, is the U.S. economy as it would be if we pursued a policy of bringing highway performance up to 1978 standards by 1995. The study evaluates two alternative year-by-year scenarios of the economy out to 1995 and compares them with the base case. The principal scenario examined is one in which highway performance is allowed to deteriorate over time. This scenario was constructed on the basis of FHWA projections, which show a declining trend in real capital spending. The second scenario is one in which the highway system is quickly brought up to a "full-needs" level of performance, i.e., no poor pavement, no congestion, no alignment problems, etc., although not all mileage would be at full-design standards.

The base-case scenario and the low-investment and full-needs scenarios were simulated by the Transportation Systems Center using both a long-term macroeconomic model and a large-scale input-output model. Linkages between these two models ensure compatibility and consistency between the macroeconomic and industry-specific analyses.

The most important macroeconomic results show that if the low-investment scenario were allowed to run its course, projected impacts on the macroeconomic performance of the economy in 1995

include the following changes from the 1978 service level base case:

(1)	Gross National Product	-3.2%
(2)	Implicit GNP Deflator	+5.3%
(3)	Consumer Price Index	+8.0%
(4)	Disposable Income	-5.9%
(5)	Consumption Expenditures	-3.6%
(6)	Gross Private Domestic Investment	-1.3%
(7)	After-tax Corporate Profits	+26.9%
(8)	Employment	-2.2%
(9)	Labor Productivity in Manufacturing	-2.7%
(10)	Labor Productivity in Non-manufacturing	-3.6%
(11)	Imports of Goods and Services	-3.1%
(12)	Exports of Goods and Services	+0.3%

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 (with a relative decline of 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 auto repair industry is projected to incur a relative 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 are projected to experience growth in output as a result of increased vehicle wear and tear and lower operating efficiency caused by deteriorating highway conditions, especially for trucks, whose use would not decline significantly in response to declining highway performance. 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 are realized, households would accommodate the lower level of income by both spending and saving less. Overall, personal consumption expenditures 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. Groups that show significant expenditure reductions are:

(1)	Food	$76
(2)	Household Furnishings	49
(3)	Clothing	36
(4)	Medical Care	122
(5)	Transportation	164
(6)	Entertainment	61
(7)	Services	54

Of course, the changes noted are relative changes. 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, the family's highway VMT would be 12,786 miles, a reduction of 26 percent, or 4,440 miles. The significant decline in the private use of automobiles is in sharp contrast to the negligible decline in the use of trucks. This would lead to less frequent replacement of automobiles and smaller expenditures on

1.0 Introduction

Analyses conducted by the Federal Highway Administration [4] 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. This report extends FHWA's analyses to explain and quantify the impacts of changes in highway expenditures and highway performance on measures of macroeconomic performance of the U.S. economy. It also analyzes economic impacts on specific industry sectors. The method of analysis is to compare the levels of economic variables under alternative assumptions about highway conditions. As in studies of this sort, it is the direction and relative magnitude of the changes that are important and not the estimated absolute levels.

The macroeconomic and interindustry impacts that are examined are consequences of departures from a multi-year program of highway expenditures that, by 1995, would restore the operating characteristics of highways that users experienced in 1978. As a convenient shorthand, this base case will be referred to as the 1978 level of highway performance. Two specific sets of changes from the 1978 level of performance are postulated year by year from 1981 to 1995:

(1) Movement from a 1978 service level that assumes 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 [4, Appendix B]. In the low-investment scenario, VMT growth declines as a result of deterioration of highway performance.

(2) Movement from a 1978 service level that assumes an annual growth in VMT of 1.2 percent to a full-needs scenario, defined as a highway system having no poor pavement, no congestion, no alignment problems, etc., although not all mileage would be at full-design standards. The full-needs scenario also assumes a 1.2 percent annual increase in VMT.

For each of the two sets of departure from the 1978 service level, Section 2.0 of the report describes and provides the rationale for the postulated changes in highway expenditures, funding, industrial productivity, motor vehicle depreciation, and VMT. Section 3.0 describes the computer-based macroeconomic model that was used to simulate the future repercussions of departures from the 1978 service level. Section 4.0 presents detailed results of the macroeconomic simulation of the low-investment scenario in terms of impacts on twelve measures of aggregate economic performance.

INFORUM, a dynamic input-output model, was selected as the analytical framework for projecting the interindustry impacts of the two departures from the 1978 base case. This model and the modifications that were made to it to incorporate FHWA's empirical relationships are described in Section 5.0. The results of the interindustry analysis of the low-investment scenario are reported in Section 6.0. The macroeconomic and INFORUM simulations of the full-needs scenario are discussed in Section 7.0. Section 8.0 summarizes the implications of changes in highway performance for the economy as a whole, for some individual industries, and for the average U.S. family.

2.0 Scenario Descriptions

This section describes two 1978 level base cases and the departures from them in terms of changes in highway expenditures, taxation, and resultant changes in industrial productivity, motor vehicle depreciation, and highway usage. The macroeconomic and interindustry impacts of these changes are discussed in subsequent sections.*

2.1 Highway Expenditures

The capital and non-capital expenditure patterns for two 1978 highway performance scenarios, the low-investment scenario, and the full-needs scenario are presented in Table 1. The total capital spending in the two 1978 service level scenarios is assumed to meet 85 percent of the full needs under the specified assumption about the annual rate of VMT growth. These two scenarios serve as the base cases to which the high- and low-investment alternatives are compared.

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

*The changes made in the Chase Macroeconomic and INFORUM models for purposes of simulating the low-investment and full-needs scenarios are presented in Sections 2.3, 3.2, and 5.2. These changes are the end products of lengthy and detailed calculations. In the interest of economy of space, these have been omitted from the report. They are available on request from the Economic Analysis Division, Transportation Systems Center, Kendall Square, Cambridge, Massachusetts 02142.

TABLE I

Expenditure Scenarios, Capital and Non-Capital, 1981-1995
(billions of 1980 dollars)

	Constant 1978 Highway Performance (2.8% VMT growth)		Low Investment (Declining VMT growth)		Constant 1978 Highway Performance (1.2% VMT growth)		Full Needs (1.2% VMT growth)	
Year	Capital*	Non-Capital	Capital	Non-Capital	Capital	Non-Capital	Capital	Non-Capital
1981	17.4	20.7	17.4	20.7	57.90	13.32	67.15	13.0
1982	15.7	19.6	15.7	19.6	57.90	13.32	67.15	13.0
1983	16.5	23.4	12.7	23.4	57.90	13.32	67.15	13.0
1984	19.8	23.5	12.1	23.5	57.90	13.32	67.15	13.0
1985	23.0	23.5	11.5	23.5	57.90	13.32	67.15	13.0
1986	26.1	23.5	10.8	23.5	6.81	23.31	7.9	22.75
1987	29.4	23.3	10.2	23.3	6.81	23.31	7.9	22.75
1988	32.7	23.1	9.6	23.1	6.81	23.31	7.9	22.75
1989	36.0	22.7	9.1	22.7	6.81	23.31	7.9	22.75
1990	39.3	22.4	8.6	22.4	6.81	23.31	7.9	22.75
1991	42.7	22.0	8.1	22.0	3.41	29.97	3.95	29.25
1992	46.1	21.5	7.7	21.5	3.41	29.97	3.95	29.25
1993	45.8	21.0	7.4	21.0	3.41	29.97	3.95	29.25
1994	45.4	20.5	7.0	20.5	3.41	29.97	3.95	29.25
1995	45.0	19.9	6.6	19.9	3.41	29.97	3.95	29.25
Total	480.9	330.6	154.5	330.6	340.6	333.0	395.0	325.0

*The capital expenditures for the years 1981-92, 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

because of deteriorating highway performance. The capital expenditures in the base case for the years 1981-1992 are assumed to be sufficient for attainment of the 1978 performance level by 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 [4], except that actual and projected capital expenditures for 1981 and 1982 are used in place of the values in the table. The stream of non-capital spending is the same in both scenarios; it too is taken from Table A-7 of the cited report, with appropriate adjustments for the 1981 and 1982 values. VMT in the low-investment scenario will continue to increase, but by less than 2.8 percent a year.

The second 1978 performance level case assumes a 1.2 percent annual VMT growth, which corresponds to the assumption made for the full-needs scenario. In each of these two cases, 85 percent of the capital expenditures for the period 1981-1995 is allocated equally among the first five years, 10 percent is allocated equally among the next five years, and the remaining 5 percent is allocated equally among the last five years. Non-capital expenditures for these two scenarios are allocated on a 20 percent-35 percent-45 percent basis to the five-year intervals under the assumption that required operating and maintenance expenditures will increase as capital expenditures decrease.

The time path of capital spending for each of the four

scenarios is plotted in Figure 1. Two important points are shown clearly in the diagram. The first is the increasing divergence between capital spending in the base case with 2.8 percent VMT growth and the low-investment scenario, except in the first two years when actual amounts are used. The other is that capital spending patterns in the full-needs case and its base scenario parallel each other, although the dollar spread between them is greater in the first five years than throughout the rest of the period.

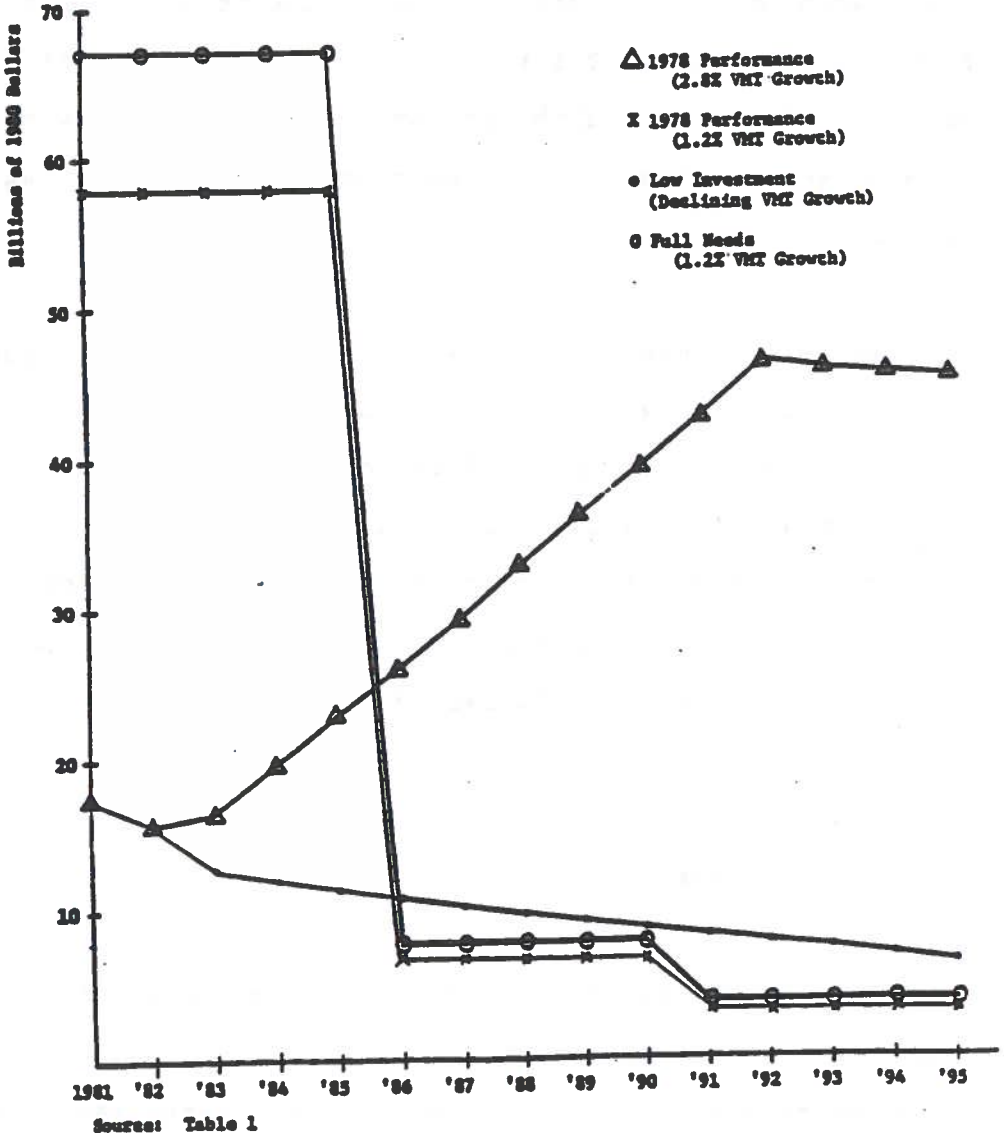
Table 2 presents the total expenditure levels (capital plus non-capital) for each scenario, and these are plotted in Figure 2. There is only one significant difference between Figures 1 and 2. Beginning in 1991, total spending for the full-needs scenario is less than that for the associated base case as a result of the assumptions made about the levels of noncapital spending. However, the dollar differences between them are small.

2.2 Funding Sources

In most years, the alternative highway expenditure scenarios represent substantial increases or decreases from the levels of spending assumed for the two 1978 highway performance scenarios. To obtain comprehensive estimates of the macroeconomic and inter-industry implications of these spending changes, the sources of funding as well as the spending changes themselves must be taken

FIGURE 1

Capital Expenditure Levels,
by Scenario



Source: Table 1

TABLE 2

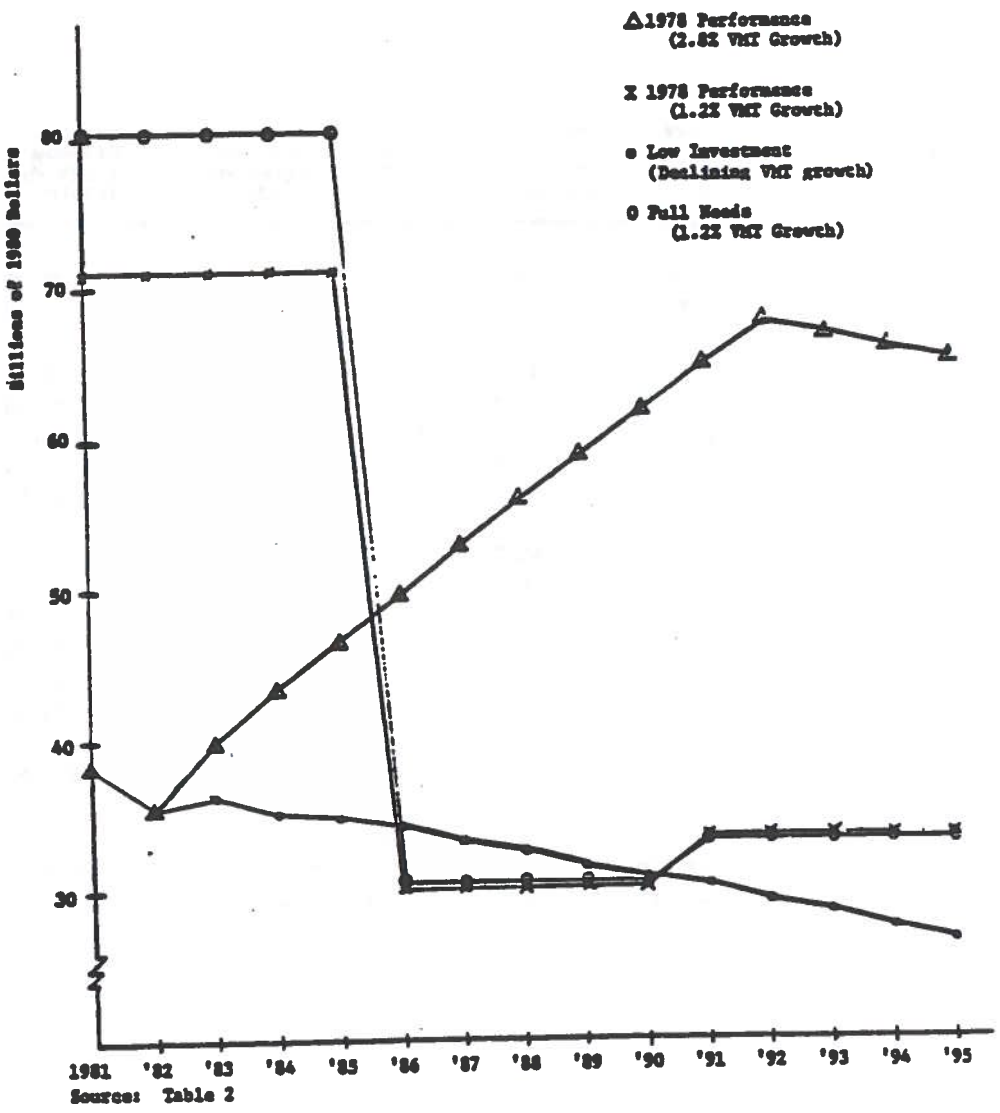
Combined Expenditure Levels by Scenario
(billions of 1980 dollars)

Year	Constant 1978 Highway Performance (2.8% VMT growth)	Low Investment (Declining VMT growth)	Constant 1978 Highway Performance (1.2% VMT growth)	Full Needs (1.2% VMT growth)
1981	38.1	38.1	71.22	80.15
1982	35.3	35.3	71.22	80.15
1983	39.9	36.1	71.22	80.15
1984	43.3	35.6	71.22	80.15
1985	46.5	35.0	71.22	80.15
1986	49.6	34.3	30.12	30.65
1987	52.7	33.5	30.12	30.65
1988	55.8	32.7	30.12	30.65
1989	58.7	31.8	30.12	30.65
1990	61.7	31.0	30.12	30.65
1991	64.7	30.1	33.38	33.2
1992	67.6	29.2	33.38	33.2
1993	66.8	28.4	33.38	33.2
1994	65.9	27.5	33.38	33.2
1995	64.9	26.5	33.38	33.2
Total	811.5	485.1	673.6	720.0

*In the low-investment scenario VMT growth subsequently declines as a result of deterioration of highway performance.

FIGURE 2

Combined Expenditure Levels,
by Scenario



into account. The following paragraphs describe the relation between the requisite funding changes and specific taxes. No distinction is made between capital investment and operations and maintenance expenditures in terms of sources of funding.

Historically, financing for highways has come from four sources:

(1) User fees (including tolls and parking fees)

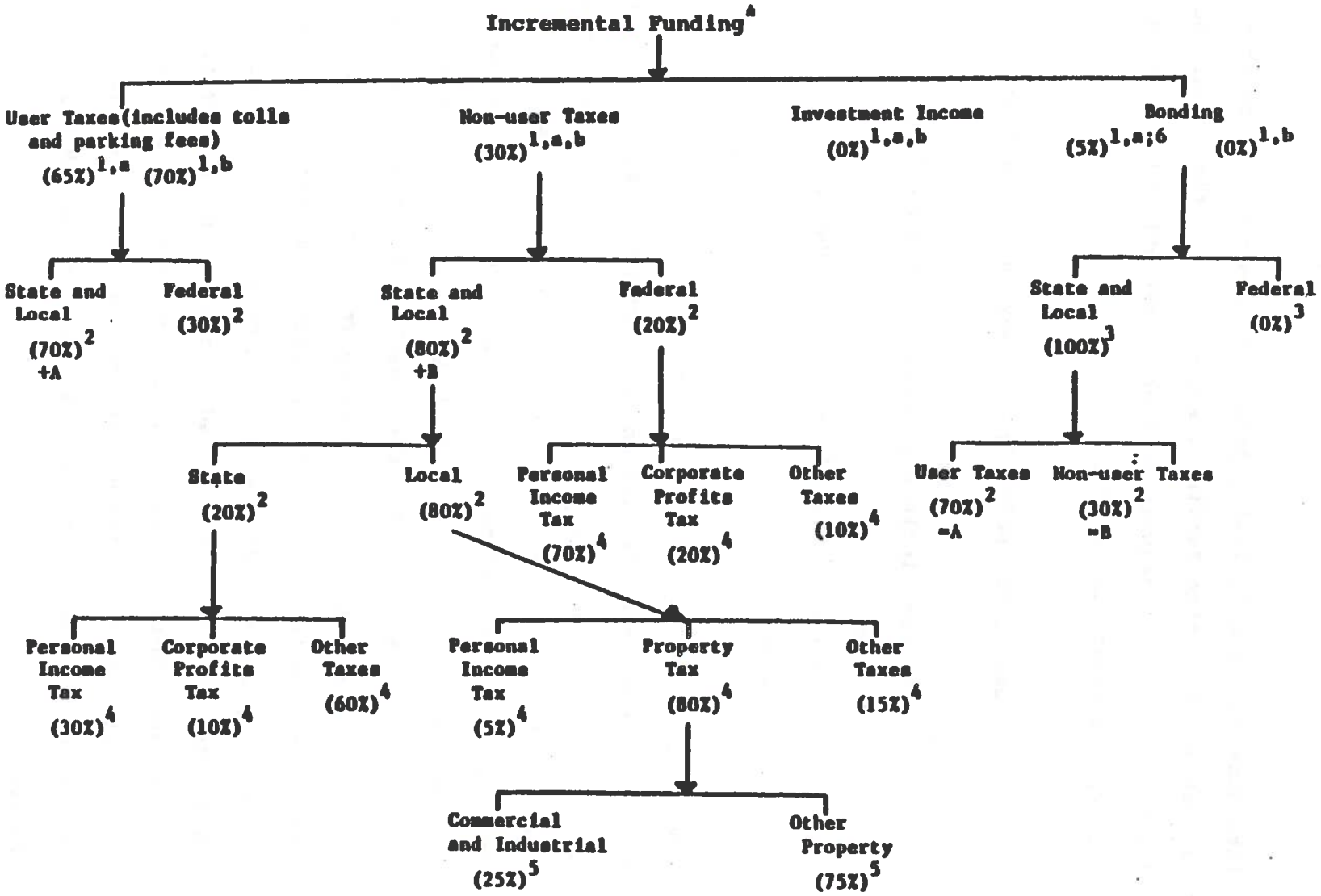
(2) Non-user taxes

(3) Investment income from highway trust funds

(4) Bonding

Information on the relative importance of each of these sources was provided by FHWA, and adjustments in the percentages were made to accommodate specific characteristics of the alternative scenarios. For the full-needs scenario, incremental funding, i.e., funding above that required to maintain the 1978 performance level, is assumed to come from user fees, non-user taxes, and bonding. No incremental funding is drawn from investment income under the assumption that the limited investment income currently available from the Highway Trust Fund is dedicated to base-case spending. 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 non-user taxes. The following table identifies the sources of funding increments or decrements by scenario. The percentages correspond to the figures given in the top line of Figure 3.

FIGURE 3



*Superscripts refer to notes on the next page.

Notes for Figure 3

1. Percentages based on information from FHWA. Adjustments were made to reflect the assumption that no incremental funding comes from investment income, i.e., all investment income supports the base case level of spending.

   (a) Applies when change in funding is positive.

   (b) Applies when change in funding is negative.

2. The Status of the Nation's Highways: Conditions and Performance, January, 1981, Table B-3.

3. FHWA, Highway Statistics 1980, Table HF-10.

4. U.S. Bureau of the Census, Governmental Finances in 1977-78, Series GF, No. 5.

5. Advisory Commission on Intergovernmental Relations, Significant Features of Fiscal Federalism, 1976-1977 Edition, Vol. II.

6. Debt service on bond issues is calculated at 3 percent real rate of return. Principal is assumed to be payable after 1995.

	Full-Needs Scenario	Low-Investment Scenario
User Fees	65%	70%
Non-User Taxes	30%	30%
Bonding	5%	

Debt service on bond issues, calculated at a 3 percent real rate of interest, is assumed to be funded from both user and non-user taxes. The portion of debt service attributed to each category of taxes is assumed to equal the category's contribution to tax revenue at the state and local level. In Figure 3, the dollar amounts of debt service designated A and B, are added to the state and local tax burdens identified in the first step of the calculations to derive the full amount of revenue that must be raised from tax sources. The principal of the bond issues is assumed to be payable at maturity, after 1995.

Once the required revenue changes have been allocated to the broad funding categories, the next step is to identify the federal, state, and local shares. In most cases, it is sufficient to distinguish between federal and the combination of state and local. Only in the case of non-user taxes is the state and local share further disaggregated, because the mix of taxes at the state level is quite different from that at the local level. The data on which the percentages by level of government are based are taken from FHWA publications.

The last stage is to apply the revenue changes to specific federal, state, and local taxes and to associate these specific taxes with variables in the macroeconomic model. Revenue changes funded from non-user taxes are allocated among personal income taxes, corporate profits taxes, property taxes, and "other" taxes. The share designated for a particular tax at each level of government is equal to its share of "general tax revenue from own sources" net of highway user taxes. The data on which these percentages are calculated are taken from the U.S. Bureau of the Census, Governmental Finances. The tax burden assigned to local property taxes is divided between commercial/industrial owners and other owners. Section 3.2 provides a discussion of the relationships between the tax types shown in Figure 3 and the macroeconomic model's tax variables.

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 impacted by "multiplier effects." In this report, these fiscal impacts will be

distinguished from economic impacts caused by changes in highway performance. These latter impacts are considered next.

2.3 Changes in Productivity, Depreciation and VMT

Both improvement and deterioration of highway performance exert impacts on the economy primarily through their influence on three variables: productivity, depreciation of motor vehicles, and VMT.* This section explains how these variables are affected by changes 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 this affects the efficiency with which commodities and industry personnel are carried by motor vehicles. Thus, for example, a move from the 1978 service level to full-needs conditions could be expected to enhance the efficiency with which goods are distributed. Truck transport would be easier, faster, and hence cheaper. If,

*In addition, inventories in transit would increase in the low-investment case as a result of slower vehicle speeds and would decrease in the full-needs case. However, preliminary calculations indicate that the effects on enroute inventories are negligible.

however, 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 are shown in Table 3 for the movement to the low-investment case and in Table 4 for the movement to the full-needs scenario. Reachieving the 1978 highway condition and performance level by 1995 (either of the base cases) requires increased funding over the historical trend in funding extrapolated into the future (the low-investment case). The productivity values in Table 3 assume that such increases in funding could not be legislated until 1983 and that it would take three 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 Federal Highway Administration travel and speed-as-a-function-of-highway-investment forecasts, EXP computed the 1995 increase in labor productivity that would result from the additional highway expenditures. This 1995 value was 2.3 percent of the base case value. The intermediate 1985 to 1995 values in Table 3 are an exponential interpolation between the 1985 value of 1.0 and the 1995 value (1.0-2.3/100=.977).

In its analysis of the effects of highway performance on productivity, EXP estimated that, during 1978-80, the number of hours spent in business travel, e.g, by truck drivers and sales

TABLE 3

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

Year	Adjustment to: Productivity (weighting factor)[1]	Depreciation (billions 1972$)[2]
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	.998	0.0
1987	.995	.8
1988	.993	1.9
1989	.991	3.0
1990	.989	4.5
1991	.986	6.3
1992	.984	8.5
1993	.982	10.8
1994	.978	13.6
1995	.977	16.9

Sources: [1]EXP Associates

[2]TSC in association with EXP Associates

TABLE 4

Adjustments to Productivity and Depreciation in Going from 1978 Service Level to Full-Needs Case

Year	Adjustment to: Productivity (weighting factor)[1]	Depreciation (billions 1972$)[2]
1981	1.0002	0.0
1982	1.0003	-.2
1983	1.0011	-.2
1984	1.0020	-.2
1985	1.0020	-.4
1986	1.0021	-.6
1987	1.0021	-.6
1988	1.0021	-.8
1989	1.0022	-1.0
1990	1.0022	-1.4
1991	1.0023	-1.6
1992	1.0023	-2.0
1993	1.0023	-2.4
1994	1.0023	-2.7
1995	1.0023	-3.1

Sources: [1]EXP Associates

[2]FHWA, TSC, and EXP Associates in association

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 and full-needs scenarios and their respective base cases 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 of automobiles used for business purposes is a component 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 Federal Highway Administration estimates of changes in operation costs, EXP Associates estimated that the rate of depreciation of these

vehicles in 1995 would be 22 percent higher in the low-investment scenario than it would be in the 1978 service level case and 4 percent lower in the full-needs scenario. For producers' durable equipment, this means a 1995 increase of 1.96 percent in the low-investment scenario and a reduction of 0.36 percent in the full-needs scenario.

The dollar equivalents of these percentage changes are also shown in Tables 3 and 4. 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. All effects of the transition to the full-needs scenario, however, are assumed to begin immediately.

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 above. Higher depreciation could well result in faster replacement of vehicles and/or 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, i.e., 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 to be an important factor in the determination of the economic impacts of the movement to the low-investment scenario. It was incorporated into that analysis by a two-step procedure.

First, 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 by almost 28 percent over and above what they were projected to be in the base case, and average time in transit per VMT was projected to increase by 21 percent. Also, the productivity weighting factors in Table 3 were lower than

those shown, and the increases in depreciation of motor vehicles were larger.

Second, this 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 3, feedback effects between highway performance and VMT growth were estimated in the context of the INFORUM model. The methodology that was used is explained in Section 5.0.

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 measures for the low-investment scenario.

3.0 The Macroeconomic Model

Section 2.0, above, describes changes in highway expenditures, taxes, productivity, depreciation and vehicle miles of travel that would occur with the implementation of government policy of improving the nation's highways or of allowing them to deteriorate. A change in just one of these five variables 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 makes the use of such a model essential. The macroeconomic model selected for use in this project was developed by Chase Econometrics Associates, Inc.

3.1 General Description

The Chase Long-Term Macroeconomic Model 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.

The model may be simulated over a specified future period of time in a unaltered state, or it may be modified by the analyst to reflect changes in policy assumptions or economic activity. The result of a simulation is a prediction of the impacts of

user-specified changes as these work through the structure of the model. Changes may be in the form of scaling factors, growth rates, or simple additions (positive or negative) to variables. Alternative patterns of economic activity may thus be specified and evaluated. A more complete description of the Chase model is presented in Reference (1).

3.2 Use of the Chase Model to Simulate Scenarios

The Chase Long-Term model was used to analyze the impacts of simultaneous changes in all five of the variables discussed in Section 2.0. This was done for both (a) the movement from the first 1978 service level case - assuming a 2.8 percent annual growth in VMT - to the low-investment scenario with declining VMT growth and (b) the movement from the second 1978 service level case - assuming a 1.2 percent annual growth in VMT - to the full-needs scenario, which also assumes a 1.2 percent annual growth in VMT. For each movement, impacts on 12 major macroeconomic variables were estimated for the period from 1982 through 1995. The results of this analysis are presented in Sections 4.0 and 7.0.

Simulation of the alternative scenarios requires that specific variables in the macroeconomic model be modified to reflect the changes described in Section 2.0. The highway spending modifications were made to "State and Local Purchases of Structures" in the Chase model. This was as close a match as

possible given the level of disaggregation in the state and local sector of the model. Along with changes to "State and Local Purchases of Structures," the variable "Grants-in-Aid" (from the federal government to states and localities) had to be modified by the changes in federal taxes raised. This allowed changes in federal tax revenues to pass through to the state and local governments, where the actual spending is done. Had this not been done, the model would have increased the state and local deficit to account for the revenue shortfall, which in turn would have caused state and local indirect business taxes to increase.

The tax adjustments shown in Figure 3 were assigned to the following tax variables in the model:

(1) Federal personal tax receipts
(2) Federal corporate profit taxes
(3) Federal indirect business taxes
(4) State and local personal tax receipts
(5) State and local corporate profit taxes
(6) State and local indirect business taxes

All revenue changes funded by user taxes were assigned to the two indirect business tax variables. Revenue changes funded by non-user taxes (personal income taxes, corporate profits taxes, property taxes, and "other" taxes) were allocated among all the model's tax variables. Changes in personal income taxes were assigned to the two personal tax variables, and changes in corporate profit taxes were assigned to the corporate profit tax variables. Commercial/industrial property taxes were treated as

state and local indirect business taxes, and other property taxes were included in the state and local personal tax receipts variable. "Other" taxes were assumed to be indirect business taxes - both (a) federal and (b) state and local.

The model was modified to reflect changes in manufacturing productivity by multiplying "Productivity Trend in Manufacturing" by the productivity weighting factors in Tables 3 and 4. However, because no such index is available for non-manufacturing, an indirect method of affecting productivity in non-manufacturing was employed. The approach taken was to utilize relationships between prices and productivity. As productivity in a sector rises, it is expected that the prices of the output will fall, at least in reasonably competitive industries. In the model, then, increases in productivity in non-manufacturing were represented by decreases in prices for various outputs, while productivity declines were simulated by increasing prices. Changes were made in the price of food, beverages, apparel, gasoline, household operations, transportation services and "other services." Changes in motor vehicle depreciation were simulated by adding the depreciation columns in Tables 3 and 4 to "Corporate Depreciation."

Because VMT is not a variable in either the Chase Long-Term Macroeconomic Model or INFORUM, it was necessary to modify variables related to VMT in order to reflect changes in highway usage. Two modifications, which were made only for the movement

to the low-investment scenario, were estimated for the INFORUM model and then aggregated for the macroeconomic model. The procedures that were used to estimate the INFORUM modifications for VMT changes are explained in Section 5.0.

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

(1)	Recreational vehicles	9.6%
(2)	Household operations	4.8%
(3)	Other consumer nondurables	1.2%
(4)	Tires and parts	1.1%
(5)	Transportation services	0.8%
(6)	Food and beverages	0.7%
(7)	Other consumer services	0.6%
(8)	Furniture and bedding	0.5%
(9)	Other consumer durables	0.5%
(10)	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.

Commodities whose purchases by consumers would be directly impacted 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:

(1)	Gasoline and oil	11.0%
(2)	New passenger car sales	8.4%
(3)	Tires and parts	2.0%
(4)	Transportation services	1.9%

Like the commodity prices, these decreases in sales were scaled back to 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. The more important of these results are presented in the following section.

4.0 Macroeconomic Simulation of the Low-Investment Scenario

This section presents the results of simulating the low-investment scenario and comparing it with its 1978 service level base case. The results of simulating the full-needs scenario are presented in Section 7.0. Impacts on the following macroeconomic variables are analyzed:

(1) Gross National Product (GNP)

(2) GNP Implicit Price Deflator

(3) Consumer Price Index

(4) Disposable Personal Income

(5) Consumption

(6) Corporate Profits after Taxes

(7) Gross Private Investment

(8) Employment

(9) Labor Productivity in Manufacturing

(10) Other Private Labor Productivity

(11) Imports of Goods and Services

(12) Exports of Goods and Services

The total impacts of simultaneous changes in highway spending, taxation, productivity, depreciation of motor vehicles, and VMT are estimated for each of the twelve variables. The combined fiscal impacts of changes in highway spending and taxation are then distinguished from the combined impacts of simultaneous changes in productivity, depreciation and VMT.

The impacts of a reduction in highway performance from the

1978 service level to the low-investment case are presented in Tables 5 through 16*. They are also shown in Figures 4 through 15. Columns 3 and 4, which show the total macroeconomic impacts, are discussed first. The portion of these impacts that represents purely fiscal effects, shown in columns 5 and 6, is explained next. The remaining portion, which can be attributed to deterioration of highway performance, shown in columns 7 and 8, is explained last.

4.1. Total Macroeconomic Impacts

Simulation of the 1978 service level base case by using the Chase Long-Term Model yields values of macroeconomic variables shown in column 1 of Tables 5 through 16. Simulation of the low-investment scenario produces the values in column 2. Columns 3 and 4 show the absolute and percentage differences, respectively, between the two scenarios. This section summarizes these results and explores their more important implications for the U.S. economy. Explanations of these results are presented in the next two sections.

Table 5 and Figure 4 indicate that GNP is smaller in the low-investment scenario than in the 1978 service level base case

*Six of the macroeconomic variables are measured in 1972 dollars. For purposes of making comparisons with the highway expenditure scenarios in Section 2.1, which are measured in 1980 dollars, the dollar projections in Tables 5,13,14,15, and 16 should be multiplied by 1.786 (derived from the GNP deflator), and the projections in Tables 8 and 9 by 1.970 (derived from the Consumer Price Index).

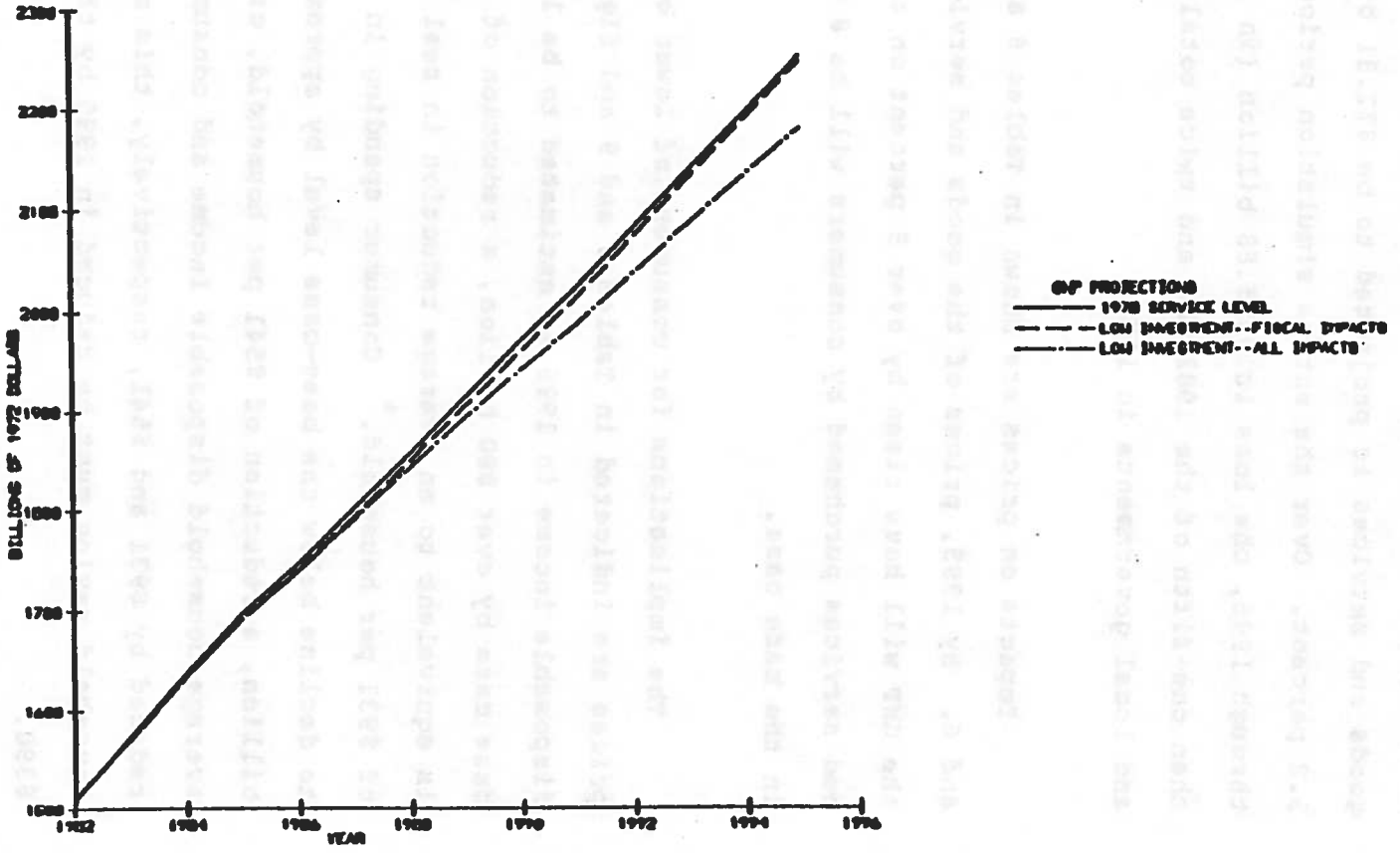
TABLE 5

ESTIMATED IMPACTS on GNP
(billions of 1972 dollars) of
CHANGE FROM 1978 SERVICE LEVEL
(2.8% annual growth in VHT)
to LOW-INVESTMENT CASE (declining growth in VHT),
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE GNP	LOW INVESTMENT GNP	IMPACT ON GNP	PERCENTAGE CHANGE	IMPACT ON GNP	PERCENTAGE OF TOTAL IMPACT	IMPACT ON GNP	PERCENTAGE OF TOTAL IMPACT
1982	1510.58	1513.14	2.56	.2	2.56	100	0	0
1983	1574.78	1572.69	-2.09	-.1	-2.09	100	0	0
1984	1639.98	1636.07	-3.91	-.2	-3.91	100	0	0
1985	1698.41	1693.2	-5.21	-.3	-5.21	100	0	0
1986	1747.85	1740.38	-7.47	-.4	-6.53	87.4	-.94	12.6
1987	1803	1792.46	-10.54	-.6	-7.53	71.4	-3.01	28.6
1988	1857.45	1842.93	-14.52	-.8	-8.37	57.6	-6.15	42.4
1989	1912.57	1892.2	-20.37	-1.1	-9.06	44.5	-11.31	55.5
1990	1968.48	1940.44	-28.04	-1.4	-9.51	33.9	-18.53	66.1
1991	2021.43	1985.58	-35.85	-1.8	-9.98	27.8	-25.87	72.2
1992	2078.65	2034.28	-44.37	-2.1	-10.03	22.6	-34.34	77.4
1993	2135.25	2083.14	-52.11	-2.4	-7.94	15.2	-44.17	84.8
1994	2191.57	2130.12	-61.45	-2.8	-6.28	10.2	-55.17	89.8
1995	2249.04	2176.73	-72.31	-3.2	-4.99	6.9	-67.32	93.1

FIGURE 4

GNP Projections
(Billions of 1972 Dollars)



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 shown in Tables 6 and 7 and Figures 5 and 6. By 1995, prices of the goods and services that make up the GNP will have risen by over 5 percent on the average. Goods and services purchased by consumers will be 8 percent higher than in the base case.

The implications for consumers of lower output and higher prices are indicated in Tables 8 and 9 and figures 7 and 8. Real disposable income in 1995 is estimated to be lower than in the base case by over $90 billion, a reduction of 5.9 percent. This is equivalent to an average reduction in real disposable income of $931 per household.* Consumer spending in 1995 is estimated to decline below the base-case level by approximately $53 billion, a reduction of $541 per household, or 3.6 percent. If average household disposable income and consumer spending are reduced by $931 and $541, respectively, this means that average household saving must be reduced in 1995 by the difference, or $390.

*Based on a projection of 97.3 million households in 1995 by the Bureau of Labor Statistics.

TABLE 6

ESTIMATED IMPACTS on IMPLICIT PRICE DEFLATOR,
GROSS NATIONAL PRODUCT (1972=100)
CHANGE FROM 1978 SERVICE LEVEL
(2.8% annual growth in VMT)
to LOW-INVESTMENT CASE (declining growth in VMT)
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE DEFLATOR	LOW INVESTMENT DEFLATOR	IMPACT ON DEFLATOR	PERCENTAGE CHANGE	IMPACT ON DEFLATOR	PERCENTAGE OF TOTAL IMPACT	IMPACT ON DEFLATOR	PERCENTAGE OF TOTAL IMPACT
1982	209.11	209.2	.09	0	.09	100	0	0
1983	225.39	225.4	.01	0	.01	100	0	0
1984	241.5	241.47	-.03	0	-.03	100	0	0
1985	259.64	259.47	-.17	-.1	-.17	100	0	0
1986	277.83	277.91	.08	0	-.42	45.7	.5	54.3
1987	297.27	298.02	.75	.3	-.78	33.8	1.53	66.2
1988	317.23	319.11	1.88	.6	-1.24	28.4	3.12	71.6
1989	337.84	341.27	3.43	1	-1.79	25.5	5.22	74.5
1990	359.22	364.71	5.49	1.5	-2.48	23.7	7.97	76.3
1991	380.38	388.44	8.06	2.1	-3.37	22.8	11.43	77.2
1992	402.72	413.96	11.24	2.8	-4.4	22	15.64	78
1993	426.23	441.42	15.19	3.6	-5.43	20.8	20.62	79.2
1994	451.06	471.03	19.97	4.4	-6.65	20	26.62	80
1995	477.36	502.77	25.41	5.3	-8.09	19.5	33.5	80.5

FIGURE 5

Projections of GNP
Implicit Price Deflator
(1972=100)

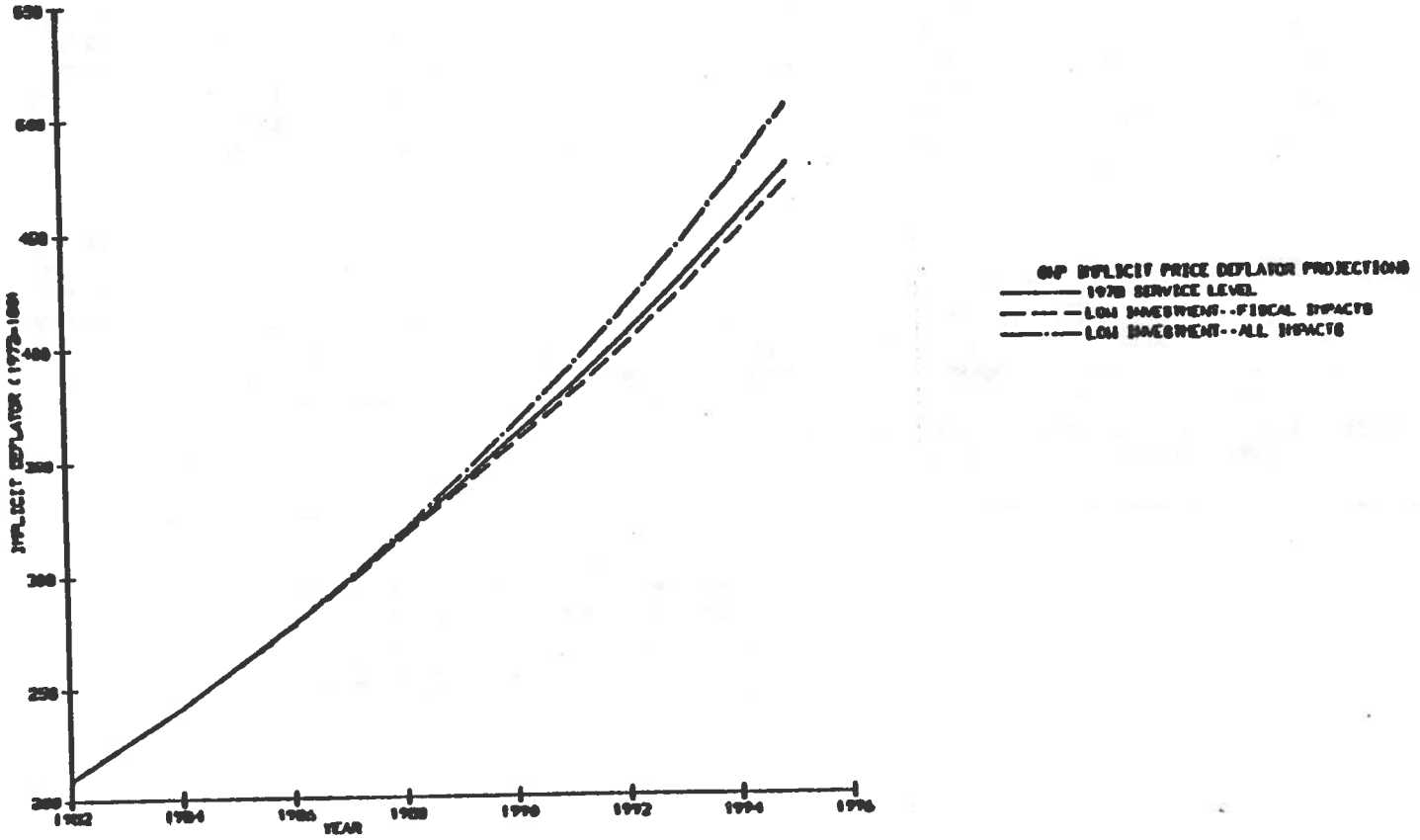


TABLE 7

ESTIMATED IMPACTS on CONSUMER
PRICE INDEX (1967=100) of CHANGE
FROM 1978 SERVICE LEVEL
to LOW-INVESTMENT CASE (declining growth in VMT)
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE CPI	LOW INVESTMENT CPI	IMPACT ON CPI	PERCENTAGE CHANGE	IMPACT ON CPI	PERCENTAGE OF TOTAL IMPACT	IMPACT ON CPI	PERCENTAGE OF TOTAL IMPACT
1982	293.75	293.89	.14	0	.14	100	0	0
1983	317.15	317.12	-.03	0	-.03	100	0	0
1984	341.36	341.5	.14	0	.14	100	0	0
1985	366.71	366.82	.11	0	.11	100	0	0
1986	391.68	392.54	.86	.2	-.08	7.8	.94	92.2
1987	418.64	421.04	2.4	.6	-.39	12.3	2.79	87.7
1988	446.42	451.26	4.84	1.1	-.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	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	-9	12.6	62.7	87.4

FIGURE 6

Consumer Price Index Projections
(1967=100)

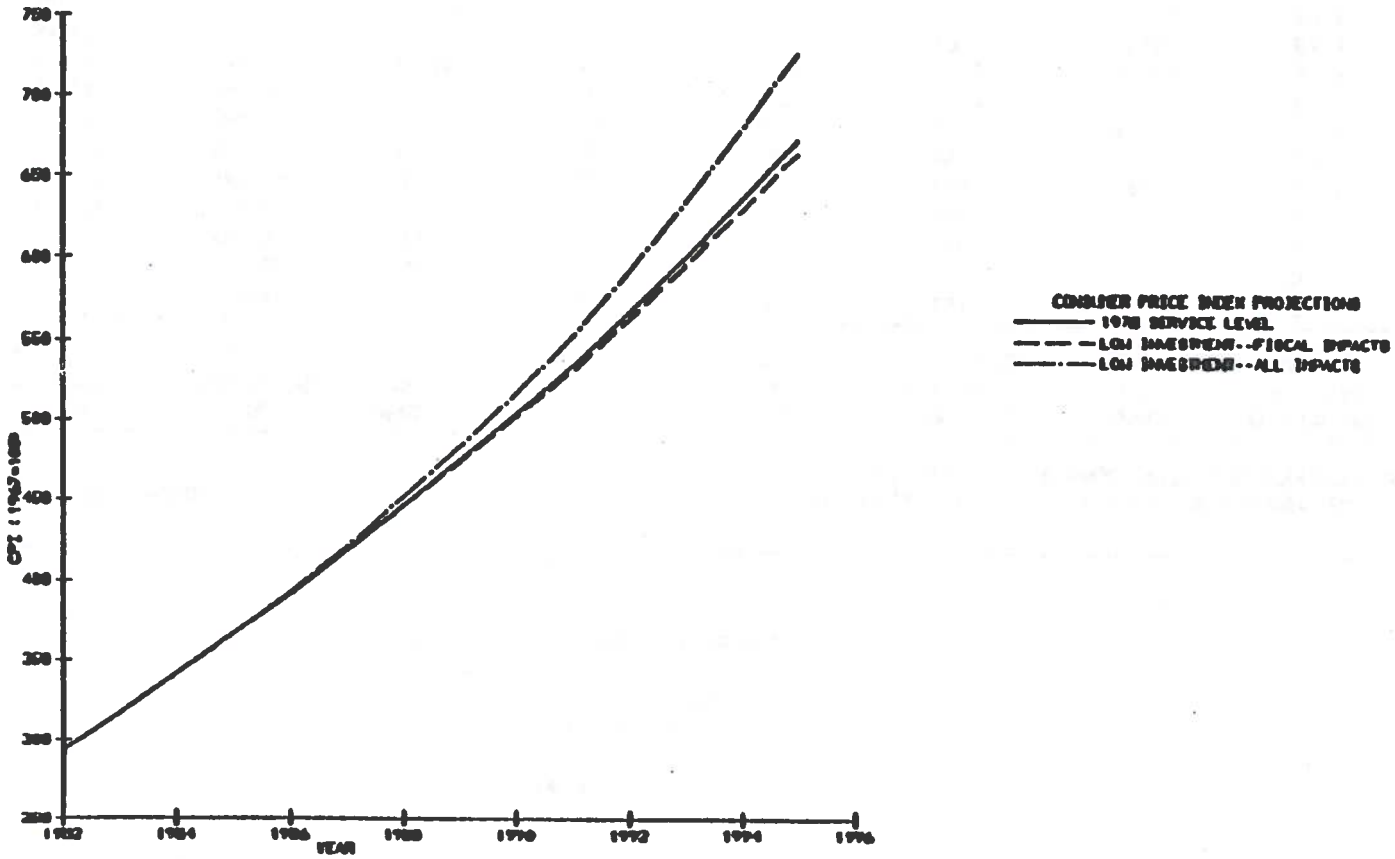


TABLE 8

ESTIMATED IMPACTS on DISPOSABLE PERSONAL INCOME
(billions of 1972 dollars)
CHANGE FROM 1978 SERVICE LEVEL
(2.8% annual growth in VMT)
to LOW-INVESTMENT CASE (declining growth in VMT)

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE INCOME	LOW INVESTMENT INCOME	IMPACT ON INCOME	PERCENTAGE CHANGE	IMPACT ON INCOME	PERCENTAGE OF TOTAL IMPACT	IMPACT ON INCOME	PERCENTAGE OF TOTAL IMPACT
1982	1062.91	1063.38	.47	0	.47	100	0	0
1983	1109.12	1108.95	-.17	0	-.17	100	0	0
1984	1140.75	1141.12	.37	0	.37	100	0	0
1985	1171.21	1172.36	1.15	.1	1.15	100	0	0
1986	1202.9	1203.71	.81	.1	1.94	43.2	-1.13	36.8
1987	1237.01	1236.04	-.97	-.1	2.99	43	-3.96	57
1988	1271.51	1267.17	-4.34	-.3	4.29	33.2	-8.63	66.8
1989	1308.11	1297.37	-10.74	-.8	5.7	25.7	-16.44	74.3
1990	1340.1	1320.25	-19.85	-1.5	7.35	21.3	-27.2	78.7
1991	1376.88	1348.3	-28.58	-2.1	8.95	19.3	-37.53	80.7
1992	1411.16	1370.78	-40.38	-2.9	10.95	17.6	-51.33	82.4
1993	1446.93	1392.58	-54.35	-3.8	12.9	16.1	-67.25	83.9
1994	1483.71	1412.59	-71.12	-4.8	14.21	14.3	-85.33	85.7
1995	1523.61	1433.05	-90.56	-5.9	15.7	12.9	-106.26	87.1

FIGURE 7

Disposable Personal Income Projections (Billions of 1972 Dollars)

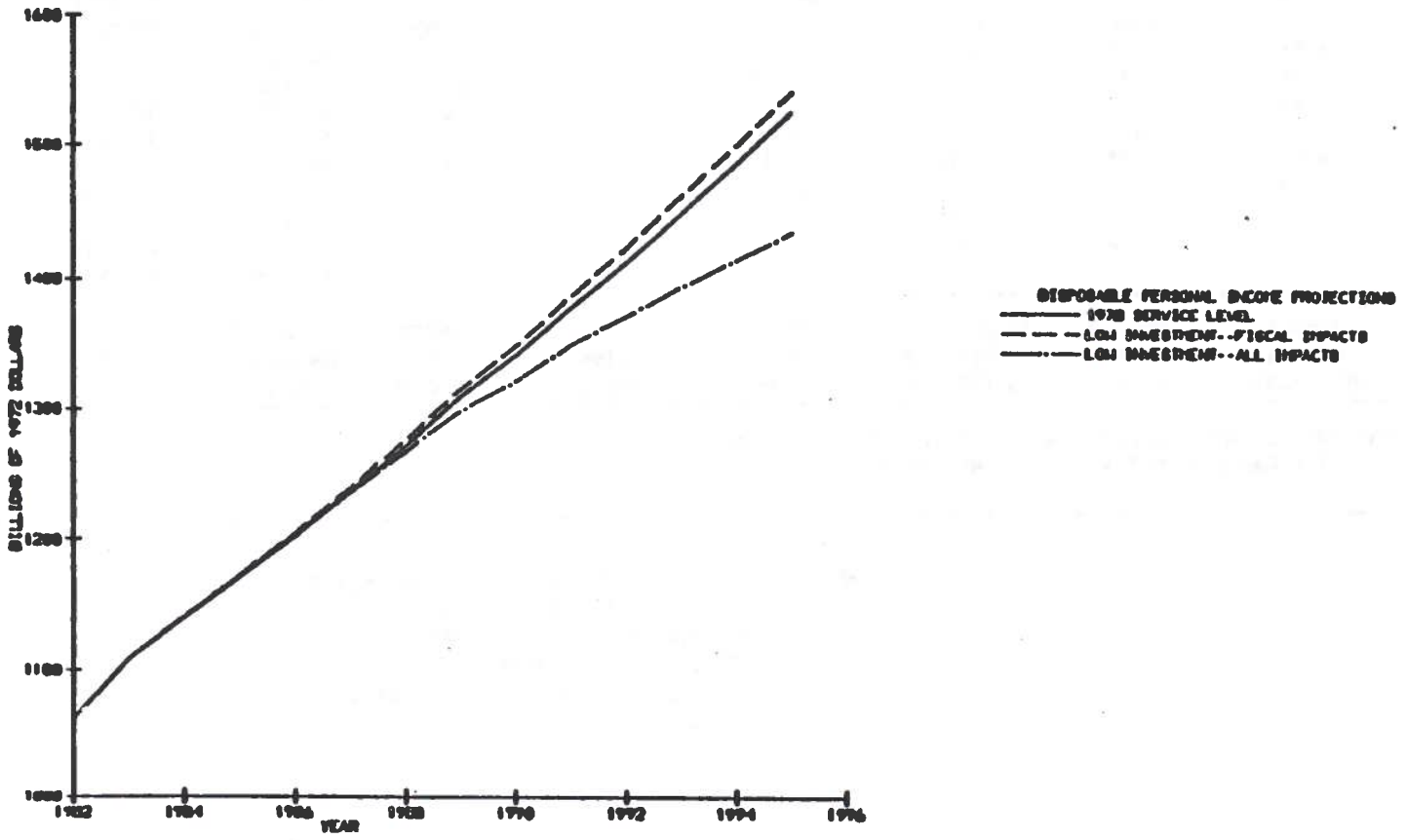


TABLE 9

ESTIMATED IMPACTS on CONSUMPTION
(billions of 1972 dollars)
of CHANGE FROM 1978 SERVICE LEVEL
(2.8% annual growth in VMT)
to LOW-INVESTMENT CASE (declining growth in VMT)
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE CONSUMPTION	LOW INVESTMENT CONSUMPTION	IMPACT ON CONSUMPTION	PERCENTAGE CHANGE	IMPACT ON CONSUMPTION	PERCENTAGE OF TOTAL IMPACT	IMPACT ON CONSUMPTION	PERCENTAGE OF TOTAL IMPACT
1982	975.18	975.77	.59	.1	.59	100	0	0
1983	1015.95	1015.78	-.17	0	-.17	100	0	0
1984	1056.59	1056.56	-.03	0	-.03	100	0	0
1985	1089.98	1090.3	.32	0	.32	100	0	0
1986	1122.37	1122.17	-.2	0	.59	42.8	-.79	57.2
1987	1156.87	1155.6	-1.27	-.1	1	30.6	-2.27	69.4
1988	1191.38	1188.27	-3.11	-.3	1.52	24.7	-4.63	75.3
1989	1227.68	1220.9	-6.78	-.6	2.09	19.1	-8.87	80.9
1990	1264.7	1252.54	-12.16	-1	2.75	15.6	-14.91	84.4
1991	1300.17	1282.45	-17.72	-1.4	3.33	13.7	-21.05	86.3
1992	1336.46	1312.07	-24.39	-1.8	4.18	12.8	-28.57	87.2
1993	1371.97	1339.66	-32.31	-2.4	5.08	12	-37.39	88
1994	1407.34	1365.44	-41.9	-3	5.59	10.5	-47.49	89.5
1995	1443.75	1391.08	-52.67	-3.6	6.06	9.4	-58.73	90.6

FIGURE 8

Consumption Expenditure
Projections
(Billions of 1972 Dollars)

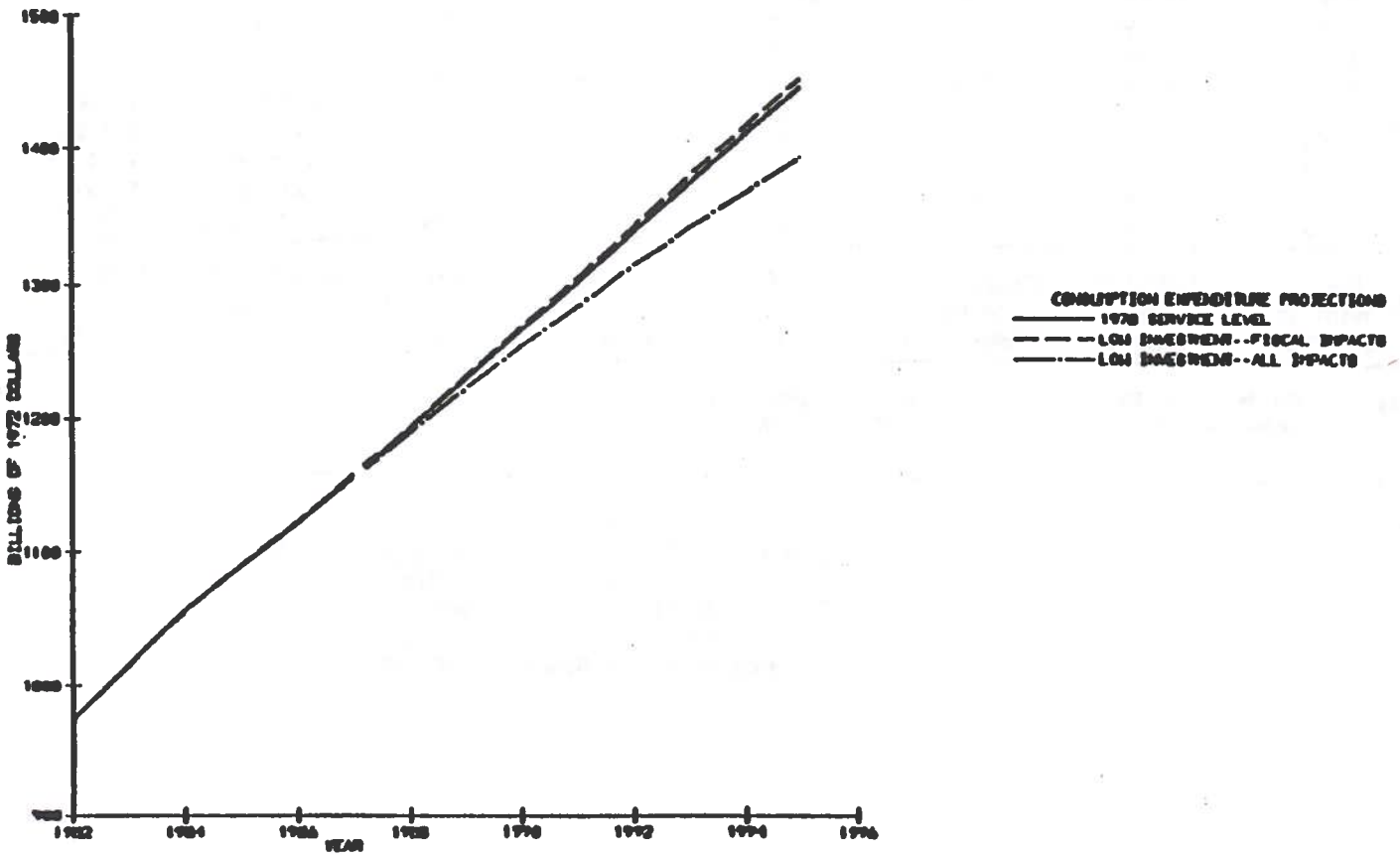


Table 10 and Figure 9 indicate that the movement to the low-investment case also depresses the level of gross private domestic investment. In 1995, investment is estimated to be below that in the base case by $24.17 billion in current dollars, a reduction of 1.3 percent. It is plausible that this reduction would have been more severe if it were not for higher after-tax corporate profits (Table 11 and Figure 10), which are estimated to increase by 26.9 percent over those in the 1978 service level base case in 1995. This rather surprising increase in after-tax corporate profits is examined in Sections 4.2 and 4.3 below.

The reduction in GNP brings with it a reduction in employment. Table 12 and Figure 11 show 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. Tables 13 and 14 and Figures 12 and 13 show that output per labor hour is projected to be lower by 2.7 percent in manufacturing industries and by 3.6 percent in "other private" industries (services, wholesale and retail trade, regulated industries and mining).

The impacts on U.S. imports and exports are presented in Tables 15 and 16 and Figures 14 and 15. Imports in 1995 are estimated to be down from the base case by $7.26 billion, a reduction of 3.1 percent. This decrease is consistent with the lower GNP projections. Not surprisingly, the impacts on exports

TABLE 10

ESTIMATED IMPACTS on GROSS PRIVATE DOMESTIC INVESTMENT (billions of current dollars) of CHANGE from 1978 SERVICE LEVEL (2.8% annual growth in VMT) to LOW-INVESTMENT CASE (declining growth in VMT), 1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE INVESTMENT	LOW INVESTMENT INVESTMENT	IMPACT ON INVESTMENT	PERCENTAGE CHANGE	IMPACT ON INVESTMENT	PERCENTAGE OF TOTAL IMPACT	IMPACT ON INVESTMENT	PERCENTAGE OF TOTAL IMPACT
1982	446.19	447.15	.96	.2	.96	100	0	0
1983	541.5	542.17	.67	.1	.67	100	0	0
1984	630.64	630.36	-.28	0	-.28	100	0	0
1985	725.44	725.18	-.26	0	-.26	100	0	0
1986	812.55	812.36	-.19	0	-.36	67.9	.17	32.1
1987	910.17	909.97	-.2	0	-.61	59.8	.41	40.2
1988	1012.59	1012.53	-.06	0	-.96	51.6	.9	48.4
1989	1112.45	1111.19	-1.26	-.1	-1.68	80	.42	20
1990	1225.27	1220.87	-4.4	-.4	-2.86	65	-1.54	35
1991	1340.05	1332.71	-7.34	-.5	-5.13	69.9	-2.21	30.1
1992	1466.14	1456.5	-9.64	-.7	-7.91	82.1	-1.73	17.9
1993	1606.37	1593.35	-13.02	-.8	-10.89	83.6	-2.13	16.4
1994	1753.3	1737	-16.3	-.9	-15.39	94.4	-.91	5.6
1995	1912.78	1888.61	-24.17	-1.3	-22.19	91.8	-1.98	8.2

FIGURE 9

Gross Private Investment Projections (Billions of Current Dollars)

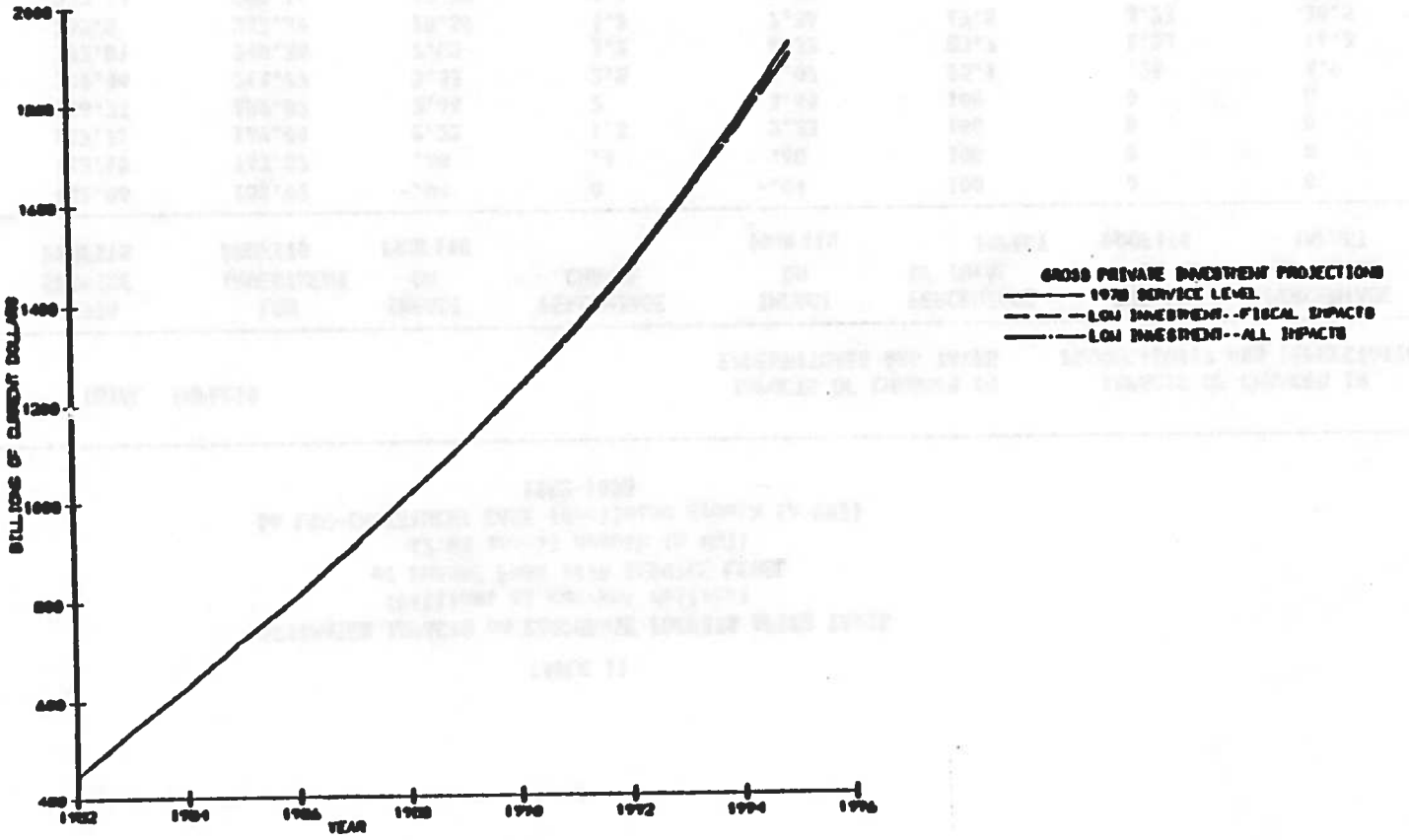


TABLE 11

ESTIMATED IMPACTS on CORPORATE PROFITS AFTER TAXES
(billions of current dollars)
of CHANGE FROM 1978 SERVICE LEVEL
(2.8% annual growth in VMT)
to LOW-INVESTMENT CASE (declining growth in VMT)
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE PROFITS	LOW INVESTMENT PROFITS	IMPACT ON PROFITS	PERCENTAGE CHANGE	IMPACT ON PROFITS	PERCENTAGE OF TOTAL IMPACT	IMPACT ON PROFITS	PERCENTAGE OF TOTAL IMPACT
1982	151.06	151.02	-.04	0	-.04	100	0	0
1983	163.19	163.87	.68	.4	.68	100	0	0
1984	167.71	169.94	2.23	1.3	2.23	100	0	0
1985	186.23	189.87	3.64	2	3.64	100	0	0
1986	209.44	214.77	5.33	2.5	5.07	95.1	.26	4.9
1987	232.81	240.36	7.55	3.2	6.32	83.7	1.23	16.3
1988	252.8	263.39	10.59	4.2	7.36	69.5	3.23	30.5
1989	272.73	290.11	17.38	6.4	8.38	48.2	9	51.8
1990	283.37	311.37	28	9.9	9.37	33.5	18.63	66.5
1991	294.55	330.8	36.25	12.3	11.19	30.9	25.06	69.1
1992	323.21	374.64	51.43	15.9	12.38	24.1	39.05	75.9
1993	357.99	425.98	67.99	19	12.12	17.8	55.87	82.2
1994	391.75	479.93	88.18	22.5	10.67	12.1	77.51	87.9
1995	424.42	538.47	114.05	26.9	9.01	7.9	105.04	92.1

FIGURE 10

Projections of
After-tax Corporate Profit
(Billions of Current Dollars)

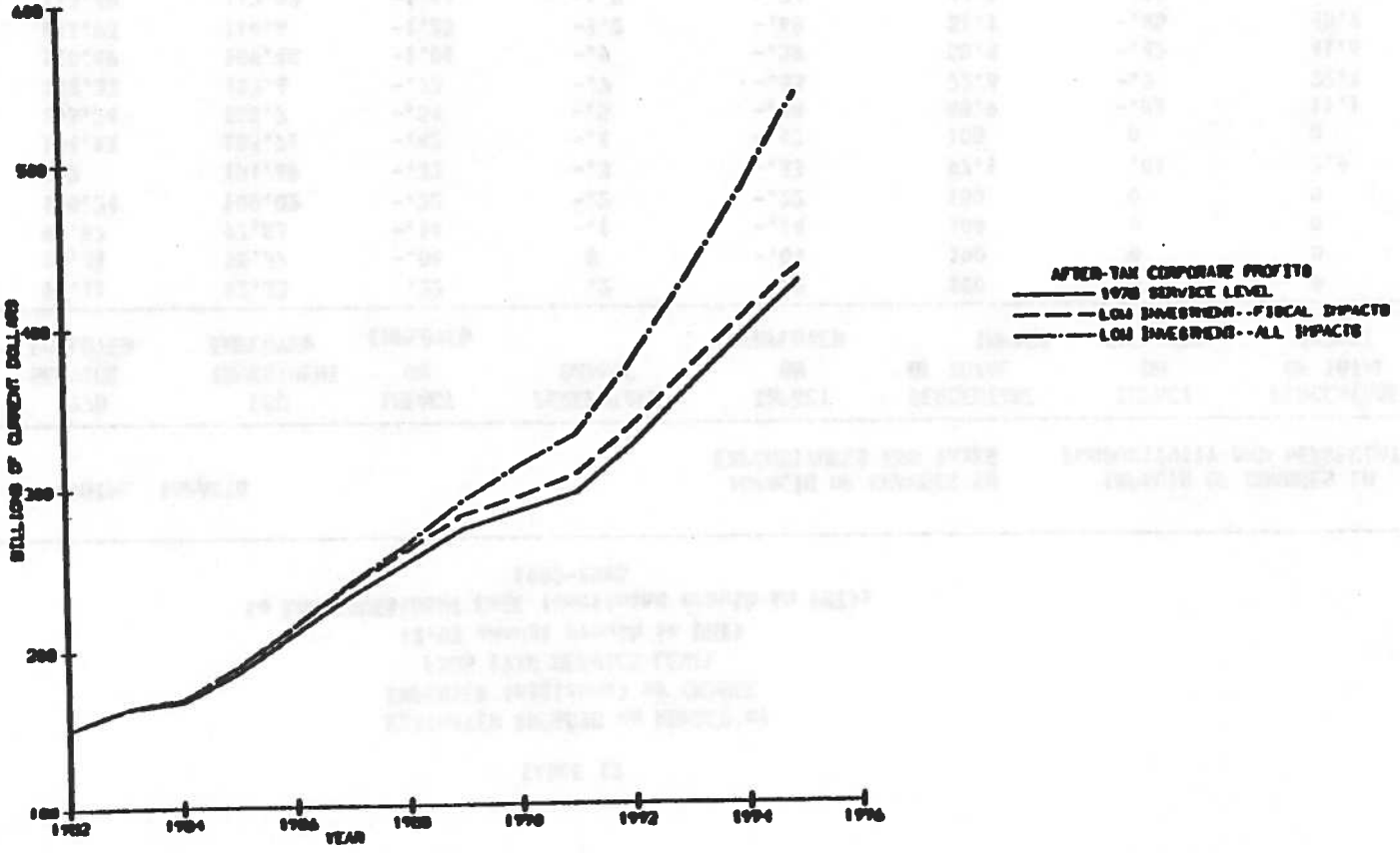


TABLE 12

ESTIMATED IMPACTS on NUMBER of
EMPLOYED (millions) of CHANGE
FROM 1978 SERVICE LEVEL
(2.0% annual growth in VMT)
to LOW-INVESTMENT CASE (declining growth in VMT),
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE EMPLOYED	LOW INVESTMENT EMPLOYED	IMPACT ON EMPLOYED	PERCENTAGE CHANGE	IMPACT ON EMPLOYED	PERCENTAGE OF TOTAL IMPACT	IMPACT ON EMPLOYED	PERCENTAGE OF TOTAL IMPACT
1982	92.11	92.33	.22	.2	.22	100	0	0
1983	95.41	95.37	-.04	0	-.04	100	0	0
1984	97.97	97.83	-.14	-.1	-.14	100	0	0
1985	100.24	100.02	-.22	-.2	-.22	100	0	0
1986	102	101.68	-.32	-.3	-.33	97.1	.01	2.9
1987	104.13	103.71	-.42	-.4	-.42	100	0	0
1988	106.24	105.7	-.54	-.5	-.48	88.9	-.06	11.1
1989	108.33	107.6	-.73	-.7	-.53	72.6	-.2	27.4
1990	110.49	109.48	-1.01	-.9	-.59	58.4	-.42	41.6
1991	111.93	110.6	-1.33	-1.2	-.68	51.1	-.65	48.9
1992	113.68	112.02	-1.66	-1.5	-.74	44.6	-.92	55.4
1993	115.32	113.4	-1.92	-1.7	-.67	34.9	-1.25	65.1
1994	117.04	114.83	-2.21	-1.9	-.64	29	-1.57	71
1995	118.68	116.02	-2.66	-2.2	-.63	23.7	-2.03	76.3

FIGURE 11

Employment Projections
(Millions)

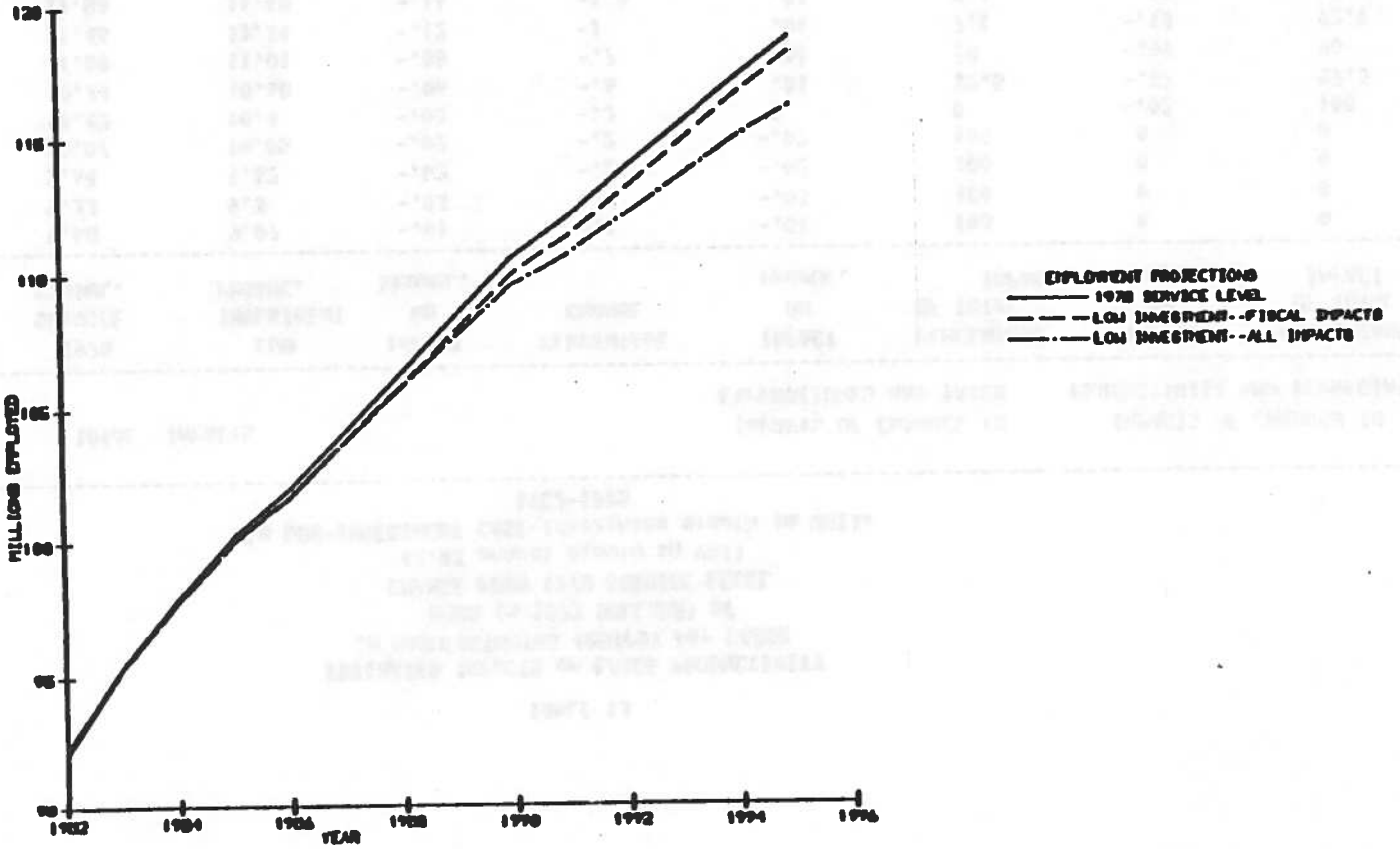


TABLE 13

ESTIMATED IMPACTS on LABOR PRODUCTIVITY
in MANUFACTURING (OUTPUT per LABOR
HOUR in 1972 DOLLARS) of
CHANGE FROM 1978 SERVICE LEVEL
(2.8% annual growth in VMT)
to LOW-INVESTMENT CASE (declining growth in VMT),
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE PRODUC.	LOW INVESTMENT PRODUC.	IMPACT ON PRODUC.	PERCENTAGE CHANGE	IMPACT ON PRODUC.	PERCENTAGE OF TOTAL IMPACT	IMPACT ON PRODUC.	PERCENTAGE OF TOTAL IMPACT
1982	9.68	9.67	-.01	-.1	-.01	100	0	0
1983	9.33	9.3	-.03	-.3	-.03	100	0	0
1984	9.64	9.62	-.02	-.2	-.02	100	0	0
1985	10.07	10.05	-.02	-.2	-.02	100	0	0
1986	10.42	10.4	-.02	-.2	0	0	-.02	100
1987	10.74	10.68	-.06	-.6	.01	12.5	-.07	87.5
1988	11.09	11.01	-.08	-.7	.01	10	-.09	90
1989	11.46	11.34	-.12	-1	.01	7.1	-.13	92.9
1990	11.84	11.68	-.16	-1.4	.01	5.6	-.17	94.4
1991	12.28	12.1	-.18	-1.5	.05	17.9	-.23	82.1
1992	12.77	12.54	-.23	-1.8	.05	15.2	-.28	84.8
1993	13.22	12.95	-.27	-2	.06	15.4	-.33	84.6
1994	13.64	13.29	-.35	-2.6	.06	12.8	-.41	87.2
1995	14.06	13.68	-.38	-2.7	.07	13.5	-.45	86.5

FIGURE 12

Projections of
Manufacturing Output per
Labor Hour
(1972 Dollars)

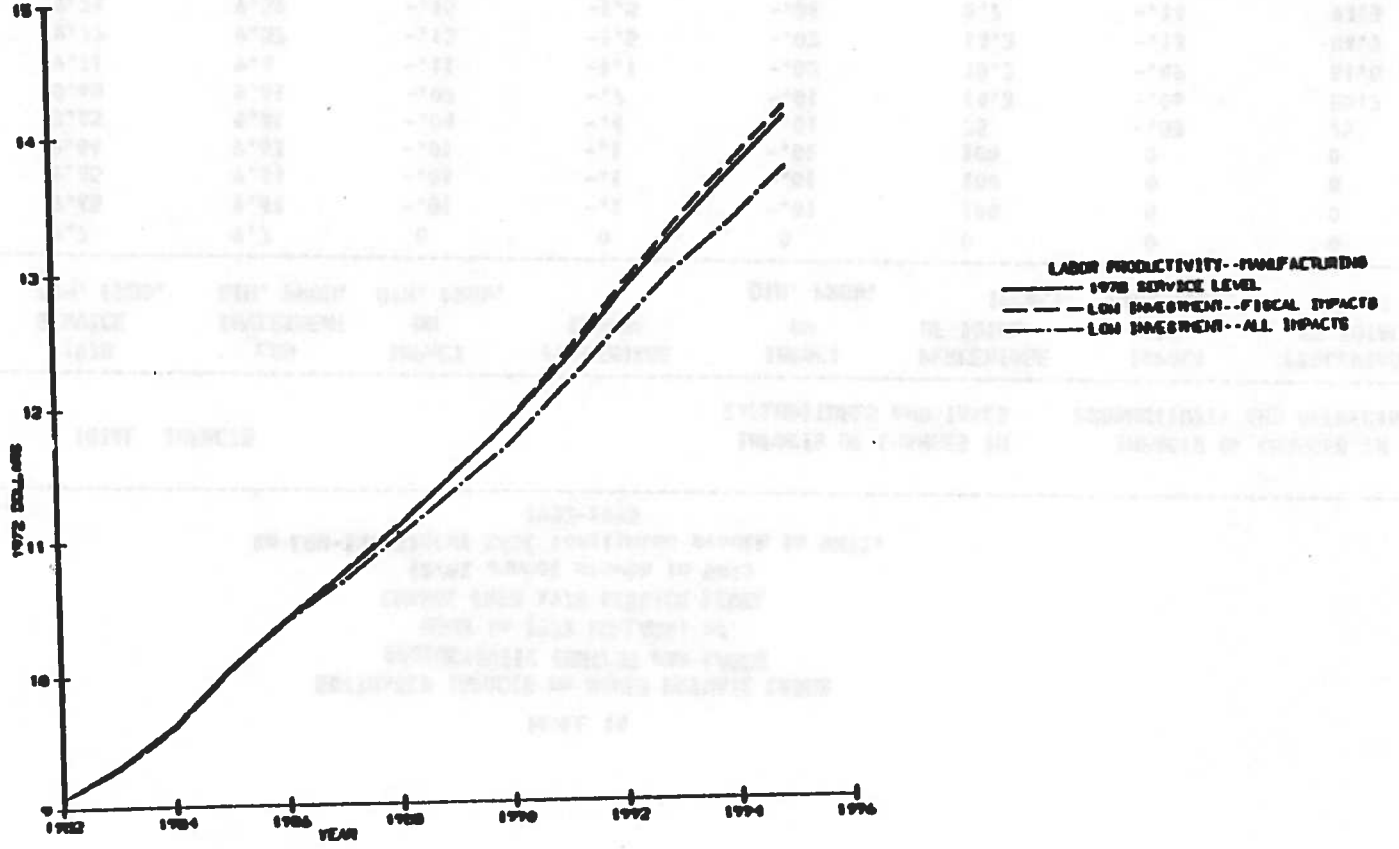


TABLE 14

ESTIMATED IMPACTS on OTHER PRIVATE LABOR PRODUCTIVITY (OUTPUT per LABOR HOUR in 1972 DOLLARS) of CHANGE FROM 1978 SERVICE LEVEL (2.0% annual growth in VMT) to LOW-INVESTMENT CASE (declining growth in VMT), 1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE OTH. PROD.	LOW INVESTMENT OTH. PROD.	IMPACT ON OTH. PROD.	PERCENTAGE CHANGE	IMPACT ON OTH. PROD.	PERCENTAGE OF TOTAL IMPACT	IMPACT ON OTH. PROD.	PERCENTAGE OF TOTAL IMPACT
1982	9.7	9.7	0	0	0	0	0	0
1983	9.65	9.64	-.01	-.1	-.01	100	0	0
1984	9.65	9.64	-.01	-.1	-.01	100	0	0
1985	9.64	9.63	-.01	-.1	-.01	100	0	0
1986	9.65	9.61	-.04	-.4	-.01	25	-.03	75
1987	9.68	9.61	-.07	-.7	-.01	14.3	-.06	85.7
1988	9.71	9.6	-.11	-1.1	-.02	18.2	-.09	81.8
1989	9.72	9.57	-.15	-1.5	-.02	13.3	-.13	86.7
1990	9.74	9.59	-.15	-1.5	-.01	6.7	-.14	93.3
1991	9.82	9.63	-.19	-1.9	-.02	10.5	-.17	89.5
1992	9.91	9.67	-.24	-2.4	-.02	8.3	-.22	91.7
1993	9.97	9.69	-.28	-2.8	-.02	7.1	-.26	92.9
1994	10.02	9.71	-.31	-3.1	-.02	6.5	-.29	93.5
1995	10.09	9.73	-.36	-3.6	-.02	5.6	-.34	94.4

FIGURE 13

Projections of
Non-manufacturing Output
per Labor Hour
(1972 Dollars)

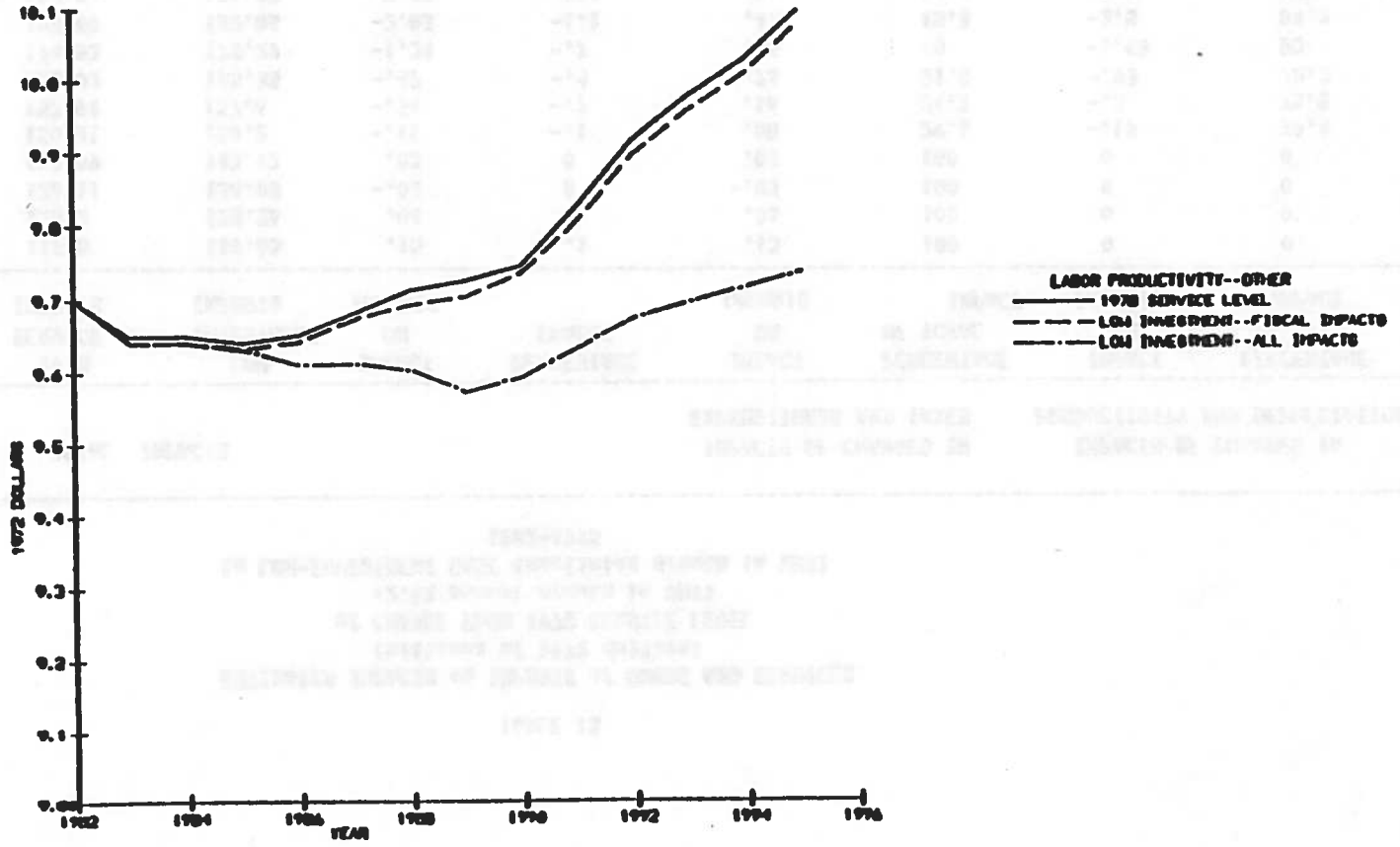


TABLE 15

ESTIMATED IMPACTS on IMPORTS of GOODS AND SERVICES
(billions of 1972 dollars)
of CHANGE FROM 1978 SERVICE LEVEL
(2.8% annual growth in VMT)
to LOW-INVESTMENT CASE (declining growth in VMT)
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE IMPORTS	LOW INVESTMENT IMPORTS	IMPACT ON IMPORTS	PERCENTAGE CHANGE	IMPACT ON IMPORTS	PERCENTAGE OF TOTAL IMPACT	IMPACT ON IMPORTS	PERCENTAGE OF TOTAL IMPACT
1982	119.5	119.65	.15	.1	.15	100	0	0
1983	128.2	128.26	.06	0	.06	100	0	0
1984	136.11	136.08	-.03	0	-.03	100	0	0
1985	143.09	143.12	.03	0	.03	100	0	0
1986	150.31	150.2	-.11	-.1	.08	29.6	-.19	70.4
1987	157.94	157.6	-.34	-.2	.16	24.2	-.5	75.8
1988	166.02	165.35	-.67	-.4	.26	21.8	-.93	78.2
1989	174.53	173.29	-1.24	-.7	.35	18	-1.59	82
1990	184.09	182.06	-2.03	-1.1	.47	15.8	-2.5	84.2
1991	193.86	191.08	-2.78	-1.4	.58	14.7	-3.36	85.3
1992	204.3	200.65	-3.65	-1.8	.75	14.6	-4.4	85.4
1993	214.49	209.79	-4.7	-2.2	.9	13.8	-5.6	86.2
1994	224.86	219.01	-5.85	-2.6	1.05	13.2	-6.9	86.8
1995	235.88	228.62	-7.26	-3.1	1.17	12.2	-8.43	87.8

FIGURE 14

Import Projections
(Billions of 1972 Dollars)

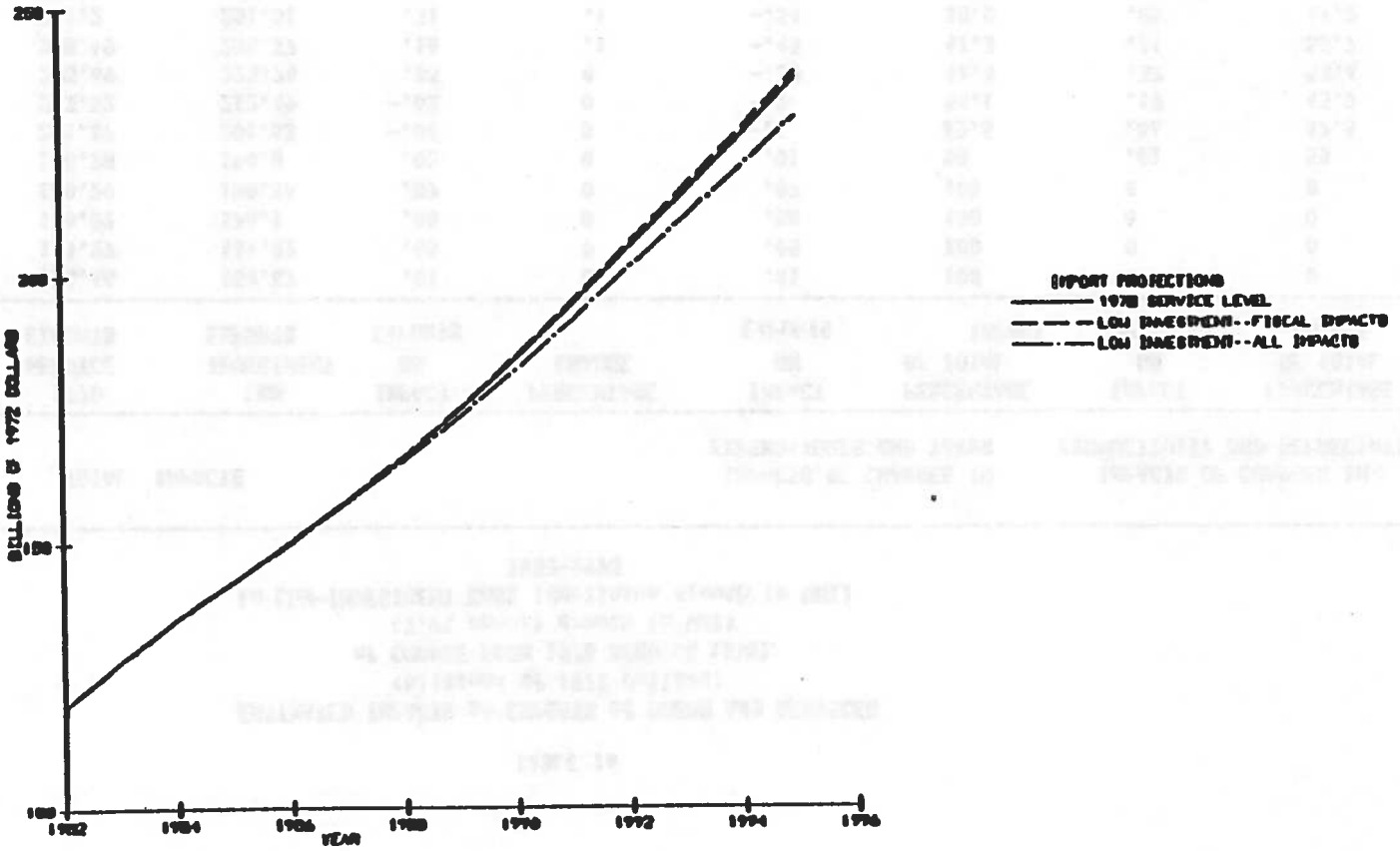


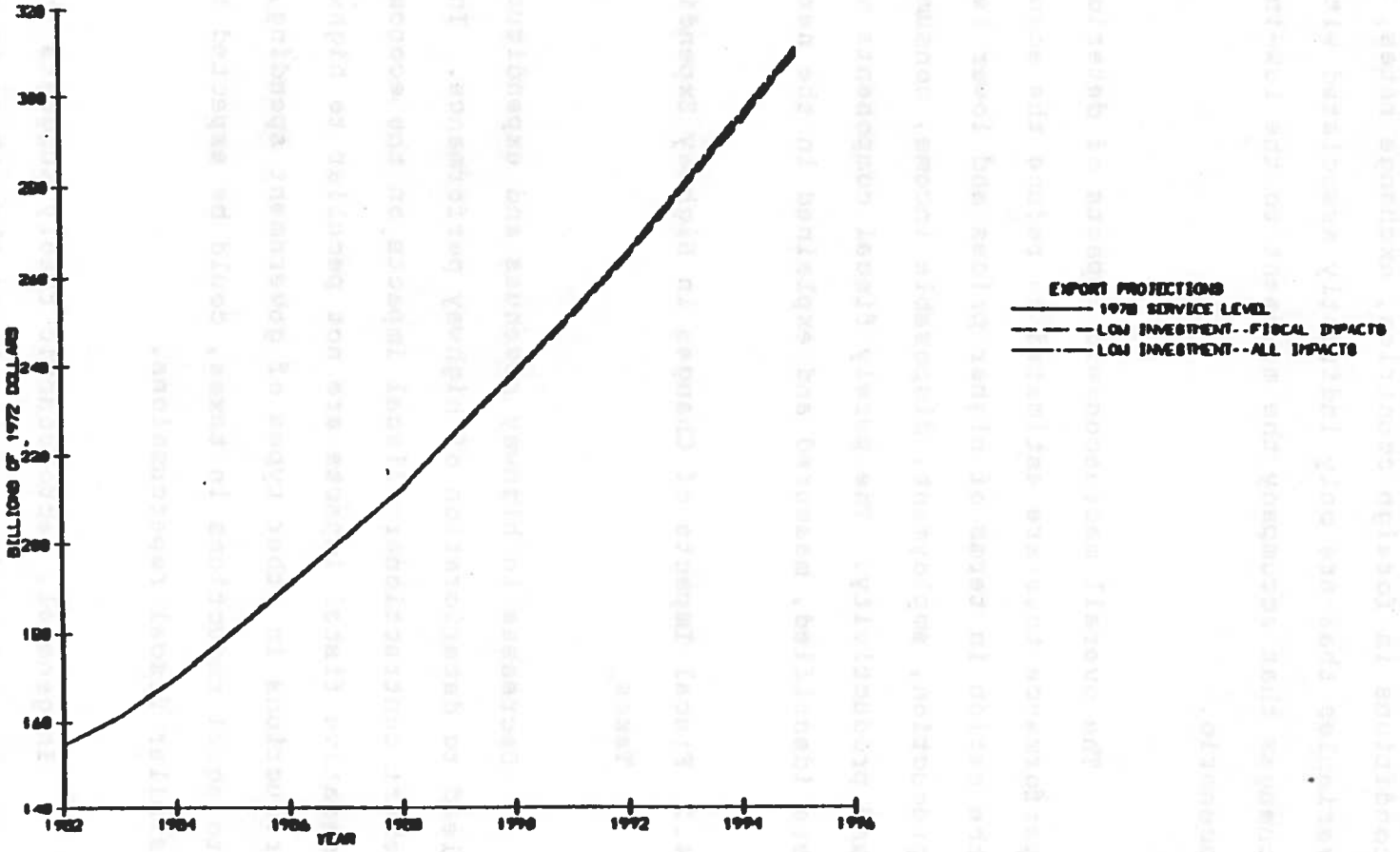
TABLE 16

ESTIMATED IMPACTS on EXPORTS of GOODS AND SERVICES
(billions of 1972 dollars)
of CHANGE FROM 1978 SERVICE LEVEL
(2.8% annual growth in VMT)
to LOW-INVESTMENT CASE (declining growth in VMT)
1982-1995

	TOTAL IMPACTS				IMPACTS OF CHANGES IN EXPENDITURES AND TAXES		IMPACTS OF CHANGES IN PRODUCTIVITY AND DEPRECIATION	
	1978 SERVICE EXPORTS	LOW INVESTMENT EXPORTS	IMPACT ON EXPORTS	PERCENTAGE CHANGE	IMPACT ON EXPORTS	PERCENTAGE OF TOTAL IMPACT	IMPACT ON EXPORTS	PERCENTAGE OF TOTAL IMPACT
1982	154.66	154.67	.01	0	.01	100	0	0
1983	161.27	161.32	.05	0	.05	100	0	0
1984	170.02	170.1	.08	0	.08	100	0	0
1985	180.29	180.36	.07	0	.07	100	0	0
1986	190.78	190.8	.02	0	.01	50	.01	50
1987	201.67	201.63	-.04	0	-.1	62.5	.06	37.5
1988	212.52	212.49	-.03	0	-.2	54.1	.17	45.9
1989	225.69	225.74	.05	0	-.32	46.4	.37	53.6
1990	238.19	238.37	.18	.1	-.43	41.3	.61	58.7
1991	251.2	251.51	.31	.1	-.54	38.8	.85	61.2
1992	264.56	265	.44	.2	-.66	37.5	1.1	62.5
1993	279.26	279.8	.54	.2	-.81	37.5	1.35	62.5
1994	293.99	294.67	.68	.2	-.94	36.7	1.62	63.3
1995	309.76	310.59	.83	.3	-1.04	35.7	1.87	64.3

FIGURE 15

Export Projections
(Billions of 1972 Dollars)



are minimal, because exports are largely a function of economic conditions in foreign countries, exchange rates, and other variables that are only indirectly associated with the economic changes that accompany the movement to the low-investment scenario.

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, employment, disposable income, consumption, savings and productivity. The purely fiscal components of these impacts are identified, measured and explained in the next section.

4.2 Fiscal Impacts of Changes in Highway Expenditures and Taxes

Decreases in highway revenues and expenditures ultimately lead to deterioration of highway performance. In addition, they exert contractionary fiscal impacts on the economy. These negative fiscal impacts are not peculiar to highway finance; reductions in other types of government spending, even when tied to equal reductions in taxes, could be expected to produce similar fiscal repercussions.

In general, macroeconomic theory suggests that when government expenditures are lower than those in a base scenario, levels of economic activity and prices will tend to be lower

also, even though the lower expenditures are matched by lower taxes. Although the lower taxes prompt higher private spending, this increase in spending tends to be smaller than the reduction in taxes. Thus, on balance, the level of aggregate (government plus private) spending in the economy is lower than in the base scenario. These results may not occur in each and every year, however, because some fiscal impacts may be distributed over a period of several years.

Because one of the purposes of this study is to assess the economic impacts of changes in highway performance, it is necessary to distinguish these impacts from purely fiscal effects. To isolate the fiscal consequences, it was necessary to simulate the macroeconomic model so that the lower highway expenditures and taxes are the only perturbations in the economy.

The results of this simulation, shown in columns 5 and 6 of Tables 5 through 16 and in Figures 4 through 15, are generally in accord with macroeconomic theory. Changes in nominal GNP, i.e., GNP in current dollars, can be decomposed into changes in real GNP and changes in prices. With a given aggregate supply, a decline in aggregate demand will result in a reduction in both real GNP and prices. As shown in Tables 5 and 6 and Figures 4 and 5, real GNP and the GNP price deflator behave as anticipated; they both decline in response to a reduction in highway expenditures and taxes. In 1995, real GNP, measured in 1972 dollars, is lower than it would otherwise be by $5 billion, a

reduction of only 0.2 percent. The implicit GNP deflator, however, is lower by over eight points, a drop of 1.7 percent. An alternative measure of prices, the consumer price index, also declines as reported in Table 7 and Figure 6. The magnitudes of the reductions in real GNP, the GNP deflator and the consumer price index increase throughout most of the period, mirroring the increasing divergence between the expenditure levels in the two scenarios (see Figure 2). The dollar declines in GNP are somewhat smaller in the last three years, because the reductions in highway expenditures are smaller.

It should be noted that the fiscal impacts on the GNP and the GNP deflator decline in importance over time relative to the combined impacts of changes in productivity and depreciation. By 1995, the fiscal impacts account for only 6.9 percent of the decline in real GNP and 19.5 percent of the reduction in the GNP deflator.

The impacts of the public finance changes on disposable income, consumption, and private investment are shown in Tables 8, 9, and 10 and Figures 7, 8, and 9. Declines in real GNP and in employment (to be discussed below) are usually associated with reductions in real disposable income and consumption expenditures. However, because of the lower taxes, these two variables increase by larger and larger amounts over the forecast period. By 1995, real disposable income and consumption are larger than they would be in the base case by $15.7 billion and

$6.1 billion respectively. Although the business tax reductions cause corporate after-tax profits to increase, as shown in Table 11, profits are not the dominant influence on private domestic investment. More important determinants of investment in the short run are GNP and new orders; thus investment (Table 10) declines by increasing amounts over most of the period. (Note that private domestic investment is reported in nominal terms.)

As in the case of the GNP and the price indices discussed above, the fiscal impacts on disposable income, consumption and profits become less important over time relative to the combined impacts of changes in productivity and depreciation. By 1995, fiscal impacts account for only 12.9 percent of the total change in disposable income, 19.4 percent of the change in consumption expenditures and 7.9 percent of the increase in corporate profits. However, in 1995, fiscal impacts account for 91.8 percent of the change in private investment.

A reduction in employment is expected to accompany a decline in real GNP, and this is indeed the case as shown in Table 12 and Figure 11. The pattern of changes in the number of persons employed follows the pattern of changes in real GNP; employment declines increasingly throughout 1983-1992 and by lesser amounts in 1993-1995. The declines in employment, like the declines in GNP, are relatively small. Employment in 1995 is down by 630,000 workers, a reduction of only 0.5 percent from projected base-case employment. Induced changes in labor productivity in

manufacturing and other private industries are shown in Tables 13 and 14 and Figures 12 and 13. The slight increase in manufacturing productivity reflects the relative changes in output and employment in the economy at large, i.e., declines in employment exceed declines in output, as shown in Tables 5 and 12. Other labor productivity declines, however, perhaps because employment in the service industries, wholesale and retail trade and regulated industries is more stable than employment in manufacturing. If this is the case, declines in non-manufacturing output would exceed declines in non-manufacturing employment.

The small increases in imports (Table 15 and Figure 14) can be explained by the larger disposable personal income, the result of lower taxes. The small decreases in exports (Table 16 and Figure 15), as explained in the preceding section, are only indirectly related to the changes that produce the low-investment scenario.

4.3 Impacts of Simultaneous Changes in Productivity, Depreciation, and VMT

The largest macroeconomic impacts of the neglect of the nation's highways are those arising from lower levels of highway performance. Most of the fiscal impacts, discussed in the last section, are relatively small in comparison, especially in the later years of the low-investment scenario. As explained in Section 2.3, above, the deterioration of highway performance exerts impacts on macroeconomic behavior largely through its

effects on labor productivity and on depreciation of motor vehicles. These effects are moderated by concomitant reductions in VMT. Of these two variables, labor productivity is by far the more influential. This section summarizes the macroeconomic impacts of the reductions in productivity and VMT and increases in depreciation associated with moving from the 1978 service level to the low-investment scenario. These projected impacts are shown in the last two columns of Tables 5 through 16 and in Figures 4 through 15.

The impacts of lower productivity and VMT and increased depreciation of motor vehicles were estimated by perturbing the Long-Term Macroeconomic Model with the changes described in Section 2.3. Three types of changes were simulated by the model:

(1) Changes in productivity and depreciation variables themselves.

(2) Changes in variables associated with lower productivity and higher depreciation, e.g., lower wages and higher prices of food, apparel, gasoline, and transportation services.

(3) Changes that reflect reductions in VMT caused by poorer highway performance:

(a) Smaller purchases of automobiles, gasoline and oil, tires, transportation services, etc.

(b) Higher prices (and thus lower sales and shipments) of commodities whose transportation costs would be increased substantially, e.g., furniture, food, tires, recreational vehicles and consumer services.

These three types of changes explain the macroeconomic impacts shown in the last two columns of Tables 5 through 16.

Macroeconomic theory suggests that a decline in productivity will lead to a decrease in real GNP and an increase in prices. The estimated impacts on real GNP and on prices induced by lower productivity and, to a much smaller extent, by higher depreciation of motor vehicles are consistent with this theory. These impacts are shown in the last two columns of Tables 5, 6 and 7 and in Figures 4 through 6. By 1995, real GNP is projected to be lower than in the 1978 service level scenario by $67.3 billion (in 1972 dollars), or by 3.0 percent. The GNP deflator in 1995 is above its base-case value by 33.5 points, or by 7.0 percent, and the consumer price index is up by 62.7 points or 9.3 percent. The importance of the productivity/depreciation impacts on real GNP increases substantially over the simulation period relative to the fiscal impacts. Indeed, by 1995, they overwhelm the fiscal impacts and account for 93 percent of the decrease.

Tables 8 and 9 and Figures 7 and 8 indicate the significance of poorer highway performance for U.S. consumers. By 1995, the reduction in real disposable income is projected to be $106

billion, or $1092 per household, a drop of 7.0 percent. Total consumption expenditures in 1995 would fall below those in the base-case scenario by $59 billion, a reduction of 4.1 percent. This means that in 1995 the average U.S. household would spend $604 less on goods and services (in 1972 dollars).

Deterioration of highway performance has a negative impact on gross private investment (Table 10, Figure 9). It should be noted, however, that this effect is much weaker than the negative fiscal impacts. The large increases in corporate after-tax profits (Table 11) are cited in Section 4.1 as being somewhat surprising. These, however, can be explained in terms of the substantial increases in the GNP price deflator and consumer price index, shown in Tables 6 and 7.

The decline in real GNP caused by lower productivity produces a reduction in employment as well (Table 12, Figure 11). Of the 2.66 million decrease in employment projected for 1995, 2.03 million, or 76.3 percent, is attributed to lower productivity and higher depreciation. Those who remain employed will work less efficiently because of poorer highway performance. By 1995, output per labor hour is projected to be down in both manufacturing (Table 13, Figure 12) and non-manufacturing (Table 14, Figure 13) by 45 cents and 34 cents, respectively, measured in 1972 dollars.

The decrease in imports (Table 15, Figure 14) is a direct

consequence of the decline in real GNP and disposable income. The impact of lower productivity on exports (Table 16, Figure 15) is less than 1 percent, because the level of U.S. exports depends more on economic conditions in foreign countries than on changes in U.S. productivity.

5.0 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. This section describes the basic structure of the model and the ways in which it was utilized to forecast interindustry impacts of the movement to the low-investment and full-needs scenarios.

5.1 The General Structure of INFORUM

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 (Interindustry Forecasting Model, University of Maryland) developed by Chase Econometrics Associates [2]. 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.

For each of its 200 industry categories, INFORUM forecasts in 1977 dollars (a) total output, (b) distribution of output to major markets, (c) personal consumption expenditures (PCE) for those products that are sold to individuals, and (d) exports and imports for products that are traded in foreign markets. Investment in producers' durable equipment (PDE) is forecast for

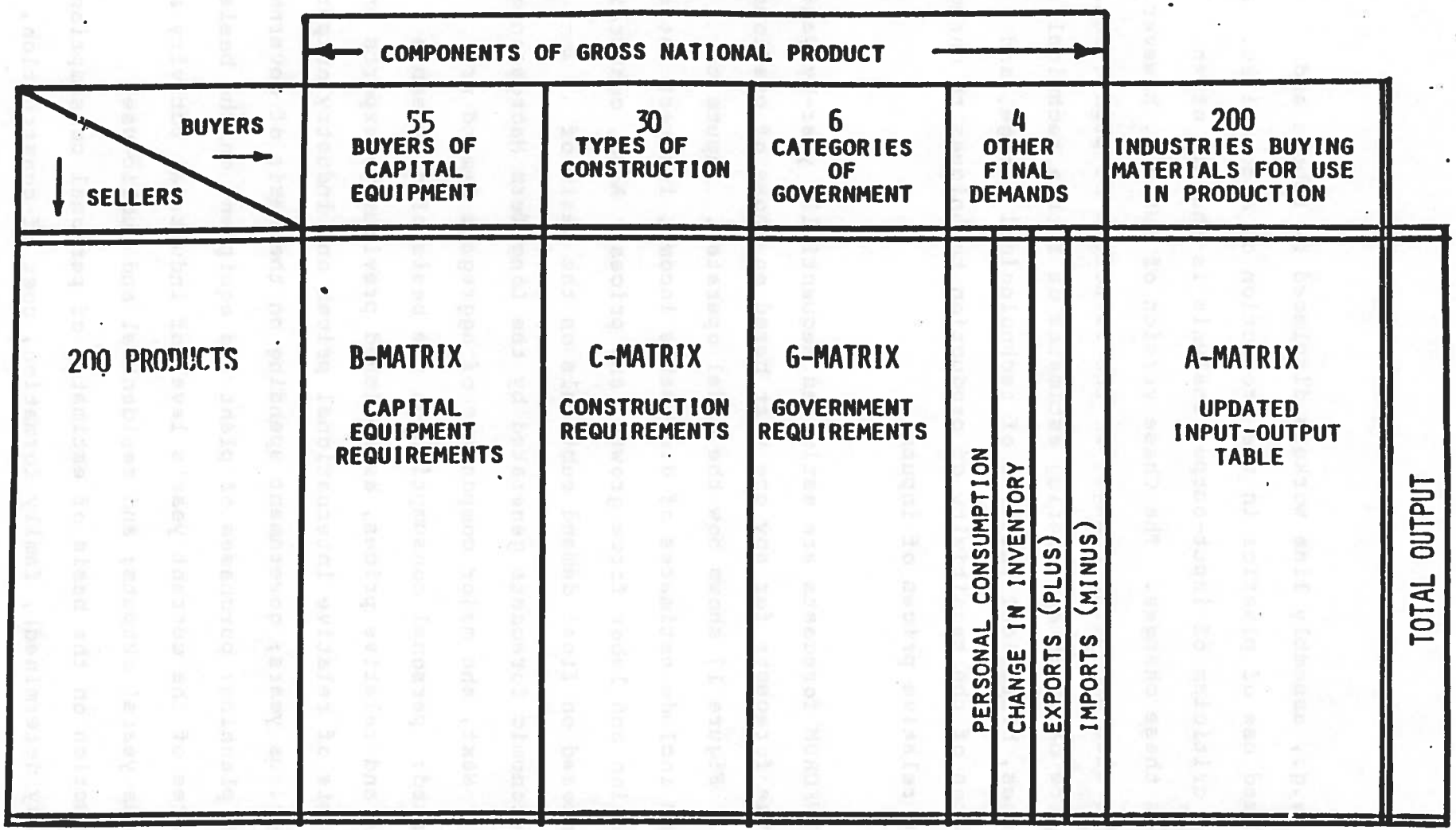
55 industry categories, which are combinations of the 200. Also forecast are (a) 19 private and 11 public categories of construction expenditures and (b) employment and productivity for 55 industries. Finally, INFORUM forecasts price indices and current-dollar output for each of its 200 sectors.

To generate this large amount of detail, the model uses several interrelated matrices, each of which depicts relationships between industries and their markets. These are shown in Figure 16. Part of the output of an industry is sold to other industries (and within the selling industry itself) for further processing, and part is sold for direct use. The former sales are "intermediate demand;" the latter, "final demand." Intermediate demands are shown in the input-output matrix on the right side of Figure 16. The final demands correspond to macroeconomic measures of personal consumption, investment (in plant, equipment and inventories), government purchases, and net foreign investment (exports minus imports). For a given percentage change in the output level of a particular industry, it is assumed in the short run that the industry's demands for its inputs all change by that percent. An input-output matrix can thus be used to estimate changes that would occur in one period of time in a number of industries as a result of a change in one sector of the economy.

Projections beyond four or five years, however, must anticipate changes in techniques of production and materials

FIGURE 16

INFORUM: Distribution of Sales by Product

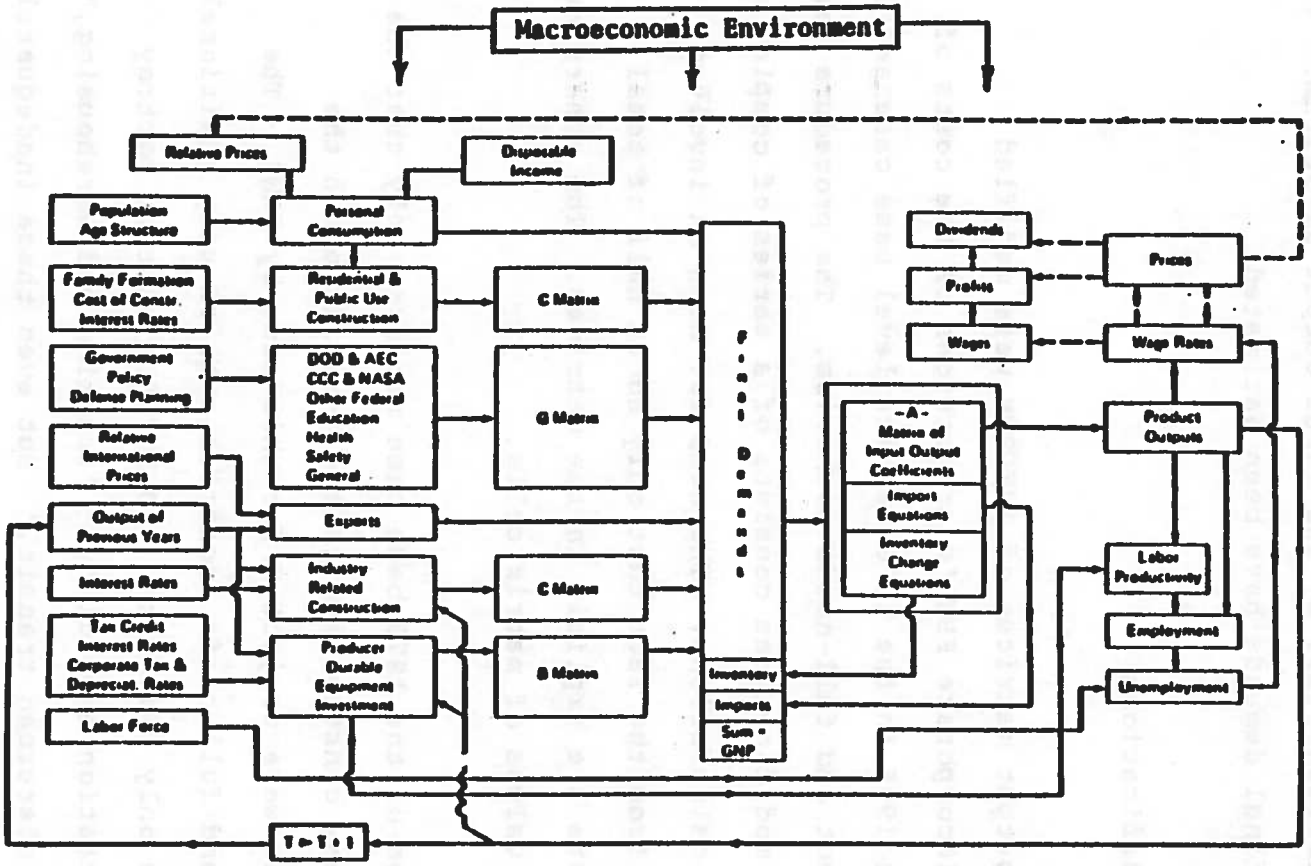


Chase Econometrics

used, e.g., assembly line workers displaced by robots and increased use of plastics in the production of automobiles. A common criticism of input-output analysis is that it often ignores these changes. The Chase version of INFORUM, however, incorporates projected changes in the structure of production. These are based on engineering estimates of future technical processes, historical patterns of technological change, and estimates of the sensitivity of production techniques to changes in the relative prices of inputs.

INFORUM forecasts are estimated sequentially year-by-year, with the forecasts for any one year based on those of previous years. Figure 17 shows how the model operates. Inputs to INFORUM include estimates of disposable income, interest rates, population and labor force growth, and prices. Also, constraints are imposed on final demand subtotals on the basis of macroeconomic forecasts generated by the Long-Term Macroeconomic Model. Next, the major components of aggregate demand are estimated: personal consumption on the basis of disposable income and relative prices, established previously; exports on the basis of relative international prices and industry outputs of previous years; government spending on the basis of government fiscal planning; purchases of plant and equipment on the basis of estimates of the current year's level of industrial activity and previous years' outputs; and residential and public-use construction on the basis of estimates of personal consumption (already determined), family formation, cost of construction, and

FIGURE 17



Flow Diagram of the Inforum Model with Solution Procedure (CEAI version)

Dotted lines indicate work still under development

interest rates. The B, C and G matrices then allocate expenditures on equipment, construction, and government purchases to various final demand sectors. Imports and inventory changes are estimated simultaneously by the input-output algorithm. At this point all final demands have been estimated.

5.2 INFORUM Modifications

The input-output matrices of INFORUM were modified extensively to incorporate FHWA's projections of the costs of highway usage in 1995 in the 1978 service level base case and in the low-investment and full-needs scenarios. The procedure for effecting these modifications consists of a series of complex and highly detailed calculations. The need for such an involved procedure stems from the fact that only about 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 C-matrix match the expenditures that were projected for this case by FHWA. The low-investment and full-needs scenarios require 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 by Jack Faucett Associates [3] estimates some relationships between highway transportation and sectors of INFORUM. Columns were developed for 13 categories of highway transportation. These categories, listed in Table 17, account for nearly all expenditures for highway transportation. Selected column entries for two of the 13 categories are shown in Table 18 for purposes of illustration.

The outputs of FHWA's Investment/Performance Impact Analysis models and FHWA's forecasts of vehicle miles of travel (VMT) were used to estimate 1995 highway operating costs for automobiles and three truck classes for urban areas and again for rural areas.* These estimates, calculated for the 1978 base case and the two alternative scenarios, were translated into changes in the Faucett columns after the columns were updated on the basis of recent highway revenue and expenditure data. Table 19 indicates which FHWA impact estimates went into each Faucett column. The adjusted columns were then imputed to the input-output matrices of the INFORUM model. The entire process required the following six steps:

*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, like the worst-case, low-investment macroeconomic scenario described in Section 4.0, was subsequently modified to reflect the negative effects of deterioration of highway performance on VMT growth. These modifications are explained later in this section.

TABLE 17

Highway Modal Columns

1.	For-hire Intercity Truck	FHIT
2.	For-hire Truck Local	FHTL
3.	Transit	TRAN
4.	Taxis	TAXI
5.	Intercity Bus	IBUS
6.	Private Truck Intercity Freight	PTIF
7.	Private Truck Local Freight	PTLF
8.	Private Truck Non Freight	PTNF
9.	Government Truck	GOVT
10.	Business Auto	BUSA
11.	Personal Auto	PERA
12.	School Bus	SCHB
13.	Other Bus	OBUS

Source: Jack Faucett Associates, Inc.

TABLE 18

Selected Inputs to For-hire Intercity Trucking
and For-hire Local Trucking, 1972

(millions of 1972 dollars)

	For-hire Local Trucking	For-hire Intercity Trucking
Petroleum Refining	133.54	139.60
Fuel Oil	35.10	398.77
Tires and Inner Tubes	88.43	255.55
Freight Forwarding	92.40	267.02
Telephone and Telegraph	105.45	304.74
Wholesale Trade	337.84	976.28
Retail Trade	133.45	385.63
Insurance	190.88	551.61
Real Estate	116.17	335.70
Auto Repair	296.41	856.55
.	.	.
.	.	.
.	.	.
Value Added	4,540.96	13,112.43
Employment	263.82	762.38
Input Sum	6,445.49	18,677.20
Revenue	6,542.15	18,905.48

Source: Jack Faucett Associates, Inc.

TABLE 19

Translating FHWA's Direct Impact Estimates to Highway Modes

Faucett Highway Modes \ Direct Impacts	50K Urban	50K Rural	12K Urban	12K Rural	5K Urban	5K Rural	5K Non Frt	Auto Urban	Auto Rural
FHIT	✓	✓	✓	✓	✓	✓			
FHTL	✓	✓	✓	✓	✓	✓			
TRAN			✓						
TAXI								✓	
IBUS			✓	✓					
PTIF	✓	✓	✓	✓	✓	✓			
PTLF	✓	✓	✓	✓	✓	✓			
PTNF							✓		
GOVT	✓	✓	✓	✓	✓	✓			
BUSA								✓	✓
PERA								✓	✓
SCHB			✓	✓					
OBUS							✓		

(1) Outputs of the Investment/Performance Impact Analysis model were used to calculate the following operating cost ratios for each vehicle type:

(a) $\frac{\text{Operating costs in low-investment scenario}}{\text{Operating cost in 1978 service level case}}$

(b) $\frac{\text{Operating costs in full-needs scenario}}{\text{Operating cost in 1978 service level case}}$

Similar ratios were calculated for fuel and other operating costs.

(2) Weighted averages of these ratios were calculated for each Faucett highway mode. Fuel consumption entries in the Faucett columns were used in the weighting of operating cost ratios of larger vehicles relative to smaller ones.

(3) These weighted average ratios were then used to modify the 13 Faucett columns. Clearly, not all of the input sectors to these columns are sensitive to changes in highway conditions and performance. The 35 sectors listed in Table 20 account for the preponderance of changes in vehicle operating costs. Changes were estimated for the low-investment and full-needs scenarios for all 13 Faucett columns by multiplying the weighted cost ratios minus one by the column values.

(4) The 13 Faucett modal columns were consolidated into seven aggregate columns, which were used to modify

TABLE 20

INFORUM Sector Inputs to Highway Travel

Sector Number	Sector Name
38	Floor Coverings
42	Household Textiles
67	Misc. Chemical Products
73	Cleaning and Toilet Preparations
74	Paints and Allied Products
76	Petroleum Refining
77	Fuel Oil
80	Tires and Inner Tubes
81	Rubber Products
86	Glass and Glass Products
90	Other Stone and Clay Products
107	Cutlery, Hand Tools, Hardware
110	Other Fabricated Metal Products
111	Engines and Turbines
114	Materials Handling Machinery
117	Other Metal Working Machinery
120	Ball and Roller Bearings
125	Service Industry Machinery
126	Machine Shop Products, Misc. Machinery
131	Motors and Generators
133	Electrical Industry Apparatus NEC
135	Electric Lighting and Wiring
136	Radios, TV Receivers, Phonos
140	Batteries
141	Engine Electrical Equipment
142	X-Ray, Electrical Equipment NEC
144	Bus, Truck, Trailer Bodies
145	Motor Vehicles and Parts
153	Trailer Coaches
180	Wholesale Trade
181	Retail Trade
182	Finance and Credit Agencies
183	Insurance Carriers and Agents
190	Auto Services and Repair
195	Federal and State and Local Government Enterprises

INFORUM columns as follows:

FHIT and FHTL:	used to modify INFORUM column 169, Trucking and Warehousing.
TRAN, TAXI and IBUS:	used to modify INFORUM column 168, Transit
PTIF, PTLF and BUSA:	used in conjunction with a modified INFORUM row 76 (modified to represent only gasoline sales to highway transportation) to generate coefficient changes throughout the INFORUM matrices.
PERA and PTNF:	used to modify the Personal Consumption Expenditure (PCE) column.
GOVT:	used to modify the INFORUM Government final demand sectors. Individual elements of the column were prorated to the individual INFORUM government columns based on their fuel consumption statistics.
SCHB:	used to modify the State and Local Government-Education INFORUM column.
OBUS:	used to modify INFORUM column 193, Private Education and Non-profit Organizations.

The above process yielded a matrix of dollar flows that estimated 1995 conditions under the low-investment and full-needs scenarios.

(5) For the low-investment scenario, the effects of the deterioration of highway performance on VMT were addressed by two additional INFORUM modifications: (a) increases in the prices of commodities whose transport costs could be expected to be strongly affected, and (b) lower personal consumption expenditures (PCE) for

sectors directly related to the personal use of automobiles, light trucks, and vans.

(a) Price modifications - The increased dollar flows that were estimated in Step 4 were summed for each of the 200 columns in the A-matrix. To each of these sums were added estimates of increased value-added stemming from higher employee compensation caused by increased time in transit and from increased depreciation, as indicated by the FHWA Investment Performance Model. Also, decreases in indirect taxes resulting from lower highway expenditures were subtracted. These results represent estimates of the increased costs of highway transportation as a result of performance deterioration. Sectors for which these higher costs in 1995 represent an increase of over one percent are listed in Table 21. On the assumption that higher costs in these 53 sectors would ultimately be passed on to consumers, they were fed into INFORUM's PCE equations. This approach thus addresses the negative effects of performance deterioration on VMT in terms of smaller shipments of commodities whose costs of private and for-hire trucking increase appreciably.

(b) PCE modifications - Highway VMT is projected by FHWA to be 2,428 billion in 1995 in the 1978 service level scenario. Of this, 1676.1 billion, or 69

TABLE 21

Estimates of Industry Price Increases Caused by Movement from 1978 Service Level Case to Low-Investment Scenario: 1995 Increases in Excess of One Percent

Sector	Percent Increase
Grains	15.1
Trucking	11.4
Buses and Local Transit	10.3
Campers	9.6
Cotton	8.8
Fishery Products	8.6
Tobacco	5.8
Mobile Homes, Prefabricated Wooden Buildings	5.4
Cycles, Transportation Equipment NEC	5.2
Stone and Clay Mining	4.3
Iron Ores	3.8
Cement, Concrete, Gypsum	3.3
Logging Camps	3.3
Postal Service	3.3
Wholesale Trade	2.6
Structural Clay Products	2.6
Paving and Asphalt	2.6
Dairy Farm Products	2.6
Copper Ore	2.6
Coal Mining	2.5
Welding Apparatus, Graphite Production	2.4
Pipelines	2.3
Canned and Frozen Foods	2.1
Miscellaneous Chemical Products	2.1
Other Stone and Clay Products	2.1
Hotel and Lodging Places	2.1

TABLE 21 (continued)

Sector	Percent Increase
Paints	2.0
Office Supplies	1.8
Maintenance Construction	1.8
Machine Shop Products	1.6
Fruits, Vegetables, Other Crops	1.6
Poultry and Eggs	1.5
Meat Animals, Other Livestock	1.5
Forestry Products	1.5
Fertilizers	1.5
Retail Trade	1.5
Paperboard Containers	1.4
Tires and Inner Tubes	1.4
Private Schools and Nonprofit Organizations	1.4
Federal, State, and Local Government Enterprises	1.4
Pottery	1.3
Water and Sewer Services	1.3
Personal and Repair Services	1.3
Agricultural, Forest, and Fishery Services	1.2
Bakery Products	1.2
Soft Drinks and Flavorings	1.2
Saw and Planing Mills	1.2
Aluminum	1.2
Engines and Turbines	1.2
Pulp Mills	1.1
Transformers and Switchgear	1.1
Miscellaneous Manufacturing	1.1
Railroads	1.1

percent, represents personal use of automobiles, small trucks, and vans. On the basis of estimates of VMT cost elasticities and FHWA estimates of the cost of highway usage, PCE VMT was projected to be 14.5 percent lower in the 1995 low-investment scenario than in the 1978 service-level case. When the value of travelers' time is taken into account, PCE VMT is reduced by an additional 14.3 percent. When VMT expense is defined as the sum of financial plus time-value costs, PCE VMT has an elasticity of -1.25.

As explained in Section 2.3, reductions in VMT imply higher levels of highway performance. Because of this two-way causality between VMT and highway performance, the ultimate effects on VMT had to be estimated iteratively. Fortunately, the VMT estimate reached a new equilibrium after only three rounds of calculations. This procedure yielded PCE VMT of 1244.1 billion, a reduction of 432 billion, or 25.8 percent, from the original 1995 projection. This result was used to estimate reductions from 1995 projections of PCE in the 1978 service level scenario. These PCE modifications are shown in Table 22.

(6) INFORUM modification computer algorithms were used to scale these 1995 changes in the matrices over the 1981-1995 period. In general, the changes in an

TABLE 22
1995 PCE Modifications of INFORUM
(Millions of 1977 Dollars)

INFORUM Sector	Changes
Motor Vehicles	-6867
Petroleum Refining	-4339
Auto Repair	-2077
Tires and Inner Tubes	-849
Insurance	-661
Batteries	-80
Electrical Equipment, NEC	-46
Misc. Chemical Products	-34
Household Textiles	-11
Cleaning Products	-11
Electrical Lighting and Wiring Equipment	-11
Radio and TV Receiving	-11
Floor Coverings	-7
Misc. Fabricated Wire Products	-7
Service Industry Machinery	-7
Cutlery, Hand Tools, Hardwear	-5
Machine Shop Products	-2
Total	-15,025

intermediate year are proportional to the percentage of the cumulative highway investments expended up to that year.

These modified versions of INFORUM, representing the 1978 service level and the low-investment and full-needs scenarios were matched with and driven by corresponding macroeconomic scenarios, whose development is described in Section 3.0, above. This procedure produced simulations of the detailed structure of the U.S. economy under conditions of (a) the 1978 service levels, (b) highway deterioration, and (c) immediate attainment of the full-needs standard of highway performance. In the next section, simulation of the low-investment scenario (highway deterioration) will be compared with the simulation of the economy under the 1978 service level. The results of the full-needs simulation will be presented in Section 7.0.

6.0 Input-Output Simulation of the Low-Investment Scenario

This section presents the results of simulating the interindustry structure of the U.S. economy under the low-investment scenario and compares this simulation with its 1978 service level base of departure.* Tables 23 and 24 show estimated differences in 1995 output and consumer purchases for selected industries that would be directly impacted by a movement from the 1978 service level case to the low-investment scenario. The first four sectors in Table 23 are projected to incur substantial reductions in output as a consequence of (a) lower levels of capital spending on highways and (b) lower levels of activity in the economy generally.

The next eight sectors are directly affected by (a) deterioration of highway performance and (b) 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 INFORUM simulation results are measured in 1977 dollars. For purposes of making comparisons with the highway expenditure scenarios, which are measured in 1980 dollars, the dollar projections in Tables 23 through 26 should be multiplied by 1.276 (derived from the GNP deflator).

TABLE 23

INDUSTRIAL SECTORS SIGNIFICANTLY IMPACTED BY MOVEMENT FROM 1978 SERVICE LEVEL CASE TO LOW INVESTMENT SCENARIO: ESTIMATED CHANGES IN 1995 OUTPUT (MILLIONS OF 1977 DOLLARS)

SECTOR	1978 SERVICE LEVEL	LOW-INVESTMENT	CHANGE	PERCENT CHANGE
RELATED TO HIGHWAY EXPENDITURES				
PAVING AND ASPHALT	8430.6	5184.8	-3245.8	-38.5
CEMENT, CONCRETE, GYPSUM	26732.5	19675.1	-7057.4	-26.4
STONE AND CLAY MINING	11318.1	8511.2	-2806.9	-24.8
OTHER STRUCTURAL METAL PRODUCTS	38876	32072.7	-6803.3	-17.5
RELATED TO HIGHWAY USAGE				
TRUCK, BUS, TRAILER BODIES	12843.7	14770.2	1926.5	15
METAL STAMPINGS	22881.7	26108	3226.3	14.1
TIRES AND INNER TUBES	16259.9	17560.7	1300.8	8
PETROLEUM REFINING	123131	128918	5787.2	4.7
MOTOR VEHICLES	191055	196978	5922.7	3.1
CRUDE PETROLEUM	29302.7	29419.9	117.2	.4
BATTERIES	6824.6	6688.1	-136.5	-2
AUTO REPAIR	80266	70874.9	-9391.1	-11.7
RELATED TO OTHER MODES				
BUSES AND LOCAL TRANSIT	12224	13605.3	1381.3	11.3
RAILROADS	38962.1	42507.7	3545.6	9.1
AIRLINES	51757.8	45495.1	-6262.7	-12.1
TRUCKING	104686	85633	-19052.8	-18.2

TABLE 24

INDUSTRIAL SECTORS SIGNIFICANTLY IMPACTED BY MOVEMENT FROM 1978 SERVICE LEVEL CASE TO LOW INVESTMENT SCENARIO: ESTIMATED CHANGES IN 1995 CONSUMER PURCHASES (MILLIONS OF 1977 DOLLARS)

SECTOR	1978 SERVICE LEVEL	LOW-INVESTMENT	CHANGE	PERCENT CHANGE
		RELATED TO HIGHWAY EXPENDITURES		
CEMENT, CONCRETE, GYPSUM	4.5	3.7	-.8	-18.3
STONE AND CLAY MINING	73.7	65.7	-8	-10.8
OTHER STRUCTURAL METAL PRODUCTS	298.8	270.7	-28.1	-9.4
		RELATED TO HIGHWAY USAGE		
METAL STAMPINGS	1055.7	1013.5	-42.2	-4
TIRES AND INNER TUBES	17997.9	17152	-845.9	-4.7
PETROLEUM REFINING	39616.9	35259	-4357.9	-11
MOTOR VEHICLES	81522.8	74674.9	-6847.9	-8.4
BATTERIES	7083.9	7006	-77.9	-1.1
AUTO REPAIR	40700.7	38625	-2075.7	-5.1
		RELATED TO OTHER MODES		
BUSES AND LOCAL TRANSIT	6798.5	7050	251.5	3.7
RAILROADS	394	453.1	59.1	15
AIRLINES	20372.6	19191	-1181.6	-5.8
TRUCKING	4776.5	4079.1	-697.4	-14.6

The increases in output of the first six of the eight sectors in this group, though a boon to these industries, represent a social cost, because they divert resources away from other sectors of the economy. It should be noted that this diversion of resources occurs despite lower consumer purchases, which are shown in Table 24.

These lower consumer purchases are the direct result of reductions in VMT. They 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, i.e., 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 usage, as indicated by lower PCE's in Table 22, and to the decrease in the level of economic activity generally.

The last four rows in Table 23 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, as explained in Section 5.2, many commodities become more

expensive in the low-investment scenario. This in turn leads to reduced sales and shipments. Second, as Table 21 indicates, the price of for-hire trucking increases by 11.4 percent. Finally, for-hire trucking can be expected to suffer from declines in macroeconomic activity.

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 PCE VMT, discussed in Section 5.2, which are apparently large enough to offset the negative effects of an increase of 10.3 percent in the price of bus and local transit (Table 21). The decrease in airline output could be anticipated because of the projected state of the economy in the low-investment scenario.

Tables 25 and 26 present estimated impacts on selected consumer goods industries less directly related to highway expenditures, highway usage, or specific transportation modes. Of these 19 sectors, none underwent INFORUM modifications of PCE of the kind described in Section 5.2. Moreover, as shown in Table 21, prices of only five of these sectors were increased because of higher transport costs: fruits, vegetables and other crops (1.6%), poultry and eggs (1.5%), hotel and lodging places (2.1%), canned and frozen foods (2.1%), and soft drinks and flavorings (1.2%). Although these price increases explain part of the declines in output and consumer purchases of these five

TABLE 25

CONSUMER GOODS SECTORS SIGNIFICANTLY IMPACTED BY MOVEMENT FROM 1978 SERVICE LEVEL CASE TO LOW INVESTMENT SCENARIO: ESTIMATED CHANGES IN 1995 OUTPUT (MILLIONS OF 1977 DOLLARS)

SECTOR	1978 SERVICE LEVEL	LOW-INVESTMENT	CHANGE	PERCENT CHANGE
TELEPHONE AND TELEGRAPH	125626	88943.4	-36682.9	-29.2
DRUGS	19584.9	16040	-3544.9	-18.1
WATCHES AND CLOCKS	2848.5	2407	-441.5	-15.5
BOOKS	11371.4	9927.2	-1444.2	-12.7
FRUITS, VEGETABLES, OTHER CROPS	45079	39714.6	-5364.4	-11.9
POULTRY AND EGGS	11430.8	10242	-1188.8	-10.4
HOTEL AND LODGING PLACES	23727.5	21425.9	-2301.6	-9.7
PHOTOGRAPHIC EQUIPMENT	27039	24524.4	-2514.6	-9.3
MEDICAL SERVICES	177740	162454	-15285.6	-8.6
CANNED AND FROZEN FOODS	33061.7	30482.9	-2578.8	-7.8
APPAREL	53988.1	50640.8	-3347.3	-6.2
SOFT DRINKS AND FLAVORINGS	16233.8	15259.8	-974	-6
MEAT PRODUCTS	60296.4	57462.5	-2833.9	-4.7
PHONOGRAPH RECORDS	2817.8	2707.9	-109.9	-3.9
HOUSEHOLD FURNITURE	18524.6	17839.2	-685.4	-3.7
NEWSPAPERS	20951.9	20281.4	-670.5	-3.2
HOUSEHOLD APPLIANCES	21286.5	20796.9	-489.6	-2.3
EATING AND DRINKING PLACES	129954	127875	-2079.3	-1.6
ALCOHOLIC BEVERAGES	25354.2	24999.2	-355	-1.4

TABLE 26

CONSUMER GOODS SECTORS SIGNIFICANTLY IMPACTED BY MOVEMENT FROM 1978 SERVICE LEVEL CASE TO LOW INVESTMENT SCENARIO: ESTIMATED CHANGES IN 1995 CONSUMER PURCHASES (MILLIONS OF 1977 DOLLARS)

SECTOR	1978 SERVICE LEVEL	LOW-INVESTMENT	CHANGE	PERCENT CHANGE
TELEPHONE AND TELEGRAPH	43299.4	36934.4	-6365	-14.7
DRUGS	13799	12695.1	-1103.9	-8
WATCHES AND CLOCKS	3014.1	2676.5	-337.6	-11.2
BOOKS	7353.9	7015.6	-338.3	-4.6
FRUITS, VEGETABLES, OTHER CROPS	20371	19413.6	-957.4	-4.7
POULTRY AND EGGS	3905.6	3827.5	-78.1	-2
HOTEL AND LODGING PLACES	11877.8	11260.2	-617.6	-5.2
PHOTOGRAPHIC EQUIPMENT	5654.4	5196.4	-458	-8.1
MEDICAL SERVICES	155809	145058	-10750.8	-6.9
CANNED AND FROZEN FOODS	32070.4	30210.3	-1860.1	-5.8
APPAREL	81003.9	78330.8	-2673.1	-3.3
SOFT DRINKS AND FLAVORINGS	14125.3	13404.9	-720.4	-5.1
MEAT PRODUCTS	45472.8	43926.7	-1546.1	-3.4
PHONOGRAPH RECORDS	4963	4794.3	-168.7	-3.4
HOUSEHOLD FURNITURE	26428.3	24499	-1929.3	-7.3
NEWSPAPERS	6907.5	6603.6	-303.9	-4.4
HOUSEHOLD APPLIANCES	26033.9	25539.3	-494.6	-1.9
EATING AND DRINKING PLACES	99684.2	95198.4	-4485.8	-4.5
ALCOHOLIC BEVERAGES	35177.2	34755.1	-422.1	-1.2

sectors, it is unlikely that they explain all of them, especially since the largest price increase is only 2.1 percent. The more important explanatory variables for the results shown in Tables 25 and 26 would appear to be aggregate disposable income and consumer spending, which, as Tables 8 and 9 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 by the variability indicated in Tables 25 and 26.

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.

7.0 Simulation of the Full-Needs Scenario

This section presents the results of simulating the full-needs scenario, described in Section 2.0, with both the Long-Term Macroeconomic Model and Chase's version of INFORUM.* Although this scenario appears less likely to occur than its low-investment counterpart, it is, nevertheless, of interest as an alternative policy option.

7.1 Macroeconomic Impacts

The macroeconomic implications of full-needs performance are presented in terms of, first, the fiscal impacts of increases in expenditures and taxes and, second, impacts that result from improved productivity and lower depreciation of motor vehicles.

*Two points regarding the results of both the macroeconomic and interindustry simulations of the full-needs scenario should be noted. First, the interindustry simulation was run on an earlier version of the INFORUM model. Time and resources did not permit rerunning this simulation after the latest version became available, although this was done for the low-investment scenario. The most noticeable consequence of this is that the INFORUM results are measured in 1976 rather than 1977 dollars. In addition, the earlier version lacks the improvements and refinements of the latest version, including updating of the I-O matrix on the basis of the 1977 Census of Manufactures. Secondly, improvements in highway performance are not reflected in increased VMT. Both the 1978 service level base case and the full-needs scenario assume that VMT will grow at 1.2 percent a year, an assumption that underlies some results of FHWA's investment/performance analysis that were used. This simplification is not a major distortion, because the movement to the full-needs scenario from its base-case scenario is relatively small compared with the movement to the low-investment scenario from its base case.

7.1.1 Macroeconomic Impacts of Increased Expenditures and Taxes

Shifting from the 1978 service level scenario (1.2 percent VMT growth) to the full-needs scenario involves an increase in highway expenditures from 1981 to 1990 and then a slight decline in expenditures from 1991 to 1995, as shown in Table 2 and Figure 2. The magnitude of the changes in the first five years is much more substantial than the changes in either the second or the third five-year periods. Associated with these changes in the level of highway spending are increases and then reductions in tax revenues. The combined effects of the changes in spending and taxes on nominal GNP are expected to be positive at first and then negative.

The anticipated effects on real output and prices of an increase in aggregate demand are positive. The figures in Table 27 show that real GNP does indeed increase when highway spending increases and then declines. The greatest changes occur in the first five years of the period. The changes in the GNP deflator and the consumer price index, reported in Tables 28 and 29 are uniformly positive. Because the exogenous changes in expenditures and taxes are so small in the last ten years of the simulation period, they are probably offset by lagged impacts that are induced by the large spending and tax changes in 1981-1985, so that prices continue to rise after GNP has started to decline.

TABLE 27

Estimated Impacts on GNP
(billions of 1972 dollars) of
Change from 1978 Service Level
(1.2% annual growth in VMT)
to Full-Needs Case (1.2% annual growth in VMT),
1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Cha in Productivi and Depreciation	
Year	Dollar Impacts	Percentage of GNP	Dollar Impacts	Percentage of Total Impact	Dollar Impacts	Percentage of Total Impact
1981	2.2	.15	2.2	100	0.0	0
1982	4.9	.31	4.9	100	0.0	0
1983	4.8	.29	4.6	96	.2	4
1984	4.6	.27	4.6	100	0.0	0
1985	4.5	.26	4.6	96	-.2	4
1986	.4	.02	0.6	75	-.2	25
1987	.9	.05	1.0	91	-.1	9
1988	.7	.04	0.5	71	.2	29
1989	.6	.03	0.2	33	.4	66
1990	.3	.02	-0.1	17	.5	83
1991	.2	.01	-0.7	44	.9	56
1992	.2	.01	-0.8	44	1.0	56
1993	.2	.01	-1.1	46	1.3	54
1994	.5	.02	-0.8	38	1.3	62
1995	.7	.03	-1.0	37	1.7	63

TABLE 28

Estimated Impacts on Implicit Price Deflator,
Gross National Product (1972=100)
of Change from 1978 Service Level
(1.2% annual growth in VMT)
to Full-Needs Case (1.2% annual growth in VMT)
1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	Impact on Deflator	Percentage of Deflator	Impact on Deflator	Percentage of Total Impact	Impact on Deflator	Percentage of Total Impact
1981	0.1	0.05	0.1	100	0.0	0
1982	0.1	0.07	0.2	66.7	-0.1	33.3
1983	0.2	0.08	0.3	75.0	-0.1	25.0
1984	0.2	0.10	0.4	66.7	-0.2	33.3
1985	0.4	0.14	0.7	70.0	-0.3	30.0
1986	0.2	0.06	0.6	60.0	-0.4	40.0
1987	0.4	0.13	1.0	62.5	-0.6	37.5
1988	0.5	0.15	1.2	63.2	-0.7	36.8
1989	0.5	0.16	1.4	60.9	-0.9	39.1
1990	0.6	0.17	1.7	60.7	-1.1	39.3
1991	0.6	0.15	1.9	59.4	-1.3	40.6
1992	0.6	0.15	2.1	58.3	-1.5	41.7
1993	0.6	0.15	2.3	57.5	-1.7	42.5
1994	0.6	0.14	2.4	57.1	-1.8	42.9
1995	0.6	0.13	2.6	56.6	-2.0	43.5

TABLE 29

Estimated Impacts on Consumer Price Index (1967=100) of Change from 1978 Service Level (1.2% annual growth in VMT) to Full-Needs Case (1.2% annual growth in VMT), 1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Cha in Productivit and Depreciation	
Year	Impact on Index	Percentage of CPI	Impact on Index	Percentage of Total Impact	Impact on Index	Percentage of Total Impact
1981	.1	.03	.1	100	0	0
1982	-.1	-.02	.0	0	0	0
1983	.0	.0	.1	50	-.1	50
1984	.0	.01	.4	50	-.4	50
1985	.3	.08	.8	57	-.6	43
1986	.2	.05	1.0	56	-.8	44
1987	.8	.18	1.8	64	-1.0	36
1988	1.0	.21	2.3	64	-1.3	36
1989	1.1	.23	2.7	63	-1.6	37
1990	1.3	.24	3.2	62	-1.9	38
1991	1.3	.24	3.6	62	-2.2	38
1992	1.5	.25	4.0	62	-2.5	38
1993	1.6	.25	4.4	61	-2.8	39
1994	1.7	.25	4.8	61	-3.1	39
1995	1.8	.26	5.2	61	-3.3	39

The changes in disposable income, consumption, and investment are given in Tables 30, 31, and 33; all these variables increase throughout the period. The largest changes in disposable income and consumption occur in the middle of the simulation period, and the greatest changes in investment occur at the end; this behavior is most likely attributable to the lag structure of the macroeconomic model. The changes in corporate profit taxes and indirect business taxes reduce corporate profits as shown in Table 32, but this reduction does not have an identifiable negative impact on investment.

As in the base case to low-investment simulation, the changes in employment are closely tied to changes in real GNP. The figures in Table 34 show that the number of persons employed increases between 1981 and 1990, with the greatest changes in the first five years. Employment falls between 1991 and 1995. If other factors are held constant, increases in employment have a negative effect on labor productivity, and increases in production have a positive influence. The small increases in labor productivity in manufacturing shown in Table 35 indicate that the latter factor is the more important. The changes in productivity in the "other private industry" sector, reported in Table 36 are positive at first, and then negative; in this case also, the changes in sectoral output outweigh the shifts in employment.

The figures presented in Tables 37 and 38 show that real

TABLE 30

Estimated Impacts on Disposable Personal Income
(billions of 1967 dollars)
of Change from 1978 Service Level
(1.2% annual growth in VMT)
to Full-Needs Case (1.2% annual growth in VMT)
1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	Impact on Personal Income	Percentage of Personal Income	Impact on Personal Income	Percentage of Total Impact	Impact on Personal Income	Percen of Tot Impact
1981	0	0	0	0	0	
1982	0.7	0.09	0.7	100	0	
1983	1.0	0.12	0.8	80.0	0.2	20.
1984	0.8	0.09	1.1	78.6	-0.3	21.
1985	0.8	0.09	1.2	75.0	-0.4	25.
1986	1.2	0.14	1.7	77.3	-0.5	22.
1987	1.0	0.11	1.3	81.2	-0.3	18.
1988	0.9	0.10	1.2	75.0	-0.3	25.
1989	0.8	0.09	1.1	78.6	-0.3	21.
1990	0.7	0.07	0.8	88.9	-0.1	11.
1991	-0.7	0.07	0.9	77.8	-0.2	22.
1992	0.7	0.07	0.8	88.9	-0.1	11.
1993	0.8	0.08	1.0	83.3	-0.2	16.
1994	1.0	0.09	1.1	91.7	-0.1	8.
1995	1.0	0.10	1.2	85.7	-0.2	14.

TABLE 31

Estimated Impacts on Consumption
(billions of 1972 dollars)
of Change from 1978 Service Level
(1.2% annual growth in VMT)
to Full-Needs Case (1.2% annual growth in VMT)
1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	Impact on Consumption	Percentage of Consumption	Impact on Consumption	Percentage of Total Impact	Impact on Consumption	Percentage of Total Impact
1981	0.2	0.02	0.2	100	0.0	0
1982	0.4	0.04	0.4	100	0.0	0
1983	0.7	0.07	0.6	85.7	0.1	14.3
1984	0.6	0.06	0.9	75.0	-0.3	25.0
1985	0.6	0.06	1.1	68.8	-0.5	31.2
1986	0.4	0.04	1.0	62.5	-0.6	37.5
1987	0.7	0.06	1.1	73.3	-0.4	26.7
1988	0.6	0.05	1.1	68.8	-0.5	31.2
1989	0.5	0.04	0.9	69.2	-0.4	30.8
1990	0.4	0.03	0.6	75.0	-0.2	25.0
1991	0.3	0.02	0.4	80.0	-0.1	20.0
1992	0.4	0.03	0.4	100	0.0	0
1993	0.4	0.03	0.3	75.0	0.1	25.0
1994	0.6	0.04	0.4	66.7	0.2	33.3
1995	0.9	0.06	0.5	55.6	0.4	44.4

TABLE 32

Estimated Impacts on Corporate Profits After Taxes
(billions of current dollars) of
Change from 1978 Service Level
(1.2% annual growth in VMT)
to Full-Needs Case (1.2% annual growth in VMT)
1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Change in Productivity and Depreciation	
Year	Impact on Profits	Percentage of Profits	Impact on Profits	Percentage of Total Impact	Impact on Profits	Perce of To Impac
1981	-1.9	1.33	-1.9	100	0	
1982	-3.1	1.96	-3.2	97.0	0.1	3.
1983	-3.6	1.96	-3.7	97.4	0.1	2.
1984	-3.0	1.58	-4.8	72.8	1.8	27.
1985	-3.1	1.53	-5.4	70.1	2.3	29.
1986	-2.1	0.92	-5.2	62.7	3.1	37.
1987	0.6	0.23	-4.2	46.7	4.8	53.
1988	1.1	0.39	-4.2	44.2	5.3	55.
1989	0.3	0.10	-6.3	48.8	6.6	51.
1990	-0.2	0.06	-9.1	50.6	8.9	49.
1991	0.0	0.00	-9.8	50.0	9.8	50.
1992	0.0	0.00	-11.8	50.0	11.8	50.
1993	0.0	0.00	-13.4	50.0	13.4	50.
1994	-0.3	0.07	-17.2	50.4	16.9	49.
1995	-0.2	0.04	-18.1	50.3	17.9	49.

TABLE 33

Estimated Impacts on Gross Private Domestic Investment (billions of current dollars) of Change from 1978 Service Level (1.2% annual growth in VMT) to Full-Needs Case (1.2% annual growth in VMT), 1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation Depreciation	
Year	Dollar Impacts	Percentage of Investment	Dollar Impacts	Percentage of Total Impacts	Dollar Impacts	Percentage of Total Impacts
1981	.1	.03	0.2	100	0	0
1982	.5	.10	0.6	86	-.1	14
1983	.8	.14	1.1	85	-.2	15
1984	1.2	.16	1.9	73	-.7	27
1985	1.9	.24	3.5	70	-1.5	30
1986	2.3	.25	4.4	68	-2.1	32
1987	3.1	.30	5.5	69	-2.5	31
1988	3.5	.31	6.4	69	-2.9	31
1989	3.4	.27	6.9	66	-3.5	34
1990	3.4	.25	7.5	65	-4.0	35
1991	3.6	.24	8.4	64	-4.8	36
1992	3.1	.19	8.4	61	-5.3	39
1993	3.1	.18	9.3	60	-6.2	40
1994	3.2	.17	10.1	59	-6.9	41
1995	3.3	.16	10.9	59	-7.6	41

TABLE 34

Estimated Impacts on Number of Employed (millions) of Change from 1978 Service Level (1.2% annual growth in VMT) to Full-Needs Case (1.2% annual growth in VMT), 1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Ch in Productivi and Depreciatio	
Year	Impact on Number of Employed	Percentage of Number Employed	Impact on Number of Employed	Percentage of Total Impact	Impact on Number of Employed	Percen of Tot Impact
1981	.10	.11	.10	100	0	0
1982	.22	.23	.22	100	0	0
1983	.21	.21	.22	92	-.02	8
1984	.21	.21	.25	89	-.03	11
1985	.21	.21	.26	87	-.04	13
1986	0	0	.05	50	-.05	50
1987	.02	.02	.07	58	-.05	42
1988	.02	.02	.06	60	-.04	40
1989	.01	.01	.05	56	-.04	44
1990	-.01	-.01	.02	40	-.03	60
1991	-.03	-.03	0	0	-.02	100
1992	-.03	-.03	-.01	33	-.02	67
1993	-.04	-.04	-.02	50	-.02	50
1994	-.03	-.02	-.01	50	-.01	50
1995	-.04	-.04	-.03	75	-.01	25

TABLE 35

Estimated Impacts on Labor Productivity in Manufacturing
in Constant Dollars per Labor Hour (1972=100)
of Change from 1978 Service Level
(1.2% annual growth in VMT)
to Full-Needs Case (1.2% annual growth in VMT)
1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	Impact on Productivity	Percentage of Productivity	Impact on Productivity	Percentage of Total Impact	Impact on Productivity	Percentage of Total Impact
1981	0.001	0.01	0.000	0	0.001	100
1982	0.005	0.05	0.002	40.0	0.003	60.0
1983	0.013	0.13	0.002	15.0	0.011	85.0
1984	0.024	0.24	0.003	12.5	0.021	87.5
1985	0.025	0.24	0.004	16.0	0.021	84.0
1986	0.027	0.25	0.004	14.8	0.023	85.2
1987	0.029	0.26	0.005	17.2	0.024	82.8
1988	0.030	0.26	0.005	16.7	0.025	83.3
1989	0.032	0.27	0.005	15.6	0.027	84.4
1990	0.033	0.27	0.005	15.2	0.028	84.8
1991	0.036	0.29	0.005	13.9	0.031	86.1
1992	0.037	0.29	0.005	13.5	0.032	86.5
1993	0.037	0.28	0.004	10.8	0.033	89.2
1994	0.039	0.28	0.005	12.8	0.034	87.2
1995	0.040	0.28	0.005	12.5	0.035	87.5

TABLE 36

Estimated Impacts on Other Private Labor Productivity in Constant Dollars per Labor Hour (1972=100) of Change from 1978 Service Level (1.2% annual growth in VMT) to Full-Needs Case (1.2% annual growth in VMT) 1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	Impact on Other Productivity	Percentage of Other Productivity	Impact on Other Productivity	Percentage of Total Impact	Impact on Other Productivity	Perce of Imp
1981	0.007	0.07	0.007	100	0.000	
1982	0.006	0.06	0.006	100	0.000	
1983	0.008	0.08	0.009	90.0	-0.001	10
1984	0.036	0.37	0.008	22.2	0.028	77
1985	0.034	0.35	0.006	17.6	0.028	83
1986	0.022	0.22	-0.007	19.4	0.029	80
1987	0.026	0.26	-0.006	15.8	0.032	84
1988	0.025	0.25	-0.005	14.3	0.030	85
1989	0.027	0.27	-0.005	13.5	0.032	86
1990	0.026	0.25	-0.007	17.5	0.033	82
1991	0.026	0.25	-0.008	19.0	0.034	81
1992	0.027	0.26	-0.008	18.6	0.035	81
1993	0.029	0.27	-0.008	17.8	0.037	82
1994	0.031	0.29	-0.008	17.0	0.039	83
1995	0.032	0.30	-0.006	13.6	0.038	86

TABLE 37

Estimated Impacts on Imports of Goods and Services
(billions of 1972 dollars)
of Change from 1978 Service Level
(1.2% annual growth in VMT)
to Full-Needs Case (1.2% annual growth in VMT)
1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Changes in Productivity and Depreciation	
Year	Impact on Imports	Percentage of Imports	Impact on Imports	Percentage of Total Impact	Impact on Imports	Percentage of Total Impact
1981	0.0	0.00	0.0	0	0	0
1982	0.1	0.08	0.1	100	0	0
1983	0.2	0.15	0.2	100	0	0
1984	0.2	0.15	0.2	100	0	0
1985	0.2	0.14	0.3	75.0	-0.1	25.0
1986	0.2	0.13	0.3	75.0	-0.1	25.0
1987	0.2	0.13	0.3	75.0	-0.1	25.0
1988	0.2	0.12	0.3	75.0	-0.1	25.0
1989	0.2	0.11	0.3	75.0	-0.1	25.0
1990	0.1	0.05	0.2	66.7	-0.1	33.3
1991	0.1	0.05	0.2	66.7	-0.1	33.3
1992	0.1	0.05	0.2	66.7	-0.1	33.3
1993	0.1	0.05	0.2	66.7	-0.1	33.3
1994	0.1	0.04	0.2	66.7	-0.1	33.3
1995	0.2	0.09	0.2	100	0	0

TABLE 38

Estimated Impacts on Exports of Goods and Services
(billions of 1972 dollars)
of Change from 1978 Service Level
(1.2% annual growth in VMT)
to Full-Needs Case (1.2% annual growth in VMT)
1981-1995

	Total Impacts		Impacts of Changes in Expenditures and Taxes		Impacts of Change in Productivity and Depreciation	
Year	Impact on Exports	Percentage of Exports	Impact on Exports	Percentage of Total Impact	Impact on Exports	Perce of To Impac
1981	0.0	0.00	0.0	0	0	
1982	0.0	00.0	0.0	0	0	
1983	0.0	0.00	0.0	0	0	
1984	-0.1	0.05	-0.1	100	0	
1985	-0.1	0.05	-0.1	100	0	
1986	0.0	0.00	-0.1	50.0	0.1	50.
1987	0.0	0.00	-0.1	50.0	0.1	50.
1988	0.0	0.00	-0.1	50.0	0.1	50.
1989	-0.1	0.04	-0.2	66.7	0.1	33.
1990	-0.1	0.04	-0.2	66.7	0.1	33.
1991	-0.1	0.04	-0.2	66.7	0.1	33.
1992	-0.1	0.04	-0.2	66.7	0.1	33.
1993	-0.1	0.03	-0.2	66.7	0.1	33.
1994	-0.1	0.03	-0.2	66.7	0.1	33.
1995	0.0	0.00	-0.2	50.0	0.2	50.

imports increase and real exports decline. Imports increase because disposable income is rising and because rising U.S. prices make foreign goods relatively less expensive. Rising U.S. prices also lead to a reduction in the demand for U.S. commodities abroad, so exports decline.

7.1.2 Macroeconomic Impacts of Simultaneous Changes in Productivity and Depreciation

Section 2.3 describes the increases in productivity and depreciation that are expected to accompany the move from the 1978 service level to the full-needs scenario. The productivity increase is generally expansionary, while the anticipated effect of a reduction in depreciation is an increase in after-tax corporate profits.

Tables 27, 28, and 29 present the impacts on output and prices. As Table 27 shows, the simulated long-range effects of simultaneous changes in productivity and depreciation on real GNP are positive. Although GNP fluctuates at the beginning of the simulation period, it increases continually after 1987; this indicates that the productivity changes dominate other exogenous changes. Tables 28 and 29 present the changes in the GNP deflator and the consumer price index, which, as expected, are negative.

Changes in disposable income, consumption, corporate

profits, and private investment are shown in Tables 30-33. Given the trend in GNP, one might expect disposable income and consumption to increase as well. However, disposable income declines throughout the period, and consumption increases only in the last few years. This behavior may be related to the decrease in employment, since wage and salary payments are a large portion of personal income. Private domestic investment declines, although corporate profits increase in response to the decline in depreciation.

As shown in Table 34, the number of persons employed declines throughout the period; the greatest reductions occur in 1985-1989, the period following the greatest rate of change for the productivity weighting factor (see Table 4). The productivity changes in constant dollars per labor-hour are given in Tables 35 and 36. The reduction in employment indicates that the productivity changes are so substantial that the level of real output can be maintained and even increased with fewer employees. The decline in employment is the most likely cause of the reduction in personal disposable income shown in Table 30.

Real imports decline and real exports increase as a result of the productivity and depreciation changes. Imports decrease due to the decline in disposable income and the reduction in U.S. prices, with world prices held constant. Exports increase because of the change in relative prices.

The changes that occur in the shift from the 1978 service level to the full-needs case are primarily expansionary. Real GNP, disposable income, consumption and investment all increase. Corporate profits fluctuate. Employment increases at first and then decreases, with the downward pressure apparently due to the sizeable productivity increases. Imports increase throughout the period and exports decline slightly, so that net exports decline. The general increase in prices is due to the expansionary public finance changes.

7.2 Interindustry Impacts

Table 39 is the full-needs counterpart of Tables 23 and 24. As expected, several algebraic signs are the opposite of those in the low-investment scenario. In addition, the magnitudes of the percentage changes are notably smaller. This is because the full-needs scenario is closer to its 1978 service level base case than the low-investment scenario is to its base case.

The third column of Table 39 implies that an improvement in highway performance would allow consumers to spend less of their disposable income on automobile maintenance and repair, fuel, tires, vehicle replacement, etc. and more on other goods and services. Table 40 indicates some of the personal consumption items that would be purchased in larger quantities. These increases would be the result of lower transport costs and the stronger economy inherent in the full-needs scenario.

TABLE 39

Industry Sectors Significantly Impacted by Movement from 1978 Service Level Case to Full-Needs Scenario: Estimated Percentage Changes in 1995 Output, Employment, Consumer Purchases, and Imports

INFORUM Sector	Output	Employment	Consumer Purchases	Imports
Paving and roofing materials	0.5	*	**	1.8
Cement, concrete and gypsum	0.3	*	**	1.1
Stone and clay mining	0.3	*	**	1.0
New construction	0.2	*	**	**
Other structural metal products	0.2	*	**	0.9
Local and Interurban transit	0.9	*	1.4	**
Trucking and warehousing	0.2	-0.1	**	**
Auto services and repair	-3.1	*	-5.0	**
Motor vehicles and parts	-1.7	-1.5	-6.9	-7.0
Tires and inner tubes	-2.9	-1.9	-6.6	-3.6
Engine electrical equipment	-2.0	*	-8.5	-3.6
Metal stampings	-0.8	-0.6	**	-1.0
Truck, bus and trailer bodies	-0.1	*	**	***
Petroleum and natural gas extraction	-1.4	-0.1	**	-1.2
Synthetic rubber	-1.9	*	**	-2.1
Fuel oil	-0.3	*	-4.6	-1.2
Petroleum refining, excluding fuel oil	-0.6	*	-4.8	-1.2
Batteries	-2.6	*	-5.0	-2.7
Trailer coaches	-0.3	*	-7.1	***

*INFORUM estimate is for a broader category than that cited here.

**Not applicable.

***Not estimated by INFORUM.

TABLE 40

Consumer Goods Sectors Favorably Impacted by Movement from 1978 Service Level Case to Full-Needs Scenario: Estimated Percentage Increases in 1995 Output and Consumer Purchases

INFORUM Sector	Output	Consumer Purchases
Poultry and Eggs	0.9	1.8
Fruits, Vegetables, Other crops	0.8	1.3
Forestry Products	0	2.7
Ammunition	0.1	0.2
Meat Products	1.0	1.1
Dairy Products	1.2	1.4
Canned and Frozen Foods	1.2	1.2
Grain Mill Products	0.9	1.1
Bakery Products	1.3	1.3
Sugar	1.6	1.1
Confectionary Products	1.3	1.3
Alcoholic Beverages	1.0	1.4
Soft Drinks and Flavorings	1.2	1.3
Fats and Oils	0.7	1.2
Tobacco Products	0.4	0.5
Periodicals	0.2	0.6
Books	1.4	0.3
Footwear, excluding Rubber	0.4	0.6
Pottery	0	4.1
Household Appliances	4.9	6.8
Phonograph Records	0.1	0.1
Photographic Equipment and Supplies	0.4	0.1
Pens, Pencils, and Related Articles	0.3	1.8
Airlines	0.8	3.1
Water and Sewer Services	0.6	0.5
Postal Service	0	0.2

8.0 Conclusions

This final section summarizes the study's findings regarding the impacts of changes in highway performance on the U.S. economy, with emphasis on the consequences of performance deterioration. The importance of the low-investment scenario, which reflects this deterioration, derives from the fact that it is based on actual FHWA projections of highway expenditures from 1982 to 1995.

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

(1)	Gross National Product	-3.2%
(2)	Implicit GNP Deflator	+5.3%
(3)	Consumer Price Index	+8.0%
(4)	Disposable Income	-5.9%
(5)	Consumption Expenditures	-3.6%
(6)	Gross Private Domestic Investment	-1.3%
(7)	After-tax Corporate Profits	+26.9%
(8)	Employment	-2.2%
(9)	Labor Productivity in Manufacturing	-2.7%
(10)	Labor Productivity in Non-manufacturing	-3.6%
(11)	Imports of Goods and Services	-3.1%
(12)	Exports of Goods and Services	+0.3%

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 auto 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 usage. 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 are realized, households would accommodate the lower level of income by both spending and saving less. Overall, personal consumption expenditures 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. Groups that show significant expenditure reductions are:

(1)	Food	$76
(2)	Household Furnishings	49
(3)	Clothing	36
(4)	Medical Care	122
(5)	Transportation	164
(6)	Entertainment	61
(7)	Services	54

Of course, the changes noted are relative changes. 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, the 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 usage. For example, the family would spend $45 less on gasoline, $21 less on auto 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.

The attainment of the full-needs level of highway performance will result in economic changes generally opposite to those above. The study projects increases in GNP, disposable income, consumption, gross private domestic investment, and productivity. On the other hand, employment and after-tax corporate profits would decline.

Attainment of the full-needs standard is also projected to result in higher output levels for the highway construction sector and its suppliers and in declines for auto services and repair, motor vehicles and parts, tires and inner tubes, engine electrical equipment, metal stampings, truck, bus and trailer bodies, crude petroleum, synthetic rubber, petroleum refining, and batteries. From a societal point of view, these declines in output represent an increase in the availability of resources for use in other sectors of the economy.

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