STATE REVENUE SCENARIOS FOR DIFFERENT ECONOMIC CONDITIONS AND TAXATION POLICIES

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Alternative Highway Expenditure
Strategies Under Changing Revenue Conditions

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PREFACE

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The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented in this report. The contents do not necessarily reflect the official views or policies of the State Department of Highways and Public Transportation.

TABLE OF CONTENTS

SUMMARY

Recent changes in basic economic conditions have had a considerable impact on state revenues available to the State Department of Highways and Public Transportation (SDHPT). The historical growth pattern for revenues has been interrupted because of reduced growth in travel and numbers of vehicles. This change in the revenue growth pattern, coupled with large increases in costs, has resulted in a large reduction in the real purchasing power of available revenues. Because of this new revenue and cost situation, it is more difficult to predict future SDHPT revenues for different possible economic conditions and taxation policies.

This report presents a method that can be used to project future revenues for different scenarios (forecasts) of economic conditions and different taxation policies.

Revenue projections for the different economic conditions considered in this report reveal that there is a wide variation in future revenues, depending upon which scenario is considered. Even in the most optimistic case, however, a considerable increase in taxes would be necessary to prevent real revenues from decreasing substantially, if current trends in highway costs continue in the future.

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

Purpose of Report

It has become increasingly important to the State Department of Highways and Public Transportation (SDHPT) to have available accurate forecasts of future revenues for several reasons. There is a relative shortage of highway funds in Texas since the state gasoline tax is only 5 cents per gallon, and the SDHPT receives only 70 percent of this tax, part of which then goes to the Department of Public Safety. (The Texas constitution stipulates that 25 percent of fuels taxes are earmarked for education, and another 5 percent goes to uses other than for state highways.) Forty-eight states have gasoline taxes higher than Texas; 21 have 7 cents or 7.5 cents per gallon; 14 have 8 cents or 8.5 cents; and 12 have 9 cents or higher. Texas also is handicapped in that it is one of the states that receives considerably less in federal aid than it pays in federal user taxes. The SDHPT revenue situation has worsened considerably in recent years, partially because of smaller purchases of vehicles and fuels because of the energy crisis and the economic recession, but even more because of the tremendous increase in the costs of highway construction and maintenance. These conditions are a significant departure from previous years when revenues were steadily growing and highway costs were not increasing rapidly.

Because of these changing conditions, it is more difficult, but also more important than before, to accurately project revenues and costs so that the SDHPT can adequately plan future expenditure programs. It is hoped that the revenue models that are presented in this report, and that will be further developed in this research study, will partially fulfill the need for better projection techniques.

The purpose of this report is to develop revenue models for projecting future revenues available for state highway use and to use these models to project revenues to the year 1990. Several different projections are made for different economic conditions and tax policies. As is explained in the next section, most state highway revenues in Texas are derived from three basic sources: state fuels taxes, federal aid, and license and registration fees. This report is focused on only the state fuels taxes and licence and registration fees.

Past Revenue Sources

As Table 1 indicates, the three major sources of revenue for the Texas Highway Department are fuels taxes, license fees and federal funding. (For detailed breakdown of historical revenues see Table 2).

TABLE 1

Percentage Breakdown of 1974 Revenues by Source

Source	Revenue	Percent of Total
Motor Fuels Taxes	$279,878,000	37.8%
Federal Funds	216,777,000	29.3
License Fees	193,090,000	26.0
Certificate of Title Fees and Office and Sundry	6,975,000	0.9
Texas Highway Beautification and Railroad Crossing Safety Funds	5,250,000	0.8
County and Other Funds	38,607,000	5.2
Total	$740,577,000	100.0%

In 1974, the gasoline taxes accounted for 37.8 percent of total revenue, federal funding accounted for 29.3 percent and license fees accounted for

Table 2

Highway Department Revenues

Year Ended August 31st	Net License Fees	Gasoline Taxes	Certificate of Title Fees	Depository Interest on State Highway Fund	Office & Sundry	Federal Funds
1954	41,699,845	74,088,176	452,993	217,169	1,219,373	28,458,048
1955	47,770,062	78,412,270	567,089	240,330	1,231,585	43,576,682
1956	52,421,154	104,902,385	996,381	463,361	1,320,766	51,018,147
1957	56,091,985	111,199,204	891,730	672,059	1,607,648	69,449,060
1958	66,172,670	117,293,033	872,650	1,222,223	2,021,842	111,973,910
1959	71,349,920	124,282,198	908,754	736,473	2,572,126	164,919,802
1960	75,797,411	129,946,823	535,733	938,651	2,921,305	185,785,948
1961	78,020,878	133,845,802	510,851	899,271	4,810,554	135,987,906
1962	83,932,944	138,601,914	471,307	972,562	3,917,177	136,218,783
1963	88,719,671	144,688,056	1,033,933	797,547	3,045,444	160,720,500
1964	94,539,995	153,396,104	1,118,200	1,607,571	3,182,355	196,279,390
1965	99,923,269	161,922,944	1,146,061	1,904,639	3,544,004	211,559,429
1966	107,474,836	171,552,004	1,203,191	2,899,413	3,402,029	181,790,030
1967	112,451,527	181,290,749	1,220,032	3,831,948	3,681,313	203,568,583
1968	125,647,784	190,504,674	1,259,092	4,207,227	4,278,743	229,760,781
1969	138,793,277	208,418,115	1,327,962	4,790,983	5,060,590	189,955,923
1970	145,534,966	221,582,428	1,340,966	3,898,471	4,500,815	228,346,707
1971	152,695,699	236,750,678	1,410,427	3,058,858	4,931,463	273,456,240
1972	164,957,456	255,204,950	1,587,216	3,094,619	4,948,350	236,597,918
1973	179,189,682	275,189,769	1,709,579	4,860,346	3,576,225	215,511,466
1974	193,089,716	279,877,975	1,753,779	11,076,522	5,221,252	216,777,537

Source: Texas Highway Department Biennial Reports

Table 2 (Continued)

Highway Department Revenues

Year Ending August 31st	Farm to Market Road Fund	County Funds	Other	Sales Tax on Lubricants	Outdoor Advertising License Fees	Highway Beautification	Railroad Grade Crossing Safety	Total Revenues
1954	12,987,742	2,157,526	2,183,081					163,457,952
1955	15,039,494	813,100	2,829,649					190,480,263
1956	16,217,982	466,196	3,618,728					231,425,102
1957	20,224,530	672,494	5,723,852					266,532,562
1958	11,485,013	640,701	4,117,127					315,799,169
1959	16,652,839	866,828	2,664,509					384,953,450
1960	15,105,715	710,521	3,930,283					415,672,389
1961	14,878,250	1,104,501	2,328,483					372,395,495
1962	13,310,635	513,109	2,951,225					380,889,655
1963	13,254,245	383,756	6,404,125	2,877,984				421,925,262
1964	14,251,261	1,206,263	8,293,882	1,573,440				475,448,462
1965	16,205,562	1,600,175	5,680,553	1,648,944				505,135,581
1966	19,829,647	952,044	6,751,205	1,683,264				497,537,663
1967	19,868,844	1,776,710	8,044,147	1,723,755				537,457,608
1968	18,000,894	875,658	5,486,531	1,749,888				581,771,273
1969	20,068,363	730,818	6,773,054	2,528,568				578,447,652
1970	15,960,765	837,832	13,234,463	2,697,372				637,934,786
1971	15,000,000	637,621	14,026,457	3,202,940				705,206,382
1972	15,000,000	690,652	9,611,921	3,942,080				695,987,412
1973	15,000,000	369,765	6,731,393	4,244,700	126,503	2,000,000	250,000	708,759,428
1974	15,000,000	453,984	7,459,150	4,575,527	41,603	5,000,000	250,000	740,577,045

Source: Texas Highway Department Biennial Reports

26 percent. Thus combined, the three sources accounted for over 93 percent of all revenues.

Other sources of revenue, such as title fees, outdoor advertising fees and the sales tax on lubricants represent only a minor portion of the Highway Department's funds and, while they may be affected by changing economic conditions, the major impact on revenues will clearly be due to the impact of changing economic conditions on license fees, gasoline taxes and federal funding.

Contents of Report

Part II of this Report describes the type of models used and gives equations used in making revenue projections. Part III describes the forecasts of independent variables used in the different revenue scenarios. Part IV discusses the "base, or most likely" scenario, and how some of the other scenarios differ from it. Appendix A gives the complete results for the twelve scenarios developed, and Appendix B includes a discussion of the concept of elasticity.

II. METHOD OF PROJECTING REVENUES

The method used in this report to project revenues is to statistically estimate functional relationships between variables and then to use forecasts of independent variables in the estimated functions. First, estimates are made of the relationships between revenue-related dependent variables and independent variables. Economic theory is used to specify relationships between variables, and statistical procedures are used with historical time series data to estimate these relationships. These estimated relationships are referred to as "revenue models", or "structural equations". Forecasts of the independent variables in the revenue models are used to develop different projections of revenues. Projections are made by assuming that the historical relationship between the dependent and independent variables, as estimated by the revenue models, will be the same in the future as they were in the past.

Economic Theory and "Real" Values of Independent Variables

Economic theory tells us that the number or quantity of a good purchased will depend upon its price, the income of buyers, and the price of other related goods. In this study, the principal variables used to explain the amount of highway fuels consumed and license and registration fees paid in Texas are (1) the price of gasoline, (2) total state personal income, and (3) the U.S. unemployment rate. The U.S. unemployment rate is included in the license and registration fees equation to account for the impact of national economic conditions, specifically the national recession, because in terms of numbers of trucks and commercial vehicles purchased, the current recession is more severe nationwide than in Texas.

Since time series data are used to estimate the revenue models in this report, the independent, monetary variables are specified in "real" 1967 dollars. That is, both the gasoline price and state personal income for each year are divided by the U.S. Consumer Price Index for that year (with the base year 1967 = 1.0) to convert these figures (variables) to a constant purchasing power, or "real 1967 dollars". Figure 1 is a plot of the Consumers Price Index by year. It can be seen that the Consumers Price Index has increased considerably in the period of time shown, especially in the last few years. Figures 2 and 3 show how this increase in prices has affected real state personal income and real gasoline prices. Although state personal income has increased substantially over this period, real income has not increased nearly as much and has actually decreased during the last two years of recession and energy crisis. Figure 3 shows a somewhat different picture for gasoline prices. Gasoline prices in current dollars decreased slightly from 1958 through 1963, increased gradually from 1963 to 1973 and then increased dramatically in 1974 and 1975. In real terms, however, gasoline prices steadily decreased from about 35¢ per gallon in 1958 to about 26¢ per gallon in 1973, then increased back to 35¢ in 1975. Thus, in real terms, gasoline prices currently are at about the same level as they were in 1958.

Economic theory indicates that per capita gasoline consumption should have increased from 1958 through 1973 for two reasons: (1) increasing real per capita personal income, and (2) decreasing real prices. Also, since automobiles and other highway vehicles are complementary goods to gasoline, and are jointly used with gasoline for travel, it would be expected that the number of vehicles per capita also would tend to increase.

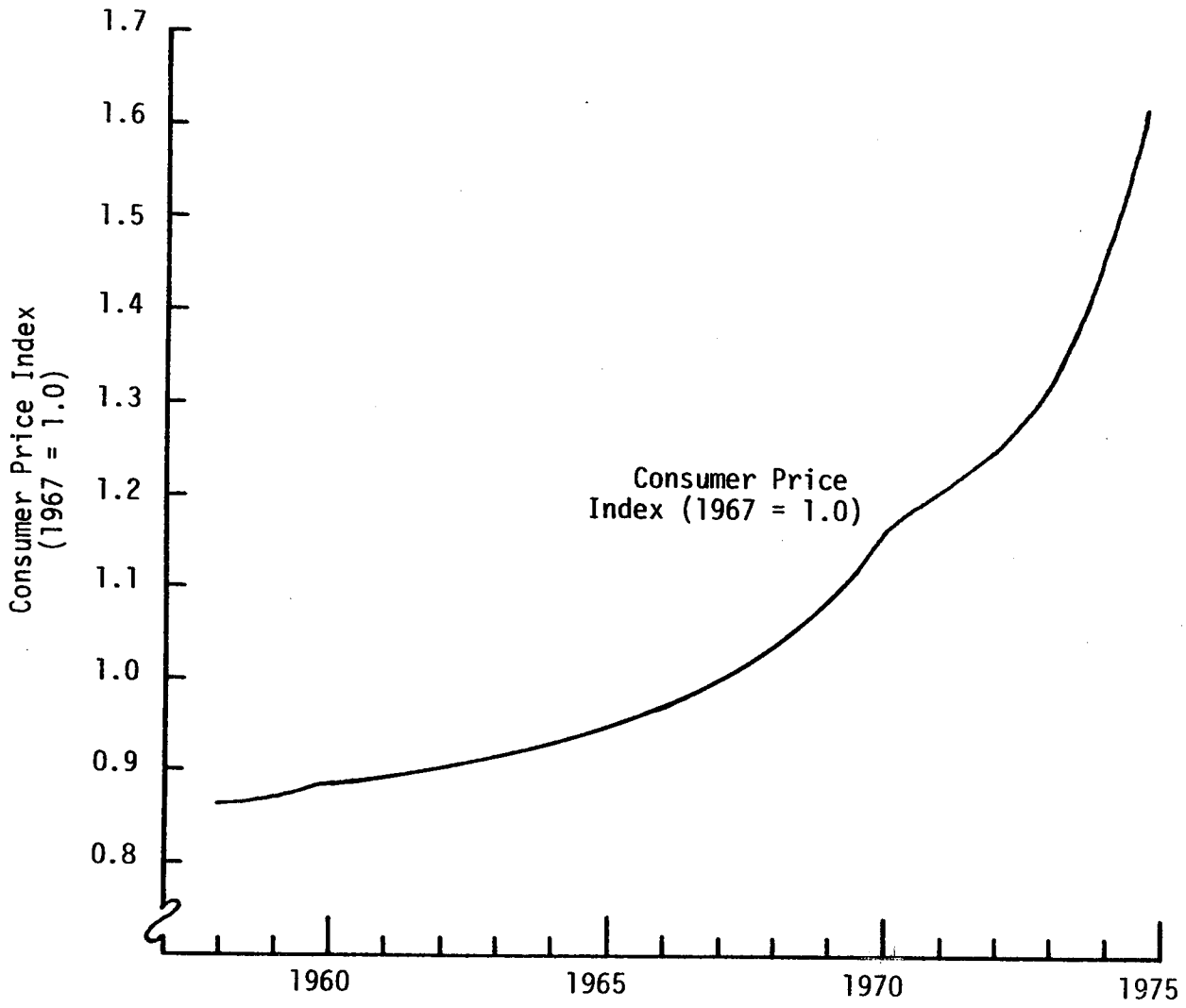

Figure 1. U.S. Consumer Price Index, for the Years 1958-1975 (1967 = 1.0)

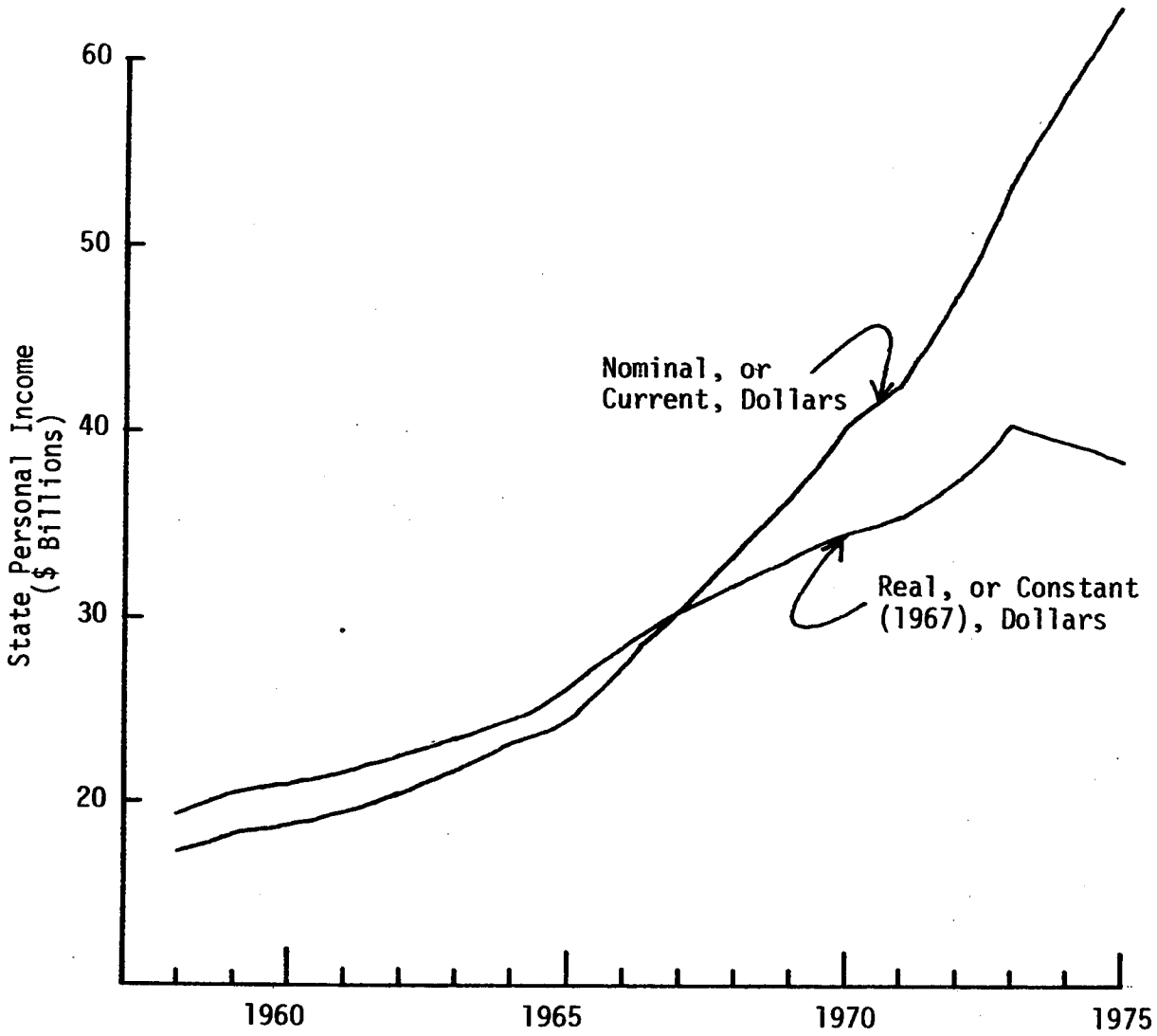

Figure 2. Real and Nominal State Personal Income for the Years 1958-1975

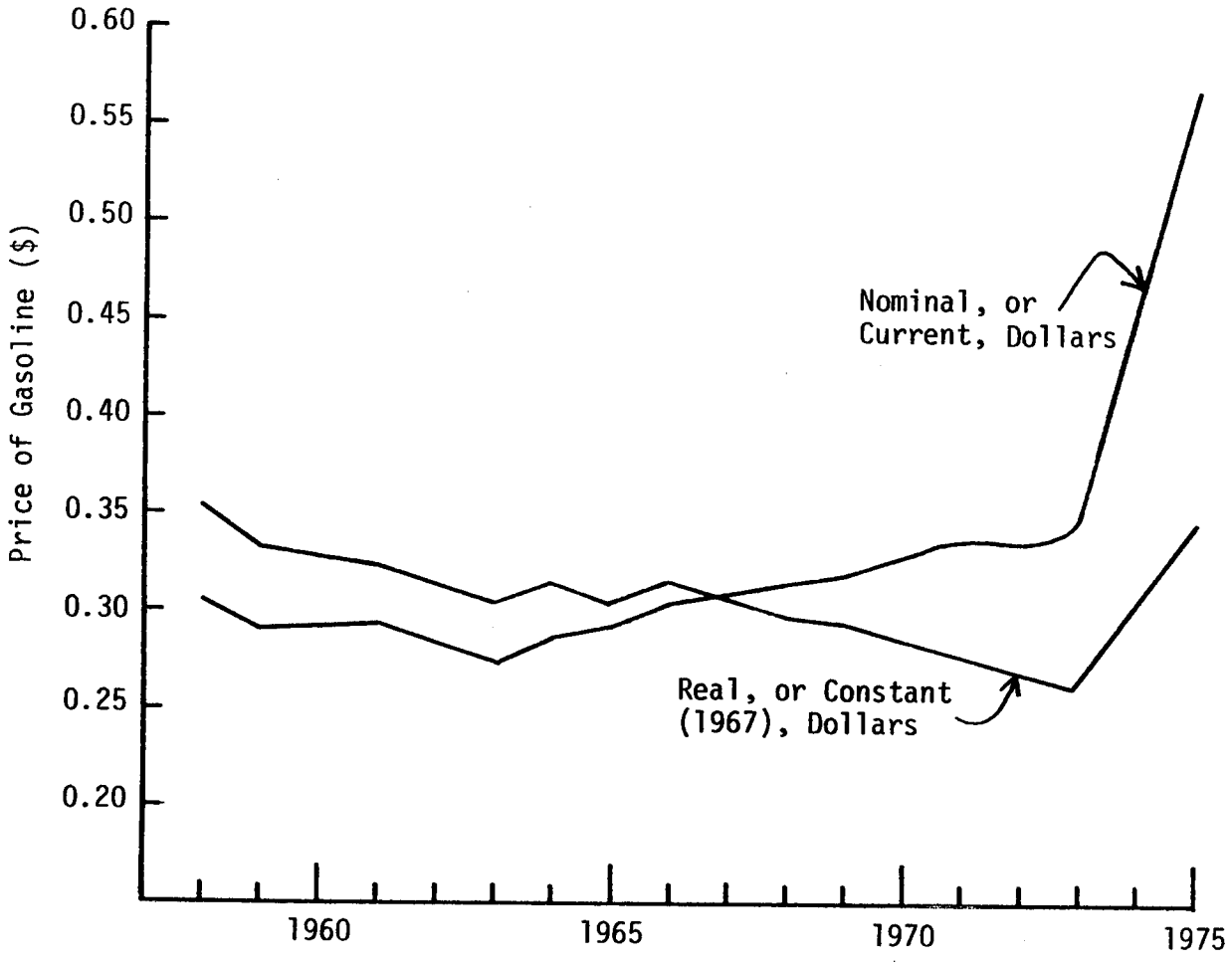

Figure 3. Real and Nominal Prices of Regular Gasoline, Including Taxes, for the Years 1958-1975

As predicted, per capita consumption of gasoline and vehicles did increase during this time period. For example, per capita vehicles increased from 0.47 in 1960 to 0.60 in 1970; motor fuel consumed per vehicle per week increased from 16.1 gallons to 18.1 gallons, in the same time period. In addition, vehicle sizes and other characteristics associated with motorist comfort were the object of increased expenditure because of increased real incomes, decreased real prices, and the associated increase in the value of motorist time, comfort, and convenience. The development of revenue models in this study is based upon deriving statistical relationships of how changes in these "real" variables have affected changes in revenues and revenue-related variables.

Type of Model Used

The type of model used in this study is a "flow-adjustment", or "dynamic partial adjustment" model. In this type of model, the value of the dependent variable being estimated for a particular year is assumed to be a function of the same dependent variable in the previous year or years, as well as other independent variables. This model assumes that consumers do not instantaneously adjust to a change in the independent variables, but rather adjust their quantities consumed over a period of time. This type of model yields both short-run and long-run estimates of the price elasticity of demand.

This type of model recently has been used in at least three studies to estimate the demand for gasoline in the United States [See Philips, Houthakker and Verleger, and Verleger and Sheehan in Table B-1, Appendix B]. All three studies were cross-sectional or mixed cross-sectional/time series studies conducted on U.S. data. This type of model also has been

used by Thompson [Also, see Appendix B for results and reference] to estimate the demand for gasoline in Texas. This type of model has been described by Thompson as follows.

Let Q_t^* be the desired level of fuel consumption in time period t associated with P_t and Y_t:

$$Q_t^* = Q(P_t, Y_t) \tag{1}$$

where P_t = Price of fuel in time period t

Y_t = Income in time period t.

However, due to the time adjustment process, and cost of change, consumption does not immediately adjust to changes in P and Y, but partial adjustment does occur such that

$$Q_t - Q_{t-1} = \lambda(Q_t^* - Q_{t-1}): \quad 0<\lambda<1 \tag{2}$$

where Q_t = actual consumption in time period t

Q_{t-1} = actual consumption in the time period previous to t

λ = adjustment coefficient

Then, specifying the demand function:

$$Q_t^* = \beta_0 + \beta_1 P_t + \beta_2 Y_t \tag{3}$$

and substituting it into the time adjustment equation, actual consumption in time period t is:

$$Q_t = \beta_0^* + \beta_1^* P_t + \beta_2^* Y_t + \beta_3^* Q_{t-1} \tag{4}$$

where $\beta_i^* = \lambda\beta_i$, $i = 0,1,2$

$\beta_3^* = 1-\lambda$

Equation (4) is the function which is actually estimated. β_1^* is interpreted as the short-run (one year) price coefficient and $(\beta_1^* \div \lambda)$ is the long-run price coefficient (β_1). β_2^* and β_2 are interpreted similarly for income. β_3^* is the weight which the previous period's consumption has on the present period's consumption.

Four revenue equations with the same general form as equation (4) were estimated in this study using the *Cochrane-Orcutt Iterative Procedure*, a statistical procedure which yields unbiased least squares estimates of the β coefficients. All equations yielded R^2 in excess of 0.99, implying that the independent variables explain more than 99 percent of the changes in the dependent variable.

It might be noted that, in the equations that are developed, similar to Equation (4), in the report, all of the independent variables (except for the lagged dependent variables for revenue) are expressed in real terms, either in real 1967 dollars or in percent (of employment). Even though the dependent variables are either physical units (gallons of gasoline or special fuels) or weighted multiples of physical units, all revenue projections are in current (not real) dollars. The fuel tax revenues are the cents per gallon tax multiplied by gallons of fuel, and the license and registration fees are a complex multiple of number of vehicles registered. Thus, because of fuel taxes and the license fee structure being fixed, the dependent variables are always direct measures of physical quantities, even though they always are in current dollars. All projections of revenues, therefore are in current dollars and would have to be deflated by a price index to derive estimates of real revenues.

Alternative Models and Methods

The revenue models developed in this report represent only one approach of several different approaches available for estimating revenues. Different models could be specified using different variables and different sets of data; data covering different time periods or disaggregated in different ways could be used. For example, equations have been developed that related numbers of vehicles and average license fees per vehicle to real income, real gasoline prices, and real car prices.

Another method of estimating future revenues is to make assumptions about the behavior of certain critical variables, such as automobiles per household, vehicle sizes and weights, miles per gallon for the average vehicle of a certain weight class, etc. Then using definitions (or identities) stipulating the relationships between revenues and combinations of the assumed or forecasted variables, revenues can be projected.

Each of these approaches has certain advantages and disadvantages. For example, the method used in this report estimates future consumer behavior by specifying and estimating models based on historical observations. When these models are used to project future consumption (and revenues), it is assumed that there will be little change from the historical relationships among these variables. Also, use of a partial adjustment type of model assumes that there are no violent shifts in the dependent variable from one time period to the next, but rather these shifts are distributed over time. The models may be wrong, however, if they are mis-specified, i.e., if the wrong variables have been used, by (1) omitting a relevant variable or by (2) including an irrelevant variable. Mis-specification also can occur if the wrong mathematical form is used for the regression equation or if there is a qualitative change in one or more

of the independent variables. Also, these models are only statistical estimates, and there is a degree of uncertainty inherent in such estimates.

There have been several basic changes that may affect highway revenues in ways that may not be fully reflected in past relationships. For example, the "energy crisis" and Project Independence have led to governmental programs such as the 55 mph speed limit, increased funds for public transportation, and recommendations for deregulation of certain segments of transportation. In addition, automobile manufacturers have indicated that they will significantly reduce weights of specific models of vehicles. This action in particular seems to be somewhat exogenous, or determined independently of the factors determining the models developed in this report. For example, there are indications that auto manufacturers plan to reduce vehicle weights and increase vehicle efficiency by an amount greater than what would be expected simply on the basis of the real price of gasoline increasing as it has. The extent to which such actions by auto manufacturers represent a basic structural change is difficult to extimate and may not be fully reflected in the type of model developed in this report. A more complex model incorporating supply and demand equations with exogenous changes in types of vehicles supplied might be more appropriate if this is a major exogenous change. Another alternative is the method mentioned previously whereby revenues are forecast by making assumptions about critical variables such as vehicle sizes and fuel efficiency.

Another point that should be made is that the models developed in this report incorporate the influence of increased real fuel taxes on both fuel consumption and license fees. However, none of the models incorporates the effects of an increase in license fees on number of vehicles (and thus reductions in license fees and fuel taxes associated with fewer vehicles being registered and

operated because of higher license fees). Also, there may be a relationship between expenditures on highways and the number of vehicles registered (and number of miles traveled); this possible relationship is not considered in this report. Two additional limitations should be noted. First, there is an interrelationship between the demands for special fuels and gasoline because increases in special fuel consumption occurs not only because of growth in total truck miles but also because of shifts from gasoline trucks to diesel trucks as gross weights and relative efficiencies change. This interrelationship is currently the object of further study. In the models in this report, this possible mis-specification may give an upward bias to the special fuels forecast. Second, increases in the real price of gasoline have an effect on real income; only the direct effect of gasoline price changes are considered, however, and the price effect on state income is assumed to be only that resulting from an increase of six percent per year in the consumer price index. Thus, when the real price of gasoline is doubled in some scenarios, this is assumed to have no effect on the forecast of real state personal income.

Errors in revenue projections, in addition to occurring because of poor models, can result from poor forecasts of the independent variables. Thus, the projection for a specific scenario developed in later sections of this report is only as good as the forecast of the independent variables, if the revenue equations were perfect.

After reviewing the different methods and models available, the method used in this report was chosen mainly because (1) it used past relationships among real variables as indicated by actual behavior, (2) it made use of independent variables which were available in forecasts or could be the basis of developing interesting tax policy scenarios, and (3) the feature of adjusting

slowly over time seemed to be an important characteristic of vehicle and fuel consumption. In addition, the method is such that the equations can be easily refined as more data becomes available, and, thus, the models can be modified and improved in the future with relative ease.

Fuel Tax Revenue Models

As mentioned earlier, fuel taxes account for a major portion of the SDHPT's annual revenues. Texas has two separate fuels taxes, the Motor Fuel Tax and the Special Fuels Tax. The Motor Fuel (gasoline) tax applies to all products known or sold as gasoline and the Special Fuels Tax applies to liquefied gas and distillate fuel. Both taxes are excise taxes levied upon the sale of these fuels on a per gallon basis. The Motor Fuel tax is five cents per gallon and the Special Fuels tax is five cents per gallon on liquefied gas and six and one-half cents on distillate fuels used for the propulsion of motor vehicles upon public highways of the State. For buses owned by a transit company that serves a town or city, the Special Fuels tax is four cents per gallon on liquefied gas and six cents per gallon on distillate fuel. Of the total gross revenue collected from the two taxes, approximately 74 percent goes to the State Highway Department, with one percent of the gross going to the State Comptroller, 25 percent going to the available Free School Fund, and $7,300,000 going to the County and Road District Highway Fund. Thus, it is clear that as total fuel consumption rises, the revenue accruing to the Highway Fund will also increase and this has been the case in the past. Rising fuel consumption in the past may largely be attributed to rising income and declining real fuel prices.

Since the percent of total highway fuel revenues that is used for state highway purposes is a complicated function and has been increasing over time,

it was decided that the state fuel revenues for state highway use would be estimated directly; therefore, an equation with such revenues as the dependent variable were developed. However, for estimating revenues from possible future state fuel taxes, it was decided that it would be preferable to directly estimate both gallons of gasoline and gallons of special fuels, and separate equations were developed with each of these as the dependent variable. Total state fuel revenues from new taxes then are estimated by multiplying the additional tax per gallon by the number of gallons. Then, the revenues for state highway use are estimated as 75 percent of total state fuel revenues from new taxes. The other 25 percent is assumed to go to education as currently provided by law.

The revenue equation for state highway purposes from existing taxes is

$$\ln R_t = 1.7373 + 0.1965 \ln Y_t - 0.1396 \ln P_t + 0.8299 \ln R_{t-1} \quad (5)$$

where "$\ln$" denotes "the natural logarithm of" and where

R_t = state fuel revenues, for state highway use, in year t,

Y_t = real state personal income in year t, in millions of 1967 dollars,

P_t = real regular gasoline price, including taxes, in year t, in 1967 cents per gallon, and

R_{t-1} = same as R_t except for year $t-1$.

For estimating revenues from future tax increases, separate equations were developed for annual gasoline sales and annual special fuel sales. The model estimated for gasoline sales is given by equation 6.

$$\ln G_t = 1.6360 + 0.1859 \ln Y_t - 0.1710 \ln P_t + 0.8098 \ln G_{t-1} \quad (6)$$

where

G_t = amount of gasoline sold for highway use in fiscal year t, in millions of gallons,

Y_t = real state personal income in year t, in millions of 1967 dollars,

P_t = real regular gasoline price, including taxes, in year t, in 1967 cents per gallon, and

G_{t-1} = the amount of gasoline sold for highway use in fiscal year $t-1$, in millions of gallons.

The equation for estimating gallons of special fuels is

$$ln\ S_t = -3.2301 + 0.7746\ ln\ Y_t - 0.0377\ ln\ P_t + 0.6422\ ln\ S_{t-1} \quad (7)$$

where Y_t and P_t are the same as for equation 6 and where

S_t = amount of special fuels sold for highway use in fiscal year t, in millions of gallons, and

S_{t-1} = amount of special fuels sold for highway use in fiscal year $t-1$, in millions of gallons.

License and Registration Fees Model

Texas law requires that vehicles must be registered annually. Vehicles are registered by class and registration fees are assessed by class and weight. The fees are collected by County Tax Collectors within each county. The first $50,000 of fees collected and fifty percent of the next $250,000 collected in each county goes to its County Road and Bridge Fund. Thus, the maximum that any one county's Road and Bridge Fund receives is $175,000, and other net fees collected go into the state highway fund. In 1973, for example, total fees were about $219 million of which $179 million went to the State, $34 million went to the counties and $6 million went for commissions and refunds. The license-and-registration-fee revenue model used in this report estimates the amount of revenue going to the state. The estimated model is

$$L_t = \$20{,}435{,}000 + 606.836Y_t - 616{,}972P_{t-1} - \$1{,}036{,}270\ U_t + 0.9402\ L_{t-1}$$

where

L_t = license and registration fees available for state highway use in fiscal year t,

Y_t = real state personal income in year t, in millions of 1967 dollars,

P_{t-1} = real regular gasoline price, including taxes, in year t-1, in 1967 cents per gallon,

U_t = U.S. unemployment rate in year t in percent, and

L_{t-1} = license and registration fees available for state highway use in fiscal year t-1.

Price Elasticities of Demand for Fuels

Price elasticities of demand for fuels can be used to estimate the short-term and long-term changes in gallons of fuel consumed associated with a change in real fuel prices, assuming nothing else changes (see Appendix B for a discussion of elasticities). When equations are in logarithmic form as are those above, the coefficient for price is the short-run (one-year) price elasticity. The short-run elasticity for gasoline is -0.1710 and the short-run elasticity for special fuels is -0.0377. This indicates, for example, that a 10 percent increase in the real price of gasoline would lead to a 1.71 percent decrease in gasoline sales and a 0.377 percent decrease in special fuels sales, during the first year.

The long-run price elasticities are -0.8991 for gasoline and -0.1054 for special fuels, and the respective long-run adjustment periods are 5.3 years and 2.8 years. This indicates, for example, that a 10 percent increase in the real price of gasoline would have an effect on gasoline sales over a 5.3 year period, with a total decrease in consumption of 8.991 percent (assuming nothing else changed). The 10 percent increase in the price of gasoline would lead to a 1.054 percent decrease in the use of special fuels over a 2.8 year period.

Elasticities were also calculated for gasoline and special fuels combined, even though this equation is not used in this report. The short-run elasticity

for all highway fuels is -0.1593, the long-term elasticity is -0.9382, and the long-term adjustment period is 5.9 years, about the same as for gasoline alone (since gasoline historically has represented over 90 percent of all highway fuel).

III. FORECASTS OF ECONOMIC CONDITIONS USED IN CONSTRUCTING SCENARIOS

The revenue models discussed in this report include these independent variables (not including the lagged dependent variables): (1) real state personal income, (2) the U.S. unemployment rate, and (3) the real price of regular gasoline, including taxes. Discussion of forecasts of these independent variables in this part of the report is divided into two sections. The first section includes a discussion of how real state income and unemployment are forecasted for two different base forecasts of income and three different economic recovery rates. The second section includes a discussion of the two components of the real price of gasoline (to consumers): (1) the real price of gasoline, excluding taxes, and (2) the real gasoline tax.

Income and Unemployment

As was shown previously in Figure 2, state personal income in current dollars has increased steadily in Texas during the period of time considered. Because of the current recession and rapidly increasing consumer prices, however, real state personal income decreased in 1974 and 1975 (The 1975 value is an estimate based on the first 8 months of 1975).

In developing forecasts of real state personal income for use in this study, it was decided that the real state personal income forecast made for Texas, for year 1990, by the U.S. Department of Commerce would be used as the basis for a "low" forecast. This forecast is based on a 1990 (midyear) population forecast of 14,304,400 and total Texas employment of 6,091,000. A "basic" forecast of state personal income for each year between 1975 and 1990 was developed by assuming that there is a basic trend in state personal income. This trend is given by 1973 real state income growing at an annual rate that will give the 1990 real state personal income forecasted by the

Department of Commerce. Real state personal income for 1974 and 1975 is regarded as the downturn part of a recession which is assumed to end at the end of 1975. It is assumed that state personal income begins increasing in 1976 and returns to the "basic" low forecast trendline forecasted for 1973 to 1990 as described above. This return to the 1973-1990 trendline is assumed to be linear, and gets back on the trendline in 1978, 1981, or 1984 depending upon whether a fast, medium, or slow economic recovery rate is assumed, as will be discussed more fully below.

The "high" forecast of state personal income is constructed with a 1973-1990 trendline similar to that for the "low" forecast described above. The high forecast also uses the same trend of per capita personal income as does the low forecast. The only difference is that the high forecast uses a higher population estimate. This higher population estimate for each year was derived by fitting a curve to the latest population estimates, developed at the Center for Population Research at the University of Texas, for 1980 and 1990. Thus, the high income forecast is derived by using the same per capita personal income as the low forecast, but uses a higher population forecast. The population forecasts used in developing the high income forecast were 13,230,000 persons in 1980 and 15,842,000 persons in 1990.

Like the low forecast, the high forecast assumes that 1975 is the last year of the current recession, and that a linear growth in income occurs such that the forecast returns to the basic 1973-1990 trendline for the high forecast by 1978, 1981, or 1984.

The high and low forecasts of state real personal income used in this study are shown in Figure 4, with a fast recovery rate (by 1978) for each. It should perhaps be mentioned that this "low" forecast of real state personal income probably should be classified as an optimistic forecast, and

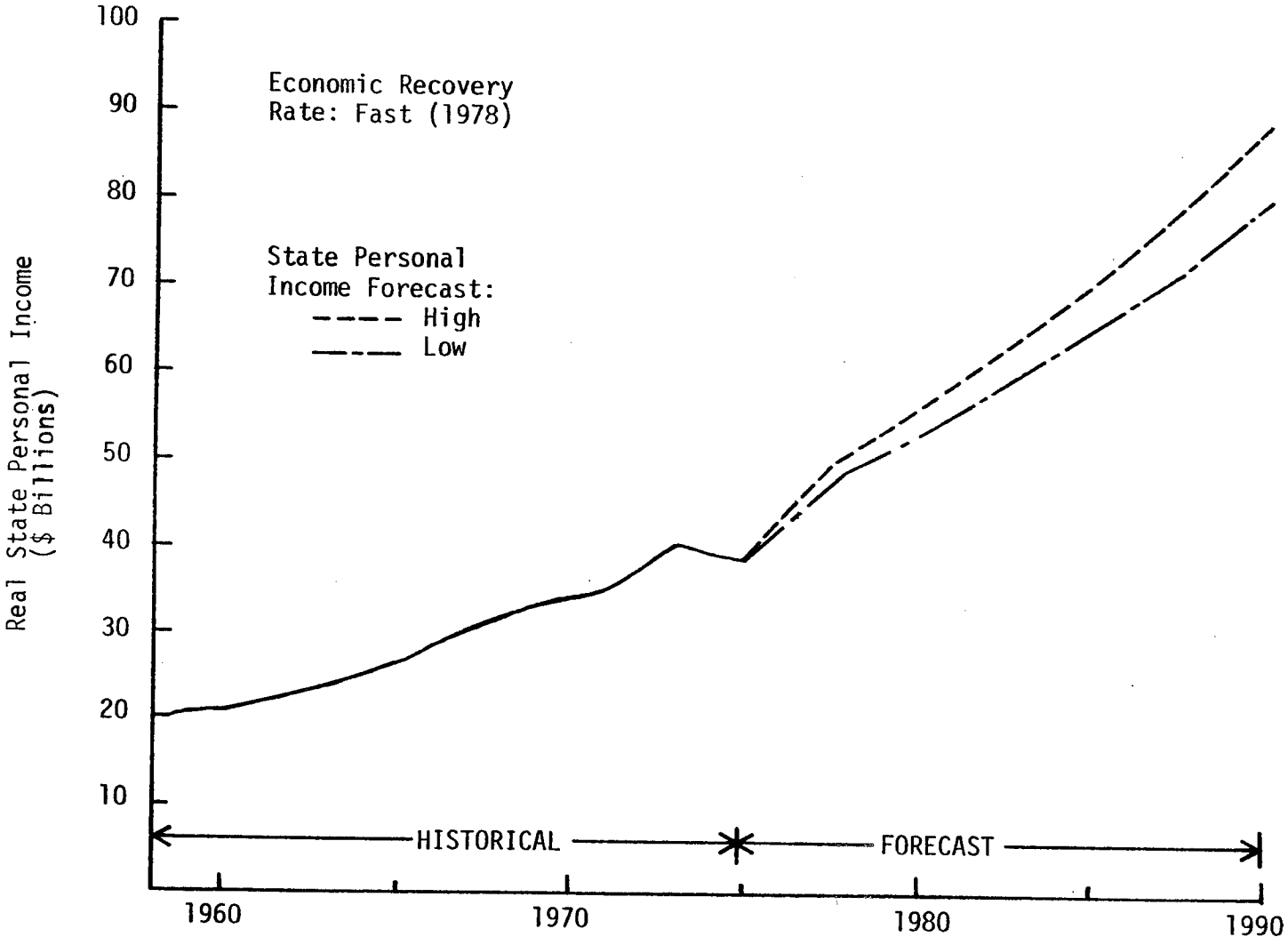

Figure 4. Historical and Forecasted Real State Personal Income, Using a Fast Economic Recovery Rate for Both High and Low Forecasts

is only low in relation to the higher forecast, and should by no means be considered to be the lowest conceivable forecast.

As was mentioned above, it is assumed that there are three possible paths of full economic recovery to the 1973-1990 trendlines, and only the fast recovery paths are depicted in Figure 4. Figure 5, however, shows a comparison of the three recovery rates for the low forecast. The complete set of income projections is shown in Table 3, for the three economic recovery rates (fast, medium, and slow) for each of the two basic income forecasts (low and high).

In addition to assuming three different recovery rates for real state personal income, three corresponding recovery patterns are assumed for U.S. unemployment. Unemployment rates are assumed to recover, that is, decline to a non-recession level by 1978, 1981, or 1984. The level of unemployment in 1975 has averaged about 8.6% to date and this rate is assumed to apply for all of 1975. It further is assumed that this rate reduces linearly with time to 5.5% in 1978, 1981, or 1985 depending upon whether the economic recovery rate is fast, medium, or slow. Historical unemployment rates and the rates forecasted for the future are shown in Figure 6. It is assumed that these three recovery patterns for unemployment are the same for, and correspond to, the high and low income forecasts.

Gasoline Prices and Taxes

In this report, the "real price of gasoline" refers to the real price of gasoline, including taxes. However, when a forecast of the real price of gasoline is referred to as remaining "constant" or "doubling," it means that only the part excluding taxes is constant or doubling. The tax part of the price, for any given tax, is always stated in real (1967) dollars. In

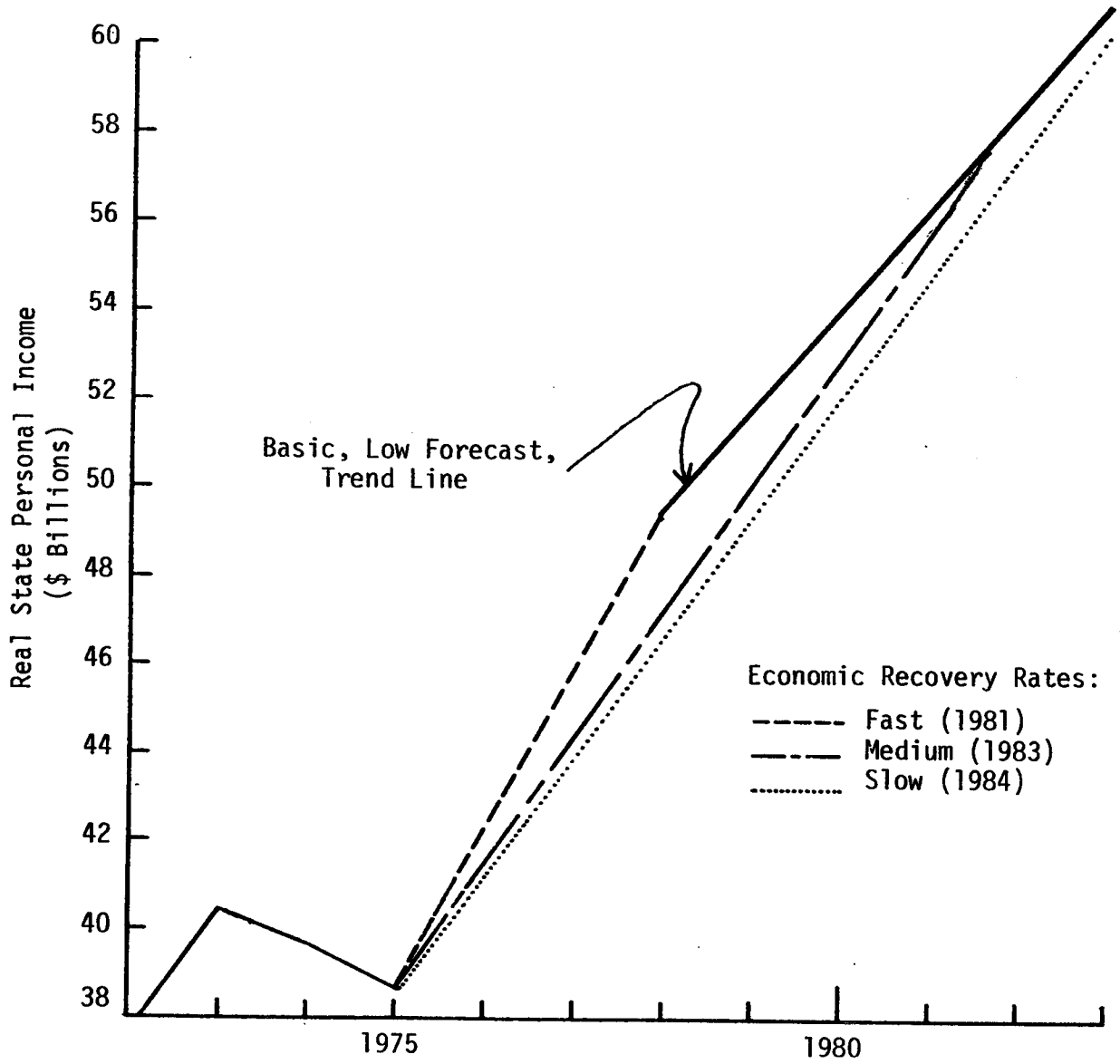

Figure 5. Low Forecast of Real State Personal Income, Showing Three Economic Recovery Rates

Table 3. Low and High Forecasts of Real State Personal Income with Different Recovery Rates

Year	Low Forecast			High Forecast		
	Fast	Medium	Slow	Fast	Medium	Slow
1976	42,377	41,643	41,491	42,785	42,055	41,945
1977	45,980	44,514	44,210	46,797	45,338	45,117
1978	49,540	47,385	46,928	50,809	48,620	48,289
1979	51,636	50,255	49,646	53,231	51,902	51,461
1980	53,772	53,125	52,365	55,791	55,185	54,634
1981	55,996	55,996	55,083	58,467	58,467	57,806
1982	58,313	58,313	57,801	61,277	61,277	60,978
1983	60,725	60,725	60,520	64,227	64,227	64,150
1984	63,238	63,238	63,238	67,322	67,322	67,322
1985	65,854	65,854	65,854	70,572	70,572	70,572
1986	68,578	68,578	68,578	73,969	73,969	73,969
1987	71,415	71,415	71,415	77,534	77,534	77,534
1988	74,370	74,370	74,370	81,287	81,287	81,287
1989	77,447	77,447	77,447	85,206	85,206	85,206
1990	80,651	80,651	80,651	89,317	89,317	89,317

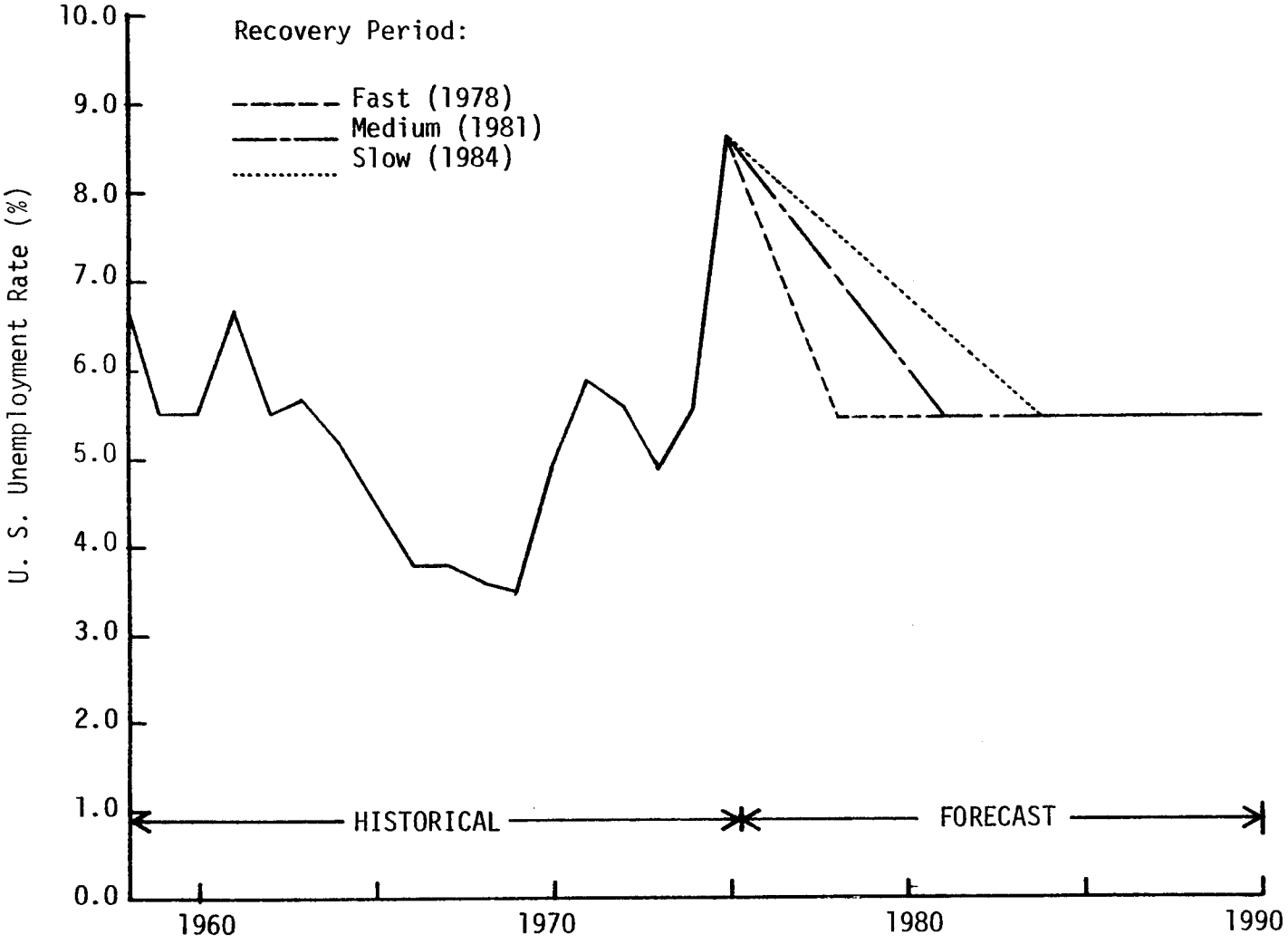

Figure 6. Historical and Forecasted U. S. Unemployment Rates for Different Economic Recovery Periods

forecasts of future prices, the tax part of the price declines annually at 6 percent per year, the assumed increase in the Consumer Price Index.

Two different scenarios are assumed for the real gasoline price, excluding taxes. Either the real price, excluding taxes, reamains constant, or it increases at a uniform annual rate such that it doubles between 1975 and 1990.

Gasoline taxes in current dollars are: (1) the federal tax always is assumed to be 4 cents per gallon, and (2) the state gasoline tax is 5.0¢, 10.5¢, or 12.5¢, depending upon the year, tax policy, and scenario being considered. There are three forecasts for the state tax: (1) the 5¢ tax applies for all (fiscal) years, 1976-1990, (2) the 5¢ tax applies for 1976-77, and the tax is 10.5¢ for 1978-1990, and (3) the 5¢ tax applies for 1976-77, 10.5¢ applies for 1978-1981, and 12.5¢ applies for 1982-1990.

Historical and forecast real prices for gasoline, including taxes, are shown in Figure 7 for constant and doubling of the real price, plus real taxes, and for three different state taxes. The "constant real gasoline price" curves decline because the real value of fixed, cents-per-gallon tax declines. For the same reason, the "doubling real gasoline price" curves increase at a slightly slower rate than they otherwise would.

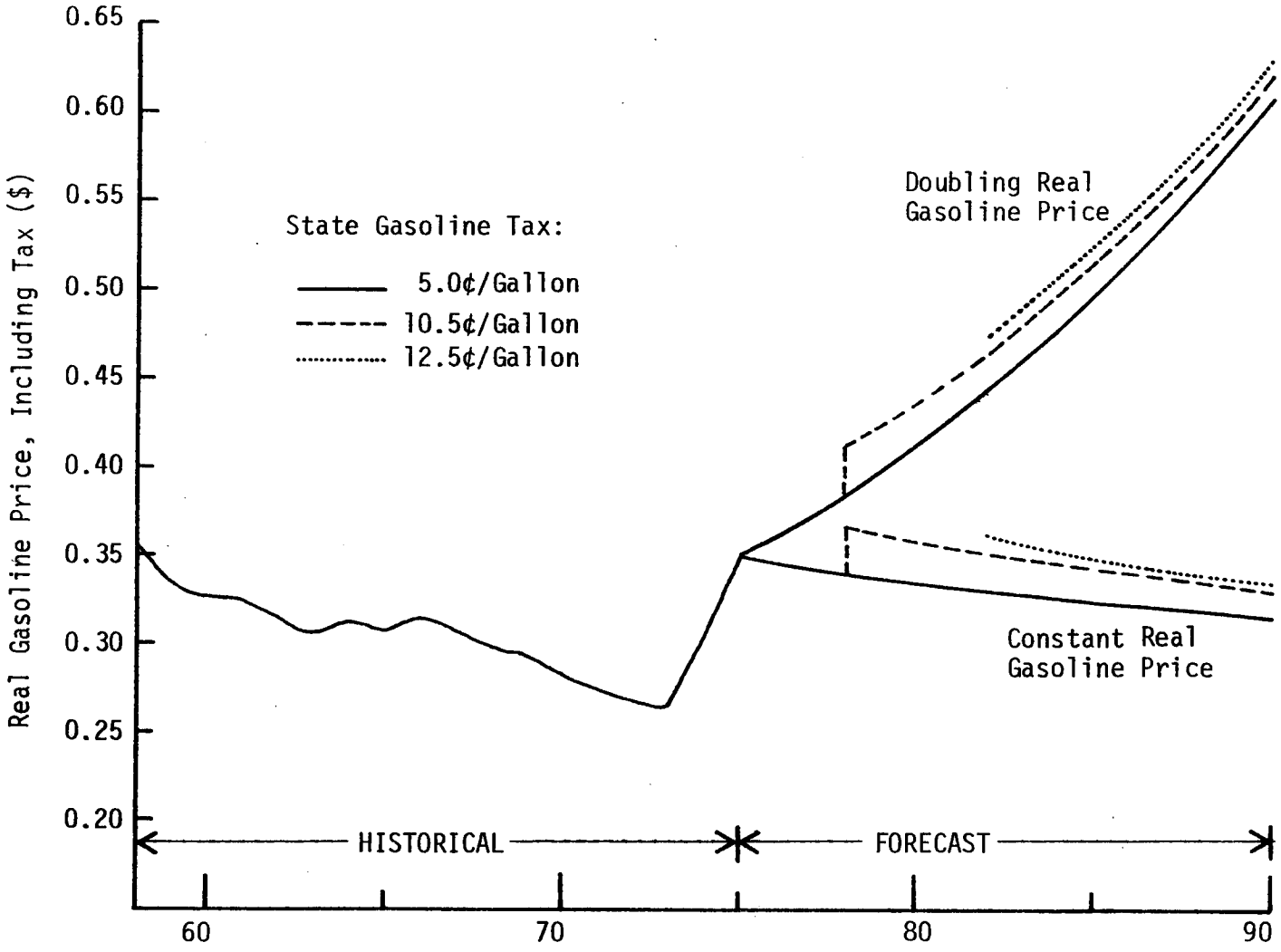

Figure 7. Historical and Forecasted (Assumed) Real Gasoline Prices

IV. REVENUE SCENARIOS

Description of Scenarios

Using the revenue models in Part II of this report, twelve scenarios of revenue projections were developed. These twelve scenarios show different combinations of the forecasts of the independent variable discussed in Part III of this report. These twelve scenarios are different combinations of: (1) the two forecasts of real state personal income (high and low), (2) the three forecasts of economic recovery rates for real state personal income and unemployment (fast, medium, and slow), and (3) the two forecasts of real gasoline prices (constant and doubling by 1990). These scenarios are numbered 1 through 12 with conditions as shown in Table 4.

In addition to considering twelve different scenarios of economic conditions, three different fuels taxes are considered as well as different license and registration fees and lump sum payments into highway revenues, as was discussed in Part III. Thus, there actually are several taxation policies as subcases of each of the twelve basic scenarios (and these subcases actually can be considered as separate scenarios). Sets of twelve graphs and twelve tables in Appendix A give the complete projections for the twelve scenarios, and only a few of these will be discussed here. In the graphs in Appendix A and shown in this part of the report, only selected taxation policies are shown. The way these are denoted in the graphs and an explanation of these taxation policies are as follows:

(1) LRF + 5¢ - pertains to all historical data and denotes projection for which it is assumed that current license and registration fees (LRF) and current state fuel taxes (5¢ per gallon for gasoline) remain unchanged.

(2) 2 X LRF + 5¢ - the same as (1) except that all license and registration fees are doubled.

Table 4: Economic Conditions for Different Scenarios

Scenario Number	Real State Personal Income Forecast	Economic Recovery Rate	Real Gasoline Price (Excluding Taxes)
1	High	Fast	Constant
2	High	Medium	Constant
3	High	Slow	Constant
4	High	Fast	Doubles
5	High	Medium	Doubles
6	High	Slow	Doubles
7	Low	Fast	Constant
8	Low	Medium	Constant
9	Low	Slow	Constant
10	Low	Fast	Doubles
11	Low	Medium	Doubles
12	Low	Slow	Doubles

(3) LRF + 5¢ + 5.5¢ + 2¢ - pertains to revenues projected with current fees and taxes plus an additional 5.5¢ per gallon fuel tax effective beginning in Fiscal Year 1978 and an additional 2¢ per gallon fuel tax effective beginning in Fiscal Year 1982.

(4) LRF + 5¢ + $150M - the same as (1) except that a lump sum of $150 million is added to each year's revenues beginning in Fiscal Year 1978.

Base Scenario

Given twelve different scenarios, there is a need to say which scenario seems most likely to occur in the future. This is subject to some analysis, of course, but all that is offered here is a qualified opinion. Scenario 2, with the high real state income forecast, the medium economic recovery rate,

and constant real gasoline prices was selected as the "base, or most likely" scenario for the following reasons. First, the population forecast, provided by the Center for Population Research at the University of Texas, that is used in the "high" real state income forecast is more consistent with current population growth than is the forecast used in the low income projection. Second, the economic recovery currently seems to be meeting some resistance, and thus, there appear to be problems with achieving a rapid recovery. On the other hand, a slow recovery, not culminating until 1984, is considerably slower than recent recoveries (such as during 1961, which was typical of a fast recovery). Therefore, the medium recovery rate was selected through a process of elimination. A constant real gasoline price was selected in the absence of any clear indication of either an increase or a decrease in real prices. It should be pointed out, however, that the Scenario 2 projections could be classified as optimistic from the viewpoint of both the revenue models and the independent variable forecasts used.

Figure 8 shows the four revenue forecasts for the different tax policies described earlier. Since the real price of gasoline is constant and state income growth is high, revenues are projected to increase considerably (in current, not real, dollars) by 1990 in this scenario.

Effect of Lower Income Forecast

Figure 9 shows the effect on two tax policies of using the low real income forecasts from Scenario 8, as compared to the high forecast, with other conditions the same as in Scenario 2. In 1976, the low income forecast gives revenues about $3 million less than does the high income forecast. In 1990, the low income scenario gives $106 million less for the case where license fees are doubled and $162 million (about 10%) less for the case where fuel taxes are increased by 5.5¢ in FY 1978 and an additional 2¢ in FY 1982.

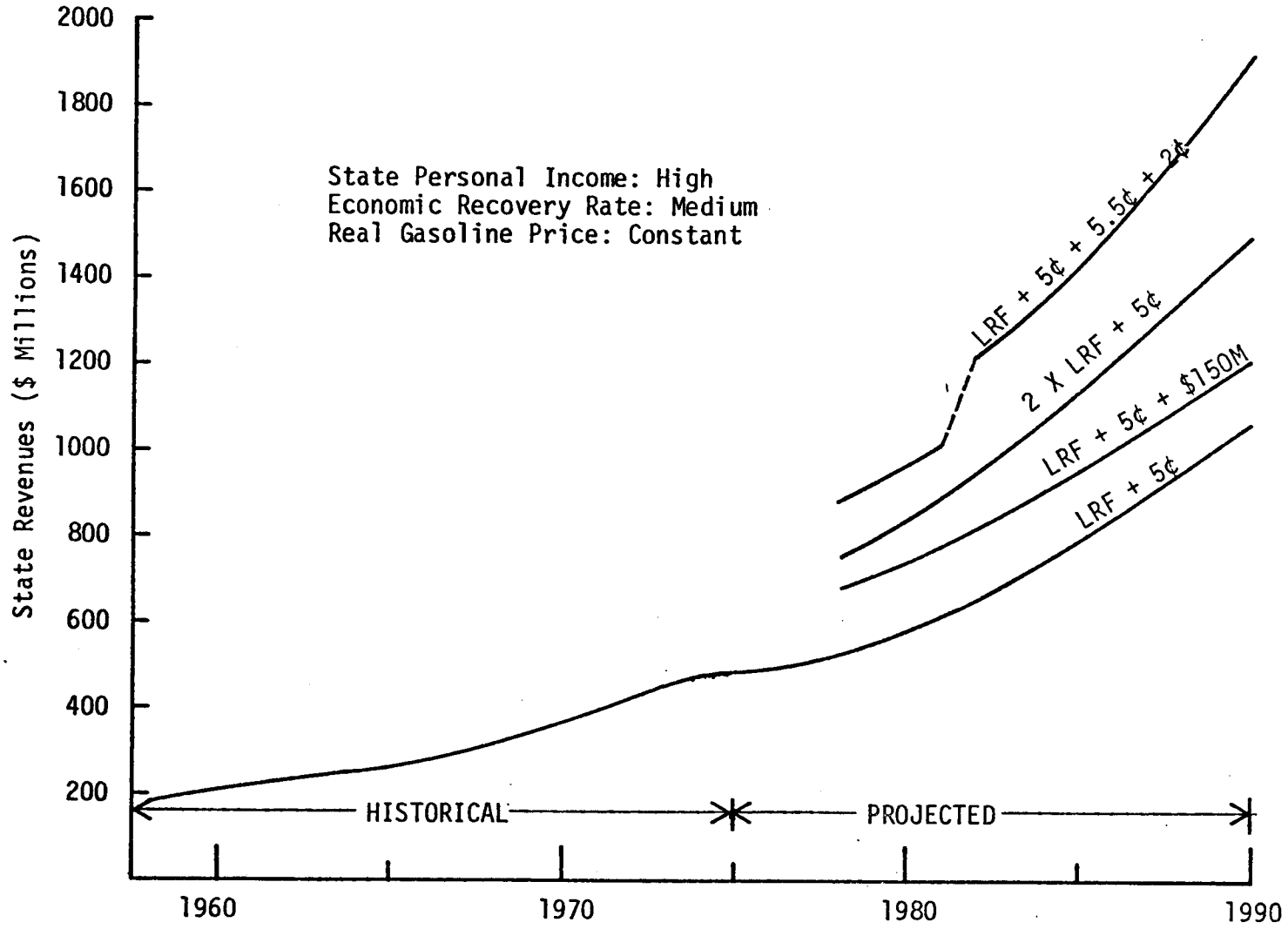

Figure 8. Projected Revenues for Base Case Scenario (Scenario 2)

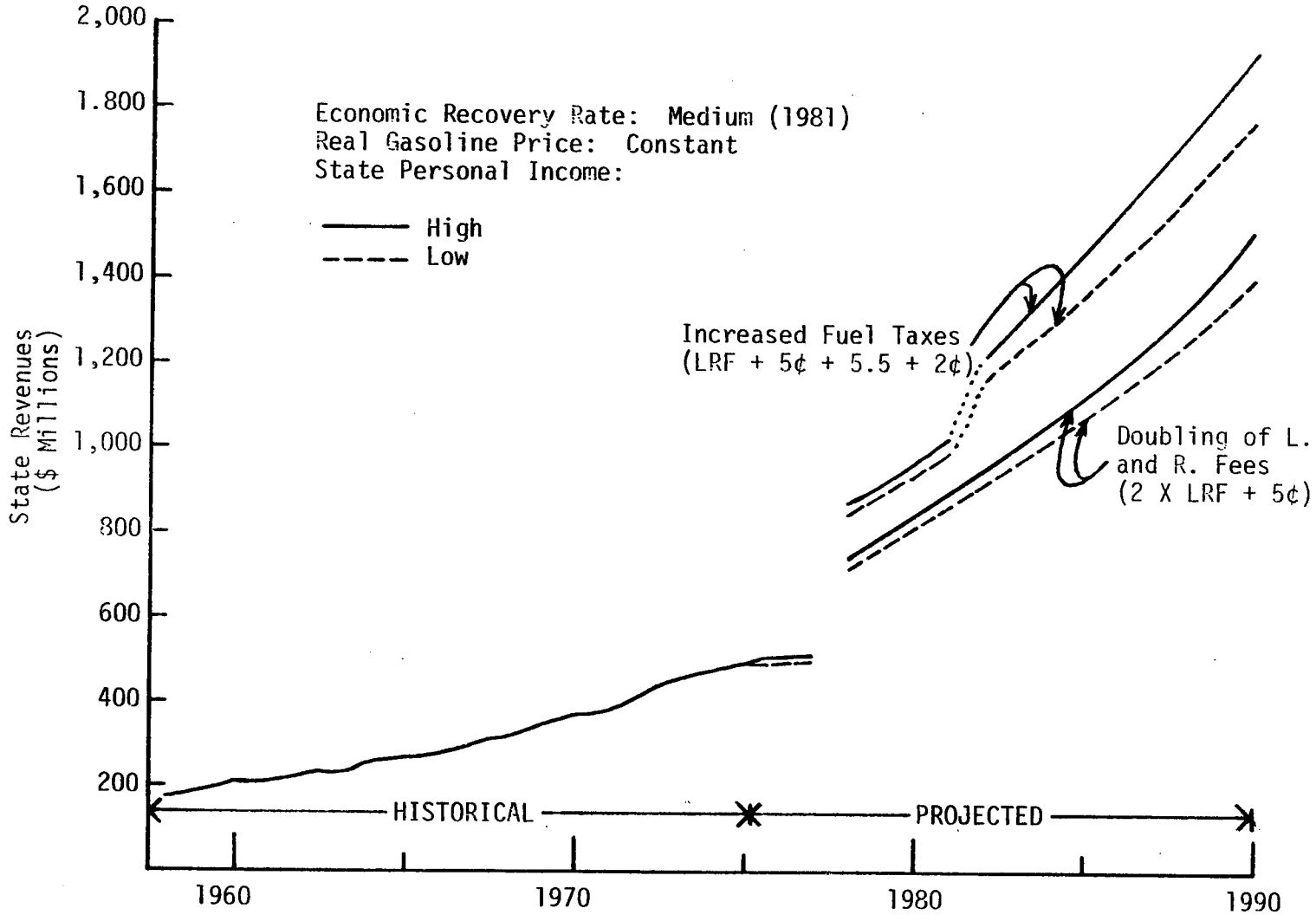

Figure 9: Historical Revenues and Projected Revenues, with Doubling of License and Registration Fees or Increased Fuel Taxes, for High and Low Forecasts of Real State Personal Income

Effect of Different Economic Recovery Rate

Figure 10 shows the effect of the three different recovery rates with current taxes and license fees, but with other conditions the same as in Scenario 2. Different recovery rates have a direct influence on revenues from 1976 through 1984 and an indirect influence (because of the lagged variables) in later years. This influence is not a large percentage of total revenues but, of course, has a meaningful impact on short-term increases. In 1979, for example, current taxes (LRF + 5¢) yield $574 million with fast recovery, $561 million with medium recovery, and $558 million with slow recovery. Thus, there is a larger difference between fast and medium recovery rates than between the medium and slow rates.

Effect of Doubling Gasoline Prices

Figure 11 shows Scenario 5 which is the same as Scenario 2 (the "most likely" scenario) except that the real gasoline price doubles by 1990. Figure 12 shows a comparison of two taxation policies with constant and doubling prices, taken from Scenarios 2 and 5 (Figures 8 and 11). There is a large difference in revenues for these two different real price trends, as is evident in Figure 12. Thus, if there is a continuous increase in real gasoline prices, any fuel tax or license fee policy will yield substantially less revenue than otherwise.

Scenario with Lowest Revenue Projections

The least revenue of any of the twelve scenarios is that from Scenario 12 with low income, slow recovery, and doubling gasoline prices, shown in Figure 13. For example, with current taxes (LRF + 5¢), revenues would increase only to $716 million by 1990 with Scenario 12 as compared to $1,066 million with Secnario 2. Although this scenario is not considered "probable

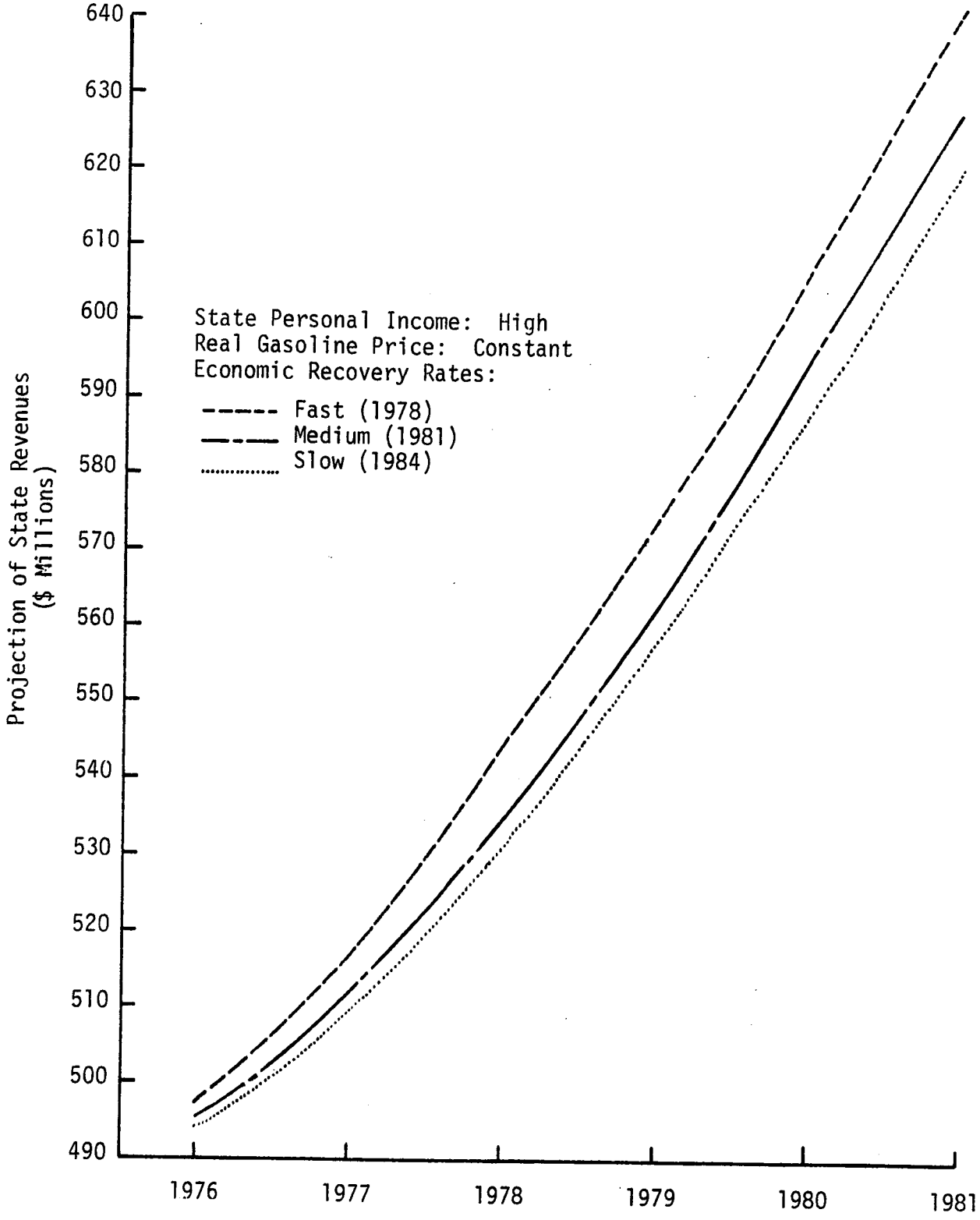

Figure 10. Projection of State Revenues with Current License and Registration Fees and Fuel Taxes, for Different Economic Recovery Rates, for the Years 1976-1981

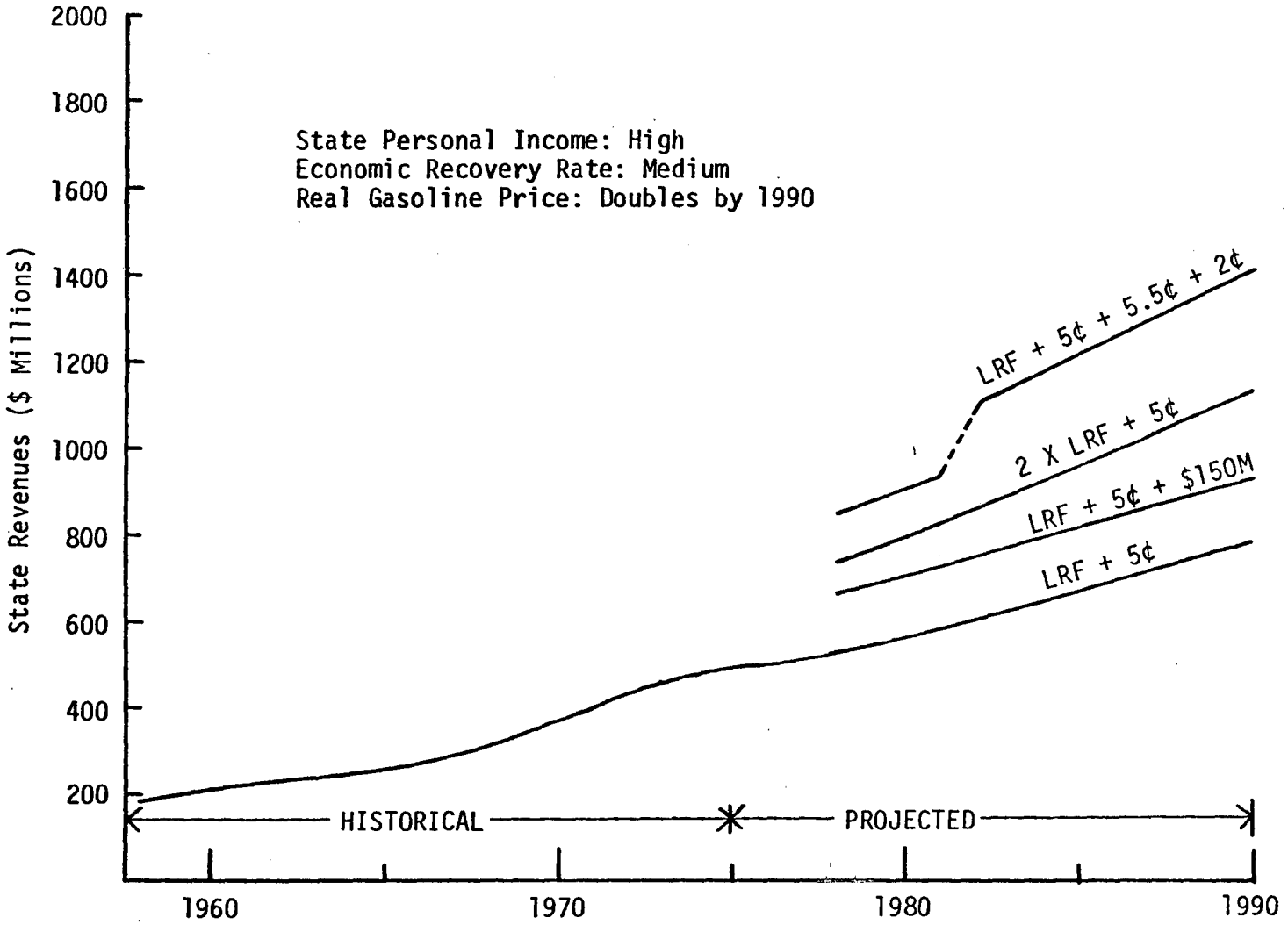

Figure 11. Projected Revenues for Base Case Scenario Conditions, Except that Gasoline Price Doubles by 1990 (Scenario 5)

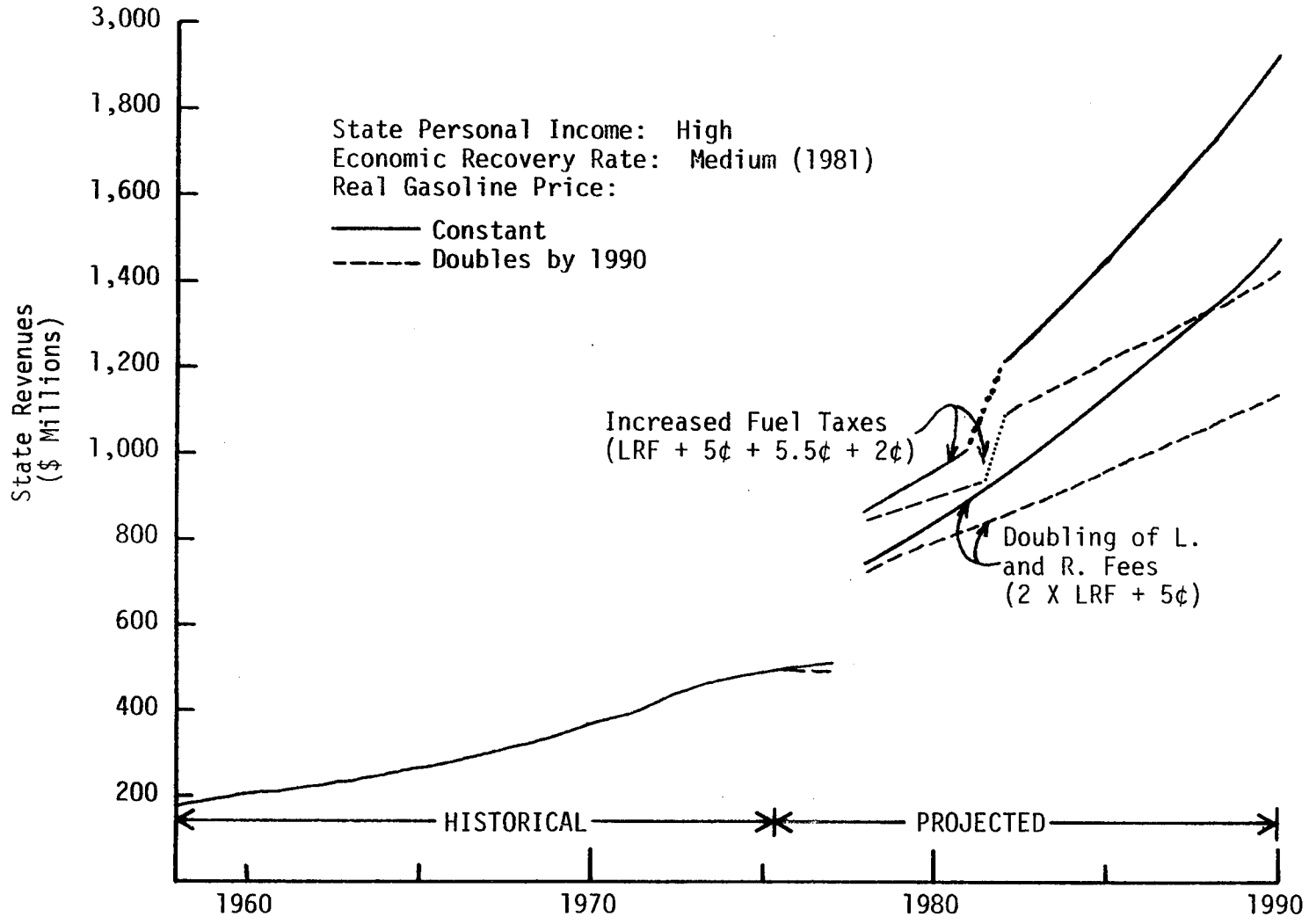

Figure 12. Historical Revenues and Projected Revenues, with Doubling of License and Registration Fees or Increased Fuel Taxes, for Constant and for Doubling-by-1990 Real Gasoline Prices

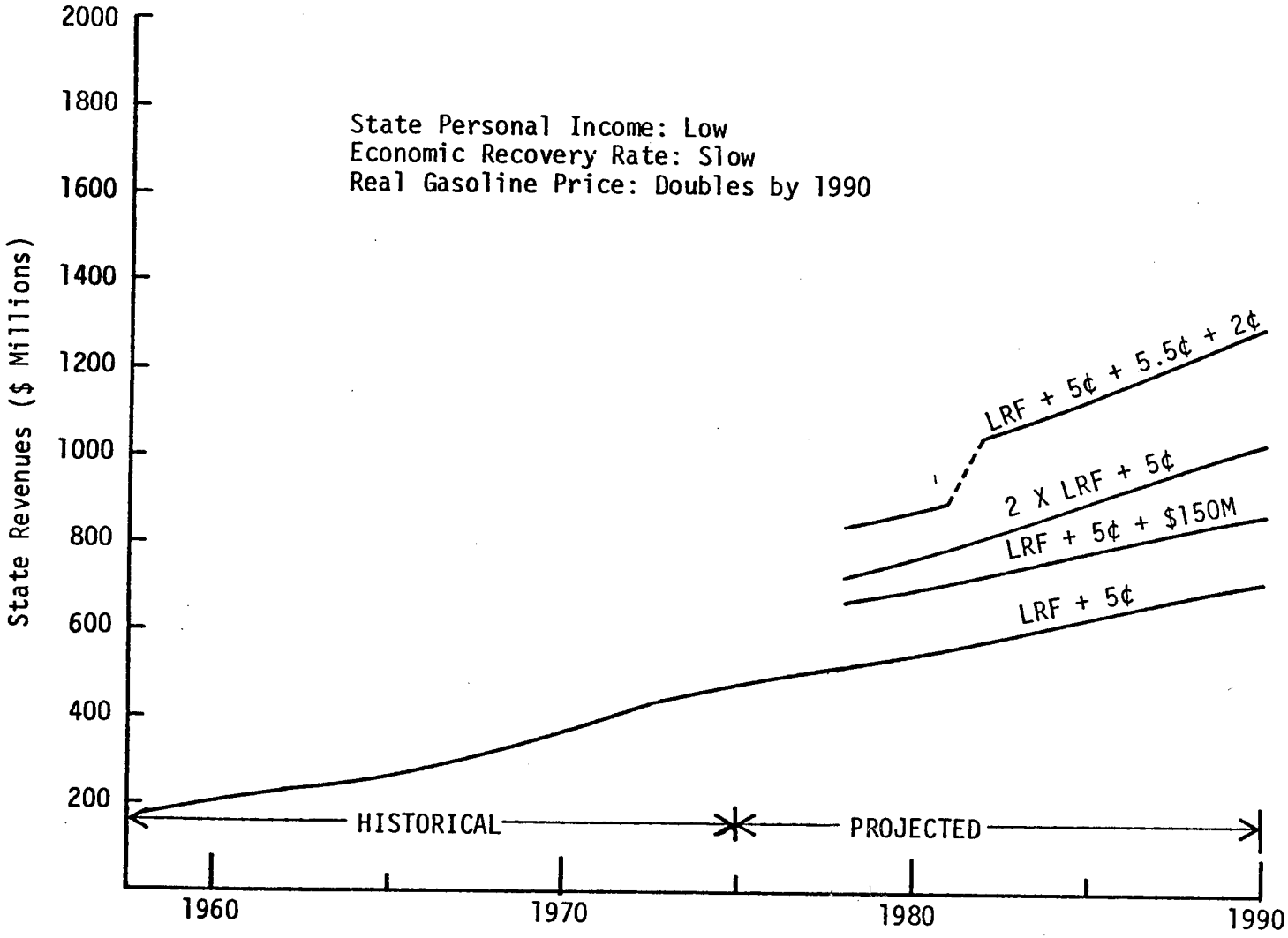

Figure 13. Projected Revenues for Scenario with Lowest Revenues (Scenario 12)

to happen" it is by no means the most pessimistic scenario that could be developed. Indeed, the "low" income forecast is from the Bureau of Economic Analysis, U.S. Department of Commerce, an organization that typically gives optimistic forecasts. Similarly, the slow recovery rate is the most pessimistic of those considered in these scenarios, but it is a relatively optimistic forecast in that it does assume that the economy will recover to the 1973-1990 trend line, which is a complete recovery. Probably the most pessimistic aspect of Scenario 12 is the doubling real gasoline price. However, given the uncertain world petroleum supply situation, even this cannot be completely ruled out as a possibility.

APPENDIX A

RESULTS OF THE TWELVE BASIC SCENARIOS

This appendix includes twelve graphs and twelve tables that show projections of revenues for the twelve different scenarios that were developed. Each table has eight columns and the headings to these columns signify the following:

(1) LRF - License and registration fees for state highway purposes.

(2) 5¢ - Revenues, for state highway purposes, from the existing state fuel taxes.

(3) LRF + 5¢ - The sum of (1) and (2).

(4) 2 X LRF + 5¢ - The same as (3) except that (1) is doubled beginning in FY1978.

(5) LRF + 5¢ + 5.5¢ - (3) plus revenues for state highway purposes of an additional 5.5¢ per gallon fuel tax beginning in FY1978.

(6) LRF + 5¢ + 5.5¢ + 2¢ - (5) plus revenues for state highway purposes of an additional 2¢ per gallon fuel tax beginning in 1982.

(7) LRF + 5¢ + $150M - (3) plus $150 million per year for 1978-1990.

(8) LRF + 5¢ + $500/$150M - (7) plus an additional $350 million in the year 1978 and 1979.

The twelve figures and twelve tables in this appendix are arranged in a logical order, according to which basic forecast of the real state personal income, the economic recovery rate, and the real price of gasoline, is used. (Note: Some of the columns may not add precisely because of rounding).

GUIDE TO FIGURES AND TABLES IN APPENDIX A

Scenario Number	Figure Number	Table Number	State Income	Recovery Rate	Gasoline Prices*
1	A-1	A-1	High	Fast	Constant
2	A-2	A-2	High	Medium	Constant
3	A-3	A-3	High	Slow	Constant
4	A-4	A-4	High	Fast	Doubles
5	A-5	A-5	High	Medium	Doubles
6	A-6	A-6	High	Slow	Doubles
7	A-7	A-7	Low	Fast	Constant
8	A-8	A-8	Low	Medium	Constant
9	A-9	A-9	Low	Slow	Constant
10	A-10	A-10	Low	Fast	Doubles
11	A-11	A-11	Low	Medium	Doubles
12	A-12	A-12	Low	Slow	Doubles

*When real gasoline prices are denoted as "constant" or "doubles," this means the "real gasoline price, excluding taxes" is the part that remains constant or doubles. The tax part of the price, for a given tax, decreases at 6 percent per year (the assumed rate of inflation in the Consumer Price Index).

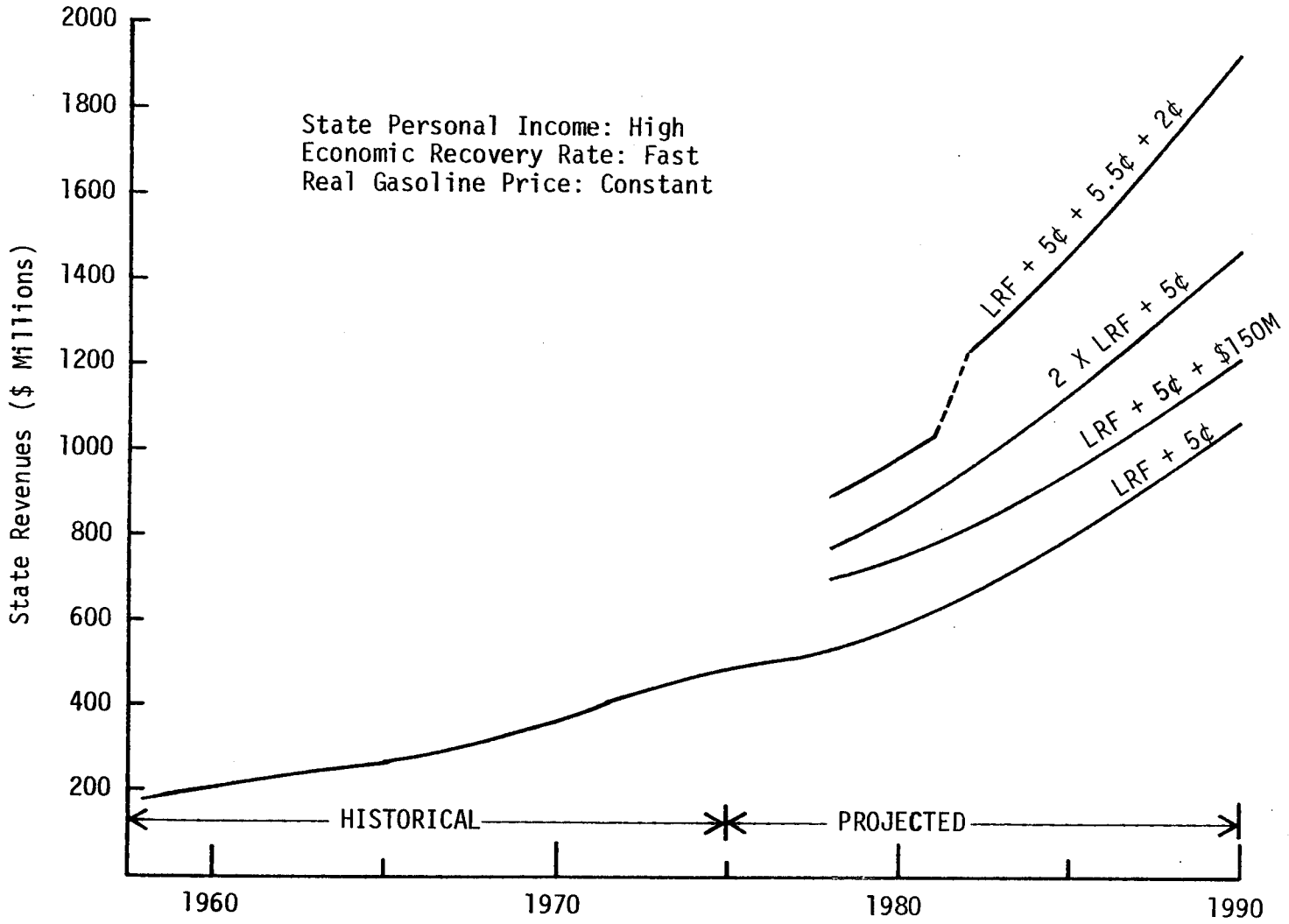

Figure A-1. Revenue Projections, Scenario 1

Table A-1: SDHPT REVENUE FORECASTS (Millions of Dollars)
State Personal Income: High
Economic Recovery Rate: Fast (1978)
Real Gasoline Price: Constant

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$203	$294	$497	$ 497	$ 497	$ 497	$ 497	$ 497
1977	212	305	517	517	517	517	517	517
1978	223	321	545	768	893	893	695	1,045
1979	236	338	574	811	933	933	724	1,074
1980	250	357	607	856	979	979	757	757
1981	264	377	641	905	1,029	1,029	791	791
1982	280	398	678	958	1,085	1,236	828	824
1983	296	421	718	1,014	1,145	1,302	868	868
1984	314	446	760	1,074	1,210	1,374	910	910
1985	332	472	804	1,137	1,281	1,453	954	954
1986	352	500	852	1,204	1,357	1,538	1,002	1,002
1987	373	529	902	1,275	1,439	1,630	1,052	1,052
1988	395	561	956	1,350	1,526	1,728	1,106	1,106
1989	418	594	1,012	1,430	1,619	1,834	1,162	1,162
1990	442	630	1,072	1,514	1,719	1,947	1,222	1,222

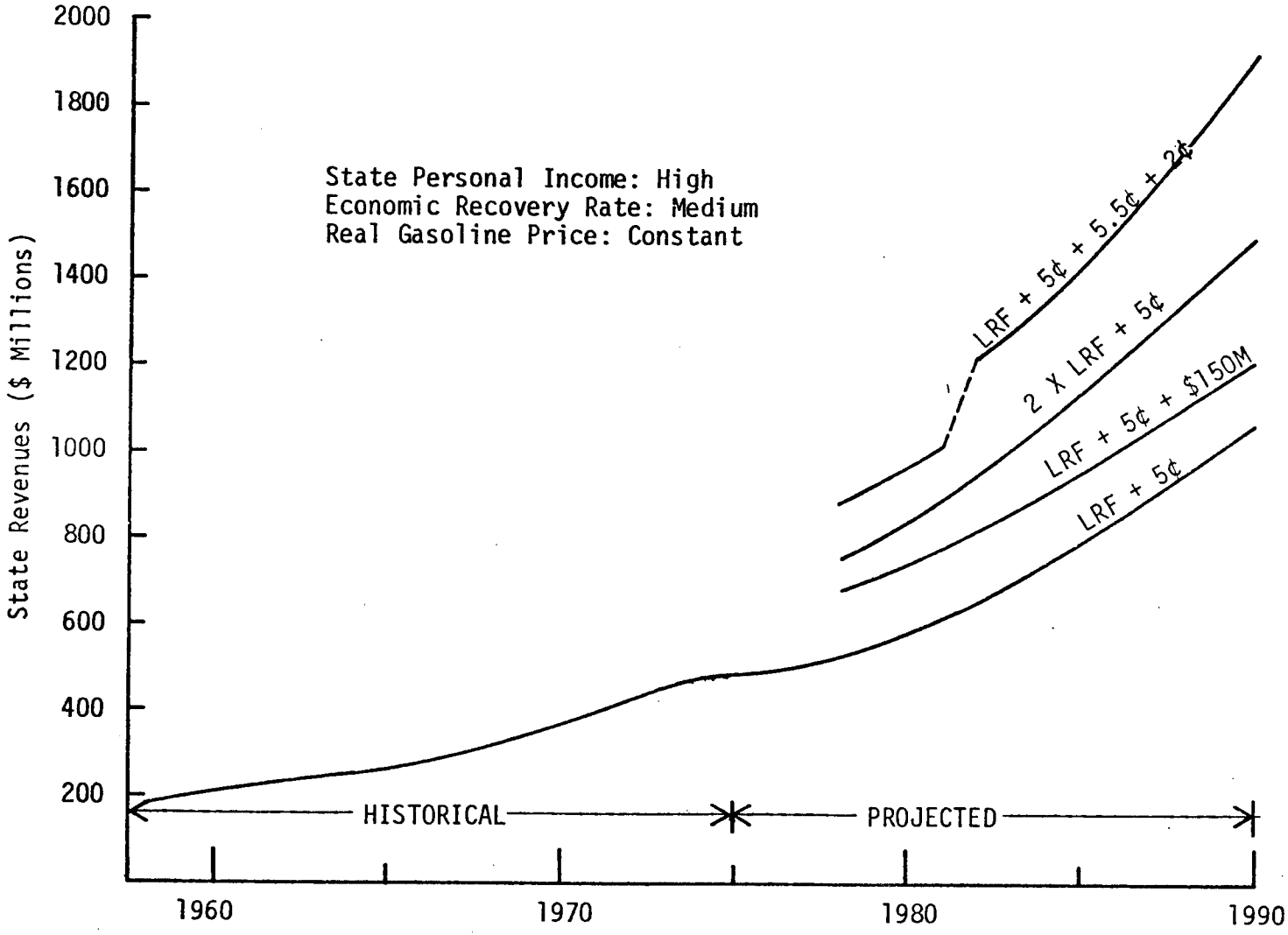

Figure A-2. Revenue Projections, Scenario 2

Table A-2: SDHPT REVENUE FORECASTS (Millions of Dollars)

State Personal Income: High
Economic Recovery Rate: Medium (1981)
Real Gasoline Price: Constant

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$202	$293	$ 495	$ 495	$ 495	$ 495	$ 495	$ 495
1977	209	303	512	512	512	512	512	512
1978	218	316	534	752	876	876	684	1,034
1979	229	332	561	790	912	912	711	1,061
1980	242	351	593	835	958	958	743	743
1981	257	371	629	886	1,011	1,011	779	779
1982	273	394	667	940	1,068	1,218	817	817
1983	290	417	707	997	1,131	1,286	857	857
1984	308	442	750	1,058	1,198	1,360	900	900
1985	327	469	796	1,122	1,270	1,440	946	946
1986	347	497	844	1,191	1,347	1,527	994	994
1987	368	527	895	1,263	1,430	1,620	1,045	1,045
1988	390	559	949	1,339	1,518	1,719	1,099	1,099
1989	413	592	1,006	1,419	1,612	1,826	1,156	1,156
1990	438	628	1,066	1,504	1,712	1,940	1,216	1,216

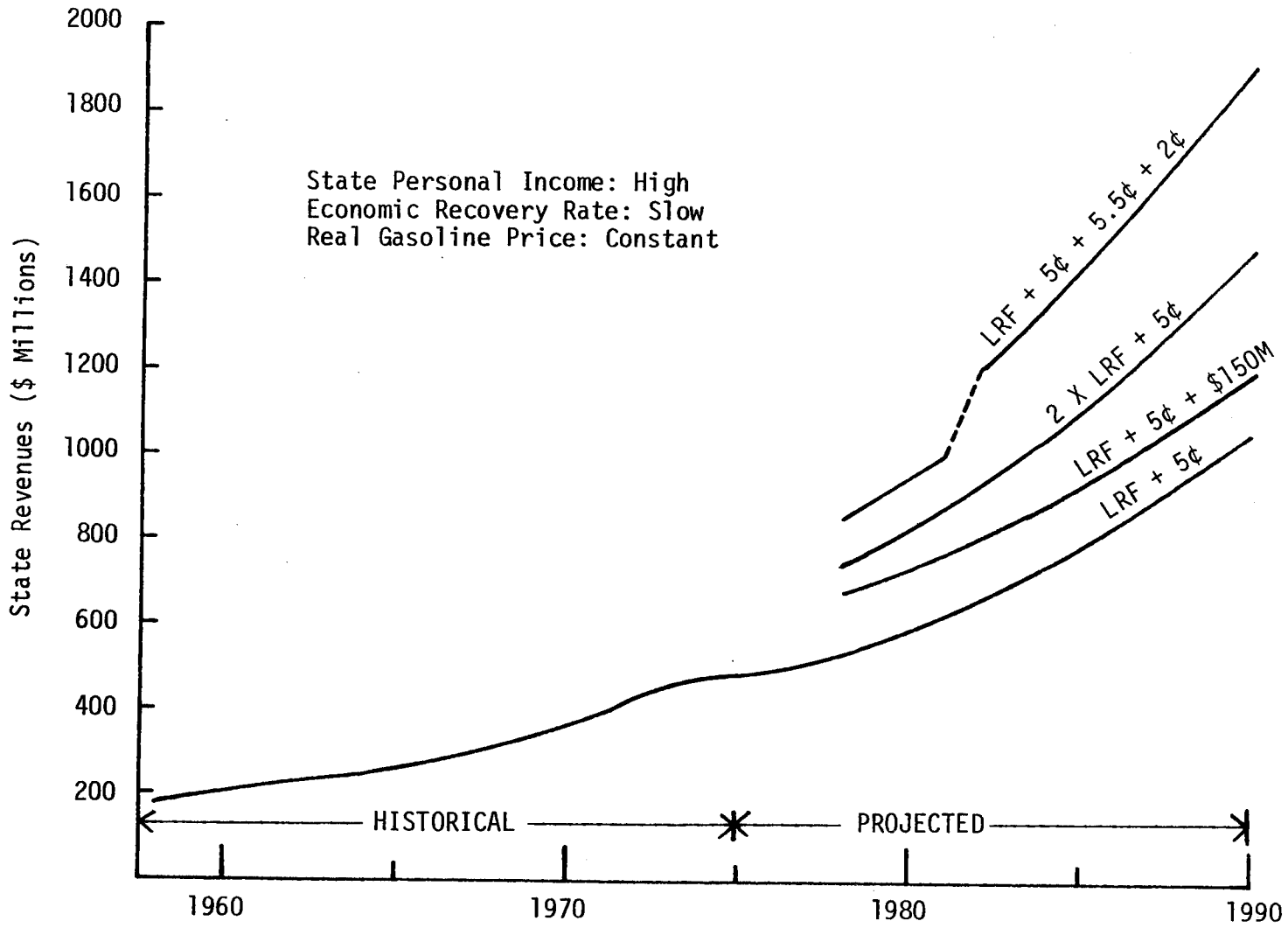

Figure A-3. Revenue Projections, Scenario 3

Table A-3: SDHPT REVENUE FORECASTS (Millions of Dollars)
State Personal Income: High
Economic Recovery Rate: Slow (1984)
Real Gasoline Price: Constant

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$202	$292	$ 494	$ 494	$ 494	$ 494	$ 494	$ 494
1977	208	302	510	510	510	510	510	510
1978	216	315	532	748	872	872	682	1,032
1979	227	331	558	784	907	907	708	1,058
1980	239	349	588	826	950	950	738	738
1981	252	369	621	874	1,001	1,001	771	771
1982	268	391	659	927	1,058	1,207	809	809
1983	285	415	699	984	1,120	1,275	849	849
1984	303	440	743	1,046	1,189	1,351	893	893
1985	322	467	789	1,111	1,262	1,432	939	939
1986	342	496	838	1,180	1,340	1,519	988	988
1987	364	526	889	1,253	1,423	1,613	1,039	1,039
1988	386	558	944	1,330	1,512	1,713	1,094	1,094
1989	410	591	1,001	1,411	1,606	1,820	1,151	1,151
1990	434	627	1,062	1,496	1,707	1,935	1,212	1,212

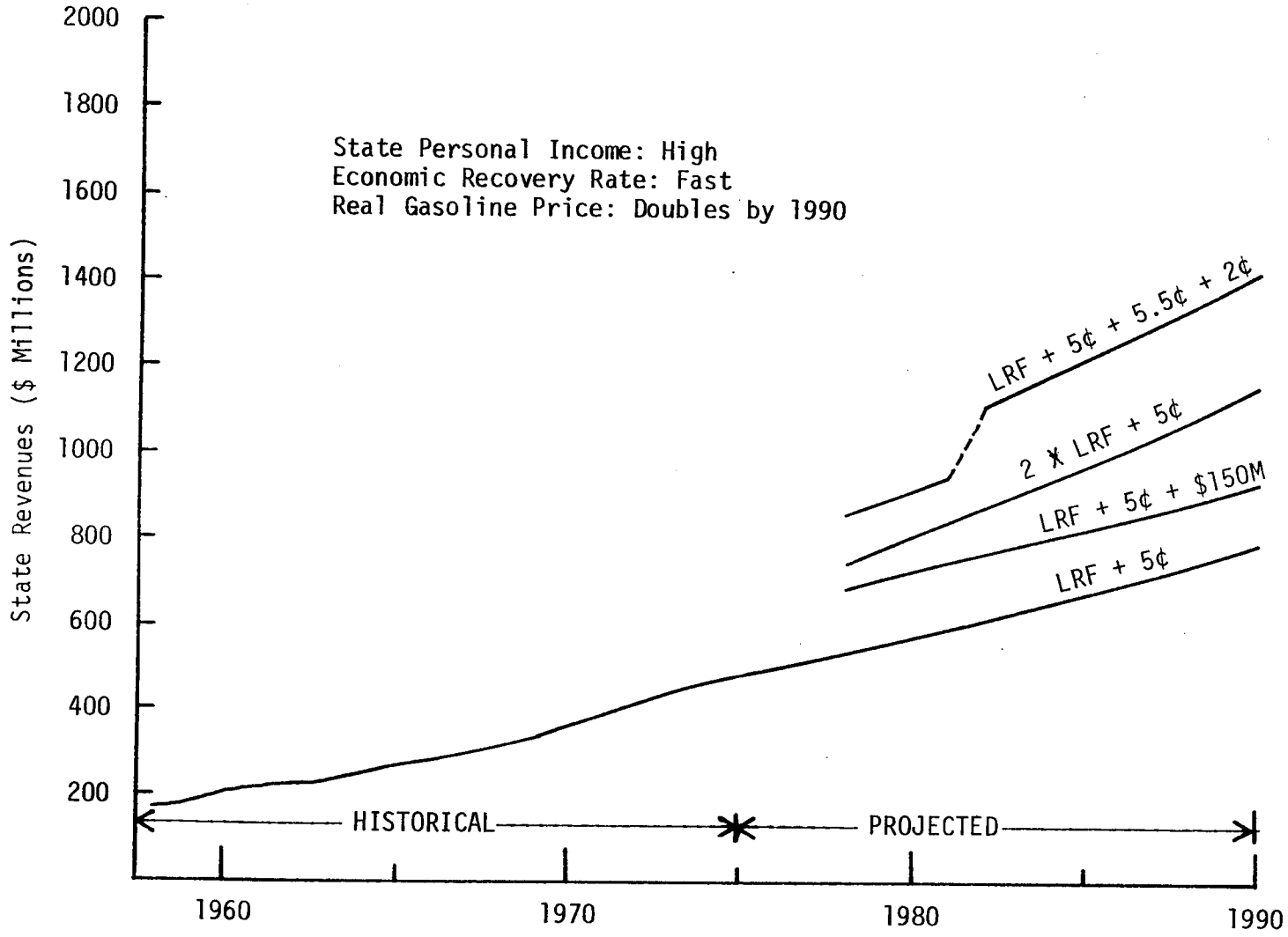

Figure A-4. Revenue Projections, Scenario 4

Table A-4: SDHPT REVENUE FORECASTS (Millions of Dollars)
State Personal Income: High
Economic Recovery Rate: Fast
Real Gasoline Price: Doubles by 1990

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$203	$292	$495	$ 495	$ 495	$ 495	$ 495	$ 495
1977	211	301	512	512	512	512	512	706
1978	221	312	533	754	871	871	688	712
1979	231	323	554	785	896	896	704	704
1980	241	333	575	816	923	923	725	725
1981	252	344	596	847	952	952	746	746
1982	262	355	617	879	981	1,118	767	767
1983	273	365	638	910	1,012	1,151	788	788
1984	283	375	659	942	1,044	1,185	809	809
1985	295	385	680	974	1,077	1,222	830	830
1986	306	396	701	1,007	1,112	1,260	851	851
1987	317	406	723	1,040	1,147	1,301	873	873
1988	329	416	745	1,074	1,184	1,343	895	895
1989	341	426	767	1,108	1,223	1,387	917	917
1990	353	436	789	1,143	1,262	1,433	939	939

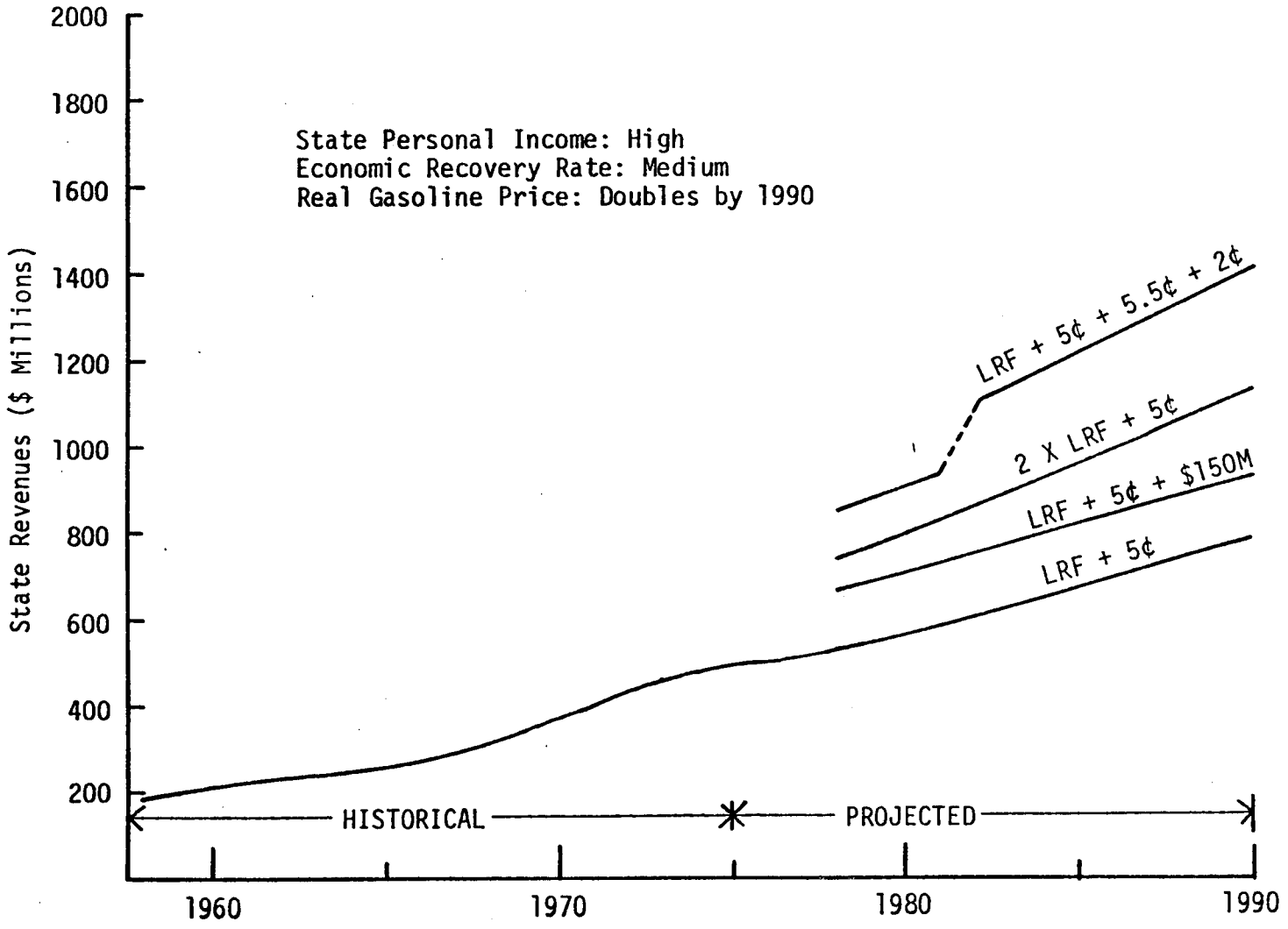

Figure A-5. Revenue Projections, Scenario 5

Table A-5: SDHPT REVENUE FORECASTS (Millions of Dollars)

State Personal Income: High

Economic Recovery Rate: Medium (1981)

Real Gasoline Price: Doubles by 1990

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$202	$291	$493	$ 493	$ 493	$ 493	$ 493	$ 493
1977	208	298	506	506	506	506	506	506
1978	215	307	522	737	853	853	672	1,022
1979	224	317	541	764	876	876	691	1,041
1980	234	328	561	795	903	903	711	711
1981	244	339	583	828	934	934	733	733
1982	255	350	606	861	966	1,101	756	756
1983	266	361	628	894	999	1,136	778	778
1984	277	372	650	927	1,032	1,173	800	800
1985	289	383	672	961	1,067	1,211	822	822
1986	300	393	694	994	1,103	1,250	844	844
1987	312	404	716	1,028	1,139	1,292	866	866
1988	324	414	739	1,063	1,177	1,335	889	889
1989	337	425	761	1,098	1,216	1,380	911	911
1990	349	435	784	1,133	1,256	1,426	934	934

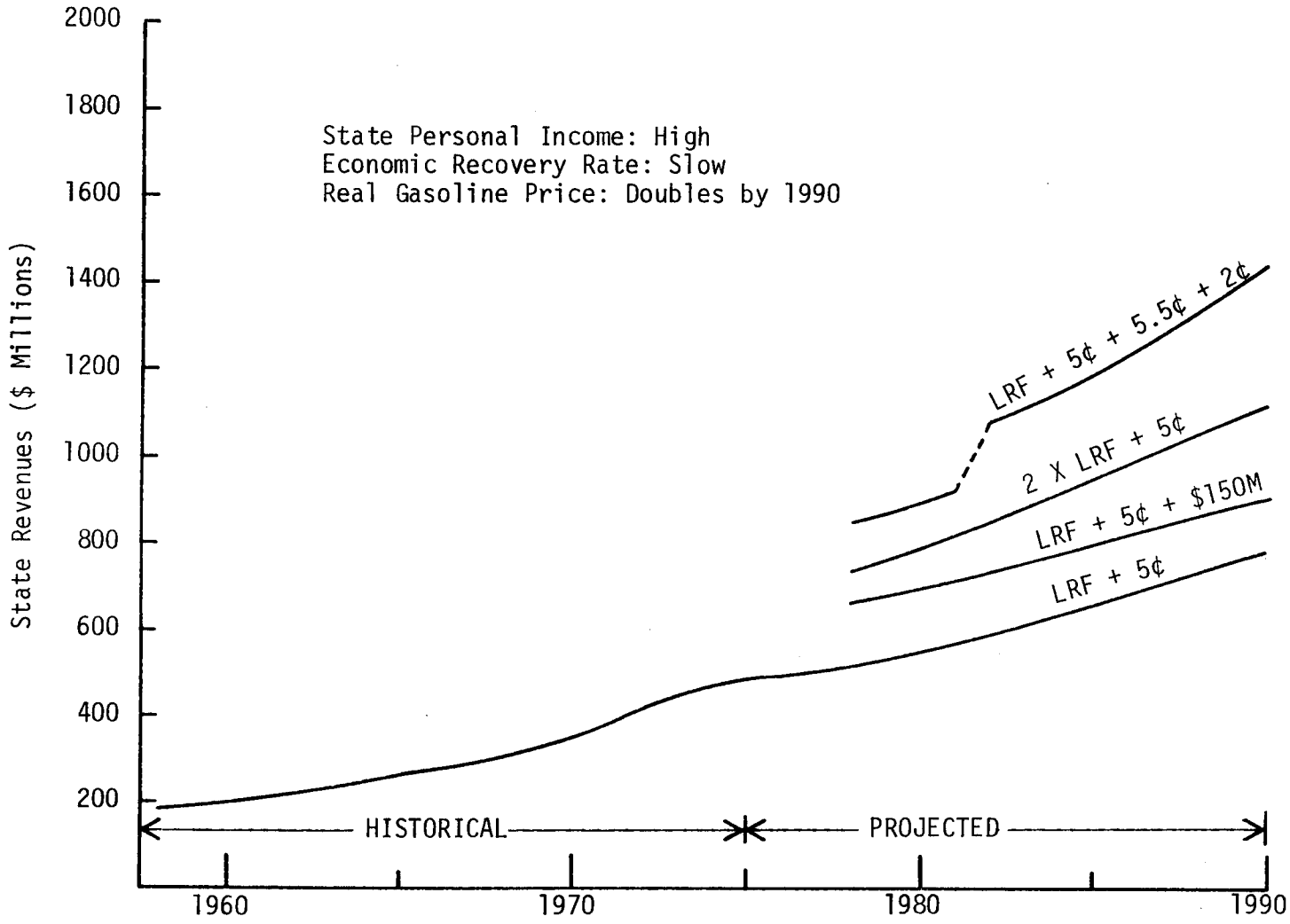

Figure A-6. Revenue Projections, Scenario 6

Table A-6: SDHPT REVENUE FORECASTS (Millions of Dollars)
State Personal Income: High
Economic Recovery Rate: Slow
Real Gasoline Price: Doubles by 1990

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$202	$291	$493	$ 493	$ 493	$ 493	$ 493	$ 493
1977	207	298	505	505	505	505	505	1,005
1978	214	306	520	734	850	850	670	1,170
1979	221	316	537	759	871	871	687	687
1980	230	326	556	786	896	896	706	786
1981	240	337	577	816	925	926	727	727
1982	250	348	598	848	956	1,090	748	748
1983	261	359	620	881	989	1,126	770	770
1984	272	370	643	915	1,024	1,163	774	774
1985	284	381	666	950	1,059	1,203	795	795
1986	296	392	688	984	1,096	1,243	817	817
1987	308	403	711	1,019	1,133	1,285	839	839
1988	320	413	734	1,054	1,171	1,329	862	862
1989	333	424	757	1,090	1,211	1,374	885	885
1990	346	434	780	1,126	1,252	1,442	908	908

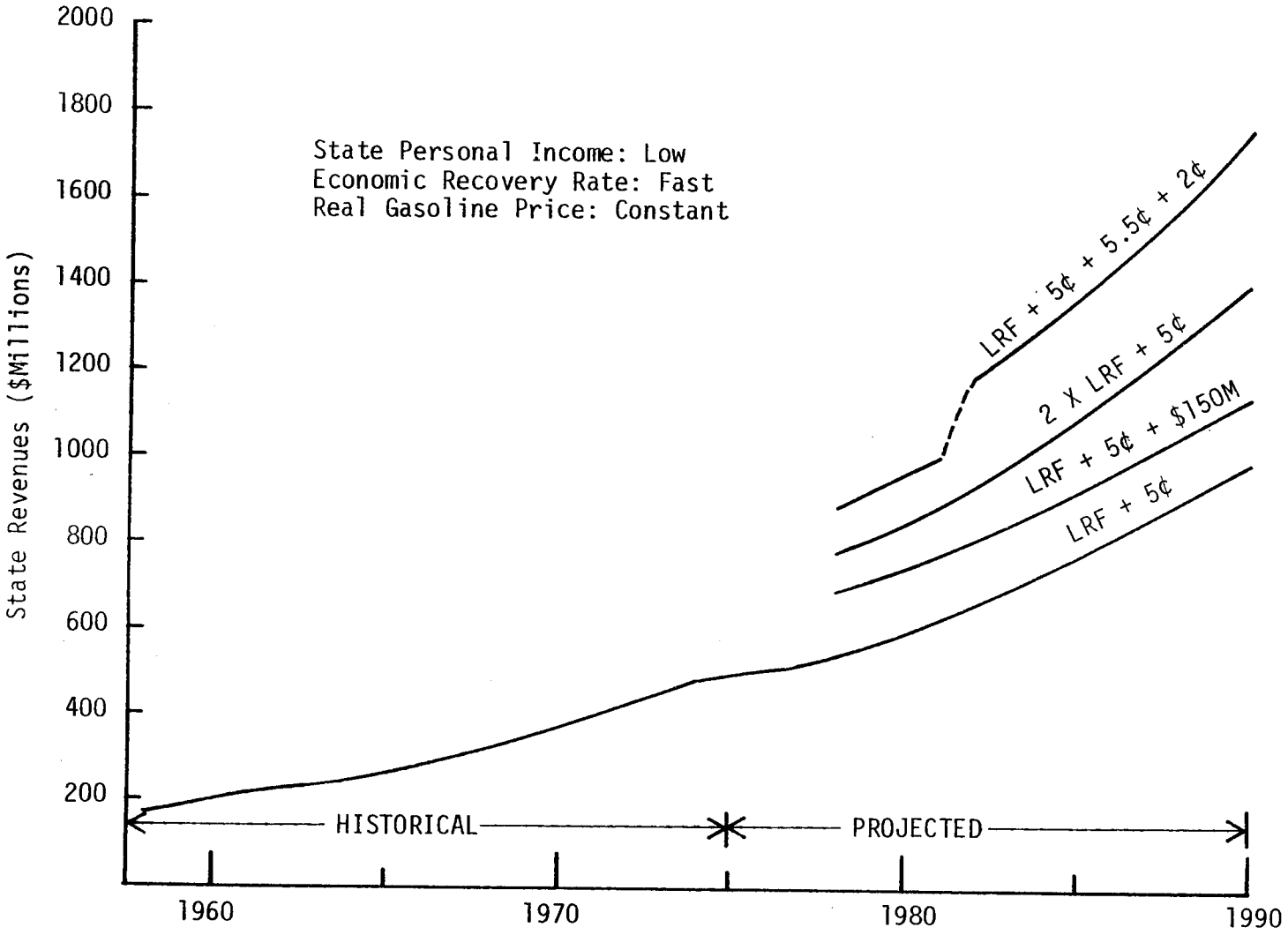

Figure A-7. Revenue Projections, Scenario 7

Table A-7: SDHPT REVENUE FORECASTS (Millions of Dollars)

State Personal Income: Low
Economic Recovery Rate: Fast
Real Gasoline Price: Constant

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$203	$293	$496	$496	$496	$496	$496	$496
1977	211	304	515	515	515	515	515	515
1978	222	318	540	762	885	885	690	1,040
1979	234	334	568	801	921	921	718	1,068
1980	246	350	597	843	960	960	747	747
1981	260	368	628	887	1,004	1,004	778	778
1982	274	387	660	934	1,052	1,199	810	810
1983	288	407	695	983	1,104	1,255	845	845
1984	304	428	731	1,035	1,160	1,316	881	881
1985	320	450	770	1,090	1,220	1,381	920	920
1986	337	473	810	1,148	1,283	1,452	960	960
1987	355	498	853	1,208	1,351	1,528	1,003	1,003
1988	374	524	898	1,272	1,422	1,608	1,048	1,048
1989	394	551	945	1,338	1,498	1,694	1,095	1,095
1990	414	580	994	1,408	1,579	1,785	1,144	1,144

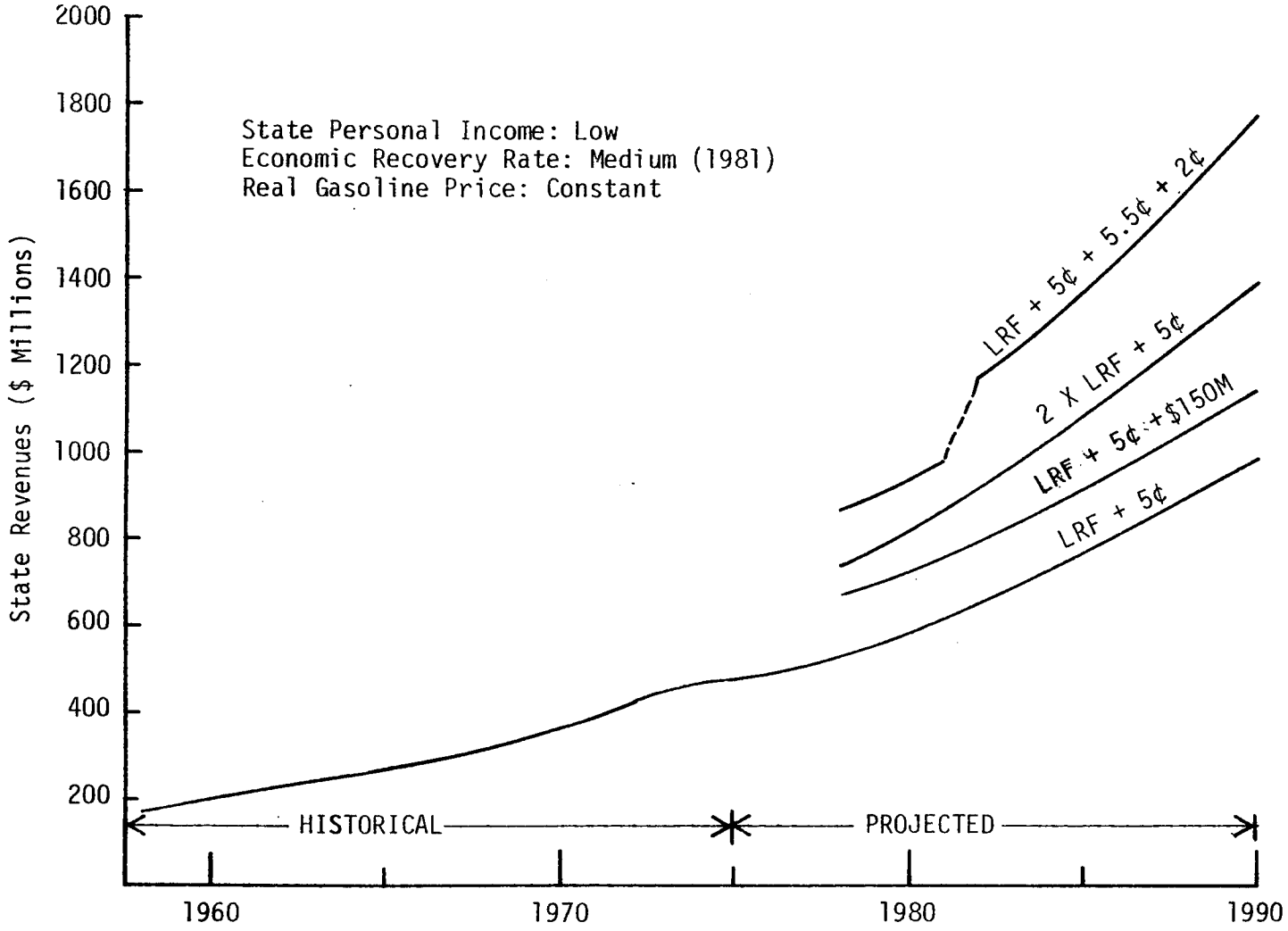

Figure A-8. Revenue Projections, Scenario 8

Table A-8: SDHPT REVENUE FORECASTS (Millions of Dollars)

State Personal Income: Low

Economic Recovery Rate: Medium (1981)

Real Gasoline Price: Constant

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$202	$292	$494	$494	$494	$494	$494	$494
1977	208	301	509	509	509	509	509	509
1978	216	313	529	746	867	867	679	1,029
1979	227	328	554	781	899	899	704	1,054
1980	239	344	583	821	939	939	733	733
1981	252	363	615	867	986	986	765	765
1982	267	382	649	915	1,036	1,181	799	799
1983	282	402	684	966	1,090	1,239	834	834
1984	298	424	722	1,020	1,147	1,302	872	872
1985	315	447	761	1,076	1,208	1,369	911	911
1986	332	470	802	1,134	1,273	1,441	952	952
1987	350	495	846	1,196	1,342	1,518	996	996
1988	369	522	891	1,260	1,414	1,600	1,041	1,041
1989	389	549	938	1,327	1,491	1,686	1,088	1,088
1990	410	578	988	1,398	1,572	1,778	1,138	1,138

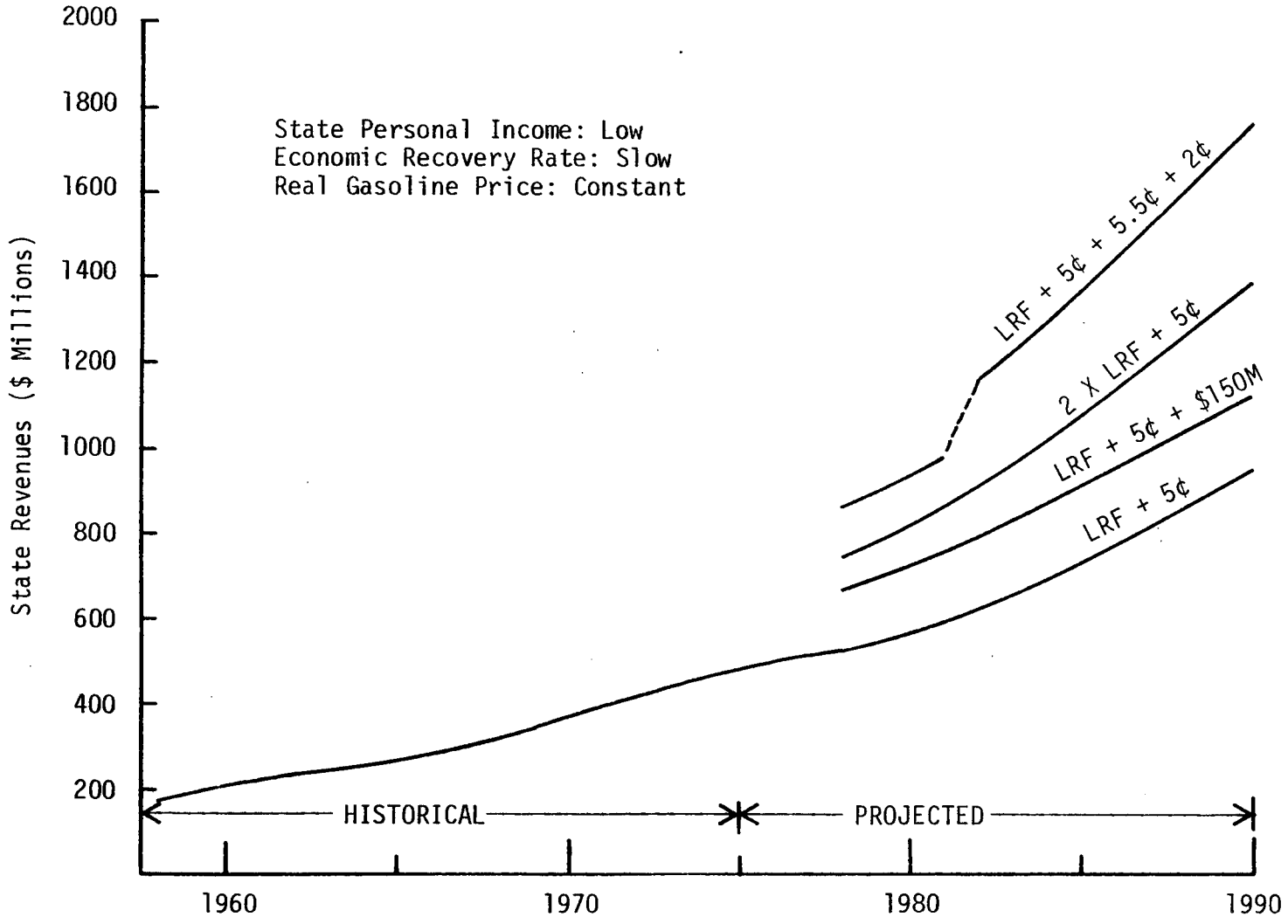

Figure A-9. Revenue Projections, Scenario 9

Table A-9: SDHPT REVENUE FORECASTS (Millions of Dollars)

State Personal Income: Low
Economic Recovery Rate: Slow
Real Gasoline Price: Constant

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$202	$292	$494	$494	$494	$494	$494	$494
1977	207	301	508	508	508	508	508	508
1978	215	312	523	742	863	863	673	1,027
1979	224	326	542	774	893	893	692	1,050
1980	235	342	564	811	930	930	726	726
1981	247	359	590	853	973	973	756	756
1982	261	378	619	900	1,022	1,166	789	789
1983	276	399	650	951	1,077	1,224	825	825
1984	292	421	685	1,005	1,136	1,289	863	863
1985	309	444	722	1,062	1,198	1,358	903	903
1986	327	468	761	1,122	1,264	1,431	945	945
1987	346	493	802	1,184	1,333	1,509	989	989
1988	365	520	846	1,250	1,407	1,592	1,035	1,035
1989	385	548	892	1,318	1,484	1,679	1,083	1,083
1990	406	577	940	1,389	1,566	1,771	1,133	1,133

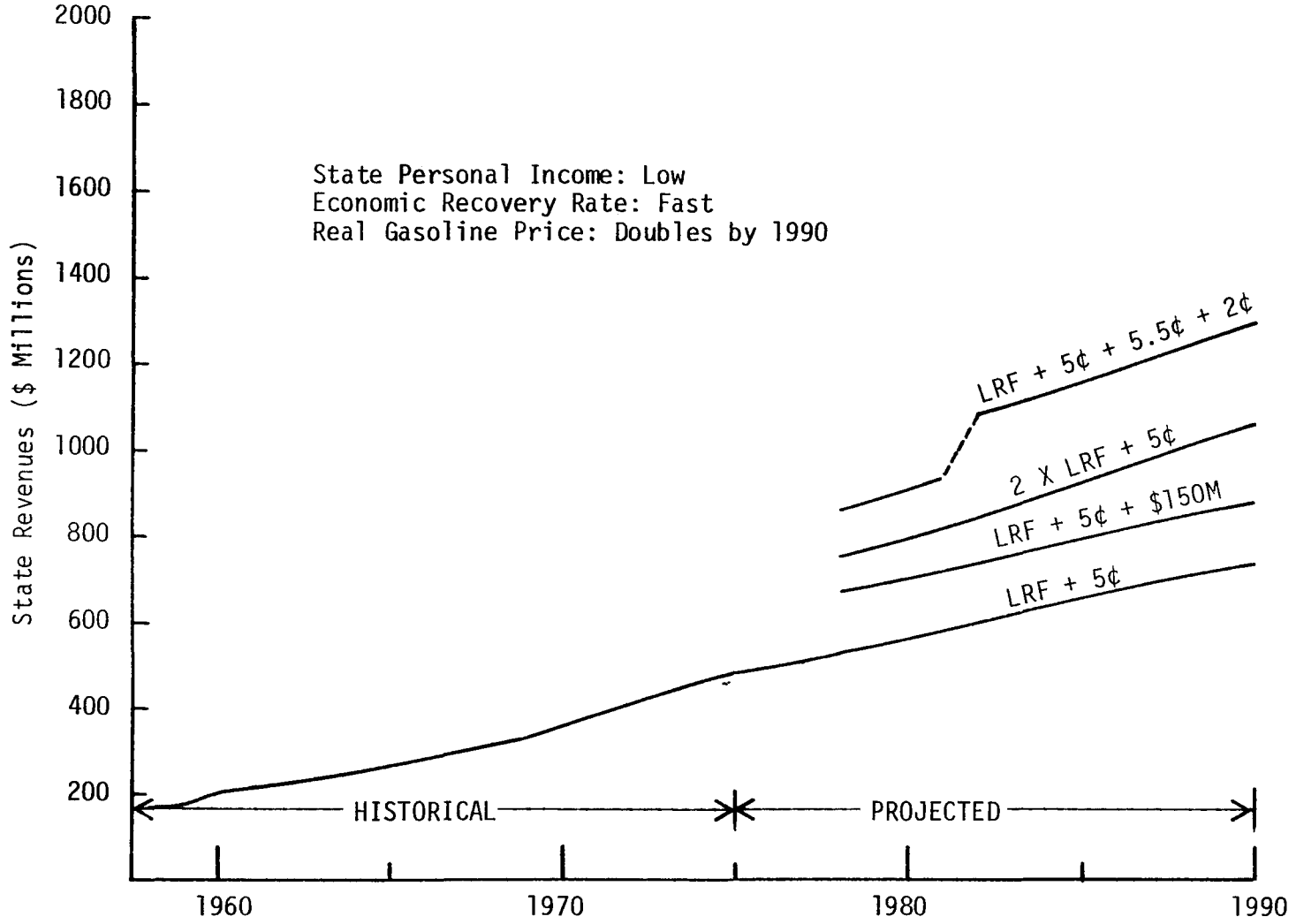

Figure A-10. Revenue Projections, Scenario 10

Table A-10: SDHPT REVENUE FORECASTS (Millions of Dollars)

State Personal Income: Low

Economic Recovery Rate: Fast

Real Gasoline Price: Doubles by 1990

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$203	$291	$494	$494	$494	$494	$494	$494
1977	210	299	509	509	509	509	509	509
1978	219	309	528	748	863	863	678	1,028
1979	229	318	547	776	884	884	697	1,047
1980	238	327	565	803	906	906	715	715
1981	247	336	583	830	929	929	733	733
1982	256	344	600	856	952	1,083	750	750
1983	265	352	617	882	975	1,108	767	767
1984	273	360	633	907	999	1,138	783	783
1985	282	367	650	932	1,023	1,159	800	800
1986	291	374	665	956	1,048	1,187	815	815
1987	300	381	681	981	1,073	1,215	831	831
1988	308	388	697	1,005	1,098	1,243	847	847
1989	317	395	712	1,029	1,124	1,273	862	862
1990	325	401	727	1,052	1,151	1,303	877	877

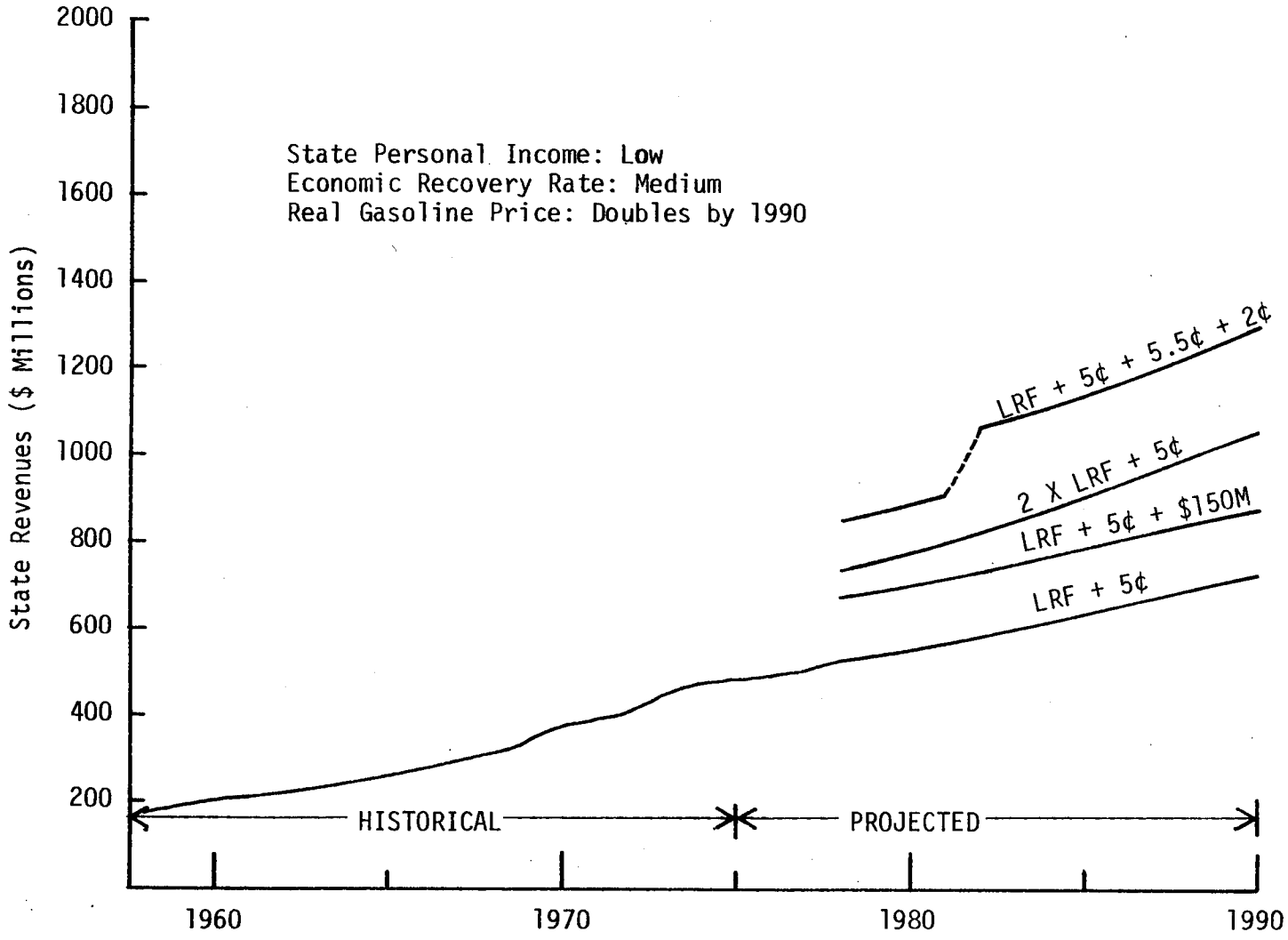

Figure A-11. Revenue Projections, Scenario 11

Table A-11: SDHPT REVENUE FORECASTS (Millions of Dollars)

State Personal Income: Low

Economic Recovery Rate: Medium

Real Gasoline Price: Doubles by 1990

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$202	$290	$492	$492	$492	$492	$492	$492
1977	207	296	504	504	504	504	504	504
1978	214	304	518	731	845	845	668	1,018
1979	221	312	534	755	863	863	684	1,034
1980	230	321	551	782	885	885	701	701
1981	240	331	570	810	911	911	720	720
1982	249	340	589	838	936	1,066	739	739
1983	258	349	607	865	962	1,093	757	757
1984	267	357	624	892	987	1,120	774	774
1985	277	365	641	918	1,013	1,148	791	791
1986	286	372	658	944	1,039	1,177	808	808
1987	295	380	674	969	1,066	1,206	824	824
1988	304	387	690	994	1,091	1,236	840	840
1989	313	393	706	1,018	1,118	1,266	856	856
1990	321	400	721	1,042	1,145	1,297	871	871

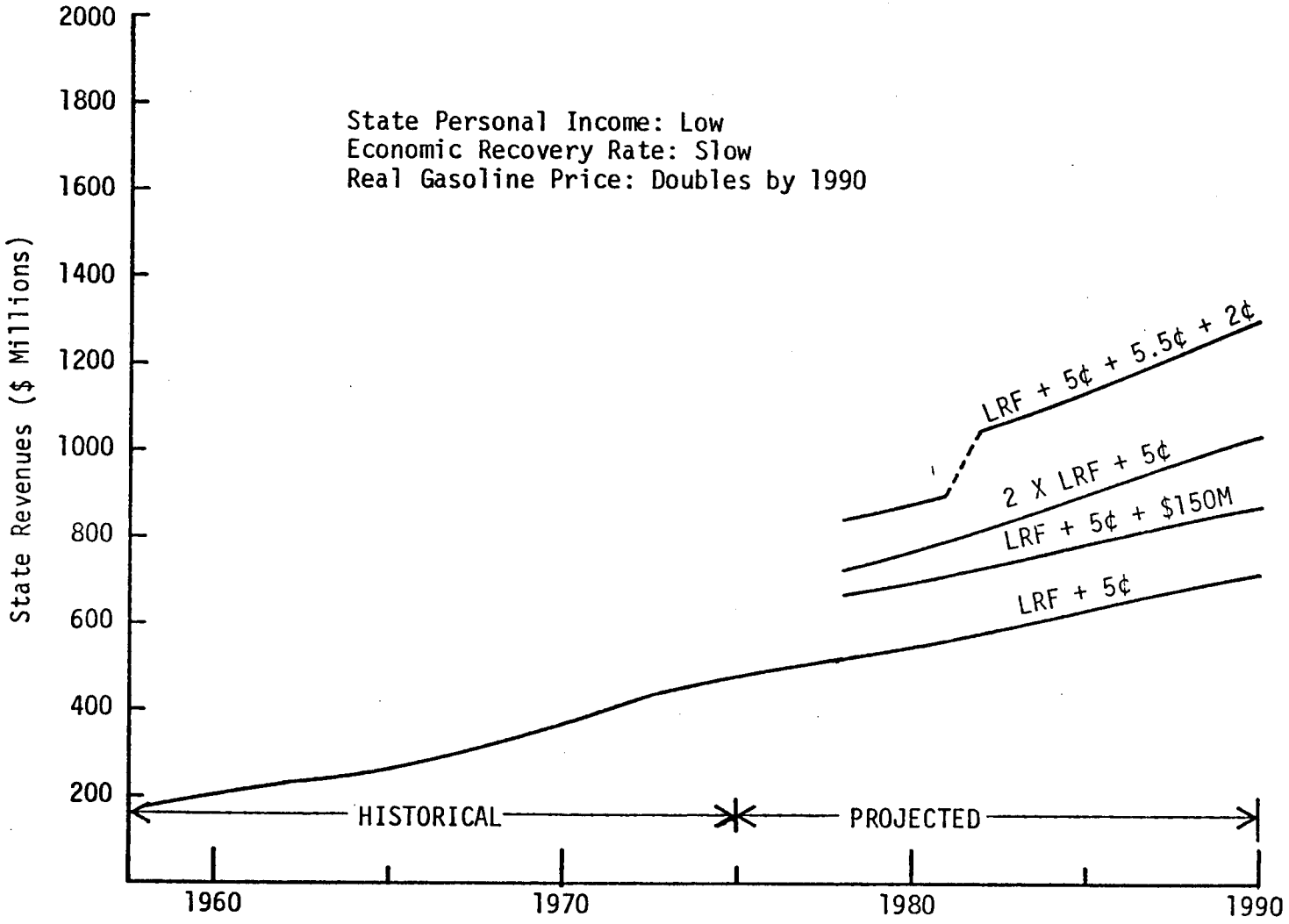

Figure A-12. Revenue Projections, Scenario 12

Table A-12: SDHPT REVENUE FORECASTS (Millions of Dollars)
State Personal Income: Low
Economic Recovery Rate: Slow (1984)
Real Gasoline Price: Doubles by 1990

FY	LRF	5¢	LRF + 5¢	2 x LRF + 5¢	LRF + 5¢ + 5.5¢	LRF + 5¢ + 5.5¢ + 2¢	LRF + 5¢ + 150M	LRF + 5¢ 500/150M
1976	$202	$290	$492	$ 492	$ 492	$ 492	$492	$ 492
1977	206	296	502	502	502	502	502	502
1978	212	304	515	727	841	841	665	1,015
1979	219	312	530	748	857	857	680	1,030
1980	226	321	545	772	876	876	695	695
1981	234	331	562	797	899	899	712	712
1982	243	340	580	823	923	1,052	730	730
1983	252	349	598	850	949	1,079	748	748
1984	262	357	616	878	977	1,109	766	766
1985	271	365	634	905	1,004	1,138	784	784
1986	281	372	651	932	1,030	1,168	801	801
1987	290	380	668	958	1,057	1,198	818	818
1988	299	387	685	984	1,084	1,229	835	835
1989	308	393	701	1,009	1,112	1,260	851	851
1990	317	400	716	1,034	1,139	1,291	866	866

APPENDIX B

THE CONCEPT OF ELASTICITY AND RECENT ELASTICITY ESTIMATES

To estimate the impact of changing fuel prices on the demand for fuel, usually the concept of price elasticity is used. Price elasticity measures the percentage change in the quantity demanded relative to the percentage change in price. This concept is readily illustrated mathematically. If at the original price, p_1, the quantity demanded is q_1 and the price changes to p_2 and quantity demanded changes to q_2, then the price elasticity of demand would be:

$$\frac{\frac{q_2-q_1}{q_1}}{\frac{p_2-p_1}{p_1}} \quad \text{or more generally} \quad \frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}} .$$

The concept of elasticity may be applied to changes in gasoline consumption resulting from changes in the price of gasoline, the price of automobiles, the price of automobile maintenance, and changes in income. Furthermore, the elasticity concept may be applied to different adjustment periods, such as one month, one year, or several years. This is because changes in the consumption levels of gasoline require time. Usually, short-run (generally considered to be one year or less) changes in quantity demanded of any good are less dramatic than are long-run changes due to the time involved in changing consumption patterns. In terms of elasticities, this means that short-run elasticities are more inelastic (less responsive) than are long-run elasticities. For instance, if the price of gasoline were to rise, in the short run a consumer may lower his consumption of gas by reducing the number of miles he drives and by changing the way in which he drives. However, in the long run, he may change his residence so as to lower the number of miles he must drive to work, he may purchase an automobile with greater fuel efficiency, change the way in which he drives, and reduce the number of miles traveled by automobile.

Recently, several studies have been conducted to estimate the demand for gasoline in the United States. Phillips[1] in 1972, Houthakker and Verleger[2] and Verleger and Sheehan[3] in 1973 used very similar techniques in estimating the demand for gasoline. All three studies were cross-sectional or mixed cross-sectional/time series studies conducted on U.S. data. The type of model used in each of these studies is referred to as a "flow-adjustment" or "dynamic partial adjustment" model. This type of model assumes that consumers do not instantaneously adjust to a change in the price of gas but rather gradually adjust their consumption over time until their "optimal" level of consumption for the new price, given their income, is attained. Most studies that have been done on the demand for gasoline are of this nature and yield both a short-run and a long-run price elasticity for gasoline. A common characteristic of all of the studies that have been done using this type of model is that the short-run price elasticity is consistently lower (less elastic) than the long run price elasticity (See Table B-1. However, estimates of elasticities vary a great deal between studies, the estimates of the short-run elasticity for the U.S. varies from -0.06 to -0.83 and estimates of the long-run price elasticity for the U.S. vary from -0.07 to -0.92.

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[1]Louis Philips, "A Dynamic Version of the Linear Expenditure Model," Review of Economics and Statistics, Vol. LIV, November, 1972, pp. 450-458.

[2]H. S. Houthakker and P. K. Verleger, "The Demand for Gasoline: A Mixed Crossectional and Time-Series Analysis," Preliminary Paper, May, 1973.

[3]P. K. Verleger and D. D. Sheehan, "A Study of the Quarterly Demand for Gasoline and Impacts of Alternative Gasoline Taxes," DRI Special Study for the EPA and CEQ, December, 1973.

TABLE B-1

Recent Estimates of the Price Elasticity
of Motor Fuel Demand

Author	Type of Data	Elasticity	
J. Ramsey, A. Rasche, B. Allen	Annual U.S. for passenger cars & motorcycles	- .77	--
Charlotte Chamberlain (D.O.T.)	Annual U.S. Passenger car	-0.06	- .07
Data Resources, Inc.	Quarterly U.S. highway motor fuel	- .196	- .446
Louis Philips	Annual, U.S.	- .11	- .68
Charlotte Chamberlain	Annual-International	- .12	-1.21
Hendrick Houthakker	Annual-International	- .465	- .82
John Enns (RAND)	Annual, U.S.	- .10 to - .18	
H.S. Houthakker and Verleger	Annual, U.S.	- .43	- .75
F. Adams, H. Graham, and J.M. Griffin	Cross-sectional, International	--	- .9
NAV (Model)	Annual, U.S. (automobile only)	- .83	- .92
FEA		- .2	- .8
Thompson	Annual, Texas	- .2	-1.43

Sources for Table B-1

J. Ramsey, R. Rasche, and B. Allen, "An Analysis of the Private and Commercial Demand for Gasoline," (unpublished paper) February 18, 1974.

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Hendrik S. Houthakker and Michael Kennedy, "Demand for Energy as a Function of Price," unpublished and undated paper.

B. Burright and J. Enns, Econometric Models of the Demand for Motor Fuel, The RAND Corporation, R-1561- NSF (forthcoming).

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Sorrell Wildhorn, Burke Burright, John Enns, and Thomas Kirkwood, NAV Model in How to Save Gasoline: Public Policy Alternatives for the Automobile R-1560-NSF (October, 1974).

Federal Energy Administration, Project Independence, Project Independence Report, U.S. Government Printing Office, Washington, D.C. (November, 1974).

Russell G. Thompson, "Relationship Between Supply/Demand and Pricing for Alternative Fuels in Texas: A Study in Elasticities, " Report for the Governor's Energy Advisory Council of Texas, January, 1975.