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FORECAST OF TRUCKLOAD FREIGHT OF CLASS I MOTOR CARRIERS OF PROPERTY IN THE SOUTHWESTERN REGION TO 1990

MARY LEE GORSE

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DEPARTMENT OF TRANSPORTATION
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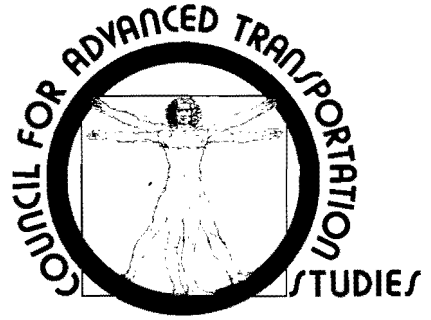

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FORECAST OF TRUCKLOAD FREIGHT OF CLASS I MOTOR CARRIERS OF PROPERTY IN THE SOUTHWESTERN REGION TO 1990

Mary Lee Gorse

MARCH 1975

RESEARCH REPORT

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16. Abstract

Truckload revenue freight of Class I common and contract motor carriers of property operating in intercity service in the Southwestern Region has been forecast to 1990 using multiple regression analysis.

Data were gathered on the dependent variable (truckload freight) and on thirty independent variables (economic indicators of the Southwestern Region) for the base period 1957 to 1971. Missing values from the time series data were estimated by curve fitting techniques to the known data points.

Multiple regression analyses were used to measure the linear relationship between the dependent variable and a set of independent variables, taking into consideration the interrelationships among the independent variables. From these analyses, predictor regression equations were formulated using either uniform or mixed inclusion levels for all independent variables. Three equations were chosen for further analysis. The independent variables in the selected equations were forecast by extrapolation from the curve which best fit the known data points of each variable.

Comparison of the three predictor regression equations, a Department of Transportation projection, and the closest fitting extrapolation of the truckload freight data, along with all the statistical evidence available, led to the selection of a "best" forecast, which is a set of four economic indicators.

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EXECUTIVE SUMMARY

INTRODUCTION

This forecast of truckload freight in the Southwestern Region is the second of five reports which provide forecasts of future demand for various modes of freight transportation. It is part of a larger research effort designed to improve the existing freight transportation system. A forecast of air cargo originations in Texas has already been published and other reports in this series soon to be published are forecasts of revenue freight tons carried by rail in Texas; air cargo originations in Arkansas, Louisiana, and Oklahoma; and pipeline movements in Texas.

PROBLEM STUDIED

Truck freight transportation is an important segment of the overall freight transportation system. Trucks haul 51 percent of manufacturers' intercity tons of freight and 31 percent of manufacturers' intercity ton-miles of freight. This report forecasts total truckload revenue freight of Class I common and contract motor carriers of property operating in intercity service in the Southwestern Region (hereafter referred to as truckload freight) to 1990, using multiple regression analysis and trend analysis.

RESULTS ACHIEVED

Data were gathered on the dependent variable (truckload freight) and on thirty independent variables (economic indicators for the Southwestern Region) for the base period 1957 to 1971. Any missing values for a time series were estimated by use of the OMNITAB computer program POLYFIT. The data were then analyzed using the computer program SPSS (Statistical Package for the Social Sciences) subprogram REGRESSION, using the stepwise mode.

Multiple regression analysis was used to measure the linear relationship between the dependent variable (truckload freight) and a set of independent variables (the economic indicators), taking into consideration the inter-relationships between the independent variables. The objective of multiple regression analysis was to formulate a predictor equation that was a linear combination of independent variables and had the highest correlation with the dependent variable. The predictor regression equation took the form of

$$Y_c = A + B_1X_1 + B_2X_2 + B_3X_3 + \ldots + B_nX_n$$

where the X's were the independent variables, the B's were the regression coefficients, A was a constant, and Y_c was the predicted value for the dependent variable, such that Y_c - the actual value = E, the error (or residual) term.

The SPSS subprogram REGRESSION, using the stepwise mode and a uniform inclusion level for all independent variables, made available a series of thirteen regression equations. The equations from step three and step five were selected as having the optimal combination of the following four factors: 1) the highest R^2 (the coefficient of determination); 2) the lowest α level for the significance of the coefficients; 3) the lowest coefficient of variability; and 4) the lowest α level for the significance of the regression equation.

The variables included in the three-step and five-step equations were run on the STATPAK computer program TREN and the OMNITAB program POLYFIT to fit the base period data to a first degree polynomial, an exponential curve, and a Gompertz curve (if possible). The coefficient of variability was computed for each curve and the curve with the lowest coefficient of variability was chosen to forecast that variable. Forecasts for each variable for the years 1975, 1980, 1985, and 1990 were computed by extrapolating the chosen curve.

These forecast values for each variable for each year were substituted into the two regression equations to produce a forecast for truckload freight for the years 1975, 1980, 1985, and 1990. The three-step and five-step forecasts are presented in Figure 2 (page 20 of the text). Inspection of these forecasts revealed a large divergence, so another regression equation was developed to corroborate the results of either the three-step or the five-step equation.

A third forecast, the four-step equation, was formulated by the method previously described, except for the use of mixed inclusion levels for the independent variables. In addition a 1972 Department of Transportation projection of the U.S. annual percentage increase in "Truck for Hire--Intercity" was applied to the Southwestern Region truckload data, starting with 1971, to produce a projection to 1990, and a trend analysis of the base period freight data was performed, indicating that the Gompertz curve was the best fit.

Comparison of the three predictor regression equations, the projection derived from Department of Transportation national percentage increases, and the Gompertz curve (presented in Figure 5, page 35 of the text), along with all the statistical evidence available, led to the selection of the

four-step equation. The four-step predictor regression equation is:

$$\text{TRUKLOAD} = 4{,}985.45897\ \text{CHEMICAL} + 2{,}323.73557\ \text{POPULATN} - 24{,}439.82163\ \text{LUMBER} + 8{,}593.57920\ \text{METALS} - 28{,}796{,}494.49892$$

with $R^2 = 0.99403$, $\alpha_c < 0.005$, $V_{\bar{x}} = 0.0235709$, and $\alpha_{eq} < 0.001$.

The forecasts for total truckload revenue freight of Class I common and contract motor carriers of property operating in intercity service in the Southwestern Region were computed to be:

Year	Tons
1975	37,793,827
1980	46,753,424
1985	57,535,753
1990	71,062,453

Although multicollinearity was considered to be a problem since the multiple regression model used time series data, the analysis presented was believed to be reliable for predictive purposes. This belief was based on the fact that the variables selected for use in the two regression equations were not subject to extreme observations and that the pattern of intercorrelations among the variables had been sustained for a sufficiently long period of time to indicate that it would be likely to continue in the future.

UTILIZATION OF RESULTS

The results will be of interest to the following: transportation planners for the Southwestern Region, forecasters of traffic in all transportation modes, and individuals needing a large body of information concerning economic indicators in the Southwestern Region.

CONCLUSION

In this study, total truckload revenue freight of Class I common and contract motor carriers of property operating in intercity service in the Southwestern Region has been forecast to 1990 by multiple regression analysis and trend analysis. A four-step predictor regression equation was selected

as the "best" forecast. The four independent variables of this equation explained approximately 99.4 percent of the variation in the dependent variable (truckload freight). Truckload freight is predicted to be 71,062,453 tons in 1990.

PREFACE

The Council for Advanced Transportation Studies of The University of Texas at Austin has a contract with the U.S. Department of Transportation (DOT-OS-30093) to do a research project entitled, "Transportation to Fulfill Human Needs in the Rural/Urban Environment." This project is divided into five topics: I. Access to Essential Services; II. Influence on the Rural Environment of Interurban Transportation Systems; III. Transportation Development in the Southwest with Emphasis on Intermodal Freight and the Dallas-Fort Worth Airport; IV. Ride Quality Evaluation in Multimodal Systems; and V. Human Response in the Evaluation of Modal Choice Decisions. Topic III has two major parts: A. Improvement of Intermodal Freight Transportation in the Southwest; and B. Monitoring the Effects of the Dallas-Fort Worth Regional Airport. This report deals with a portion of the work being done on Topic III-A.

Facilities and research materials of the Bureau of Business Research of The University of Texas at Austin, under the direction of Dr. Stanley A. Arbingast, Professor of Resources, were used in the preparation of this report. The research was supervised by Dr. Charles T. Clark, Professor of Business Statistics, with helpful discussions and suggestions from Edward N. Kasparik, Research Associate, and Charles P. Zlatkovich, Research Associate and Transportation Specialist. Florence Escott, Associate Director of the Bureau of Business Research, cooperated in many details of publication; Dianne Y. Priddy, Research Associate, assisted in data collection and reviewed the drafts, making constructive comments; Dr. Lois R. Glenn, Research Associate, edited the final draft; Jewell Patton and Geraldine Edwards typed the drafts; and offset printing was the work of Robert Dorsett and Daniel Rosas, assisted by Robert Jenkins and Salvador Macias.

Mary Gorse

March 1975

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*Value Added By Manufacture

CHAPTER I

INTRODUCTION

Twenty million trucks of various kinds, including more than one million for-hire carriers, operate over a U.S. highway system of 3.5 million miles of roadway and streets, two-thirds of which are surfaced. These publicly owned rights-of-way are used by the trucking industry, whose various phases directly employ seven million people.[1]

Background Information

The for-hire carriers consists of common carriers and contract carriers. A third type of motor carrier, the not-for-hire (or private) carrier, consists of individuals or businesses that transport their own freight. Common carriers transport "public" property either as regular-route carriers or as irregular-route carriers. Some common carriers transport general freight and others limit their carriage to a particular kind of traffic, such as livestock or household goods. The contract carriers transport property for a limited number of customers under special contract. They can adapt themselves more readily to the needs of their clientele than the common carriers.

The Interstate Commerce Commission is the regulatory agency for interstate motor carriers. It classifies common and contract motor carriers of property operating in the intercity service according to their annual operating revenues. This report is concerned only with Class I carriers. A Class I motor carrier of property is one with average annual operating revenues of $1,000,000, or more, from property motor carrier operations. It should be noted that there is a sizable amount of truck carriage (probably two-thirds) not subject to regulation.[2]

Current Situation

The composition of freight transported by Class I common and contract motor carriers of property operating in intercity service in the Southwestern Region for the year ended December 31, 1971, is presented in Table I, with the commodities listed in the order of their tonnage.

"Although there is some trucking for very long distances, there is evidence that comparatively short hauls predominate in motor-truck

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[1] Roy J. Sampson and Martin T. Farris, Domestic Transportation: Practice, Theory, and Policy, 3rd ed. (Boston: Houghton Mifflin Company, 1975), pp. 61-62.

[2] Ibid., pp. 62-63.

transportation."[3] The average length of freight haul in U.S. domestic commerce for Class I common carriers was 277 miles in 1971, as compared to scheduled air carriers at 1023 miles and railroads at 505 miles.[4]

The trucking industry's use of publicly owned rights-of-way, coupled with its comparatively small investment in terminal facilities and vehicles, results in a high proportion of variable or direct costs to fixed or indirect costs. Each revenue dollar consists of approximately: 50 percent wages and fringe benefits; 13 percent terminal expenses; 13 percent administrative, general, tax, and license expenses; 15 percent depreciation and equipment expenses; and 9 percent traffic solicitation, insurance and safety, and profits. "It is generally considered that a well-managed trucking firm can operate profitably with an operating ratio (percentage of operating expenses) of ninety-three."[5]

Future Outlook

"The trucking industry basically is made up of a large number of comparatively small firms, although there are notable exceptions."[6] Currently, however, there is a dramatic trend toward consolidation in the common carrier trucking business.[7,8] Although mergers and acquisitions of for-hire carriers are most frequently sought to obtain the ICC certificate for the operating rights to a specific route held by another carrier, this acquisition and merger movement has been received with mixed reaction in the motor carrier industry. Proponents have argued that new and larger operations are able to avoid duplication in areas such as management, computer services, and accounting and legal departments. In fact a higher caliber of management expertise can be afforded, existing terminal facilities can be put to better use, and larger chunks of money can be put together for capital improvements, research and development, computers, and so forth. Opponents of mergers argue that bigness is not necessarily an asset in the labor-intensive trucking industry as compared with other capital-intensive businesses. They believe that the key to a healthy trucking industry is service to the customer and that larger companies would tend to cut out less profitable parts of their service.

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[3]D. Philip Locklin, Economics of Transportation, 7th ed. (Homewood, Illinois: Richard D. Irwin, Inc., 1972), p. 643.

[4]Transportation Association of America, Transportation Facts and Trends, 10th ed. (Washington: Transportation Association of America, 1973), p. 14.

[5]Sampson, op. cit., p. 63.

[6]Ibid., p. 62.

[7]Stu Byczynski, "Mergermania," Fleet Owner (January 1975), pp. 59-68.

[8]"Smith's Transfer Grows, Merger by Merger," Business Week (June 8, 1974), pp. 93-97.

TABLE I. COMPOSITION OF FREIGHT TRANSPORTED BY CLASS I COMMON AND CONTRACT MOTOR CARRIERS OF PROPERTY OPERATING IN INTERCITY SERVICE IN THE SOUTHWESTERN REGION FOR THE YEAR ENDED DECEMBER 31, 1971*

Commodity	Total Freight Traffic Tons (including duplications)
Petroleum and coal products	12,764,972
Chemicals and allied products	4,884,192
Food and kindred products	2,888,627
Transportation equipment	1,968,157
Stone, clay, and glass products	1,887,528
Pulp, paper, and allied products	1,173,044
Primary metal products	747,002
Lumber and wood products, except furniture	738,117
Miscellaneous products of manufacturing	732,032
Nonmetallic minerals, except fuels	705,208
Crude petroleum, natural gas, and natural gasoline	624,226
Farm products	542,043
Rubber and miscellaneous plastic products	447,329
Miscellaneous freight shipments	445,788
Machinery, except electrical	272,974
Electrical machinery, equipment, and supplies	264,575
Fabricated metal products, excluding ordnance, machinery, and transportation	256,564
Ordnance and accessories	191,661
Printed matter	111,894
Basic textiles	94,420
Metallic ores	67,042
Miscellaneous mixed shipments, excluding forwarder and shipper association	52,398
Apparel and other finished textile products, including knit	31,346
Furniture and fixtures	25,490
Waste and scrap materials	25,086
Tobacco products	23,210
Instruments, photo and optical goods, watches and clocks	22,601
Forest products	21,758
Leather and leather products	16,783
Containers, shipping, returned empty	14,473
Freight forwarder traffic	6,936
Fresh fish and other marine products	4,909
Coal	653
Shipper association or similar traffic	306

*U.S. Interstate Commerce Commission, Bureau of Accounts, Freight Commodity Statistics, Motor Carriers of Property, Year Ended December 31, 1971 (Washington: Interstate Commerce Commission, 1972), pp. 74-81.

A major deterrent to the trucking industry's development is the uncertain availability of fuel in the future. Currently fuel supplies are good and are forecasted to remain that way throughout 1975: "The Federal Energy Administration is optimistic. So are the American Petroleum Institute, the National Association of Truck Stop Operators, and American Trucking Association. Common carriers and private fleets alike are fairly satisfied with current supplies, although the price of diesel fuel has jumped sharply in the past year."[9] The long term fuel supply is very ill defined: "The U.S. energy crisis took time to come into full bloom; it will take time to cure. Something like 20 years, former energy czar John A. Love told the American Petroleum Institute recently.... The oil shortage segment of the over-all energy crisis can be partially overcome say industry spokesmen, in three to five years, more fully overcome perhaps within a decade."[10]

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[9]Stu Byczynski, "Fuel Forecast '75: Diesel Fuel Stocks Are Up--Prices Too," Fleet Owner (January 1975), p. 64.

[10]Cornelius Brodersen, "New Fuel Sources for the 1980's and Beyond," Fleet Owner (February 1974), p. 61.

CHAPTER II

DATA

Statistics on the amount of freight shipped by truck are compiled by the Interstate Commerce Commission (ICC). The ICC classifies motor carriers in three groups (Class I, Class II, and Class III) according to the amount of average annual operating revenues. Class I motor carriers of property are designated as motor carriers with average annual operating revenues of at least $200,000 from 1950 to 1956; at least $1,000,000 from 1957 to 1972; and at least $3,000,000 beginning in 1974. These changes for Class I made it impossible to find comparable data for the desired base period, 1950 to 1972. Comparable data were available for the years 1957 to 1971 (data for 1972 had not yet been published), so that was chosen as the base period. The Southwestern Region (Texas, Oklahoma, Louisiana, and Arkansas) was chosen as the forecast area since the data were not available for individual states.

Dependent Variable

The data for total truckload revenue freight of Class I common and contract motor carriers of property operating in intercity service in the Southwestern Region (hereafter referred to as truckload freight) were found in a series of three publications: Motor Carrier Freight Commodity Statistics, Class I Common and Contract Carriers of Property, by the U.S. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, for the years 1957 to 1963; Freight Commodity Statistics, Class I Motor Carriers of Property Operating in Intercity Service--Common and Contract, in the United States, by the U.S. Interstate Commerce Commission, Bureau of Accounts, for the years 1966 to 1967; and Freight Commodity Statistics, Motor Carriers of Property, by the U.S. Interstate Commerce Commission, Bureau of Accounts, for the years 1968 to 1971. Data were not available for the years 1964 and 1965, so these years were estimated by the method described in the analysis section for the estimation of missing values. The truckload freight data are presented in Figure 1 and Table II.

Independent Variables

Data were gathered on thirty other variables. Their complete titles and computer titles are listed in Table III. The variables will be referred to in this report by their computer titles.

The variables APPAREL, CHEMICAL, ELECMACH, FABMETAL, FOOD, LUMBER, METALS, NONELECM, PAPER, PETRCOAL, STCLGLAS, TOTALVAM, and TRANSEQP were all found in two publications: Annual Survey of Manufactures, by the U.S. Department of Commerce, Bureau of the Census, for the years 1957, 1959 to 1962, 1964

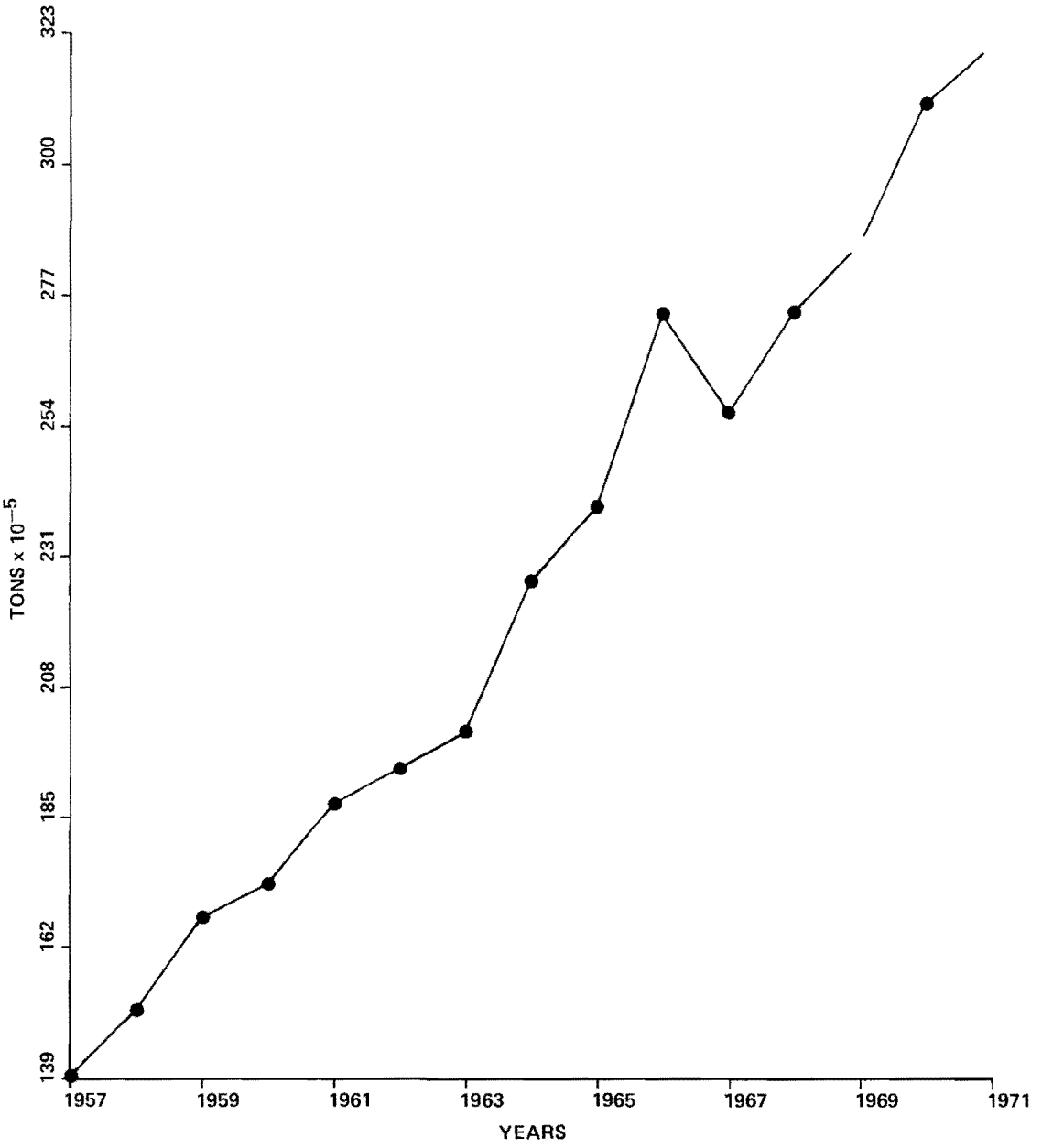

FIGURE 1. TOTAL TRUCKLOAD FREIGHT OF CLASS I COMMON AND CONTRACT MOTOR CARRIERS OF PROPERTY OPERATING IN INTERCITY SERVICE IN THE SOUTHWESTERN REGION

TABLE II. TOTAL TRUCKLOAD FREIGHT OF CLASS I COMMON AND CONTRACT MOTOR CARRIERS OF PROPERTY OPERATING IN INTERCITY SERVICE IN THE SOUTHWESTERN REGION

Year	Tons of Air Cargo
1957	13,943,748
1958	15,100,012
1959	16,737,910
1960	17,329,816
1961	18,750,130
1962	19,384,891
1963	20,024,847
1964*	22,665,720
1965*	23,960,476
1966	27,371,017
1967	25,627,877
1968	27,403,649
1969	28,576,420
1970	31,055,937
1971	32,053,344

*OMNITAB first degree equation estimate.

Sources: U.S. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Motor Carrier Freight Commodity Statistics, Class I Common and Contract Carriers of Property (Washington: Government Printing Office, 1957-63 editions).

U.S. Interstate Commerce Commission, Bureau of Accounts, Freight Commodity Statistics, Class I Motor Carriers of Property Operating in Intercity Service--Common and Contract, in the United States (Washington: Government Printing Office, 1966-67 editions).

U.S. Interstate Commerce Commission, Bureau of Accounts, Freight Commodity Statistics, Motor Carriers of Property (Washington: Government Printing Office, 1968-71 editions).

TABLE III. COMPLETE TITLES AND COMPUTER TITLES OF THE VARIABLES

Complete Titles	Computer Titles
Dependent variable:	
Truckload freight	TRUKLOAD
Independent variables:	
Apparel and related products*	APPAREL
Automobile registrations	AUTOREG
Bus registrations	BUSREG
Cash receipts from farm marketings	FARMREC
Chemical and allied products*	CHEMICAL
Crude oil and products pipeline mileage	PIPELINE
Crude petroleum production	CRUDEPET
Electrical machinery*	ELECMACH
Employees on nonagricultural payrolls	NONAGEMP
Employment in manufacturing industries	MFGEMP
Fabricated metal products*	FABMETAL
Food and kindred products*	FOOD
Lumber and wood products*	LUMBER
Motor vehicle registrations	VEHICLES
Natural gas liquids production	NATGASLQ
Natural gas production	NATGAS
Nonelectrical machinery*	NONELECM
Paper and allied products*	PAPER
Petroleum and coal products*	PETRCOAL
Primary metals*	METALS
Resident population estimates	POPULATN
Sand and gravel production	SANDGRAV
Stone, clay, and glass products*	STCLGLAS
Total gasoline consumption	GASOLINE
Total personal income	INCOME
Total value added by manufacture	TOTALVAM
Tractor-truck registrations	TRATKREG
Transportation equipment*	TRANSEQP
Truck registrations	TRUCKREG
Value of mineral production	MINERAL

*Value added by manufacture

to 1966, and 1968 to 1971; and the Census of Manufactures, volume III, Area Statistics, by the U.S. Department of Commerce, Bureau of the Census, for the years 1958, 1963, and 1967.

The variables CRUDEPET, MINERAL, NATGAS, NATGASLQ, and SANDGRAV were all found in the Minerals Yearbook, volume III, Area Reports, by the U.S. Department of the Interior, Bureau of Mines, for the years 1957 to 1971.

The variables AUTOREG, BUSREG, TRATKREG, TRUCKREG, and VEHICLES were all found in Highway Statistics, Summary to 1965, by the U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, for the years 1957 to 1965. Data for the years 1966 to 1971 were found in Highway Statistics, by the U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads.

Each of the remaining variables came from a different source. The variable GASOLINE was found in Petroleum Facts and Figures, by the American Petroleum Institute, Division of Statistics, for all years. The variable INCOME was taken from the Survey of Current Business, by the U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of Economic Analysis, for all years. The variable POPULATN was found in Current Population Reports, Series P-25, by the U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census, for all years. The variable MFGEMP was taken from an unpublished "Report of Employment," submitted to the U.S. Department of Labor, Bureau of Labor Statistics, Division of Manpower and Employment Statistics, for all years. The variable NONAGEMP was found in Employment and Earnings, States and Areas 1939-1972, Bulletin 1370-10, by the U.S. Department of Labor, Bureau of Labor Statistics, for all years. The variable FARMREC was taken from Farm Income Situation Supplement, Farm Income, State Estimates, by the U.S. Department of Agriculture, Economic Research Service, for all years. The variable PIPELINE was found in Transport Statistics in the United States, Part 6--Oil Pipe Lines, by the U.S. Interstate Commerce Commission, Bureau of Accounts, for all years.

Appendix A contains a table for each independent variable to present the data gathered for the Southwestern Region for the years 1957 to 1971.

CHAPTER III

ANALYSIS

Estimation of Missing Values

Every effort was made to assure the completeness of the 1957 to 1971 series of data for each variable; however, it was not always feasible. When a series was incomplete, the OMNITAB computer program POLYFIT was run on the data available for polynomials of degree n, with n = 1, 2, and 3. The missing value or values for the variable were then estimated by using the polynomial which had the lowest residual standard deviation not predicting a negative number for the missing value or values.

Multiple Regression Analysis

The data were analyzed with the aid of the computer program SPSS (Statistical Package for the Social Sciences), subprogram REGRESSION, using the stepwise mode. Multiple regression analysis (subprogram REGRESSION) allows one to study the linear relationship between a dependent variable (truckload freight) and a set of independent variables (all other variables), taking into consideration the interrelationships among the independent variables. The objective of multiple regression analysis is to formulate a predictor equation that is a linear combination of independent variables and has the highest correlation with the dependent variable. The predictor regression equation takes the form of

$$Y_c = A + B_1X_1 + B_2X_2 + B_3X_3 + \ldots + B_nX_n$$

where the X's are the independent variables, the B's are the regression coefficients, A is a constant, Y_c is the predicted value for the dependent variable, such that Y_c - the actual value = E, the error (or residual) term.

Multiple regression is based on several assumptions: 1) the dependent variable is a normally distributed random variable; 2) the independent variables are mathematical (fixed) and not random; 3) the variance of the estimation of the dependent variable is homoscedastic; 4) the coefficients of the predictor regression equation are maximum likelihood estimators of their respective parameters; and 5) the error (or residual) term is normally distributed and its expected value is zero.[11]

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[11] Charles T. Clark and Laurence L. Schkade, Statistical Methods for Business Decisions (Cincinnati: South-Western Publishing Company, 1969), pp. 624-625.

The stepwise mode on the SPSS multiple regression program first picks the independent variable that best correlates with the dependent variable and then proceeds to pick variables one at a time that provide the best prediction in conjunction with the variables already in the equation. The selection process uses a combination of the normalized regression coefficient value that the prospective variable would have if it were brought into the equation on the next step, as measured by the F statistic, and the tolerance of the prospective variable.

The SPSS stepwise multiple regression program made available a series of regression equations, one for each step in which the program was able to enter another variable before it reached certain preset cutoff values. The equation which had the highest R^2 (the coefficient of determination), the lowest α level for the significance of the coefficients, the lowest coefficient of variability, and the lowest α level for the significance of the regression equation, or the optimal combination of these factors was picked as the predictor regression equation.

Independent Variables Forecast

The variables which were included in the chosen equation were run on the STATPAK computer program TREN and the OMNITAB computer program POLYFIT to fit the base period data, 1957 to 1971, to a first degree polynomial, an exponential curve, and a Gompertz curve (if possible). It should be noted that a second degree polynomial fit and a third degree polynomial fit were not used in the analysis because the time span of 1957 to 1971 was believed to be too short for the results to be meaningful. Extrapolations of the base period data for each curve for each variable were computed for the years 1972 to 1990.

The standard error of estimate was computed for the fit of the two or three curves on the base period data for each of the variables. The standard error of estimate for each curve was divided by the mean of the data for the variable to give the coefficient of variability. The curve which had the smallest coefficient of variability was chosen as the best fit and the extrapolations for that curve were chosen as the forecasts for the variable to be used in the regression equation.

Dependent Variable Forecast

The forecast values for each variable for the year 1975 were substituted into the regression equation to give a forecast for truckload freight for 1975. The same procedure was followed for the years 1980, 1985, and 1990.

CHAPTER IV

RESULTS

The SPSS stepwise multiple regression program, with all variables having the same inclusion level, admitted thirteen steps, the maximum number which could be included given the 15 year time span. Table IV gives the values of R^2, the lowest α level that can be met by all variables for the significance of the coefficients, the coefficient of variability, and the lowest α level for the significance of the regression equation, for each step. The optimal combination of these factors appeared to be step three and step five.

Three-Step Equation

The predictor regression equation from step three (see Tables V and VI) is:

$$\begin{aligned} \text{TRUKLOAD} = {} & 2.68892\ \text{VEHICLES} \\ & - 23{,}168.56286\ \text{LUMBER} \\ & + 4{,}678.01239\ \text{CHEMICAL} \\ & - 5{,}103{,}804.67546 \end{aligned}$$

with $R^2 = 0.98979$, $\alpha_c < 0.025$, $V_{\bar{x}} = 0.0293995$ and $\alpha_{eq} < 0.001$.

Five-Step Equation

The predictor regression equation from step five (see Tables VII and VIII) is:

$$\begin{aligned} \text{TRUKLOAD} = {} & 1.78646\ \text{VEHICLES} \\ & - 19{,}661.33152\ \text{LUMBER} \\ & + 6{,}059.13026\ \text{CHEMICAL} \\ & - 14{,}189.69835\ \text{APPAREL} \\ & + 1.82612\ \text{GASOLINE} \\ & - 11{,}809{,}529.80136 \end{aligned}$$

with $R^2 = 0.99565$, $\alpha_c < 0.025$, $V_{\bar{x}} = 0.0212060$ and $\alpha_{eq} < 0.001$.

TABLE IV. SUMMARY OF OUTPUT FROM THE STEPWISE MODE OF THE SPSS MULTIPLE REGRESSION PROGRAM (Uniform inclusion level)

Step	R^2	α_c	$V_{\bar{x}}$	α_{eq}
1	0.98100	<0.001	0.0368978	<0.001
2	0.98414	<0.500	0.0350901	<0.001
3	0.98979	<0.025	0.0293995	<0.001
4	0.99277	<0.050	0.0259574	<0.001
5	0.99565	<0.025	0.0212060	<0.001
6	0.99719	>0.500	0.0181003	<0.001
7	0.99891	>0.500	0.0120578	<0.001
8	0.99941	>0.500	0.0095674	<0.001
9	0.99961	>0.500	0.0085531	<0.001
10	0.99991	>0.500	0.0045820	<0.001
11	0.99996	>0.500	0.0036898	<0.001
12	0.99999	>0.500	0.0023067	<0.001
13	1.00000	>0.500	0.0002984	<0.001

R^2 = the coefficient of determination
α_c = the lowest α level that can be met by all variables for the significance of the coefficients
$V_{\bar{x}}$ = the coefficient of variability
α_{eq} = the lowest α level for the significance of the regression equation

TABLE V. STEP THREE OF THE SPSS STEPWISE MULTIPLE REGRESSION PROGRAM (Uniform inclusion level)

* MULTIPLE REGRESSION *

DEPENDENT VARIABLE.. TRUKLOAD TRUCKLOAD REVENUE FREIGHT TONS

VARIABLE(S) ENTERED ON STEP NUMBER 3.. CHEMICAL CHEMICAL = ALLIED PROD, VALUE ADDED MFG,

MULTIPLE R	,99488	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	,98979	REGRESSION	3	1,807321984548,00000	869107328182,00000	355,53090
STD DEVIATION	666361,58618	RESIDUAL	11	4884414226106,09375	444037656918,73437	

MEAN RESPONSE 22665727,20000
COEFFICIENT OF VARIABILITY 2,93995 PERCENT

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
VEHICLES	2,68892	,73395	,04228	8,14320
ELASTICITY	1,07088			
LUMBER	-23168,56286	-,42023	8769,45026	6,97997
ELASTICITY	-,36423			
CHEMICAL	4678,81239	,67255	1894,84782	6,09508
ELASTICITY	,51853			
(CONSTANT)	-5183804,67546			

VARIABLES NOT IN THE EQUATION

VARIABLE	PARTIAL	TOLERANCE	F
GASOLINE	,23473	,02888	,58313
PDPULATN	,23922	,01887	,60781
PIPELINE	-,38787	,41633	1,77882
NONAGEMP	-,03606	,02238	,01382
AUTOREG	,28741	,00853	,90844
BUSREG	-,52315	,15141	3,76889
TRUCKREG	-,26240	,00297	,73944
TRATKREG	,16766	,00650	,28923
FARMREC	,13196	,00626	,17722
MINERAL	-,49884	,03836	3,29865
NATGAS	-,12140	,01365	,14959
CRUDEPET	-,35319	,05949	1,42525
MFGEMP	,01596	,05164	,00255
APPAREL	-,53974	,03366	4,11000
NATGASLQ	-,25479	,05993	,69423
INCOME	-,30400	,02997	1,01825
FOOD	-,38853	,02942	1,69324
TOTALVAM	-,15689	,01558	,25237
PETRCOAL	-,00936	,09795	,00088
PAPER	-,20002	,02489	,41673
TRANSEQP	,28184	,10585	,86285
STCLGLAS	,14052	,04006	,20144
METALS	,31007	,05164	1,06368
FABMETAL	-,37625	,04467	1,64911
ELECMACH	-,40107	,01358	1,91690
NONELECM	-,37052	,04506	1,59130
SANDGRAV	,19648	,51848	,40155

TABLE VI. SUMMARY TABLE FOR STEP THREE OF THE SPSS STEPWISE MULTIPLE REGRESSION PROGRAM
(Uniform inclusion level)

* MULTIPLE REGRESSION *

DEPENDENT VARIABLE.. TRUKLOAD TRUCKLOAD REVENUE FREIGHT TONS

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
VEHICLES	MOTOR VEHICLE REGISTRATIONS	,99845	,98100	,98100	,99845	2,68892	,73395
LUMBER	LUMBER + WOOD PRODUCTS VALUE ADDED MFG,	,99204	,98414	,00314	,95735	-23168,56286	-,42823
CHEMICAL	CHEMICAL + ALLIED PROD, VALUE ADDED MFG,	,99488	,98979	,00566	,98980	4678,81239	,67255
(CONSTANT)						-5183804,67546	

FINAL ANALYSIS OF VARIANCE

DUE TO	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	3	2607321984548,00000	869107328182,00000	355,53090
RESIDUAL	11	26884414226186,09375	2444037656918,73437	

STANDARD DEVIATION OF RESIDUALS 666361,50618

TABLE VII. STEP FIVE OF THE SPSS STEPWISE MULTIPLE REGRESSION PROGRAM (Uniform inclusion level)

* MULTIPLE REGRESSION *

DEPENDENT VARIABLE.. TRUKLOAD TRUCKLOAD REVENUE FREIGHT TONS

VARIABLE(S) ENTERED ON STEP NUMBER 5.. GASOLINE TOTAL GASOLINE CONSUMPTION

MULTIPLE R	,99782	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	,99565	REGRESSION	5	412519462798,00000	82503892559,50000	412,43537
STD DEVIATION	480649,64693	RESIDUAL	92	1079216747857,54687	23124083895,28223	

MEAN RESPONSE 22665727,20000
COEFFICIENT OF VARIABILITY 2,12060 PERCENT

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
VEHICLES	1,78646	,48762	,79806	5,00002
ELASTICITY	,71147			
LUMBER	-19661,33152	-,35662	6975,94757	7,94364
ELASTICITY	-,30909			
CHEMICAL	6059,13026	,87111	1432,56108	17,88934
ELASTICITY	,67161			
APPAREL	-14189,69835	-,44356	4282,73825	10,97750
ELASTICITY	-,24348			
GASOLINE	1,82612	,42484	,74656	5,98316
ELASTICITY	,69052			
(CONSTANT)	-11809529,80136			

VARIABLES NOT IN THE EQUATION

VARIABLE	PARTIAL	TOLERANCE	F
POPULATN	,38479	,01261	,81929
PIPELINE	-,17769	,10949	,26881
NONAGEMP	,01472	,01053	,00173
AUTOREG	-,04453	,00086	,01589
BUSREG	-,19838	,04482	,32775
TRUCKREG	,07476	,00833	,04497
TRAILREG	,59364	,05255	4,35348
FARMREG	,29534	,07930	,76449
MINERAL	-,23303	,08545	,45938
NATGAS	,41798	,00782	1,69273
CRUDEPET	-,89665	,02626	,87544
MFGEMP	,07951	,03449	,05090
NATGASLQ	,14263	,03910	,16613
INCOME	,05479	,00387	,02409
FOOD	,14978	,00427	,18360
TOTALVAM	,09988	,00465	,08062
PETRCOAL	,02102	,09358	,00354
PAPER	,43690	,00591	1,88728
TRANSEQP	,17626	,00657	,25651
STCLGLAS	,33046	,03816	,98075
METALS	,08103	,04366	,05287
FABMETAL	-,28234	,00388	,69294
ELECMACH	,03567	,00427	,01019
NONELECM	-,15847	,01895	,20609
SANDGRAV	,13252	,48263	,14301

TABLE VIII. SUMMARY TABLE FOR STEP FIVE OF THE SPSS STEPWISE MULTIPLE REGRESSION PROGRAM
(Uniform inclusion level)

* M U L T I P L E R E G R E S S I O N *

DEPENDENT VARIABLE.. TRUKLOAD TRUCKLOAD REVENUE FREIGHT TONS

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
VEHICLES	MOTOR VEHICLE REGISTRATIONS	,99045	,98100	,98100	,99045	1,78646	,48762
LUMBER	LUMBER = WOOD PRODUCTS VALUE ADDED MFG.	,99204	,98414	,00314	,95735	-19661,33152	-,35662
CHEMICAL	CHEMICAL = ALLIED PROD. VALUE ADDED MFG.	,99488	,98979	,00566	,98908	6859,13826	,87111
APPAREL	APPAREL-RELATED PRODUCTS VALUE ADDED MFG	,99638	,99277	,00297	,95469	-14189,60835	-,44356
GASOLINE	TOTAL GASOLINE CONSUMPTION	,99782	,99565	,00289	,97924	1,82612	,42484
(CONSTANT)						-11809529,88136	

FINAL ANALYSIS OF VARIANCE

DUE TO	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	5	412519462798,00000	82503892559,50000	412,43537
RESIDUAL	92	79216747857,54687	231024083095,28223	

STANDARD DEVIATION OF RESIDUALS 480649,64693

Forecast of the Independent Variables

The five variables from the predictor regression equation were run on the STATPAK program TREN and the OMNITAB program POLYFIT to fit a first degree polynomial, an exponential curve,and a Gompertz curve (if possible). The computer was only able to fit a Gompertz curve to the data from variables VEHICLES and CHEMICAL. Extrapolations of the two or three curves for each of the five chosen variables were computed. The coefficient of variability was computed for each curve and the extrapolation for the curve which had the smallest coefficient of variability was chosen as the forecast for that variable. Table IX contains the forecast values for the five variables for the years 1975, 1980, 1985, and 1990.

Forecast of the Dependent Variable

These forecast values for each variable for each year were substituted into the two regression equations to produce a forecast for truckload freight for the years 1975, 1980, 1985, and 1990. Table X presents the truckload freight forecast values and Figure 2 presents a graph of the forecasts along with the base period data.

Confirmation of the Dependent Variable Forecast

Inspection of the forecasts revealed a large divergence so it seemed desirable to formulate another regression equation to corroborate the results of either the three-step or the five-step equation.

VEHICLES, total vehicle registrations, is a composite variable including AUTOREG (auto registrations), BUSREG (bus registrations), and TRUCKREG (truck registrations). The variable VEHICLES was observed to have lost its significance in the regression equations (the α_c level became greater than 0.500) after the fifth step, when all variables had the same inclusion level. The SPSS stepwise multiple regression program was therefore run with all variables having an inclusion level of 3, except AUTOREG, BUSREG, TRUCKREG, and VEHICLES, which were given an inclusion level of 1. (It should be noted that higher inclusion level variables will be included in the regression equation before lower inclusion level variables.) The analysis followed for this set of variables parallels the first analysis.

The SPSS stepwise multiple regression program again included thirteen steps. Table XI gives the values for R^2, the lowest α level that can be met by all variables for the significance of the coefficients, the coefficient of variability, and the lowest α level for the significance of the regression equation, for each step. Step four appeared to have the optimal combination of these factors.

TABLE IX. FORECASTS FOR THE INDEPENDENT VARIABLES IN THE REGRESSION EQUATIONS (Uniform inclusion level)

Independent Variable	Tons Year 1975	Year 1980	Year 1985	Year 1990	Type of Curve
VEHICLES	13,351,600.0	15,516,100.0	17,734,300.0	19,972,100.0	Gompertz
LUMBER	789.9	1,143.7	1,655.9	2,397.6	Exponential
CHEMICAL	5,504.2	8,046.9	11,764.3	17,199.0	Exponential
APPAREL	1,087.7	1,814.6	3,027.2	5,050.3	Exponential
GASOLINE	12,513,600.0	14,927,500.0	17,806,900.0	21,241,800.0	Exponential

TABLE X. TRUCKLOAD FREIGHT FORECASTS (Uniform inclusion level)

Year	Tons Three-step Equation	Five-step Equation
1975	38,245,448	37,279,949
1980	47,663,359	43,690,692
1985	59,251,027	48,158,796
1990	73,507,763	48,068,643

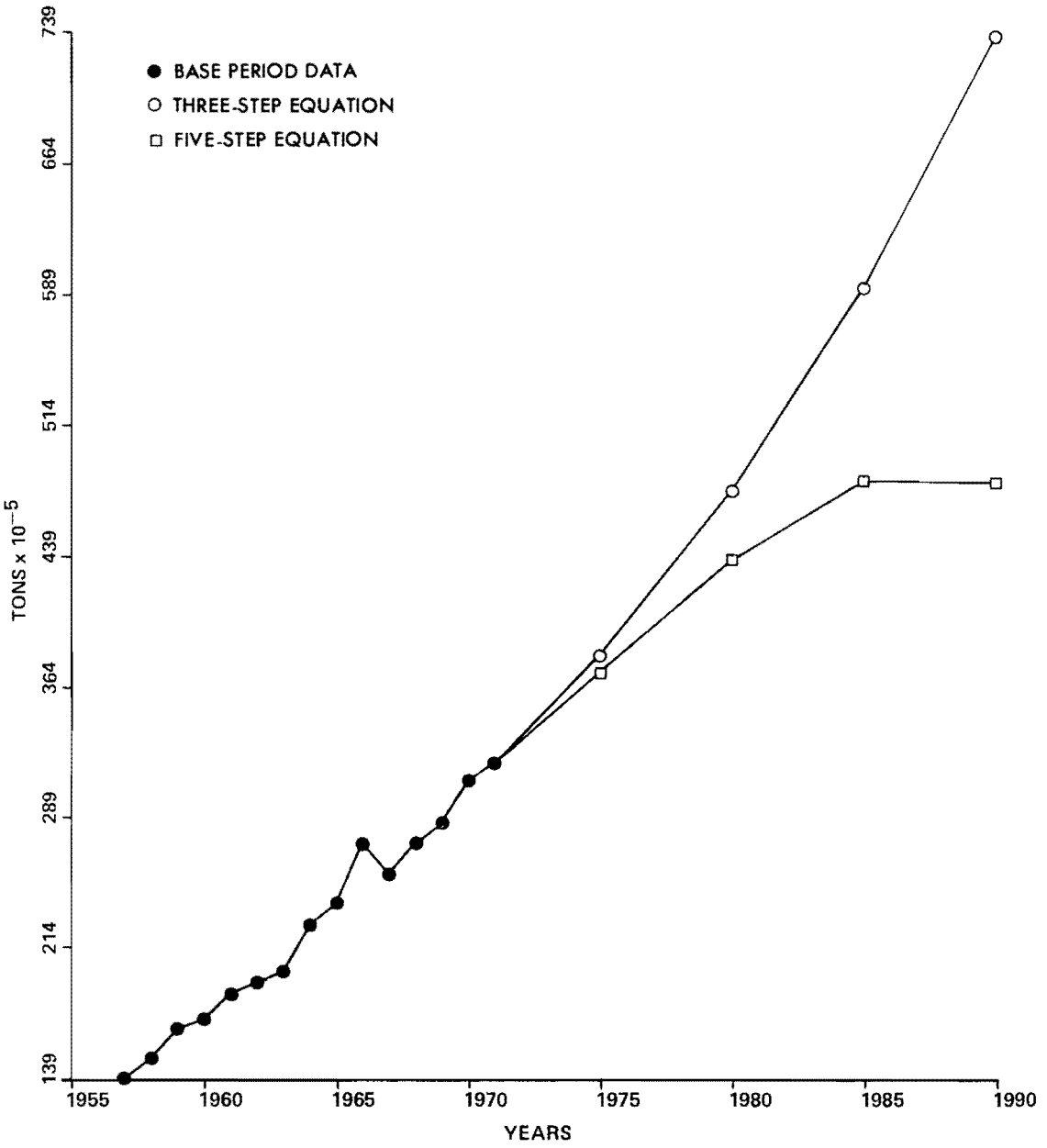

FIGURE 2. TRUCKLOAD FREIGHT FORECASTS (Uniform inclusion level)

TABLE XI. SUMMARY OF OUTPUT FROM THE STEPWISE MODE OF THE SPSS MULTIPLE REGRESSION PROGRAM (Mixed inclusion levels)

Step	R^2	α_c	$V_{\bar{x}}$	α_{eq}
1	0.97812	<0.001	0.0395888	<0.001
2	0.98562	<0.025	0.0334137	<0.001
3	0.98936	<0.050	0.0300208	<0.001
4	0.99403	<0.005	0.0235709	<0.001
5	0.99665	<0.500	0.0186167	<0.001
6	0.99817	<0.500	0.0145898	<0.001
7	0.99839	>0.500	0.0146143	<0.001
8	0.99880	<0.500	0.0136335	<0.001
9	0.99939	>0.500	0.0106254	<0.001
10	0.99976	>0.500	0.0074159	<0.001
11	1.00000	<0.050	0.0007935	<0.001
12	1.00000	<0.500	0.0001441	<0.001
13	1.00000	<0.500	0.0000383	<0.001

R^2 = the coefficient of determination
α_c = the lowest α level that can be met by all variables for the significance of the coefficients
$V_{\bar{x}}$ = the coefficient of variability
α_{eq} = the lowest α level for the significance of the regression equation

Four-Step Equation

The predictor regression equation from step four (see Tables XII and XIII) is:

$$\begin{aligned} \text{TRUKLOAD} = {} & 4{,}985.45897 \ \text{CHEMICAL} \\ & + 2{,}323.73557 \ \text{POPULATN} \\ & - 24{,}439.82163 \ \text{LUMBER} \\ & + 8{,}593.57920 \ \text{METALS} \\ & - 28{,}796{,}494.49892 \end{aligned}$$

with $R^2 = 0.99403$, $\alpha_c < 0.005$, $V_{\bar{x}} = 0.0235709$, and $\alpha_{eq} < 0.001$.

The forecasts for the four independent variables for the years 1975, 1980, 1985, and 1990 are presented in Table XIV. Table XV contains the truckload freight forecast and Figure 3 presents a graph comparing this forecast with the two original forecasts.

TABLE XII. STEP FOUR OF THE SPSS STEPWISE MULTIPLE REGRESSION PROGRAM (Mixed inclusion levels)

* M U L T I P L E R E G R E S S I O N *

DEPENDENT VARIABLE.. TRUKLOAD TRUCKLOAD REVENUE FREIGHT TONS

VARIABLE(S) ENTERED ON STEP NUMBER 4.. METALS

MULTIPLE R	,99701	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	,99403	REGRESSION	4	4637498583178,08008	909374645794,50000	416,60643
STD DEVIATION	534250,65536	RESIDUAL	10	28504237627476,06250	2854237627476,60547	

MEAN RESPONSE 22665727,20000
COEFFICIENT OF VARIABILITY 2,35709 PERCENT

---------- VARIABLES IN THE EQUATION ----------

VARIABLE	B	BETA	STD ERROR B	F
CHEMICAL	4985,45897	,71675	1271,63589	15,37040
ELASTICITY	,55260			
POPULATN	2323,73557	,42709	585,44961	15,75413
ELASTICITY	1,84829			
LUMBER	-24439,82163	-,44329	7350,66371	11,05460
ELASTICITY	-,38422			
METALS	8593,57920	,30899	3068,48606	7,84373
ELASTICITY	,26181			
(CONSTANT)	-28796494,49892			

---------- VARIABLES NOT IN THE EQUATION ----------

VARIABLE	PARTIAL	TOLERANCE	F
GASOLINE	,36172	,02216	1,35486
PIPELINE	-,23148	,34884	,58954
NONAGEMP	-,11907	,01433	,12944
AUTOREG	-,20805	,00246	,82919
BUSREG	-,15073	,09137	,20922
TRUCKREG	-,07868	,00616	,04518
VEHICLES	-,22875	,00277	,49693
TRATKREG	,29306	,03760	,84557
FARMREC	,43147	,05875	2,05877
MINERAL	-,30740	,03757	,93920
NATGAS	-,01586	,01470	,00226
CRUDEPET	-,36296	,05038	1,36553
MFGEMP	-,11477	,02843	,12013
APPAREL	-,26425	,03145	,67565
NATGASLQ	-,46785	,06114	2,52203
INCOME	-,04299	,02982	,01667
FOOD	-,08646	,07822	,06778
TOTALVAM	-,13164	,01386	,15871
PETRCOAL	-,66224	,04091	7,03042
PAPER	,08986	,02301	,07326
TRANSEQP	,31441	,05683	,98731
STCLGLAS	,49942	,02723	2,99869
FABMETAL	-,08759	,03936	,06958
ELECMACH	-,19418	,01470	,35265
NONELECM	-,22339	,03746	,47231
SANDGRAV	,31231	,50374	,97269

TABLE XIII. SUMMARY TABLE FOR STEP FOUR OF THE SPSS STEPWISE MULTIPLE REGRESSION PROGRAM (Mixed inclusion levels)

* M U L T I P L E R E G R E S S I O N *

DEPENDENT VARIABLE.. TRUKLOAD TRUCKLOAD REVENUE FREIGHT TONS

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
CHEMICAL	CHEMICAL - ALLIED PROD. VALUE ADDED MFG.	.98900	.97812	.97812	.98900	4985.45897	.71675
POPULATN	RESIDENT POPULATION ESTIMATES	.99278	.98562	.00749	.98204	2323.73557	.42709
LUMBER	LUMBER - WOOD PRODUCTS VALUE ADDED MFG.	.99466	.98936	.00374	.95735	-24439.82163	-.44329
METALS	PRIMARY METALS VALUE ADDED MFG.	.99701	.99403	.00468	.96394	8593.57920	.30099
(CONSTANT)						-28796494.49892	

FINAL ANALYSIS OF VARIANCE

DUE TO	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	4	637498583178.00000	909374645794.50000	416.60643
RESIDUAL	10	2854237627476.06250	285423762747.60547	

STANDARD DEVIATION OF RESIDUALS 534250.65536

TABLE XIV. FORECASTS FOR THE INDEPENDENT VARIABLES IN THE REGRESSION EQUATION (Mixed inclusion levels)

Independent Variable	Tons				Type of Curve
	Year 1975	Year 1980	Year 1985	Year 1990	
CHEMICAL	5,504.2	8,046.9	11,764.3	17,199.0	Exponential
POPULATN	20,631.0	21,845.0	23,059.0	24,274.0	First degree
LUMBER	789.9	1,143.7	1,655.9	2,397.6	Exponential
METALS	1,223.4	1,468.8	1,695.3	1,897.3	Gompertz

TABLE XV. TRUCKLOAD FREIGHT FORECAST (Mixed inclusion levels)

Year	Tons
	Four-step Equation
1975	37,793,827
1980	46,753,424
1985	57,535,753
1990	71,062,453

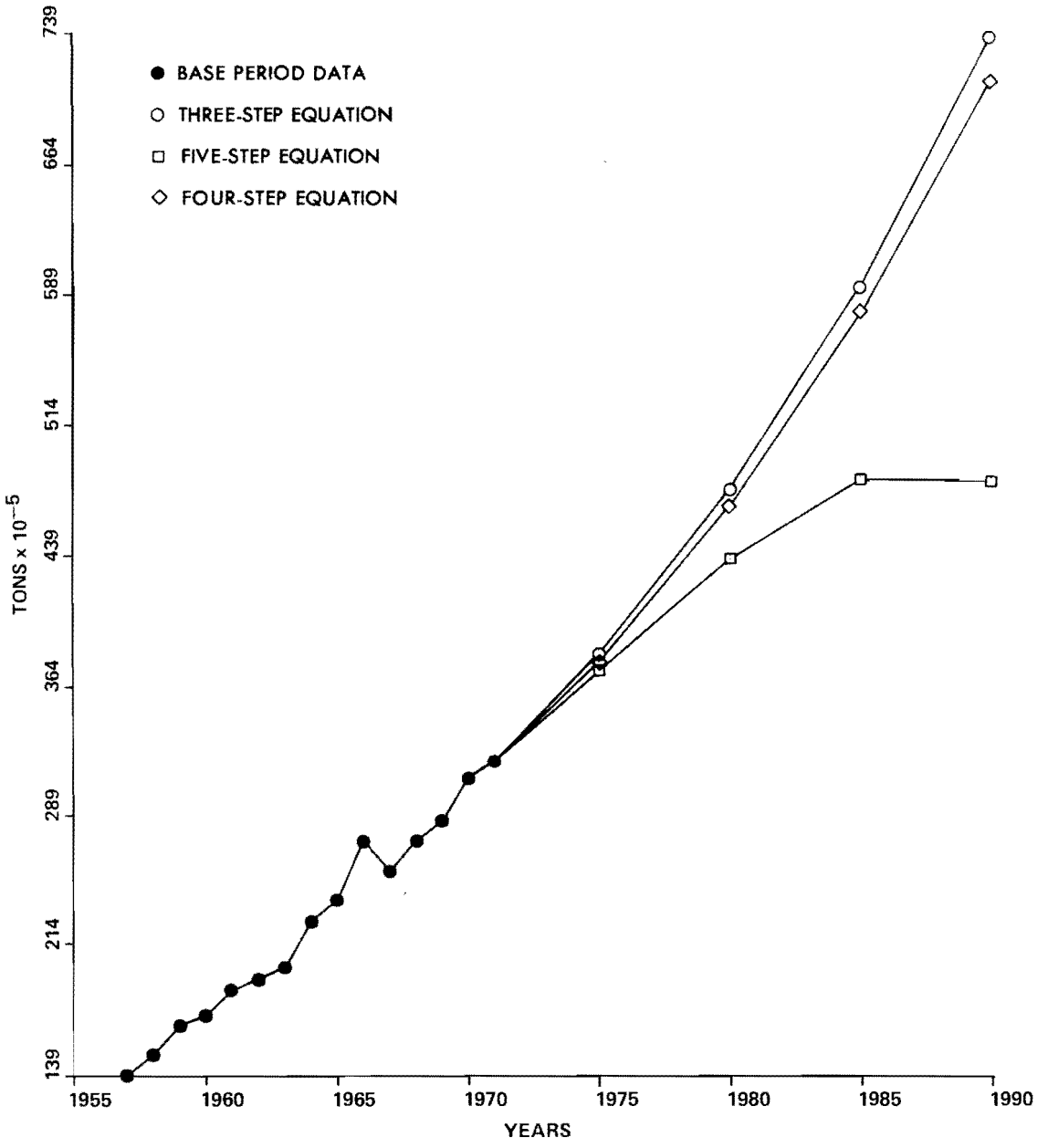

FIGURE 3. COMPARISON OF TRUCKLOAD FREIGHT FORECASTS

CHAPTER V

DISCUSSION

Results of the four-step equation (mixed inclusion levels) are a very close approximation of the results of the three-step equation (uniform inclusion level). However, before determining the best predictor regression equation, it is important to discuss the multicollinearity problem, the truckload freight extrapolations, and the 1972 U.S. Department of Transportation projections.

Multicollinearity

The data gathered for each variable form a time series, and in this type of data, the variables are often highly correlated with time and, hence, with each other. This results in little independent variation among the variables, which makes the determination of the separate effects of each variable difficult.[12] This problem of multicollinearity is indicated by the values on the matrix of correlation coefficients, Table XVI, and by the extremely high value of R^2 for the predictor regression equations, with the first variable entered into the equation alone explaining approximately 98 percent of the variation in the dependent variable.

When the problem of multicollinearity exists multiple regression analysis can be used for predictive purposes if the independent variables chosen for the regression equation are not subject to extreme observations and if the pattern of intercorrelations that produced the base period data continues in the future.[13]

The data for the seven independent variables chosen for the three regression equations are presented in Appendix B. An examination of these graphs indicates that there were no extreme observations and that the pattern of intercorrelations has been sustained for a sufficiently long time to indicate that it is likely to continue in the future.

Truckload Freight Extrapolations

The base period (1957 to 1971) data were fit to a first degree polynomial, an exponential curve, and a Gompertz curve. The coefficient of variability for each curve was computed, indicating that the Gompertz curve provided the best fit ($V_{\bar{x}} = 0.039$). Table XVII and Figure 4 present the truckload freight extrapolations.

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[12]Mahlon R. Straszheim, The International Airline Industry (Washington: Brookings Institution, 1969), p. 125.

[13]Ibid., p. 274.

TABLE XVI. CORRELATION COEFFICIENTS

A VALUE OF 99,00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.

	TRUKLOAD	GASOLINE	POPULATN	PIPELINE	NONAGEMP	AUTOREG	BUSREG	TRUCKREG	VEHICLES	TRATKREG	FARMREC
TRUKLOAD	1,00000	,97924	,98204	,71934	,97187	,99028	,87673	,98766	,99045	,95585	,94877
GASOLINE	,97924	1,00000	,96285	,78745	,99270	,98501	,89543	,99386	,98828	,91192	,94263
POPULATN	,98204	,96285	1,00000	,67423	,95136	,98955	,85947	,97911	,98746	,97047	,94870
PIPELINE	,71934	,78745	,67423	1,00000	,80685	,72503	,86105	,77565	,74074	,61957	,72751
NONAGEMP	,97187	,99270	,95136	,80685	1,00000	,98182	,88055	,99058	,98524	,98029	,92455
AUTOREG	,99028	,98501	,98955	,72503	,98182	1,00000	,87466	,99543	,99960	,95341	,93712
BUSREG	,87673	,89543	,85947	,86105	,88055	,87466	1,00000	,98756	,88552	,85728	,92199
TRUCKREG	,98766	,99386	,97911	,77565	,99058	,99543	,98756	1,00000	,99773	,94402	,95206
VEHICLES	,99045	,98828	,98746	,74074	,98524	,99960	,88552	,99773	1,00000	,95169	,94251
TRATKREG	,95585	,91192	,97847	,61957	,98029	,95341	,85728	,94402	,95169	1,00000	,92981
FARMREC	,94877	,94263	,94870	,72751	,92455	,93712	,92199	,95206	,94251	,92981	1,00000
MINERAL	,95958	,98184	,94680	,85661	,98439	,96977	,94545	,98695	,97581	,98998	,94354
NATGAS	,98193	,98793	,97834	,79058	,98663	,98912	,91347	,99656	,99226	,94571	,96237
CRUDEPET	,95026	,97584	,92908	,86226	,98932	,96426	,89774	,97728	,96898	,87961	,89761
MFGEMP	,94644	,97798	,92467	,80535	,99359	,96215	,83798	,97142	,96561	,86248	,89156
APPAREL	,95469	,98229	,94265	,83565	,98563	,97005	,93532	,98666	,97598	,91154	,94254
NATGASLQ	,93838	,95797	,93838	,78187	,97015	,96085	,84763	,96195	,96284	,87198	,87953
INCOME	,96592	,98855	,95008	,84818	,98829	,97315	,93809	,99048	,97928	,91353	,95646
FOOD	,96937	,98513	,95882	,83209	,98141	,97583	,94891	,99116	,98135	,92786	,96334
TOTALVAM	,97284	,99378	,95703	,80972	,99873	,98446	,89563	,99404	,98816	,91165	,93388
CHEMICAL	,98908	,98406	,97263	,75771	,98248	,99033	,90831	,99497	,99266	,95064	,95388
PETRCOAL	,89584	,92409	,89622	,73937	,94658	,92535	,73609	,91873	,92486	,88257	,79212
LUMBER	,95735	,97874	,95227	,73446	,98106	,97569	,86186	,98126	,97838	,92887	,92435
PAPER	,96682	,98669	,94821	,82668	,98927	,97327	,92385	,98954	,97897	,91896	,95356
TRANSEQP	,91580	,94618	,88256	,73969	,96362	,92811	,76015	,93360	,93831	,82474	,83647
STCLGLAS	,96781	,97348	,96616	,72655	,95875	,97235	,90587	,97962	,97546	,95020	,97395
METALS	,96394	,97258	,93011	,74569	,98529	,96863	,81688	,96933	,96958	,87655	,88040
FABMETAL	,95635	,98328	,93357	,85086	,98173	,96389	,94888	,98329	,97881	,89531	,95026
ELECMACH	,98884	,98783	,97585	,79765	,98383	,98822	,93021	,99629	,99160	,94223	,96266
NONELECM	,94676	,97791	,92557	,85787	,98932	,96053	,90834	,97986	,96684	,88648	,91764
SANDGRAV	,68382	,70782	,64481	,42568	,68919	,68546	,55742	,68358	,68537	,61825	,68539

TABLE XVI. (Continued)

	MINERAL	NATGAS	CRUDEPET	MFGEMP	APPAREL	NATGASLQ	INCOME	FOOD	TOTALVAM	CHEMICAL
TRUKLOAD	,95950	,98193	,95026	,94604	,95469	,93830	,96592	,96937	,97284	,98980
GASOLINE	,98184	,98793	,97584	,97798	,98229	,95797	,98855	,98513	,99370	,98406
POPULATN	,94600	,97834	,92908	,92467	,94265	,93838	,95008	,95882	,95703	,97263
PIPELINE	,85661	,79058	,86226	,80535	,83565	,78187	,84010	,83209	,80972	,75771
NONAGEMP	,98439	,98663	,98932	,99359	,98563	,97015	,98829	,98141	,99873	,98248
AUTOREG	,96977	,98912	,96426	,96215	,97005	,96085	,97315	,97583	,98446	,99033
BUSREG	,94585	,91347	,89774	,83790	,93532	,84763	,93809	,94891	,89563	,90631
TRUCKREG	,98695	,99656	,97728	,97142	,98666	,96195	,99048	,99116	,99404	,99497
VEHICLES	,97581	,99226	,96898	,96561	,97590	,96204	,97920	,98135	,98816	,99266
TRATKREG	,98998	,94571	,87961	,86240	,91154	,87190	,91353	,92786	,91165	,95064
FARMREC	,94354	,96237	,89761	,89156	,94254	,87953	,95646	,96334	,93388	,95388
MINERAL	1,00000	,98803	,98736	,96533	,99548	,95706	,99691	,99658	,98925	,98012
NATBAS	,98803	1,00000	,97396	,96872	,98704	,96020	,99263	,99380	,99148	,98967
CRUDEPET	,98736	,97396	1,00000	,98327	,98304	,96938	,98203	,97724	,98843	,96541
MFGEMP	,96533	,96872	,98327	1,00000	,96965	,96749	,97150	,95917	,98899	,95812
APPAREL	,99548	,98704	,98304	,96965	1,00000	,95746	,99556	,99441	,99134	,97957
NATGASLQ	,95706	,96020	,96938	,96749	,95746	1,00000	,95333	,95164	,96914	,94093
INCOME	,99691	,99263	,98203	,97150	,99556	,95333	1,00000	,99778	,99282	,98380
FOOD	,99658	,99380	,97724	,95917	,99441	,95164	,99778	1,00000	,98800	,98464
TOTALVAM	,98925	,99148	,98843	,98899	,99134	,96914	,99282	,98800	1,00000	,98650
CHEMICAL	,98012	,98967	,96541	,95812	,97957	,94093	,98380	,98464	,98650	1,00000
PETRCOAL	,90711	,91208	,94452	,95868	,90602	,96668	,90188	,89258	,93916	,89613
LUMBER	,96618	,97688	,95545	,96858	,97656	,93833	,97354	,96738	,98498	,98068
PAPER	,99143	,99212	,97953	,97563	,99498	,94723	,99715	,99386	,99383	,98492
TRANSEQP	,91158	,92629	,94435	,98176	,92289	,92209	,92663	,90795	,95516	,91972
STCLGLAS	,96223	,98265	,93125	,93333	,97027	,92793	,97342	,97700	,96799	,97626
METALS	,94980	,95663	,96792	,98224	,95189	,95685	,95398	,94382	,97963	,94874
FABMETAL	,99398	,98294	,97773	,96324	,99411	,95211	,99615	,99436	,98669	,97709
ELECMACH	,99150	,99653	,97424	,95920	,98957	,95717	,99259	,99665	,98985	,99101
NONELECM	,98911	,97941	,98942	,98295	,98910	,94634	,99073	,98260	,99108	,97220
SANDGRAV	,63934	,67027	,64384	,68857	,67854	,69410	,66381	,66087	,68598	,67496

TABLE XVI. (Continued)

	PETRCOAL	LUMBER	PAPER	TRANSEQP	STCLGLAS	METALS	FABMETAL	ELECMACH	NONELECM	SANDGRAV
TRUKLOAD	,89584	,95735	,96682	,91580	,96701	,96394	,95635	,98084	,94676	,68302
GABOLINE	,92409	,97874	,98669	,94618	,97348	,97258	,98328	,98783	,97791	,70702
POPULATN	,89622	,95227	,94821	,88256	,96616	,93011	,93357	,97585	,92557	,64401
PIPELINE	,73937	,73446	,82668	,73969	,72655	,74569	,85006	,79765	,85787	,42560
NONAGEMP	,94658	,98106	,98927	,96362	,95875	,98529	,98173	,98303	,98932	,68919
AUTOREG	,92535	,97589	,97327	,92811	,97235	,96863	,96309	,98822	,96053	,68546
BUSREG	,73699	,86186	,92305	,76015	,90587	,81608	,94888	,93021	,90834	,55742
TRUCKREG	,91873	,98126	,98958	,93360	,97962	,96933	,98329	,99629	,97986	,68350
VEHICLES	,92406	,97830	,97897	,93031	,97546	,96958	,97801	,99168	,96684	,68537
TRATKREG	,88257	,92087	,91896	,82474	,95028	,87655	,89531	,94223	,88648	,61825
FARMREC	,79212	,92435	,95356	,83647	,97395	,88048	,95826	,96266	,91764	,68539
MINERAL	,90711	,96618	,99143	,91158	,96223	,94988	,99398	,99158	,98911	,63934
NATGAS	,91288	,97688	,99212	,92629	,98265	,95663	,98294	,99653	,97941	,67827
CRUDEPET	,94452	,95545	,97953	,94435	,93125	,96792	,97773	,97424	,98942	,64384
NFBEMP	,95868	,96858	,97563	,98176	,93333	,98224	,96324	,95920	,98295	,68857
APPAREL	,98602	,97656	,99498	,92289	,97027	,95189	,99411	,98957	,98918	,67854
NATGASLQ	,96668	,93833	,94723	,92209	,92793	,95685	,95211	,95717	,94634	,69418
INCOME	,98188	,97354	,99715	,92663	,97342	,95398	,99615	,99259	,99873	,66381
FOOD	,89258	,96738	,99386	,98795	,97700	,94382	,99436	,99665	,98260	,66887
TOTALVAM	,93916	,98498	,99383	,95516	,96799	,97963	,98669	,98905	,99188	,68598
CHEMICAL	,89613	,98868	,98492	,91972	,97626	,96874	,97709	,99181	,97220	,67496
PETRCOAL	1,00000	,91562	,90188	,92859	,85728	,95354	,88950	,90565	,91585	,61231
LUMBER	,91562	1,00000	,97976	,93955	,97174	,96694	,96304	,97262	,97272	,68594
PAPER	,90188	,97976	1,00000	,93938	,97488	,95808	,99135	,98955	,99221	,67636
TRANSEQP	,92859	,93955	,93938	1,00000	,89221	,96469	,91534	,90826	,95051	,69158
STCLGLAS	,85728	,97174	,97488	,89221	1,00000	,92708	,96846	,98058	,94775	,74471
METALS	,95354	,96694	,95808	,96469	,92708	1,00000	,94872	,95265	,96074	,78150
FABMETAL	,88950	,96304	,99135	,91534	,96846	,94872	1,00000	,98699	,98414	,69849
ELECMACH	,90565	,97262	,98955	,90826	,98058	,95265	,98699	1,00000	,97540	,67153
NONELECM	,91585	,97272	,99221	,95851	,94775	,96074	,98414	,97540	1,00000	,63654
SANDGRAV	,61231	,68594	,67636	,69158	,74471	,78150	,69849	,67153	,63654	1,00000

TABLE XVII. TRUCKLOAD FREIGHT EXTRAPOLATIONS

Type of Curve	Tons				Coefficient of Variability
	Year 1975	Year 1980	Year 1985	Year 1990	
First degree	36,908,000	43,381,800	49,855,600	56,329,400	0.041
Exponential	41,911,700	56,240,000	75,466,700	101,266,000	0.042
Gompertz	36,122,200	41,490,700	46,149,000	50,078,500	0.039

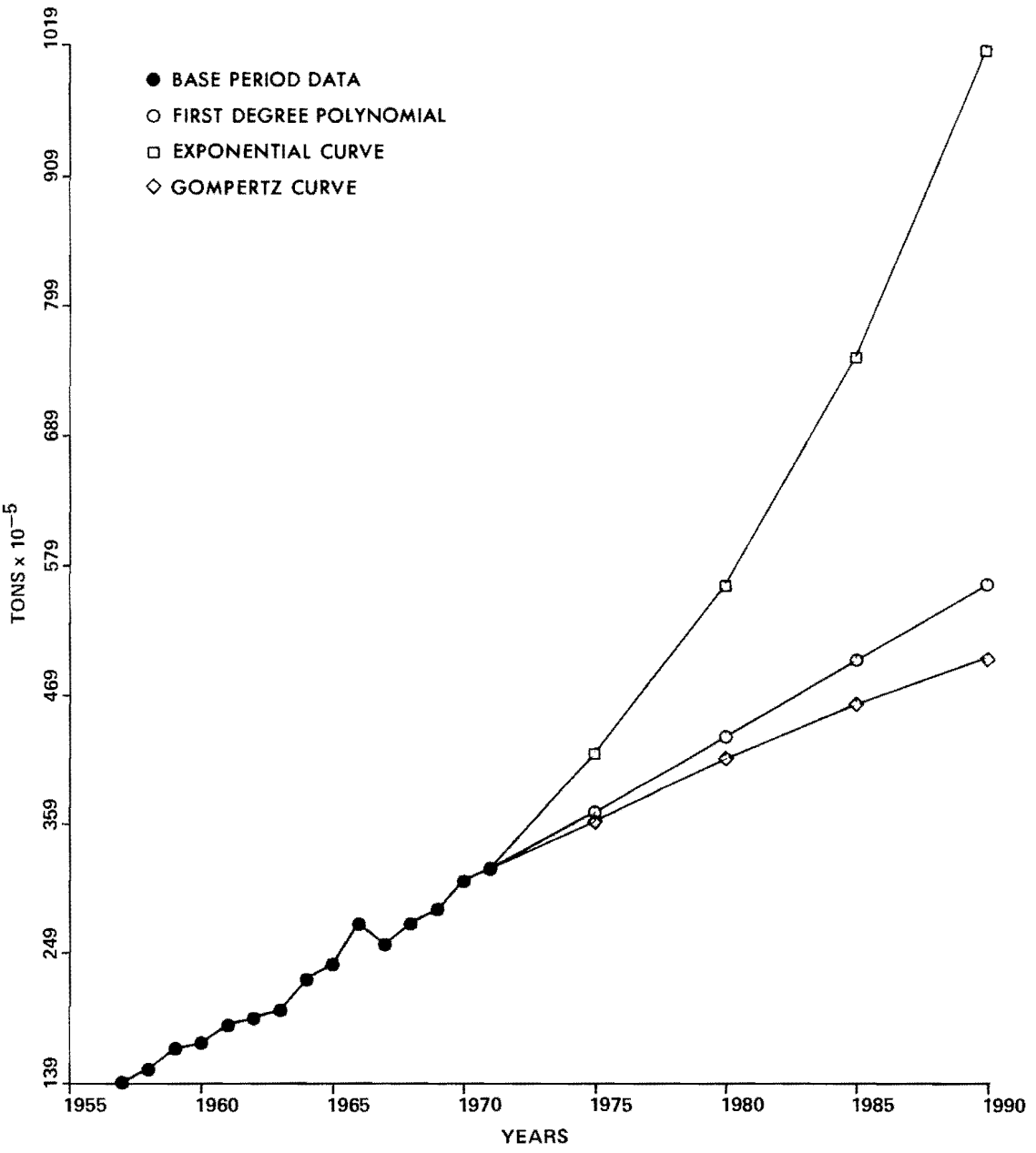

FIGURE 4. TRUCKLOAD FREIGHT EXTRAPOLATIONS

U.S. Department of Transportation Projection

In 1972 the U.S. Department of Transportation projected that the U.S. annual growth rate for "Trucks for Hire--Intercity" would be 5.5 percent from 1970 to 1980 and 3.5 percent from 1980 to 1990.[14] Beginning with the most recent data (1971), these percentages were applied to calculate projections for 1975, 1980, 1985, and 1990, which are presented in Table XVIII. An interesting comparison among the truckload freight forecasts, extrapolation, and projection is presented in Figure 5.

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[14]U.S. Department of Transportation, 1972 National Transportation Report: Present Status--Future Alternatives (Washington: Government Printing Office, 1972), p. 97.

TABLE XVIII. PROJECTION FOR THE SOUTHWESTERN REGION DERIVED FROM U.S. DEPARTMENT OF TRANSPORTATION NATIONAL PERCENTAGE INCREASE ESTIMATES*

Year	Tons
1975	39,708,473
1980	51,897,386
1985	61,637,814
1990	73,206,388

*Calculated for the Southwestern Region using 1971 as the base year and the U.S. Department of Transportation U.S. projections for "Trucks for Hire--Intercity": 1970-1980, 5.5 percent increase; 1980-1990, 3.5 percent increase.

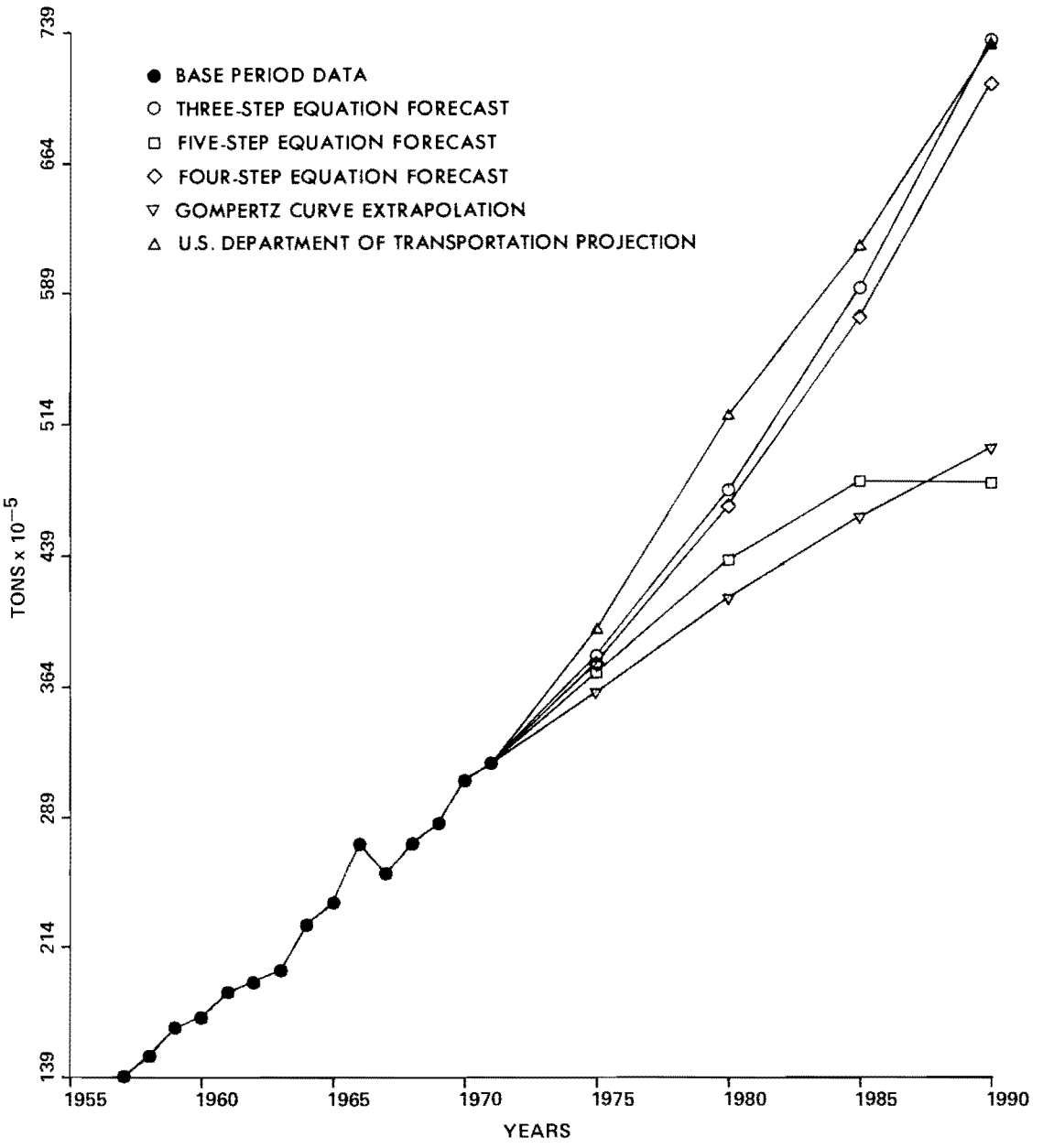

FIGURE 5. COMPARISON OF TRUCKLOAD FREIGHT EXTRAPOLATION, PROJECTION, AND FORECASTS

CHAPTER VI

CONCLUSION

The four-step equation (mixed inclusion levels) was formulated to corroborate either the three-step equation (uniform inclusion level) or the five-step equation (uniform inclusion level). The four-step equation prediction of 71 million tons of truckload freight closely approximates the prediction of 73.5 million tons for the three-step equation as compared with the wide variation indicated by the 48 million tons predicted by the five-step equation. The U.S. Department of Transportation projection further substantiates the three-step equation. The best extrapolation, the Gompertz curve, was not considered as support for the five-step equation because its coefficient of variability was greater than that of the other three: $V_{\bar{x}} = 0.039$ as compared with $V_{\bar{x}} = 0.021$ to 0.029.

The model assumes that there will be no national policy changes regarding the allocation of fuel; no constraints were put on the trend of fuel consumption. If at some time in the near future this assumption does not hold true, then a prediction on the order of the five-step equation might be appropriate. A further assumption is that there will be no drastic shift to private carriage or to other modes.

The independent variables of the three-step predictor regression equation (uniform inclusion level) will explain 98.98 percent of the variation in the dependent variable, truckload freight, at a significance level of $\alpha<0.025$ for the coefficients and $\alpha<0.001$ for the regression equation, with a coefficient of variability of 0.0293995.

The independent variables of the four-step predictor regression equation (mixed inclusion levels) will explain 99.4 percent of the variation in the dependent variable, truckload freight, at a significance level of $\alpha<0.005$ for the coefficients and $\alpha<0.001$ for the regression equation with a coefficient of variability of 0.0235709.

The four-step equation (mixed inclusion levels) was chosen as the best predictor regression equation because of its lower significance level for the coefficients, its lower coefficient of variability, and its higher value of R^2. The chosen predictor regression equation is:

$$\begin{aligned} \text{TRUKLOAD} = {} & 4{,}985.45897 \quad \text{CHEMICAL} \\ & + 2{,}323.73557 \quad \text{POPULATN} \\ & - 24{,}439.82163 \quad \text{LUMBER} \\ & + 8{,}593.57920 \quad \text{METALS} \\ & - 28{,}796{,}494.49892 \end{aligned}$$

with $R^2 = 0.99403$, $\alpha_c<0.005$, $V_{\bar{x}} = 0.0235709$, and $\alpha_{eq}<0.001$.

The forecasts for total truckload revenue freight of Class I common and contract motor carriers of property operating in intercity service in the Southwestern Region are:

Year	Tons
1975	37,793,827
1980	46,753,424
1985	57,535,753
1990	71,062,453

APPENDIX A

TABLE A-I. APPAREL AND RELATED PRODUCTS VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	200.0
1958	203.4
1959	222.6
1960	229.8
1961	221.5
1962	248.3
1963	325.7
1964	346.4
1965	359.7
1966	410.5
1967	501.7
1968	543.7
1969	607.5
1970	665.0
1971	747.9

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-II. AUTOMOBILE REGISTRATIONS IN THE SOUTHWESTERN REGION

Year	Automobiles
1957	5,359,115
1958	5,430,071
1959	5,691,119
1960	5,859,212
1961	5,984,381
1962	6,330,002
1963	6,626,457
1964	6,915,793
1965	7,252,734
1966	7,458,399
1967	7,698,782
1968	7,981,369
1969	8,238,055
1970	8,438,410
1971	8,787,145

Sources: U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics, Summary to 1965 (Washington: Government Printing Office, 1967).

U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics (Washington: Government Printing Office, 1966-71 editions).

TABLE A-III. BUS REGISTRATIONS IN THE SOUTHWESTERN REGION

Year	Buses
1957	27,439
1958	27,787
1959	27,403
1960	27,885
1961	28,967
1962	29,390
1963	29,713
1964	30,486
1965	31,041
1966	31,802
1967	33,362
1968	33,989
1969	34,365
1970	42,178
1971	46,056

Sources: U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics, Summary to 1965 (Washington: Government Printing Office, 1967).

U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics (Washington: Government Printing Office, 1966-71 editions).

TABLE A-IV. CASH RECEIPTS FROM FARM MARKETINGS IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	3,052.4
1958	3,907.2
1959	4,025.1
1960	3,966.7
1961	4,272.0
1962	4,276.6
1963	4,565.8
1964	4,312.2
1965	4,643.8
1966	5,056.3
1967	4,771.8
1968	5,085.3
1969	5,687.5
1970	6,174.8
1971	6,472.2

Sources: U.S. Department of Agriculture, Economic Research Service, Farm Income Situation, Supplement, Farm Income, State Estimates (Washington: U.S. Department of Agriculture, 1949-64 and 1959-72 editions).

U.S. Department of Agriculture, Economic Research Service, Farm Income Situation (Washington: U.S. Department of Agriculture, July 1974).

TABLE A-V. CHEMICAL AND ALLIED PRODUCTS VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	1,460.8
1958	1,430.2
1959	1,732.4
1960	1,800.6
1961	1,804.3
1962	1,931.5
1963	2,169.8
1964	2,419.9
1965	2,706.5
1966	2,975.1
1967	2,872.2
1968	3,126.1
1969	3,515.3
1970	3,667.2
1971	4,073.2

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-VI. CRUDE OIL AND PRODUCTS PIPELINE MILEAGE IN THE SOUTHWESTERN REGION

Year	Miles
1957	73,391
1958	71,081
1959	71,901
1960	72,079
1961	72,026
1962	71,734
1963	71,274
1964	71,186
1965	71,245
1966	72,488
1967	73,951
1968	74,752
1969	73,821
1970	76,903
1971	76,203

Source: U.S. Interstate Commerce Commission, Bureau of Accounts, Transport Statistics in the United States, Part 6--Oil Pipe Lines (Washington: Government Printing Office, 1957-71 editions).

TABLE A-VII. CRUDE PETROLEUM PRODUCTION IN THE SOUTHWESTERN REGION

Year	Thousands of 42-gallon Barrels
1957	1,649,471
1958	1,483,456
1959	1,559,063
1960	1,551,341
1961	1,586,480
1962	1,650,862
1963	1,722,260
1964	1,768,484
1965	1,824,973
1966	1,980,687
1967	2,146,313
1968	2,193,893
1969	2,239,156
1970	2,398,213
1971	2,389,745

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, volume III, Area Reports (Washington: Government Printing Office, 1957-71 editions).

TABLE A-VIII. ELECTRICAL MACHINERY VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	118.7
1958	143.5
1959	209.5
1960	272.1
1961	313.9
1962	364.1
1963	478.9
1964	485.6
1965	571.6
1966	681.0
1967	763.2
1968	867.6
1969	935.8
1970	1,091.3
1971	1,239.6

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-IX. EMPLOYEES ON NONAGRICULTURAL PAYROLLS IN THE SOUTHWESTERN REGION

Year	Thousand of Persons
1957	4,154.7
1958	4,125.2
1959	4,234.7
1960	4,270.3
1961	4,287.4
1962	4,418.3
1963	4,543.5
1964	4,710.5
1965	4,934.0
1966	5,234.2
1967	5,460.9
1968	5,687.5
1969	5,926.1
1970	5,981.7
1971	6,082.5

Source: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, States and Areas 1939-1972, Bulletin 1370-10 (Washington: Government Printing Office, 1974).

TABLE A-X. EMPLOYMENT IN MANUFACTURING INDUSTRIES IN THE SOUTHWESTERN REGION

Year	Persons
1957	803,800
1958	794,800
1959	812,100
1960	815,700
1961	813,500
1962	834,200
1963	864,600
1964	900,000
1965	945,800
1966	1,005,200
1967	1,083,300
1968	1,130,100
1969	1,191,900
1970	1,181,900
1971	1,152,300

Source: U.S. Department of Labor, Bureau of Labor Statistics, Division of Manpower and Employment Statistics, "Report of Employment" (unpublished, 1957-71 Reports).

TABLE A-XI. FABRICATED METAL PRODUCTS VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	314.9
1958	383.3
1959	407.8
1960	408.0
1961	424.6
1962	440.7
1963	504.4
1964	571.1
1965	695.1
1966	773.2
1967	930.0
1968	1,005.7
1969	1,083.1
1970	1,286.3
1971	1,430.6

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XII. FOOD AND KINDRED PRODUCTS VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	1,170.5
1958	1,220.3
1959	1,279.8
1960	1,342.2
1961	1,416.7
1962	1,475.3
1963	1,601.5
1964	1,657.9
1965	1,741.8
1966	1,911.8
1967	2,066.5
1968	2,229.7
1969	2,360.5
1970	2,661.6
1971	2,849.2

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XIII. LUMBER AND WOOD PRODUCTS VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	228.1
1958	233.6
1959	268.6
1960	260.9
1961	257.9
1962	277.1
1963	315.9
1964	351.2
1965	366.0
1966	380.4
1967	403.6
1968	461.6
1969	527.9
1970	465.9
1971	546.2

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XIV. MOTOR VEHICLE REGISTRATIONS IN THE SOUTHWESTERN REGION

Year	Vehicles
1957	6,867,079
1958	6,973,992
1959	7,318,074
1960	7,524,273
1961	7,705,428
1962	8,150,144
1963	8,543,685
1964	8,943,559
1965	9,404,800
1966	9,717,629
1967	10,052,227
1968	10,474,201
1969	10,854,258
1970	11,191,489
1971	11,681,410

Sources: U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics, Summary to 1965 (Washington: Government Printing Office, 1967).

U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics (Washington: Government Printing Office, 1966-71 editions).

TABLE A-XV. NATURAL GAS LIQUIDS PRODUCTION IN THE SOUTHWESTERN REGION

Year	Thousands of 42-gallon Barrels
1957	214,949
1958	215,257
1959	232,152
1960	243,827
1961	263,304
1962	275,745
1963	295,323
1964	313,350
1965	331,292
1966	355,738
1967	498,600
1968	434,920
1969	460,555
1970	483,289
1971	494,705

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, volume III, Area Reports (Washington: Government Printing Office, 1957-71 editions).

TABLE A-XVI. NATURAL GAS PRODUCTION IN THE SOUTHWESTERN REGION

Year	Millions of Cubic Feet
1957	7,986,237
1958	8,359,054
1959	9,241,446
1960	9,760,835
1961	10,187,706
1962	10,732,596
1963	11,443,445
1964	12,034,887
1965	12,507,167
1966	13,491,624
1967	14,435,231
1968	15,458,940
1969	16,773,997
1970	17,922,286
1971	18,489,026

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, volume III, Area Reports (Washington: Government Printing Office, 1957-71 editions).

TABLE A-XVII. NONELECTRIC MACHINERY VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	625.3
1958	493.0
1959	588.8
1960	580.3
1961	582.9
1962	635.0
1963	700.9
1964	799.5
1965	876.2
1966	959.4
1967	1,079.6
1968	1,257.4
1969	1,409.5
1970	1,503.1
1971	1,522.0

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XVIII. PAPER AND ALLIED PRODUCTS VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	357.5
1958	374.0
1959	404.2
1960	418.5
1961	413.7
1962	422.0
1963	484.8
1964	524.9
1965	540.7
1966	606.1
1967	638.7
1968	725.9
1969	798.7
1970	855.3
1971	889.1

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XIX. PETROLEUM AND COAL PRODUCTS VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	1,215.7
1958	921.8
1959	1,007.0
1960	1,148.1
1961	1,297.4
1962	1,273.8
1963	1,418.1
1964	1,433.8
1965	1,541.0
1966	1,788.8
1967	2,328.8
1968	2,265.9
1969	2,324.1
1970	2,073.9
1971	2,122.1

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XX. PRIMARY METALS VALUE ADDED BY MANUFACTURE IN THE SOUTH-WESTERN REGION

Year	Millions of Dollars
1957	480.5
1958	441.8
1959	512.6
1960	496.7
1961	507.6
1962	501.4
1963	549.6
1964	642.1
1965	730.9
1966	847.7
1967	872.1
1968	896.9
1969	978.1
1970	926.0
1971	973.9

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XXI. RESIDENT POPULATION ESTIMATES FOR THE SOUTHWESTERN REGION

Year	Thousands of Persons
1957	16,200
1958	16,400
1959	16,658
1960	17,009
1961	17,293
1962	17,678
1963	17,850
1964	18,059
1965	18,208
1966	18,395
1967	18,570
1968	18,827
1969	19,112
1970	19,322
1971	19,672

Source: U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census, Current Population Reports, Series P-25, "Population Estimates and Projections" (Washington: Government Printing Office, number 304 -- April 1965, number 460 -- June 1971, and number 488 -- September 1972).

TABLE A-XXII. SAND AND GRAVEL PRODUCTION IN THE SOUTHWESTERN REGION

Year	Thousands of Short Tons
1957	49,824
1958	63,808
1959	69,045
1960	58,779
1961	54,139
1962	57,399
1963	63,275
1964	61,223
1965	64,971
1966	66,534
1967	70,489
1968	70,292
1969	66,039
1970	68,569
1971	69,359

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, volume III, Area Reports (Washington: Government Printing Office, 1957-71 editions).

TABLE A-XXIII. STONE, CLAY, AND GLASS PRODUCTS VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	300.8
1958	404.7
1959	469.2
1960	427.5
1961	450.4
1962	474.3
1963	519.2
1964	555.4
1965	565.7
1966	583.0
1967	618.2
1968	683.8
1969	731.5
1970	760.4
1971	845.5

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XXIV. TOTAL GASOLINE CONSUMPTION IN THE SOUTHWESTERN REGION

Year	Thousands of Gallons
1957	6,809,876
1958	7,223,077
1959	7,241,404
1960	7,239,645
1961	7,465,131
1962	7,791,595
1963	7,812,456
1964	8,208,238
1965	8,614,973
1966	9,161,289
1967	9,342,878
1968	10,148,191
1969	10,153,864
1970	10,427,302
1971	10,919,899

Source: American Petroleum Institute, Division of Statistics, Petroleum Facts and Figures (Washington: American Petroleum Institute, 1958-72 editions).

TABLE A-XXV. TOTAL PERSONAL INCOME IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	27,401
1958	28,486
1959	30,050
1960	30,939
1961	32,542
1962	34,218
1963	36,082
1964	38,680
1965	41,767
1966	46,163
1967	50,305
1968	55,380
1969	60,322
1970	66,054
1971	70,164

Source: U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of Economic Analysis, Survey of Current Business 52, 53 (Washington: Government Printing Office, August, 1972; August, 1973).

TABLE A-XXVI. TOTAL VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	7,933.1
1958	7,791.5
1959	8,672.8
1960	8,952.2
1961	9,219.3
1962	9,729.0
1963	10,974.8
1964	12,133.0
1965	13,273.4
1966	14,907.7
1967	16,616.5
1968	18,297.0
1969	19,794.4
1970	20,373.5
1971	21,552.8

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XXVII. TRACTOR-TRUCK REGISTRATIONS IN THE SOUTHWESTERN REGION

Year	Tractor-Trucks
1957	75,261
1958	76,688
1959	82,803
1960	83,515
1961	84,460
1962	89,238
1963	93,228
1964	99,763
1965	93,790
1966	97,968
1967	95,129
1968	96,626
1969	103,324
1970	107,293
1971	111,229

Sources: U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics, Summary to 1965 (Washington: Government Printing Office, 1967).

U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics (Washington: Government Printing Office, 1966-71 editions).

TABLE A-XXVIII. TRANSPORTATION EQUIPMENT VALUE ADDED BY MANUFACTURE IN THE SOUTHWESTERN REGION

Year	Millions of Dollars
1957	654.0
1958	735.3
1959	707.8
1960	658.0
1961	615.1
1962	681.1
1963	775.2
1964	1,174.0
1965	1,274.4
1966	1,442.2
1967	1,596.4
1968	1,964.7
1969	2,163.5
1970	2,078.6
1971	1,689.6

Sources: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures (Washington: Government Printing Office, 1957-71 editions).

U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, volume III, Area Statistics (Washington: Government Printing Office, 1958, 1963, and 1967 editions).

TABLE A-XXIX. TRUCK REGISTRATIONS IN THE SOUTHWESTERN REGION

Year	Trucks
1957	1,480,525
1958	1,516,134
1959	1,599,552
1960	1,637,176
1961	1,692,080
1962	1,790,752
1963	1,887,515
1964	1,997,280
1965	2,121,025
1966	2,227,428
1967	2,320,083
1968	2,458,843
1969	2,581,838
1970	2,710,901
1971	2,848,209

Sources: U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics, Summary to 1965 (Washington: Government Printing Office, 1967).

U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, Highway Statistics (Washington: Government Printing Office, 1966-71 editions).

TABLE XXX. VALUE OF MINERAL PRODUCTION IN THE SOUTHWESTERN REGION

Year	Thousands of Dollars
1957	6,953,749
1958	6,451,137
1959	6,892,059
1960	7,036,708
1961	7,346,681
1962	7,759,425
1963	8,110,681
1964	8,374,144
1965	8,795,453
1966	9,639,699
1967	10,579,700
1968	11,042,396
1969	11,754,231
1970	12,868,217
1971	13,803,699

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, volume III, Area Reports (Washington: Government Printing Office, 1957-71 editions).

APPENDIX B

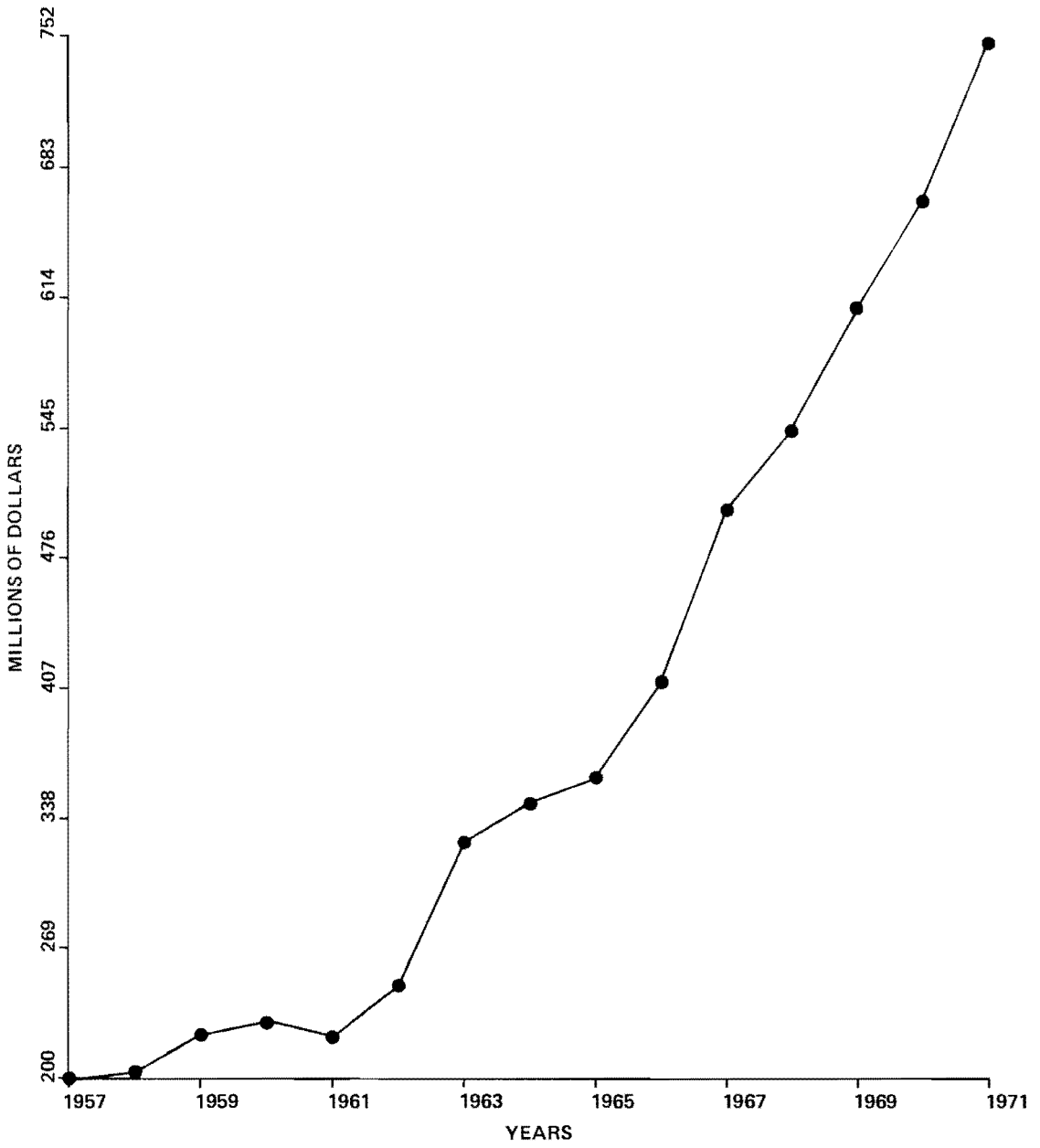

FIGURE B-1. APPAREL AND RELATED PRODUCTS
VALUE ADDED BY MANUFACTURE

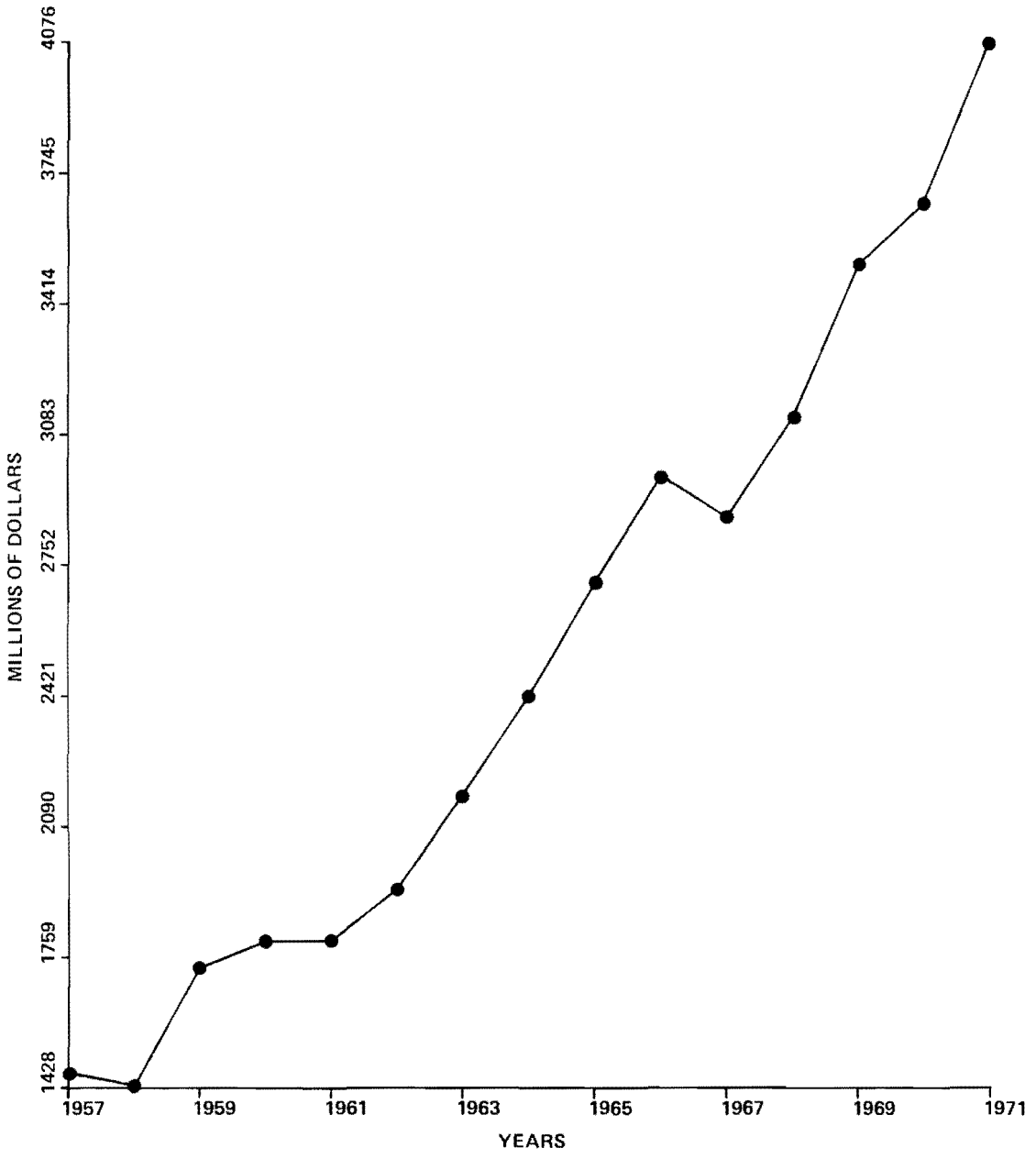

FIGURE B-2. CHEMICAL AND ALLIED PRODUCTS VALUE ADDED BY MANUFACTURE

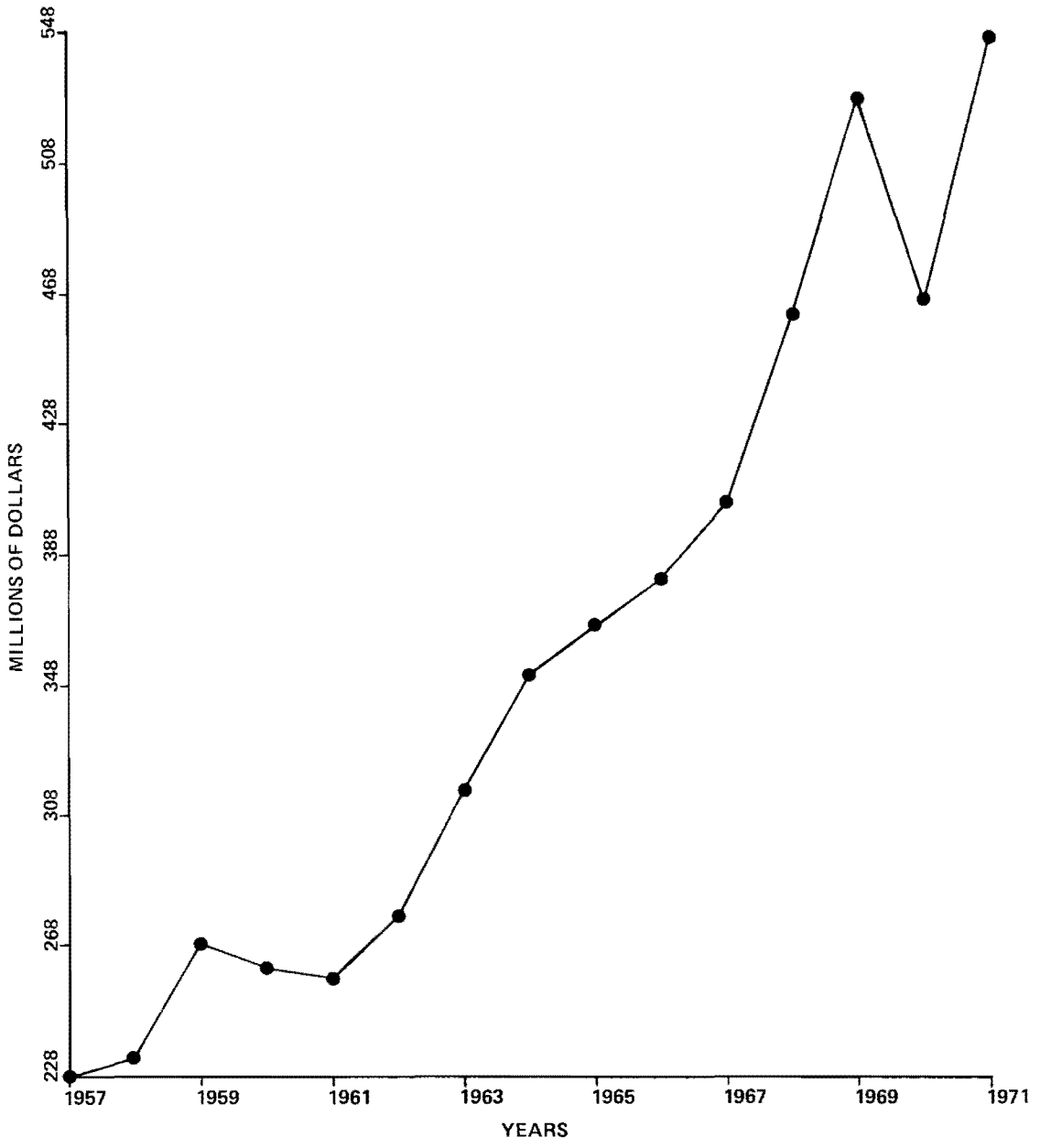

FIGURE B-3. LUMBER AND WOOD PRODUCTS
VALUE ADDED BY MANUFACTURE

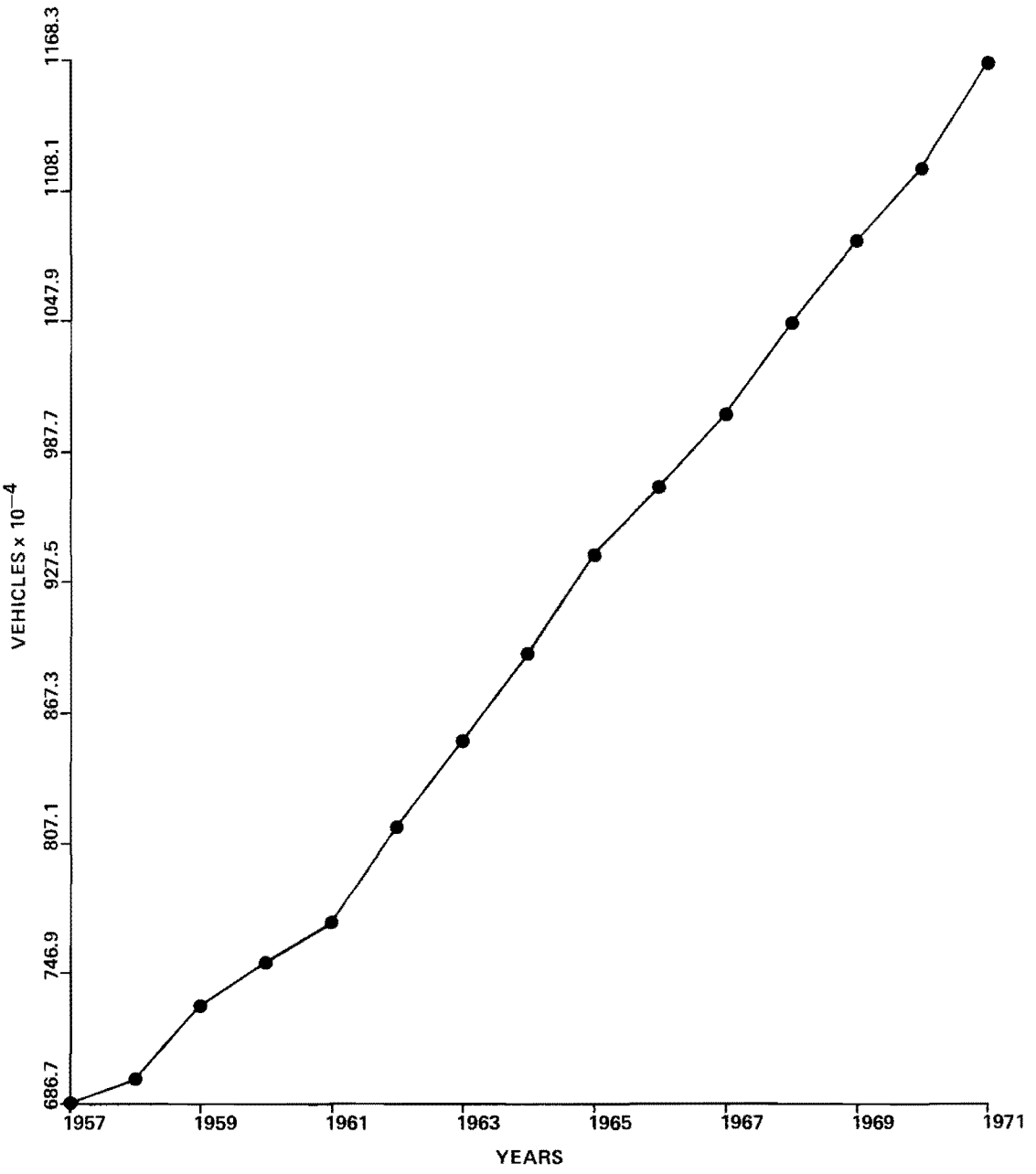

FIGURE B-4. MOTOR VEHICLE REGISTRATIONS

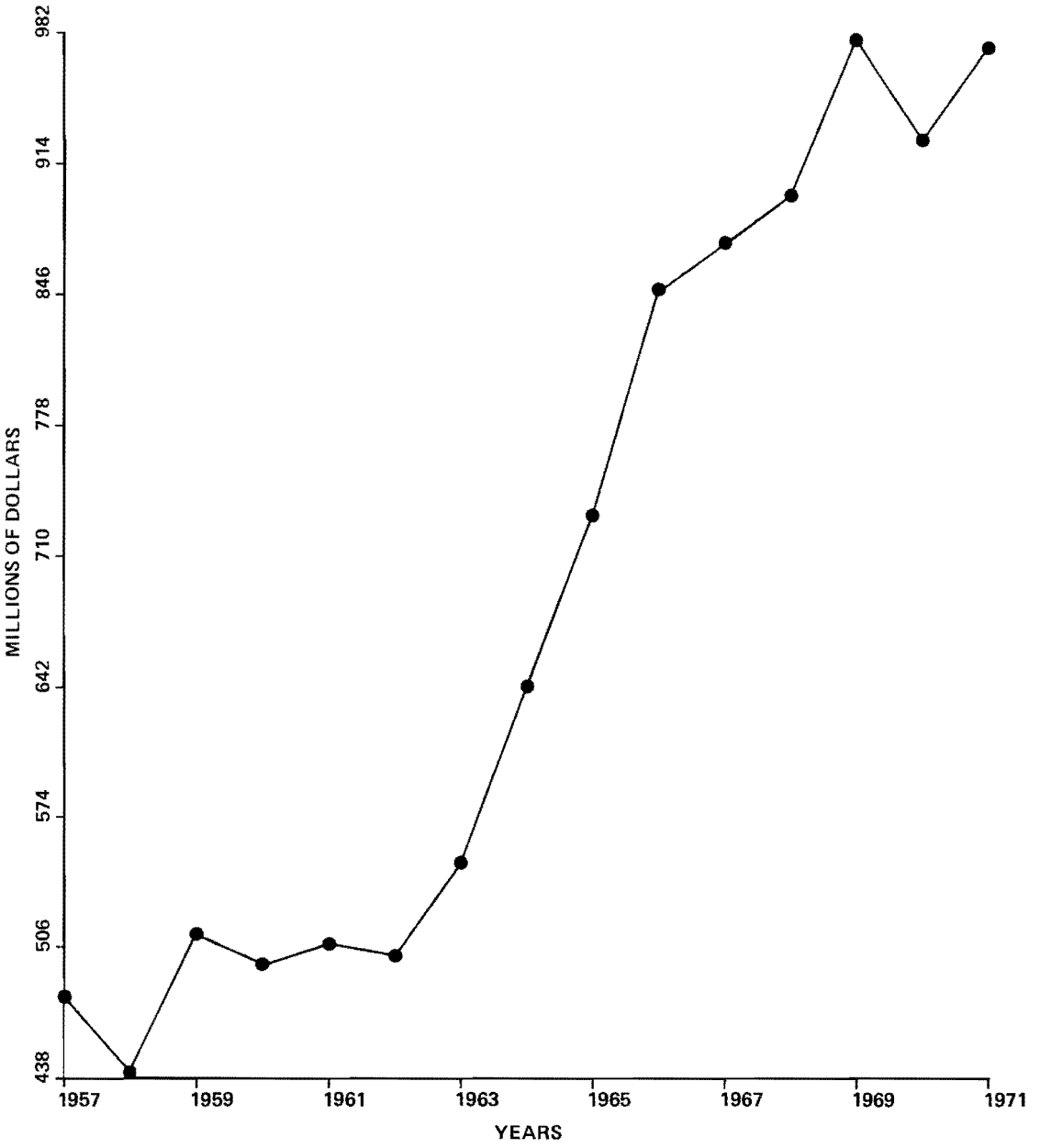

FIGURE B-5. PRIMARY METALS VALUE ADDED BY MANUFACTURE

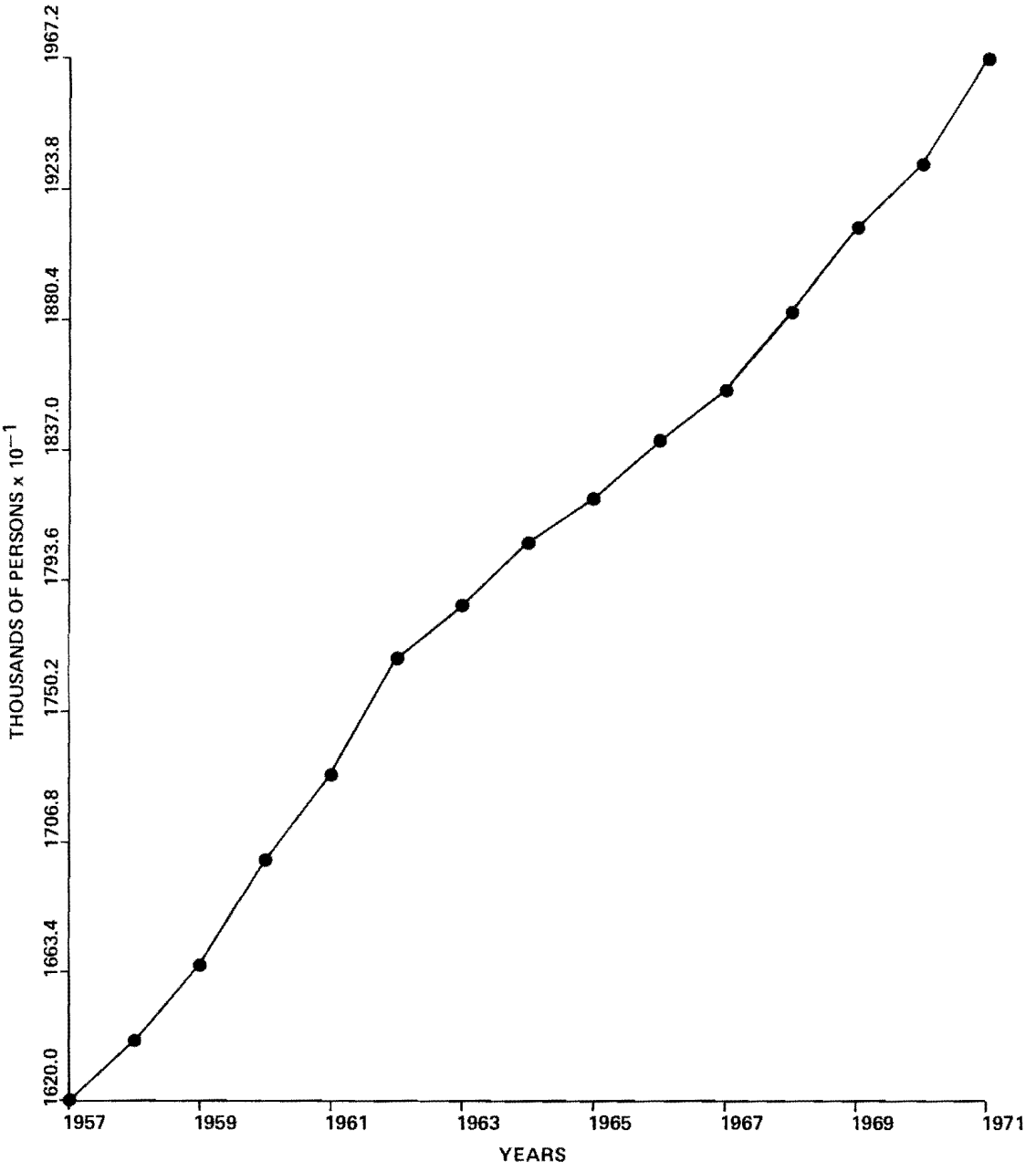

FIGURE B-6. RESIDENT POPULATION ESTIMATES

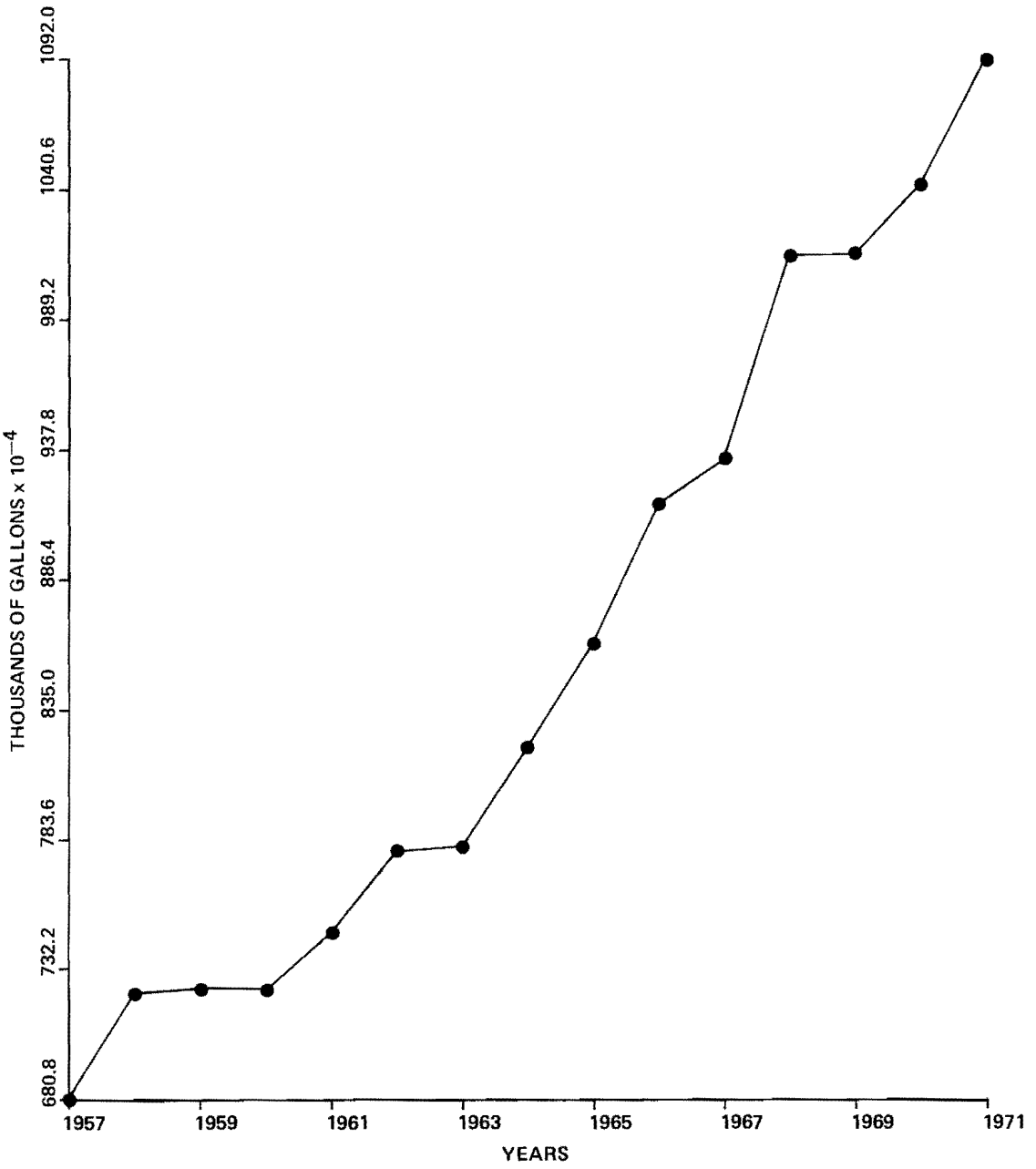

FIGURE B-7. TOTAL GASOLINE CONSUMPTION

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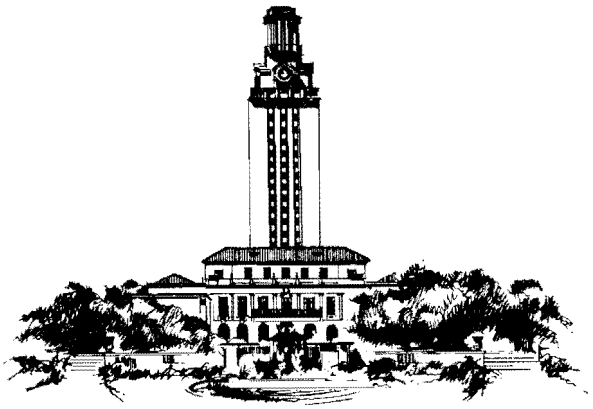

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