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An investigation into the elasticity of demand for motor gasoline

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AN INVESTIGATION INTO THE ELASTICITY OF DEMAND FOR MOTOR GASOLINE

by

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This thesis investigates the existence and determinants of the elasticity of demand for motor gasoline.

The research can be divided into four main stages. In the first stage, time series data of fifteen member countries of the Organization for Economic Cooperation and Development (OECD) are analyzed.

The ratio of gasoline price per gallon to the per capita GNP is introduced in this research to explain the variability in

the size of the price elasticities of demand over the various countries. The ratio is called the "Price Factor" and designated as P.F. The introduction of P.F. established the basis for meaningful inter-country comparisons of elasticity behavior. Three elasticity functions of P.F. are estimated via time series analysis.

In addition, time series analysis revealed a functional dependence of demand for motor gasoline on the per capita GNP lagged by one year.

In the second part of the thesis, the annual data of the various countries are examined cross sectionally. Based on the cross sectional analysis, demand is estimated as a function of P.F.

The third stage of the thesis is devoted to the validation of the research. Both the time series and the cross section findings are utilized for the retrogressive forecasting of demand levels in three countries of the OECD that were not included in the analysis of the first two stages.

The validation section is concluded by choosing one of the elasticity functions estimated via time series analysis as the most accurate forecasting model. The forecasts provided by that specific function were quite satisfactory.

President Carter's energy program is examined in the fourth stage of the thesis using the function chosen in stage three. A temporal price profile is generated until the year 1990. This profile would achieve the President's goals for national consumption of motor gasoline.

It is found that a 22% annual increase of gasoline price, to be introduced starting the year 1979 would achieve the goal of a 10% reduction in demand by the year 1985. Such a price profile suggests much higher taxation than proposed in the President's energy program.

TO MY WIFE PERIHAN

ACKNOWLEDGMENT

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CHAPTER I

BACKGROUND

INTRODUCTION

The recently realized seriousness and severity of the shortages in fossil energy resources prompted the need for detailed and thorough studies. The current study explores the demand determinants for one fossil fuel by-product, viz., motor gasoline.

Traditional models treat demand for petroleum products as basically inelastic to price (Adelman, 1975, p. 271). The levels of demand were usually related to those of GNP and population (Rothkopf, 1974, p. 107), or simply assumed to be an increasing function of time (Kalymon, 1975, p. 346).

Prior to the oil embargo of 1973, prices of crude oil were quite low relative to those of other commodities and had been decreasing in real terms. Under such conditions, the assumption of short run price inelastic demand was justifiable.

To maintain such an assumption for the post embargo era after the price of crude oil has more than quadrupled is not warranted. It seems reasonable to propose that the price elasticity question should be reexamined.

Robinson (1975, pp. 37-40) states that

> Forecasts of energy demand which take little or no account of price effects are likely to be misleading. What is needed is some econometric evidence on the likely response of aggregate energy demand to higher prices, but unfortunately there is nothing available; even for individual fuels there is little evidence on price elasticities.

Robinson emphasizes the difficulty of the task due to the structural change of post embargo vis a vis pre-embargo eras, and contends that the basis for reliable estimates may not exist. He further states:

> The best that can be done at present is to put forward some statistics which give an indication of potential for price responsiveness in the energy market, though we cannot be sure what the response will actually be.

RESEARCH OBJECTIVE

It is the objective of this research to explore and analyze the factors influencing the demand for motor gasoline in transportation, estimate demand elasticities with respect to the different factors, and simulate the consumers behavior under alternative situations and pricing policies.

Time series and cross section data from fifteen countries of the Organization for Economic Cooperation and Development (OECD); an offspring of the European Economic Community (EEC) known as the European Common Market; are analyzed in this research.

THEORETICAL CONSIDERATIONS

The following considerations pertain to the choice of the research topic and the underlying economic theory.

Significance Of The Transportation Sector

The transportation sector has been chosen for analysis for the following three reasons:

1. The amount of energy consumed in transportation is quite substantial. Leach (1973, p. 1) estimates that the 1973 world fleet of about 200 million cars used up some 12% of world crude oil production, and that the percentage amounted to 50% for the U.S. compared to 17% for Europe. In 1969 the Net Energy Input (NEI) to the transportation sector in the U.S. reached 27.9% thus placing transportation "...above the whole domestic and commercial sectors and only a little below industry as a consumer of dwindling fossil fuel resources".

   Leach states that

   > Unless the higher estimates of ultimate world reserves for oil prove to be correct, the fuel demands of road transport are likely to provoke a severe oil shortage by the end of the century.

2. The primary input to a vehicle is fossil fuel, whereas the energy intake by a factory accounts only for a part (usually small) of the total input, and is usually rigidly determined. In the

intensive studies of energy use in manufacturing industries included in the report of the Energy Policy Project of the Ford Foundation (1974, p. 568), the aluminum firms were interviewed and asked a series of questions relating to energy prices and possible industry responsiveness to higher prices. According to the report:

> Answers to our questions consistently indicated that both short- and long-term elasticities approach zero. Primary among reasons for the lack of any elasticity was the fact that the relationship between output of aluminum and inputs of energy was apparently viewed by the respondents as being technically determined and virtually rigid.

Table 1.3 on page 21 of the same report forecasts the gross energy intake by all manufacturing industries to be around 47,000 BTU—s in 1980 for every fixed 1967 dollar of value added. Knowing that the heat equivalent of one BBL of crude is 5,618,570 BTU—s, it can be seen that the above energy intake amounts to less than 1% of one BBL per 1967 dollar added.

For a price of about 10 dollars per BBL in 1975 and assuming 10% annual price increase, the 1980 energy intake by all manufacturing industries would amount to 0.22 dollars for every dollar of value added in 1967 fixed prices.

3. It is apparent that transportation, specially in

the OECD countries considered in this study, is highly decentralized and is likely to remain for at least the next 10 to 15 years. Therefore consumption decisions, hence demand, rest on individuals. This makes it amenable to the economic theory of consumer behavior.

On The Economic Theory Of Consumer Behavior

The basic economic theory of consumer behavior postulates that the quantity demanded of a certain commodity is determined by maximizing the consumers utility function, which is a function of prices, quantities, tastes, preferences,...etc., subject to the consumers budget constraint. The resulting system of equations specifies a set of relations which the slopes of the demand function must satisfy.

The problem with strictly following the theory lies in estimating the utility function. Models which exactly satisfy the theory start by assuming a form for the utility function. Other models which approximately satisfy the theory start by assuming the demand function and attempt to impose the above described constraints on it. An excellent exposition of the basic theory is contained in Goldberger (1967).

Bridge (1971) gives an excellent survey of econometric studies of demand functions which shows that demand ends up being a function of commodity prices and consumers income.

In the dynamic case, lagged values of the same variables appear in the equation.
These findings were utilized in hypothesizing the models in the current work.

The concept of Elasticity

IF a variable Y is a function of several explanatory variables X(1),X(2),....X(n) such that

$$Y=f(X(1),X(2),.....X(n)) \quad [1.1]$$

then the elasticity of Y with respect to X(i) (also called the X(i)'s elasticity of Y) is defined as the percentage change in Y resulting from a 1% change in X(i) (Ferguson, 1975, Ch. III). In mathematical terms:

$$E(Y,X(i))=(dY/Y)/(dX(i)/X(i)) \quad [1.2]$$

Formula 2.2 can equivelantely be written as

$$E(Y,X(i))=d\ ln.(Y)/d\ ln.(X(i)) \quad [1.3]$$

The size of E is a measure of the responsiveness of Y to changes in X(i).

Price elasticity of demand E(D,P) is accepted to be negative for a "Normal Good". This means that an increase in the price of a normal good to which substitutes exist and which is not a complement to an "Abnormal" good, will lead to a decrease in the quantity demanded.

Considering the absolute value of E(D,P), we can distinguish between 5 possible cases:

perfectly elastic	$E=\infty$
relatively elastic	$E>1$
unit elastic	$E=1$
relatively inelastic	$E<1$
perfectly inelastic	$E=0$

these are depicted in figure 1.1

Determinants Of The Price Elasticity Of Demand

The various factors affecting the price elasticity of demand can be summarized as (Mansfield, 1970, pp. 88-90) :

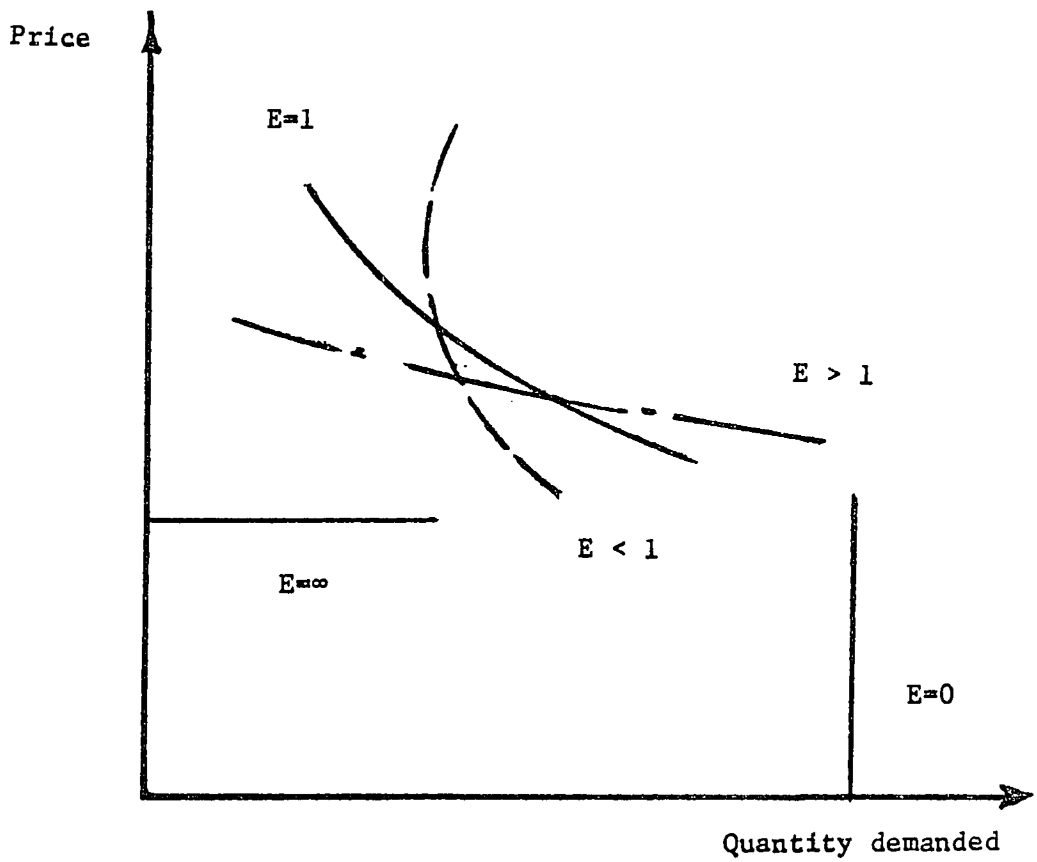
1. The existence of close substitutes. Price elasticity increases with the availability of more close substitutes.

2. Importance of the commodity in the consumer's budget. If a small fraction of the consumer's income is being spent on a specific commodity, then price fluctuations are not expected to affect demand for that commodity, and vice versa. This means that the price elasticity of demand increases with increasing proportion of the consumer's income being spent on the specific commodity.

3. The time span to which the demand curve pertains. It is in general accepted that demand is more elastic over a long period of time than over a

FIGURE I.1

VARIOUS DEMAND CONFIGURATIONS



short period. In the long run, the economic system would have more chance to incorporate structural changes which would adjust themselves in such a way as to neutralize price increases.

<u>The Income Elasticity Of Demand</u>

Beside prices, income is a strong determinant of demand. The Engel curves depicted in figure I.2 describe the theoretically and empirically accepted economic behavior of rational consumers. Panel A of figure I.2 illustrates the case where the quantity consumed of a commodity increases with income at a decreasing rate, while exhibit B depicts a demand situation increasing at a decreasing rate with higher income.

A good is called "Normal" if the quantity demanded of it increases with increasing income, otherwise it is referred to as "Inferior".

The income elasticity of demand, E(D,I), is defined as the percentage change in demand resulting from a one per cent change in income. In mathematical form:

$$E(D,I)=dD/D/dI/I \qquad [1.4]$$

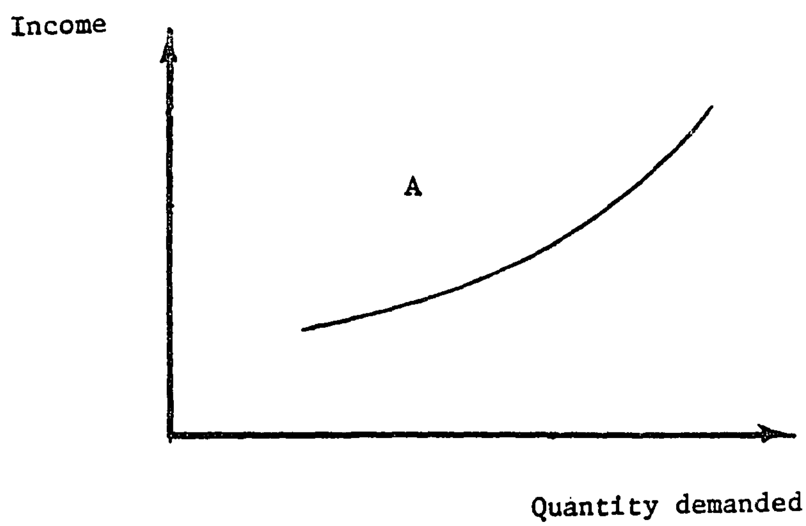
or equivalently

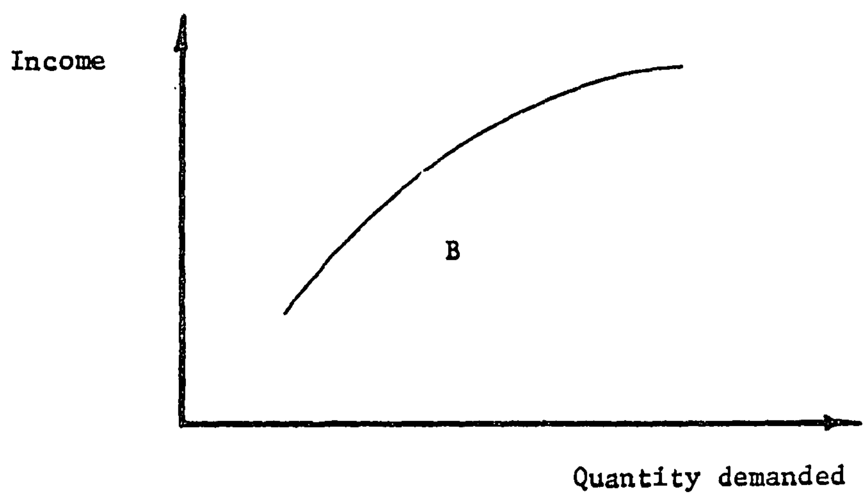
$$E(D,I)=d\ln.(D)/d\ln.(I) \qquad [1.5]$$

Normal goods have positive income elasticities while inferior goods are characterized by negative income

FIGURE I.2

ENGEL'S CURVES





elasticities of demand.

Cross Elasticities of Demand

A cross elasticity of demand measures the effect of changing prices of other commodities on the demand for a specific commodity.

Assuming a constant money income, and holding constant the price of commodity X and all other commodities but Y, the cross elasticity of demand of commodity X with respect to commodity Y is given by:

$$E(X,Y)=dD(X)/D(X)/dP(Y)/P(Y) \qquad [1.6]$$

or equivalently

$$E(X,Y)=d\ln.(D(X))/d\ln.(P(Y)) \qquad [1.7]$$

where

D(X)= Quantity demanded of commodity X

P(Y)= Price of commodity Y

Based on the sign of cross elasticities, a pair of commodities may fall in one of the two following categories:

Complements: Two commodities X and Y are said to be complements of each other if E(X,Y) is negative. This implies that an increase in the price of Y would result in a decrease in the amount demanded of X.

Substitutes: Two commodities, X and Y, are said to be substitutes if E(X,Y) is positive. An increase in the price of Y, ceteris paribus, would result in an increase in quantity demanded of its close substitute X.

Theoretical Considerations Pertaining To This Work

The relevance and applicability of the theoretical considerations described in the preceding sections to the present study are discussed in this section.

The determinants of the price elasticity of demand, discussed earlier in this section, relate to the transportation sector as treated in this study in the following fashion:

1. Substitution Effect: This study is intended for short to medium time horizon. Forecasts based on the findings of this research are assumed valid for a time span of five to ten years.

   Within the forecast period, no close competitive substitutes for motor gasoline are expected to emerge. Manne (1975) predicts the commercial introduction of synthetic fuels between the years 1990 and 2020 at an estimated cost of fifteen dollars per barrel equivalent.

   The above assumption suggests that the price elasticity of demand for motor gasoline would be neglegibly small. Yet, one can envisage different mechanisms through which price elasticities of demand may still exist despite the lack of close substitutes to motor gasoline.

   The main source of price elasticity would be through fuel conservation. The consumer may, in effect, substitute other activities for making long trips and extensive driving. Also, various structural shifts can occur in the transportation sector as a result of higher prices. Urban passengers can shift from private cars to public transportation systems, car designs may switch to higher fuel efficiency and more compactness thus reducing the specific fuel consumption of the motor vehicle,...etc.

For the planning horizon of this study, specific consumption is likely to remain unchanged. The reason for such expected constancy is that several factors, with opposing effects on fuel efficiency, are expected to occur and offset the effects of each other. One factor was pointed out by Leach (1973, p. 20) as a gradual trend toward larger engines in several western european countries, which would lead to increased specific fuel consumption per car. A second factor is the increase in fuel consumption resulting from increasing congestion as indicated by the studies of the Road Research Laboratory in Britain (Leach, 1973, p. 22). A third factor expected to have a significant impact on reducing fuel efficiency during the 1970s and the 1980s is the removal of lead additives and the incorporation of emission control devices. The Committee on Motor Vehicle Emission of The U.S. National Academy of Science (1972) and the Aerospace Corporation (1971) estimate a 10% to 15% increase in specific fuel consumptoin for the average car in the U.S. and Europe during the 1980s.

Leach (1973, p. 22) indicates that most experts agree that the technical improvements in engine design would offset the above effects, resulting in an almost constant specific fuel consumption.

For the purpose of this study, substitution through conservation, as described in the preceding paragraphs, is considered the main source of elasticity of demand for motor gasoline.

2. Relative Importance: In order to study the effect of the relative importance of motor gasoline in the consumer's budget, the ratio of price in constant 1970 U.S. cents per gallons to the GNP per capita in constant thousand dollars per person was introduced in this thesis. Since it measures the real impact of the price as felt by the average consumer, this ratio was called the "influential price factor" or the price factor, for short, and was denoted P.F. Since P.F. is proportional to the fraction of the consumer's income being spent on

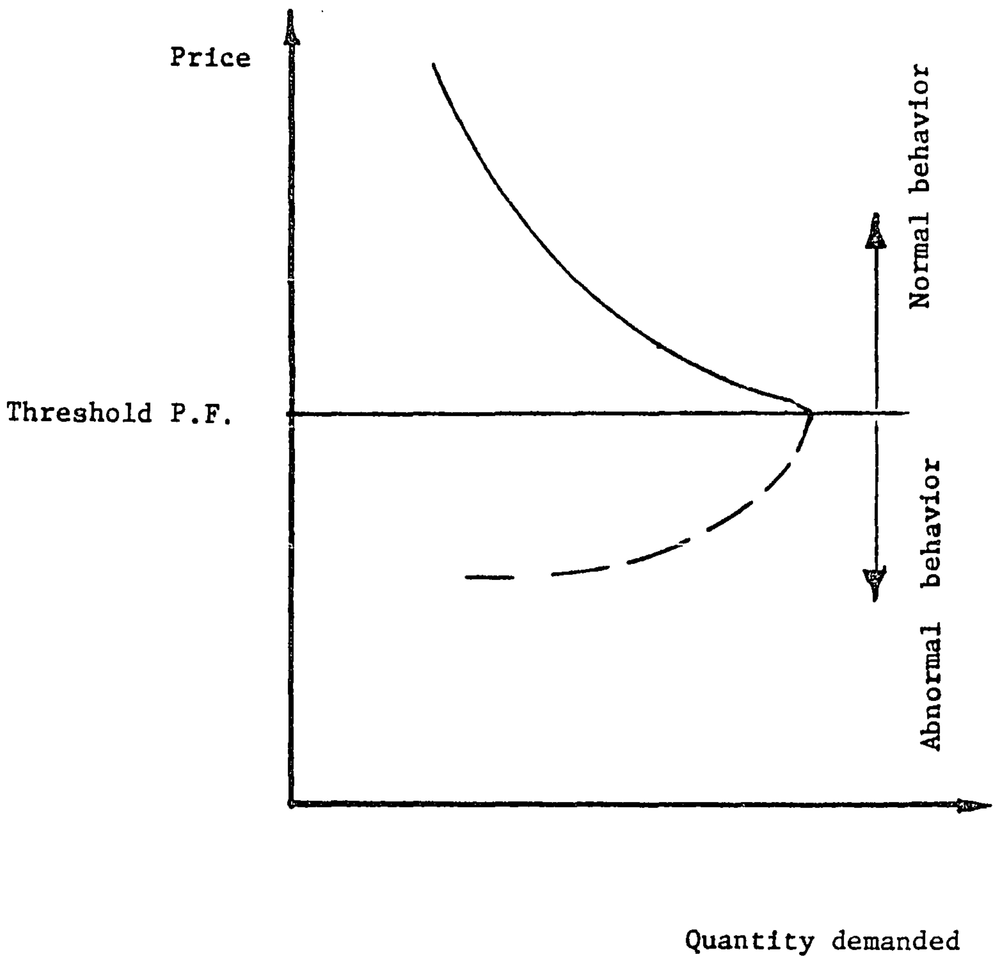
gasoline, it should be expected that the calculated price elasticities of demand would increase (with a negative sign) with increasing values of P.F. The introduction of P.F. as a measure of the variation of price elasticity of demand incorporates the income effect in the analysis.

It is proposed at this point that as long as the price of gasoline is low relative to the per capita GNP (low values of P.F.), demand may be price inelastic and may grow as a function of GNP and population. As P.F. reaches a certain critical threshold, the behavior reverses back to normal causing a "Kink" after which the negative price influence upon demand predominates.

Such behavior is depicted in figure 1.3.

FIGURE I.3

SUGGESTED EFFECT OF PRICE FACTOR



CHAPTER II

EXPERIMENTAL DESIGN AND METHODOLOGY

THE INTENSITY OF DEMAND

In order to be able to compare demand in different countries having different levels of GNP, the concept of demand intensity is used in the analysis.

Demand intensity at time t, D(t), is defined as the total demand for motor gasoline (in thousands of gallons) divided by the GNP (in billions of dollars).
This notion has been previously used in a study of the demand for paper (Aberg, 1968) and another for steel (OECD, 1974).

MODEL VARIABLES

The following variables are included in the different models:

D(t)	the demand intensity in thousand gallons/$billion.
d(t)	percentage change in D defined as (D(t)-D(t-1))/D(t-1).
G(t)	GNP per capita at time t in thousand dollars.
g(t)	defined similar to d(t).
P(t)	price at time t in U.S. cents per gallon.

p(t) percentage price change.

N(t) number of cars at time t.

THE HYPOTHESIZED MODELS

The basic model is a linear function of the explanatory variables. Since the "correct" causal relationships between the independent variables and the demand intensity are not known a priori (they seldom are in any model), the simple linear function was chosen as the preliminary assumption.

Starting with a simple hypothesis, then introducing enriching additions to it as the need arises, is a highly recommended technique in modeling and simulation (Morris, 1967). In his study of prehistoric cultural change, Plog (1967, p. 150) uses this approach without explicitly describing it.

For the sake of comparison, three other models were hypothesized. The mathematical forms of the four models were as follows:

Model I

$$D(t)=a(0)+a(1).G(t-1)+a(2).G(t)+a(3).g(t)+a(4).D(t-1)+a(5).P(t-1)+a(6).P(t)+a(7).p(t)+a(8).N(t) \quad [2.1]$$

Model II

$$d(t)=a(0)+a(1).G(t-1)+a(2).G(t)+a(3).g(t)+a(4).D(t-1)+a(5).P(t-1)+a(6).P(t)+a(7).p(t)+a(8).N(t) \quad [2.2]$$

Model III

$$\ln.(D(t))=\ln.(a)+b.\ln.(G(t-1))+c.\ln.(G(t))+e.\ln(D(t-1))+f.\ln(P(t-1))+h.\ln(P(t))+l.\ln.(N(t))+m.g(t)+n.p(t) \quad [2.3]$$

Model IV

$$d(t)=\ln.(a)+b.\ln.(G(t-1))+c.\ln.(G(t))+e.\ln.(D(t-1))+f.\ln.(P(t-1))+h.\ln.(P(t))+l.\ln(N(t))+m.g(t)+n.p(t) \quad [2.4]$$

The above models were hypothesized in functional forms that capture the essential charecteristics of dynamic demand functions as explained in chapter I.

ELASTICITIES OF DEMAND

In the following analysis it is maintained that for the value of a variable at time t, the previous value, at t-1, is given. It follows from this assumption that:

$$dp/dP(t)=1/P(t-1) \quad [2.5]$$

$$dg/dG(t)=1/G(t-1) \quad [2.6]$$

From the definition of elasticity and the above relationships, we get for the first model:

$$E(D(t),P(t))=(P(t)/D(t)).(a(6)+a(7)/P(t-1)) \quad [2.7]$$

$$E(D(t),G(t))=(G(t)/D(t)).(a(2)+a(3)/G(t-1)) \quad [2.8]$$

Following this procedure, the different elasticities of demand for the different models can be derived as:

Model 2:

$$E(D(t),P(t))=(p(t)/d(t)).(a(7)+a(6).P(t-1)) \qquad [2.9]$$

$$E(D(t),G(t))=(g(t)/d(t)).(a(3)+a(2).G(t-1)) \qquad [2.10]$$

Model 3:

$$E(D(t),P(t))=a(6)+a(7).(P(t)/P(t-1)) \qquad [2.11]$$

$$E(D(t),G(t))=a(2)+a(3).(G(t)/G(t-1)) \qquad [2.12]$$

Model 4:

$$E(D(t),P(t))=(p(t)/d(t)).(a(7)+a(6).(P(t-1)/P(t)) \qquad [2.13]$$

$$E(D(t),G(t))=(g(t)/d(t)).(a(3)+a(2).(G(t-1)/G(t)) \qquad [2.14]$$

As will be explained in chapter III, the first model was found satisfactory, and was chosen for further analysis. In the subsequent analysis, the lagged variables were dropped and the coefficients of the resulting model were estimated, once with N(t) included and once without. The same steps were then repeated with the lagged variables included and the current variables removed. The following additional elasticities were then calculated:

$$E(D(t),P(t-1))=(P(t-1)/D(t)).(a(5)-a(6).P(t)/P(t-1)) \qquad [2.15]$$

$$E(D(t),G(t-1))=(G(t-1)/D(t)).(a(1)-a(2).G(t)/G(t-1)) \quad [2.16]$$

DATA DESCRIPTION AND ANALYSIS

Table 2.1 displays the time series data of 15 OECD countries covering the period 1965-1975. The OECD is comprised of twenty countries. Two of the countries, viz. Greece and Turkey, had incomplete data and were excluded from the analysis. For the purpose of validating the research's results, three other countries of the OECD were kept for testing the forecasting accuracy of the resulting formulas. These "control" countries were France, Ireland and Japan.

Population and GNP figures were compiled from different issues of the OECD Main Economic Indicators: Historical Statistics. The GNP data are given in constant 1970 U.S. dollars, converted by the annual exchange rates and the GNP price deflators corresponding to each country.

Price figures were compiled from different issues of the International Petroleum Annual published by the U.S. Bureau of Mines. The prices in that reference are given in current U.S. dollars adjusted by annual exchange rates. The data were converted to constant 1970 dollars using the consumer price indexes given in table 2.2. The price data

TABLE II.1

TIME SERIES DATA FOR 15 OECD COUNTRIES

COUNTRY	YEAR	G(t-1)	G(t)	g(t)	D(t-1)	D(t)	d(t)	P(t-1)	P(t)	p(t)	N(t)
AUSTRIA	1966	1.54	1.57	0.0195	509.00	566.90	0.1137	58.99	58.83	-.0020	0.9849
	1967	1.57	1.61	0.0255	566.90	605.18	0.0675	58.83	56.84	-.0330	1.0765
	1968	1.61	1.71	0.0621	605.18	615.79	0.0167	56.84	55.88	-.0160	1.1672
	1969	1.71	1.80	0.0526	615.79	621.11	0.0095	55.88	54.86	-.0180	1.2359
	1970	1.80	1.93	0.0722	621.11	634.60	0.0217	54.86	53.15	-.0310	1.3242
	1971	1.93	2.03	0.0518	634.60	685.00	0.0794	53.15	53.30	0.0028	1.5351
	1972	2.03	2.15	0.0591	685.00	724.64	0.0579	53.30	56.20	0.0540	1.6052
	1973	2.15	2.26	0.0512	724.64	750.65	0.0359	56.20	76.57	0.3620	1.7111
	1974	2.26	2.35	0.0398	750.65	659.86	-.1209	76.57	96.49	0.2600	1.7875
	1975	2.35	2.30	-.0213	659.86	709.64	-.0661	96.49	107.03	0.1092	1.9837
BELGIUM	1966	2.16	2.21	0.0231	439.77	419.73	-.0456	73.63	71.83	-.0244	1.6723
	1967	2.21	2.27	0.0271	419.73	447.61	0.0664	71.83	71.03	-.0111	1.8120
	1968	2.27	2.37	0.0441	447.61	472.39	0.0554	71.03	70.27	-.0107	2.0854
	1969	2.37	2.53	0.0675	472.39	480.08	0.0163	70.27	68.90	-.0195	2.2024
	1970	2.53	2.68	0.0593	480.08	492.16	0.0252	68.90	67.35	-.0225	2.3507
	1971	2.68	2.77	0.0336	492.16	496.00	0.0078	67.35	69.32	0.0292	2.4448
	1972	2.77	2.91	0.0505	496.00	512.73	0.0337	69.32	75.00	0.0819	2.5752
	1973	2.91	3.09	0.0619	512.73	491.98	-.0405	75.00	99.07	0.3209	2.6700
	1974	3.09	3.20	0.0356	491.98	461.56	-.0618	99.07	109.88	0.1091	2.8190
	1975	3.20	3.13	-.0219	461.56	519.44	0.1254	109.88	88.96	-.1904	3.2085
DENMARK	1966	2.62	2.65	0.0115	538.40	568.09	0.0551	82.34	78.96	-.0410	1.0640
	1967	2.65	2.72	0.0264	568.09	580.58	0.0220	78.96	75.56	-.0431	1.1360
	1968	2.72	2.85	0.0478	580.58	569.12	-.0197	75.56	71.12	-.0588	1.2143
	1969	2.85	3.08	0.0807	569.12	567.71	-.0025	71.12	69.77	-.0190	1.2858
	1970	3.08	3.16	0.0260	567.71	553.17	-.0256	69.77	67.35	-.0347	1.3290
	1971	3.16	3.25	0.0285	553.17	554.31	0.0021	67.35	67.94	0.0088	1.3690
	1972	3.25	3.37	0.0369	554.31	545.96	-.0151	67.94	67.82	-.0018	1.4077
	1973	3.37	3.45	0.0237	545.96	542.49	-.0064	67.82	85.16	0.2557	1.4669
	1974	3.45	3.44	-.0029	542.49	492.58	-.0920	85.16	96.34	0.1313	1.4750
	1975	3.44	3.41	-.0087	492.58	525.98	0.0678	96.34	87.93	-.0873	1.6202

TABLE II.1 CONTD.

TIME SERIES DATA FOR 15 OECD COUNTRIES

COUNTRY	YEAR	G(t-1)	G(t)	g(t)	D(t-1)	D(t)	d(t)	P(t-1)	P(t)	p(t)	N(t)
GERMANY	1966	2.55	2.61	0.0235	409.05	440.91	0.0779	64.98	63.68	-.0200	11.6731
	1967	2.61	2.59	-.0077	440.91	464.96	0.0545	63.68	63.69	0.0002	12.3251
	1968	2.59	2.77	0.0695	464.96	460.06	-.0105	63.69	62.95	-.0116	13.1138
	1969	2.77	2.96	0.0686	460.06	469.20	0.0199	62.95	62.64	-.0049	14.2977
	1970	2.96	3.11	0.0507	469.20	485.92	0.0356	62.64	61.40	-.0198	15.6049
	1971	3.11	3.16	0.0161	485.92	523.52	0.0774	61.40	66.00	0.0749	16.6335
	1972	3.16	3.25	0.0285	523.52	534.19	0.0204	66.00	71.65	0.0856	17.6490
	1973	3.25	3.40	0.0462	534.19	518.14	-.0300	71.65	104.84	0.4632	18.3854
	1974	3.40	3.42	0.0059	518.14	501.80	-.0315	104.84	103.58	-.0120	18.6592
	1975	3.42	3.32	-.0292	501.80	565.42	0.1268	103.58	95.84	-.0747	20.8743
ITALY	1966	1.33	1.41	0.0601	490.18	506.68	0.0337	80.59	81.37	0.0097	7.0028
	1967	1.41	1.50	0.0638	506.68	524.57	0.0353	81.37	80.95	-.0052	8.0485
	1968	1.50	1.57	0.0467	524.57	549.73	0.0480	80.95	82.38	0.0177	8.9766
	1969	1.57	1.65	0.0510	549.73	562.02	0.0224	82.38	82.72	0.0041	9.8626
	1970	1.65	1.72	0.0424	562.02	577.40	0.0274	82.72	81.05	-.0202	11.1384
	1971	1.72	1.74	0.0116	577.40	594.11	0.0289	81.05	90.60	0.1178	12.3122
	1972	1.74	1.78	0.0230	594.11	624.57	0.0513	90.60	92.10	0.0166	13.5161
	1973	1.78	1.88	0.0562	624.57	626.27	0.0027	92.10	83.10	-.0977	14.5078
	1974	1.88	1.93	0.0266	626.27	563.67	-.1000	83.10	118.11	0.4213	15.4360
	1975	1.93	1.84	-.0466	563.67	626.55	0.1116	118.11	99.85	-.1546	16.5757
LUXEMBOURG	1966	2.68	2.72	0.0149	521.04	527.30	0.0120	63.11	62.50	-.0097	0.0898
	1967	2.72	2.72	0.0000	527.30	542.46	0.0288	62.50	62.62	0.0019	0.0962
	1968	2.72	2.82	0.0368	542.46	539.61	-.0053	62.62	62.39	-.0037	0.9620
	1969	2.82	3.04	0.0780	539.61	536.80	-.0052	62.39	62.30	-.0014	0.1097
	1970	3.04	3.15	0.0362	536.80	554.37	0.0327	62.30	60.85	-.0233	0.1173
	1971	3.15	3.19	0.0127	554.37	611.95	0.1039	60.85	59.50	-.0222	0.1223
	1972	3.19	3.30	0.0345	611.95	670.40	0.0955	59.50	56.40	-.0521	0.1274
	1973	3.30	3.48	0.0545	670.40	739.06	0.1024	56.40	76.88	0.3631	0.1325
	1974	3.48	3.56	0.0230	739.06	693.13	-.0621	76.88	88.59	0.1523	0.1391
	1975	3.56	3.26	-.0843	693.13	885.15	0.2770	88.59	77.77	-.1221	0.1574

TABLE II.1 CONTD.

TIME SERIES DATA FOR 15 OECD COUNTRIES

COUNTRY	YEAR	G(t-1)	G(t)	g(t)	D(t-1)	D(t)	d(t)	P(t-1)	P(t)	p(t)	N(t)
NETHERL.	1966	1.97	2.00	0.0152	466.56	500.08	0.0718	67.55	65.99	-.0231	1.7643
	1967	2.00	2.09	0.0450	500.08	517.09	0.0340	65.99	65.77	-.0033	1.9797
	1968	2.09	2.20	0.0526	517.09	538.71	0.0418	65.77	65.36	-.0062	2.4097
	1969	2.20	2.32	0.0545	538.71	530.35	-.0155	65.36	62.61	-.0421	2.5330
	1970	2.32	2.43	0.0474	530.35	551.19	0.0393	62.61	62.15	-.0073	2.8375
	1971	2.43	2.51	0.0329	551.19	564.03	0.0233	62.15	65.77	0.0582	3.0512
	1972	2.51	2.58	0.0279	564.03	572.33	0.0147	65.77	74.16	0.1276	3.2777
	1973	2.58	2.71	0.0504	572.33	562.22	-.0177	74.16	92.85	0.2520	3.5799
	1974	2.71	2.75	0.0148	562.22	494.16	-.1211	92.85	101.24	0.0904	3.7970
	1975	2.75	2.70	-.0182	494.16	542.10	0.0970	101.24	94.38	-.0678	4.2834
NORWAY	1966	2.40	2.49	0.0375	416.32	422.16	0.0140	72.78	73.51	0.0100	0.7559
	1967	2.49	2.60	0.0442	422.16	432.12	0.0236	73.51	72.76	-.0102	0.7110
	1968	2.60	2.69	0.0346	432.12	436.11	0.0092	72.76	72.30	-.0063	0.7746
	1969	2.69	2.80	0.0409	436.11	457.82	0.0498	72.30	72.96	0.0091	0.8495
	1970	2.80	2.88	0.0286	457.82	455.89	-.0042	72.96	67.70	-.0721	0.9033
	1971	2.88	2.99	0.0382	455.89	482.16	0.0576	67.70	75.38	0.1134	0.9644
	1972	2.99	3.12	0.0435	482.16	486.65	0.0093	75.38	75.39	0.0001	1.0256
	1973	3.12	3.22	0.0321	486.65	495.51	0.0182	75.39	70.45	-.0655	1.0873
	1974	3.22	3.37	0.0466	495.51	436.01	-.1201	70.45	110.71	0.5715	1.0437
	1975	3.37	3.46	0.0267	436.01	476.62	0.0931	110.71	94.00	-.1509	1.1608
PORTUGAL	1966	0.50	0.52	0.0400	356.61	380.74	0.0677	101.77	98.15	-.0356	0.3700
	1967	0.52	0.56	0.0769	380.74	394.49	0.0361	98.15	95.59	-.0261	0.4085
	1968	0.56	0.62	0.1071	394.49	396.39	0.0048	95.59	92.42	-.0332	0.4470
	1969	0.62	0.65	0.0484	396.39	435.29	0.0981	92.42	87.12	-.0573	0.5020
	1970	0.65	0.71	0.0923	435.29	440.57	0.0121	87.12	79.65	-.0857	0.5600
	1971	0.71	0.76	0.0704	440.57	485.75	0.1025	79.65	72.92	-.0845	0.7031
	1972	0.76	0.83	0.0921	485.75	494.54	0.0181	72.92	69.53	-.0465	0.8462
	1973	0.83	0.92	0.1084	494.54	519.29	0.0500	69.53	65.80	-.0536	0.9420
	1974	0.92	0.91	-.0109	519.29	486.23	-.0637	65.80	86.94	0.3213	1.0920
	1975	0.91	0.82	-.0989	486.23	594.57	0.2228	86.94	86.49	-.0052	1.2800

TABLE II.1 CONTD.

TIME SERIES DATA FOR 15 OECD COUNTRIES

COUNTRY	YEAR	G(t-1)	G(t)	g(t)	D(t-1)	D(t)	d(t)	P(t-1)	P(t)	p(t)	N(t)
SPAIN	1966	0.85	0.91	0.0706	278.05	296.75	0.0673	76.82	71.41	-.0704	1.5384
	1967	0.91	0.94	0.0330	296.75	332.99	0.1221	71.41	66.14	-.0738	1.8840
	1968	0.94	0.98	0.0426	332.99	369.77	0.1105	66.14	62.20	-.0596	2.2535
	1969	0.98	1.04	0.0612	369.77	399.95	0.0816	62.20	60.04	-.0347	2.6870
	1970	1.04	1.09	0.0481	399.95	436.45	0.0913	60.04	56.00	-.0673	3.1305
	1971	1.09	1.14	0.0459	436.45	460.04	0.0541	56.00	57.71	0.0305	3.5840
	1972	1.14	1.22	0.0702	460.04	487.58	0.0599	57.71	55.63	-.0360	4.1153
	1973	1.22	1.31	0.0738	487.58	510.94	0.0479	55.63	67.76	0.2180	4.7370
	1974	1.31	1.37	0.0458	510.94	505.02	-.0116	67.76	84.38	0.2453	5.2994
	1975	1.37	1.37	0.0000	505.02	522.49	0.0346	84.38	68.87	-.1838	5.9649
SWEDEN	1966	3.52	3.61	0.0256	469.45	472.13	0.0057	74.44	71.02	-.0459	2.0283
	1967	3.61	3.67	0.0166	472.13	479.58	0.0158	71.02	70.35	-.0094	2.1169
	1968	3.67	3.76	0.0245	479.58	487.02	0.0155	70.35	70.48	0.0018	2.2226
	1969	3.76	3.96	0.0532	487.02	484.75	-.0047	70.48	70.61	0.0018	2.3498
	1970	3.96	4.10	0.0354	484.75	482.10	-.0055	70.61	67.20	-.0483	2.4465
	1971	4.10	4.10	0.0000	482.10	489.54	0.0154	67.20	69.67	0.0368	2.5229
	1972	4.10	4.19	0.0220	489.54	496.58	0.0144	69.67	72.32	0.0380	2.6180
	1973	4.19	4.33	0.0334	496.58	507.42	0.0218	72.32	85.17	0.1777	2.6668
	1974	4.33	4.49	0.0370	507.42	449.13	-.1149	85.17	89.89	0.0554	2.8092
	1975	4.49	4.51	0.0045	449.13	504.13	0.1225	89.89	85.54	-.0484	3.1172
SWITZERL.	1966	2.93	2.99	0.0205	493.81	514.37	0.0416	55.98	54.75	-.0220	1.1192
	1967	2.99	3.01	0.0067	514.37	542.24	0.0542	54.75	53.92	-.0152	1.1973
	1968	3.01	3.10	0.0299	542.24	542.05	-.0004	53.92	53.88	-.0007	1.3859
	1969	3.10	3.24	0.0452	542.05	552.20	0.0187	53.88	53.73	-.0028	1.3893
	1970	3.24	3.35	0.0340	552.20	578.08	0.0469	53.73	53.00	-.0136	1.5300
	1971	3.35	3.46	0.0328	578.08	618.97	0.0707	53.00	55.82	0.0532	1.6248
	1972	3.46	3.54	0.0231	618.97	627.55	0.0139	55.82	62.94	0.1276	1.7310
	1973	3.54	3.62	0.0226	627.55	620.32	-.0115	62.94	74.96	0.1910	1.8221
	1974	3.62	3.67	0.0138	620.32	598.48	-.0352	74.96	84.38	0.1257	1.8995
	1975	3.67	3.41	-.0708	598.48	642.95	0.0743	84.38	93.92	0.1131	2.0507

TABLE II.1 CONTD.

TIME SERIES DATA FOR 15 OECD COUNTRIES

COUNTRY	YEAR	G(t-1)	G(t)	g(t)	D(t-1)	D(t)	d(t)	P(t-1)	P(t)	p(t)	N(t)
U.K.	1966	1.99	2.02	0.0151	580.99	601.54	0.0354	74.84	73.16	-.0224	11.6226
	1967	2.02	2.05	0.0149	601.54	628.81	0.0453	73.16	72.44	-.0098	12.4873
	1968	2.05	2.11	0.0293	628.81	643.32	0.0231	72.44	70.24	-.0304	12.7863
	1969	2.11	2.15	0.0190	643.32	650.33	0.0109	70.24	67.63	-.0372	13.4053
	1970	2.15	2.19	0.0186	650.33	674.08	0.0365	67.63	64.50	-.0463	13.7025
	1971	2.19	2.24	0.0228	674.08	691.09	0.0252	64.50	60.97	-.0547	14.2390
	1972	2.24	2.29	0.0223	691.09	715.88	0.0359	60.97	58.36	-.0428	14.9096
	1973	2.29	2.42	0.0568	715.88	719.27	0.0047	58.36	62.11	0.0643	15.4820
	1974	2.42	2.42	0.0000	719.27	698.64	-.0287	62.11	85.92	0.3834	15.8644
	1975	2.42	2.39	-.0124	698.64	692.50	-.0088	85.92	69.96	-.1858	17.3303
CANADA	1966	3.37	3.73	0.1068	1288.45	1212.96	-.0586	43.36	43.21	-.0035	6.8198
	1967	3.73	3.78	0.0134	1212.96	1227.17	0.0117	43.21	43.08	-.0030	7.0997
	1968	3.78	3.68	-.0265	1227.17	1327.83	0.0820	43.08	42.72	-.0084	7.5392
	1969	3.68	4.05	0.1005	1327.83	1236.77	-.0686	42.72	42.13	-.0138	7.8949
	1970	4.05	3.88	-.0420	1236.77	1351.71	0.0929	42.13	42.00	-.0031	8.0834
	1971	3.88	4.09	0.0541	1351.71	1332.40	-.0143	42.00	42.57	0.0136	9.0238
	1972	4.09	4.27	0.0440	1332.40	1333.59	0.0009	42.57	38.96	-.0848	9.0524
	1973	4.27	4.51	0.0562	1333.59	1368.88	0.0265	38.96	44.09	0.1317	9.6204
	1974	4.51	4.58	0.0155	1368.88	1363.52	-.0039	44.09	46.46	0.0538	10.4721
	1975	4.58	4.54	-.0087	1363.52	1407.81	0.0325	46.46	43.58	-.0620	11.7887
U.S.	1966	4.30	4.53	0.0535	1331.19	1307.66	-.0177	42.31	42.11	-.0047	94.1926
	1967	4.53	4.61	0.0177	1307.66	1312.82	0.0039	42.11	41.86	-.0059	99.9580
	1968	4.61	4.79	0.0390	1312.82	1329.44	0.0127	41.86	41.07	-.0189	101.0391
	1969	4.79	4.87	0.0167	1329.44	1357.23	0.0209	41.07	39.83	-.0302	105.0966
	1970	4.87	4.79	-.0164	1357.23	1428.29	0.0524	39.83	38.40	-.0359	108.4073
	1971	4.79	4.88	0.0188	1428.29	1443.35	0.0105	38.40	38.73	0.0086	113.1654
	1972	4.88	5.11	0.0471	1443.35	1450.97	0.0053	38.73	37.51	-.0315	118.5059
	1973	5.11	5.35	0.0470	1450.97	1436.29	-.0101	37.51	37.06	-.0120	125.4209
	1974	5.35	5.23	-.0224	1436.29	1429.70	-.0046	37.06	45.59	0.2302	129.9431
	1975	5.23	5.10	-.0249	1429.70	1483.46	0.0376	45.59	45.02	-.0125	141.1180

TABLE II.2

CONSUMER PRICE INDECES FOR VARIOUS COUNTRIES

COUNTRY \ YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AUSTRIA	85.1	87.0	90.4	93.0	95.8	100.0	104.7	111.3	119.7	131.1	142.2
BELGIUM	84.2	87.8	90.3	92.8	96.2	100.0	104.3	110.0	117.7	132.6	149.5
DENMARK	73.2	78.1	83.5	90.7	94.5	100.0	105.8	112.8	123.3	142.2	155.8
FRANCE	81.0	83.2	85.4	89.3	95.0	100.0	105.3	111.7	119.9	136.3	152.2
GERMANY	88.1	91.2	92.5	94.9	96.7	100.0	105.3	111.1	118.8	127.1	134.7
IRELAND	77.3	79.6	82.1	86.0	92.4	100.0	108.9	118.4	131.8	154.2	186.4
ITALY	86.3	88.3	91.6	92.8	95.2	100.0	104.8	110.8	122.8	146.3	171.1
LUXEMBOURG	86.2	89.1	91.0	93.4	95.6	100.0	104.7	110.1	116.8	128.0	141.7
NETHERLANDS	79.2	83.7	86.6	89.8	96.5	100.0	107.5	115.9	125.2	137.2	151.2
NORWAY	79.0	81.0	85.0	88.0	90.0	100.0	106.0	114.0	122.0	134.0	150.0
PORTUGAL	73.5	77.2	81.4	86.4	94.0	100.0	111.9	123.9	139.9	175.0	201.7
SPAIN	78.1	82.9	88.3	92.6	94.6	100.0	108.3	117.2	130.6	151.1	176.7
SWEDEN	80.0	86.0	89.0	91.0	93.0	100.0	107.0	114.0	121.0	134.0	147.0
SWITZERLAND	84.4	88.4	91.9	94.1	96.5	100.0	106.6	113.7	123.6	135.7	144.8
U.K.	80.0	83.1	85.2	89.2	94.0	100.0	109.4	117.2	128.0	148.4	184.4
CANADA	82.8	85.9	89.0	92.6	96.8	100.0	102.9	107.8	116.0	128.6	142.5
U.S.	81.3	83.6	86.0	89.6	94.4	100.0	104.3	107.7	114.4	127.0	138.6
JAPAN	76.7	80.6	83.8	88.3	92.9	100.0	106.1	110.9	123.9	154.2	172.4

for the years 1966-1970 was absent and this researcher was told on a phone conversation with the U.S. Bureau of Mines official in charge of publishing the data that these specific prices were not at all available. It was his opinion, and mine, that prices did not undergo any appreciable variations during that period. Accordingly, price data was interpolated for the period 1966-1970.

Demand figures were compiled from different issues of the OECD Oil Statistics and the number of cars from the annual issues of Automobile Facts and Figures. The various data were further compared with those reported by the International Petroleum Annual and the United Nations' Annual Bulletin of Transport Statistics.

Figure 2.1 depicts plots of G(t), D(t), and P(t) versus time for the 15 countries. The following important and interesting observations follow from the figures:

1. In general, when prices were "low", demand intensity grew almost paralell to the per capita GNP. At the sudden price jump of 1973-1974, demand dipped forming almost a mirror image of the price increase despite the fact that the GNP per capita remained high. These features characterized most of the countries, good examples of which are Norway, the Netherlands, Denmark, Belgium, Germany and Italy.

2. In the specific countries mentioned above, it is

FIGURE II.1

TIME PLOTS VARIOUS COUNTRIES

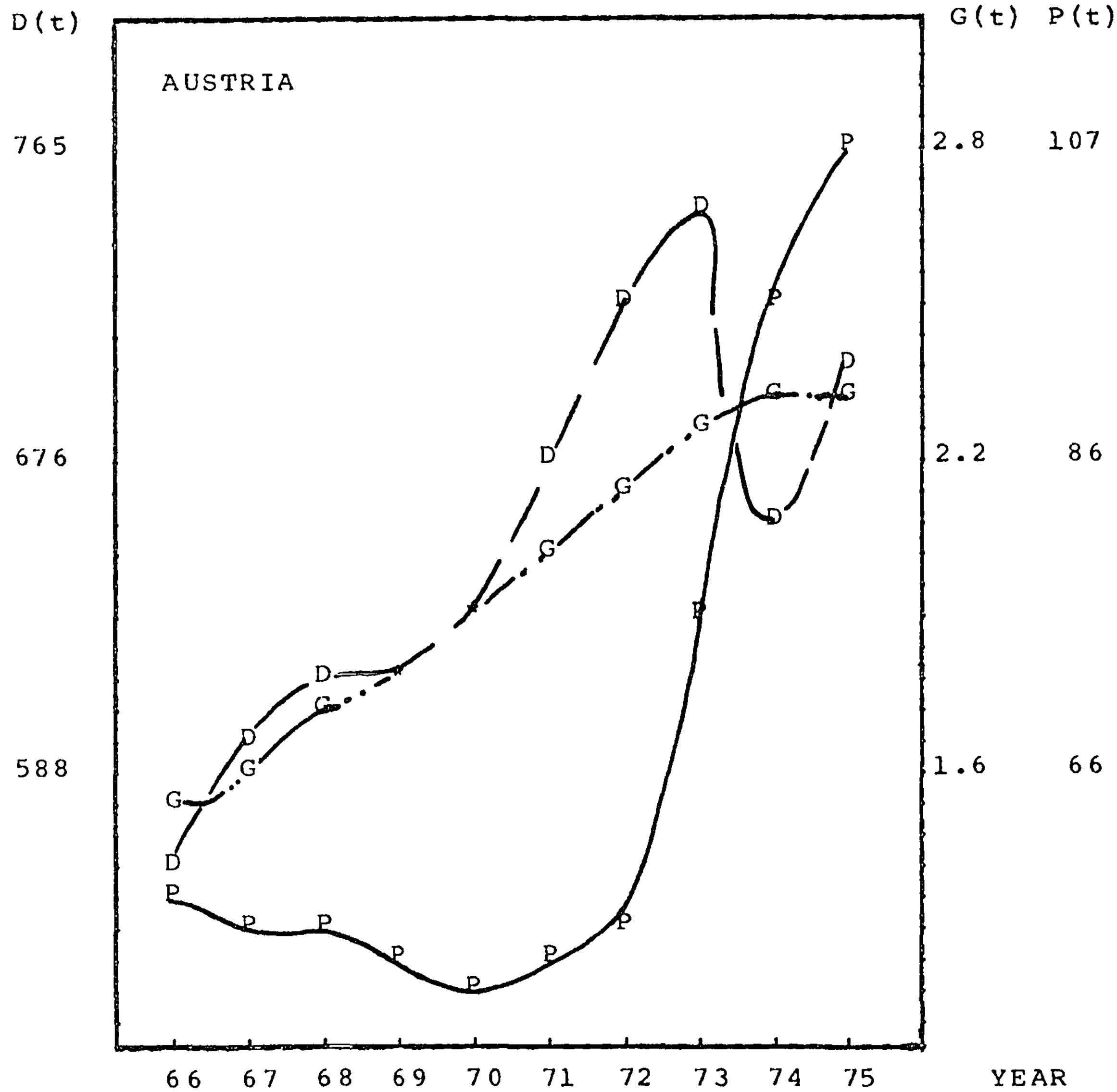


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

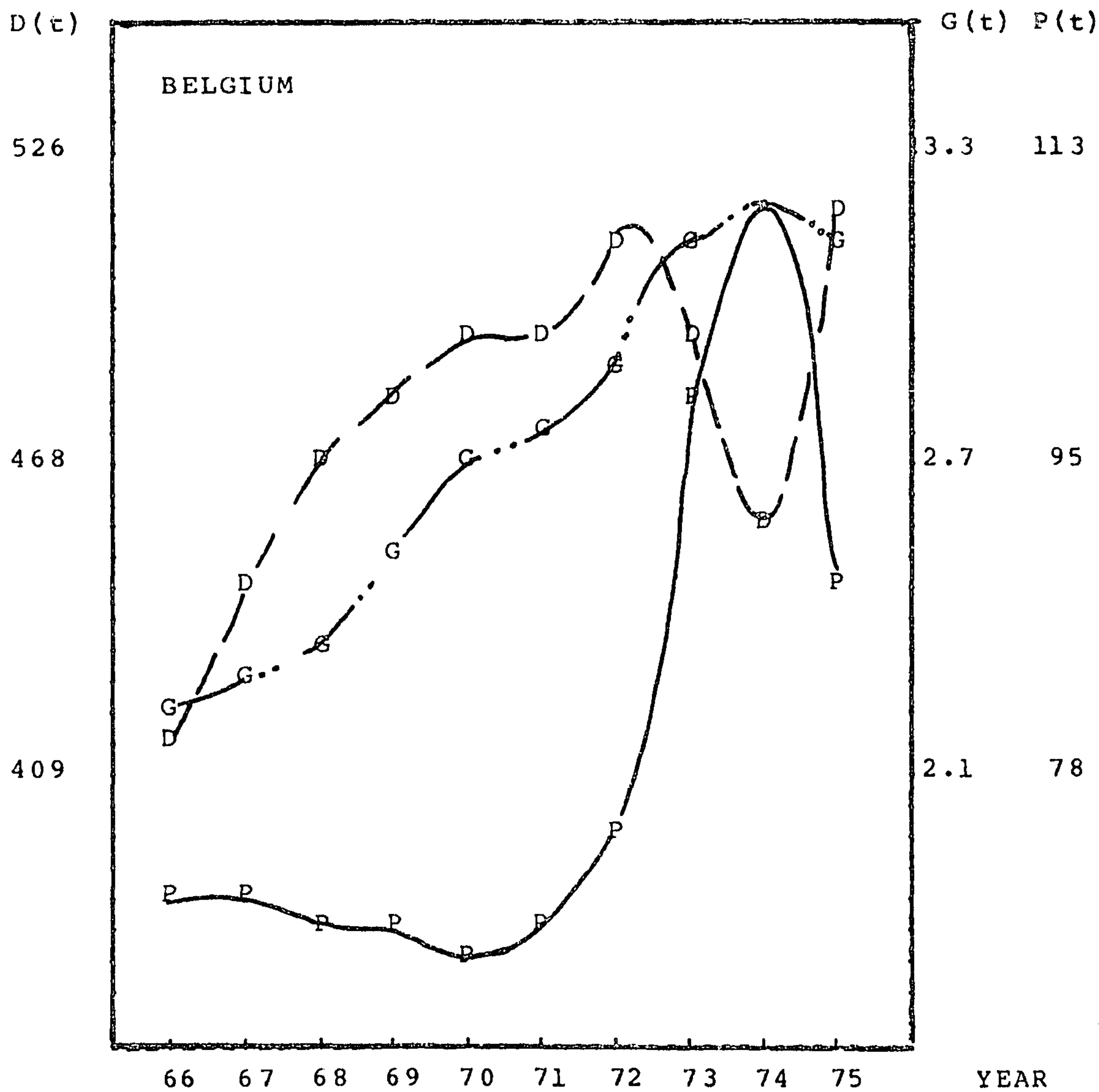


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

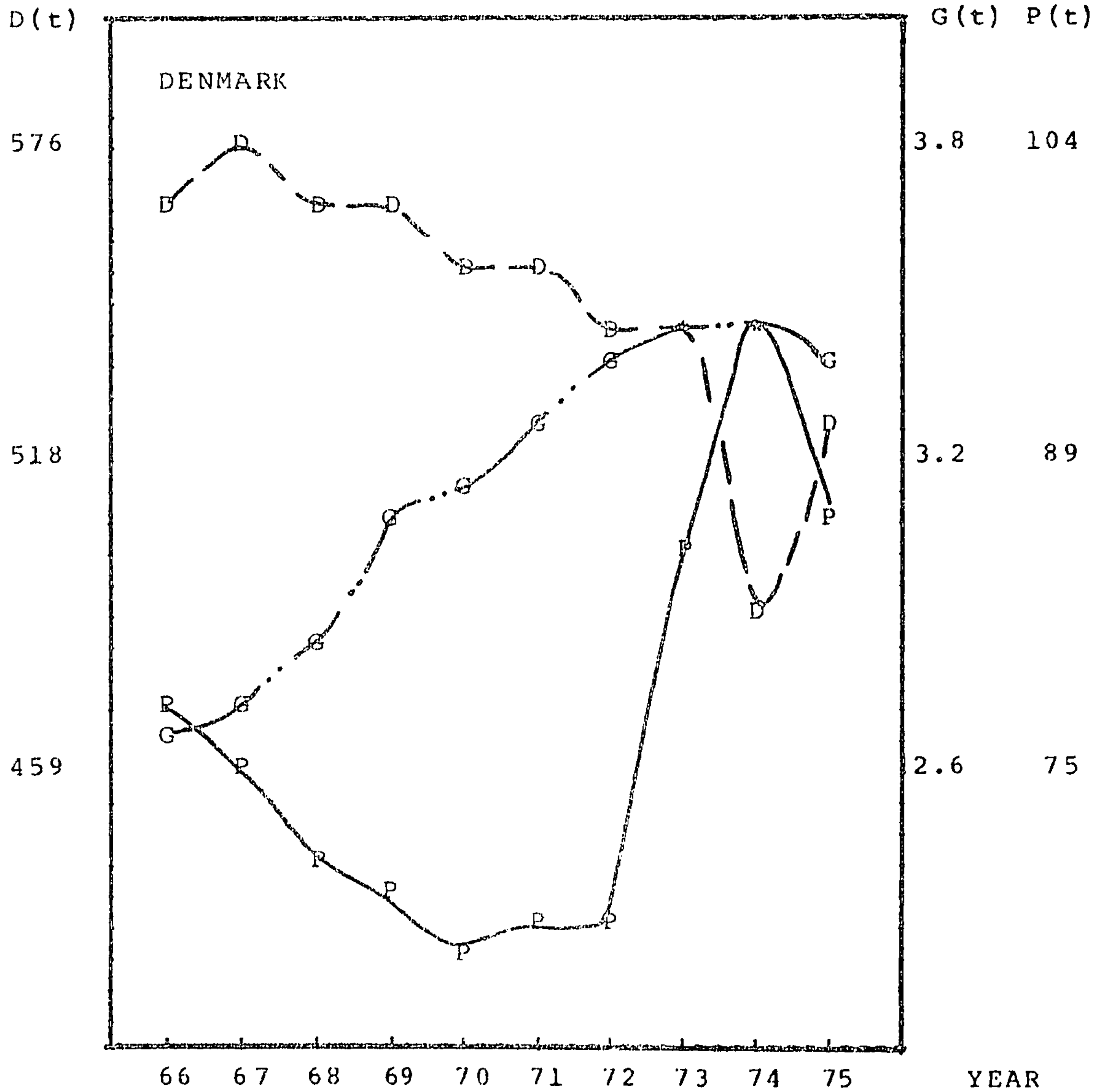


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

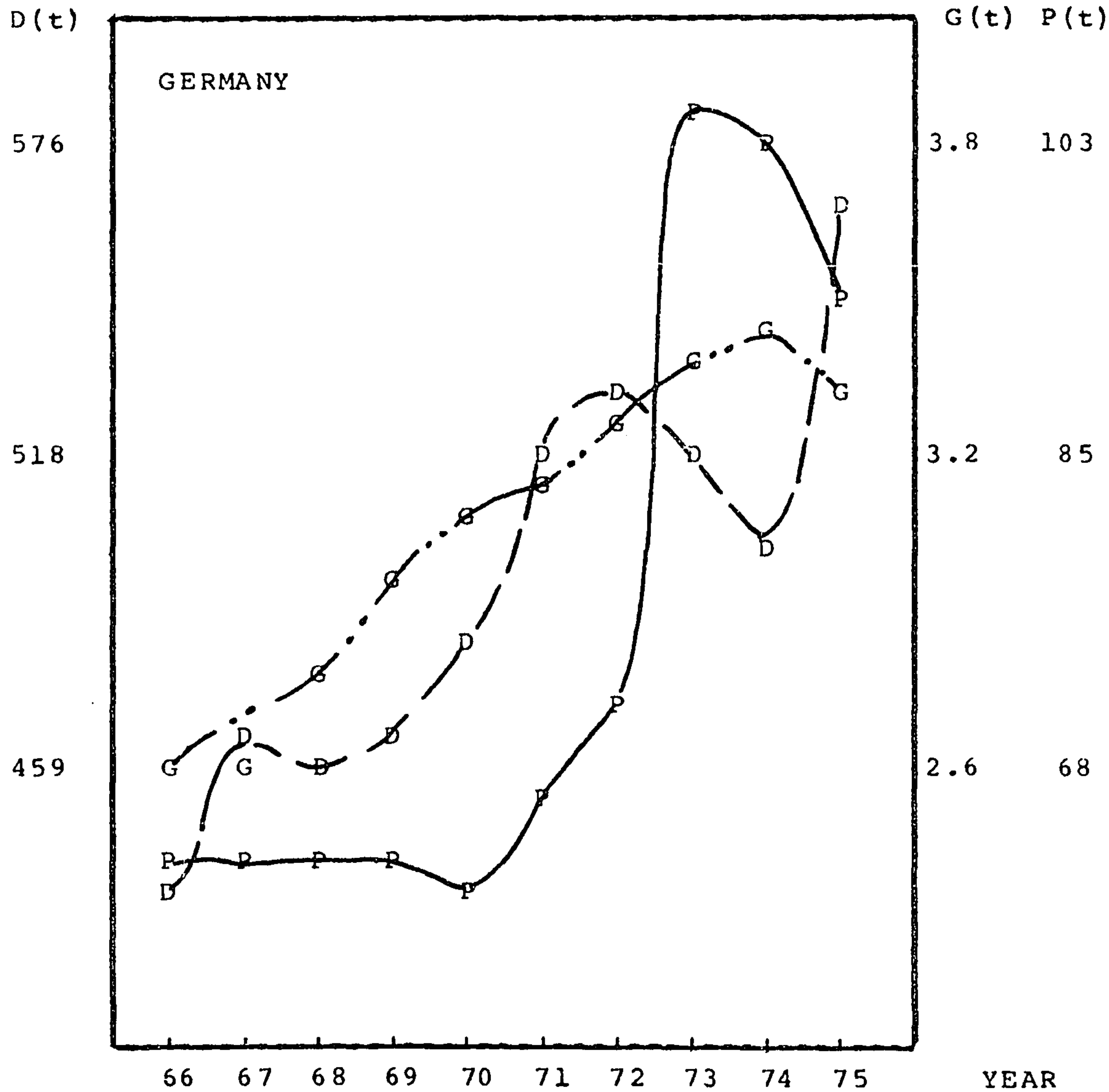


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

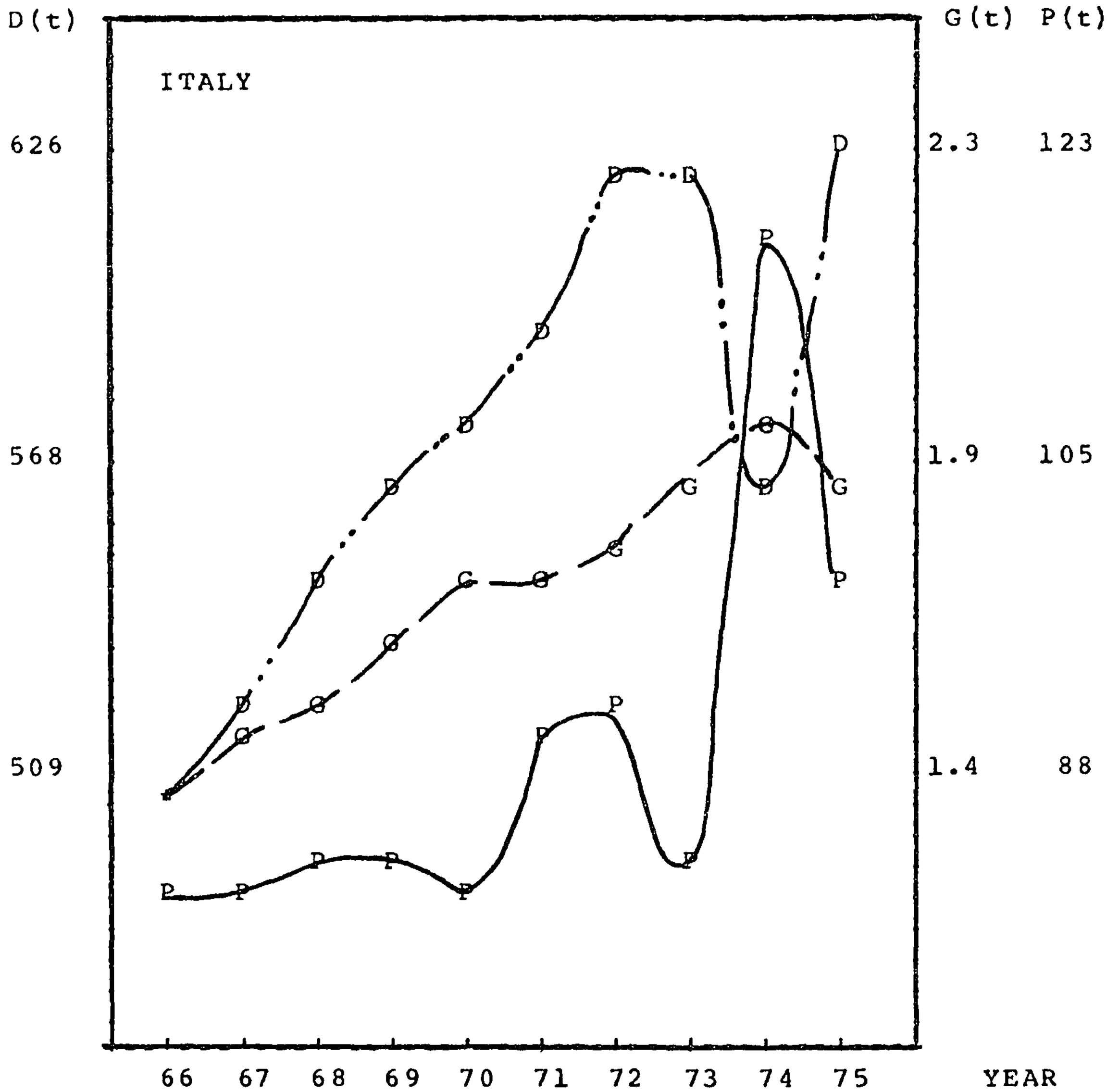


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

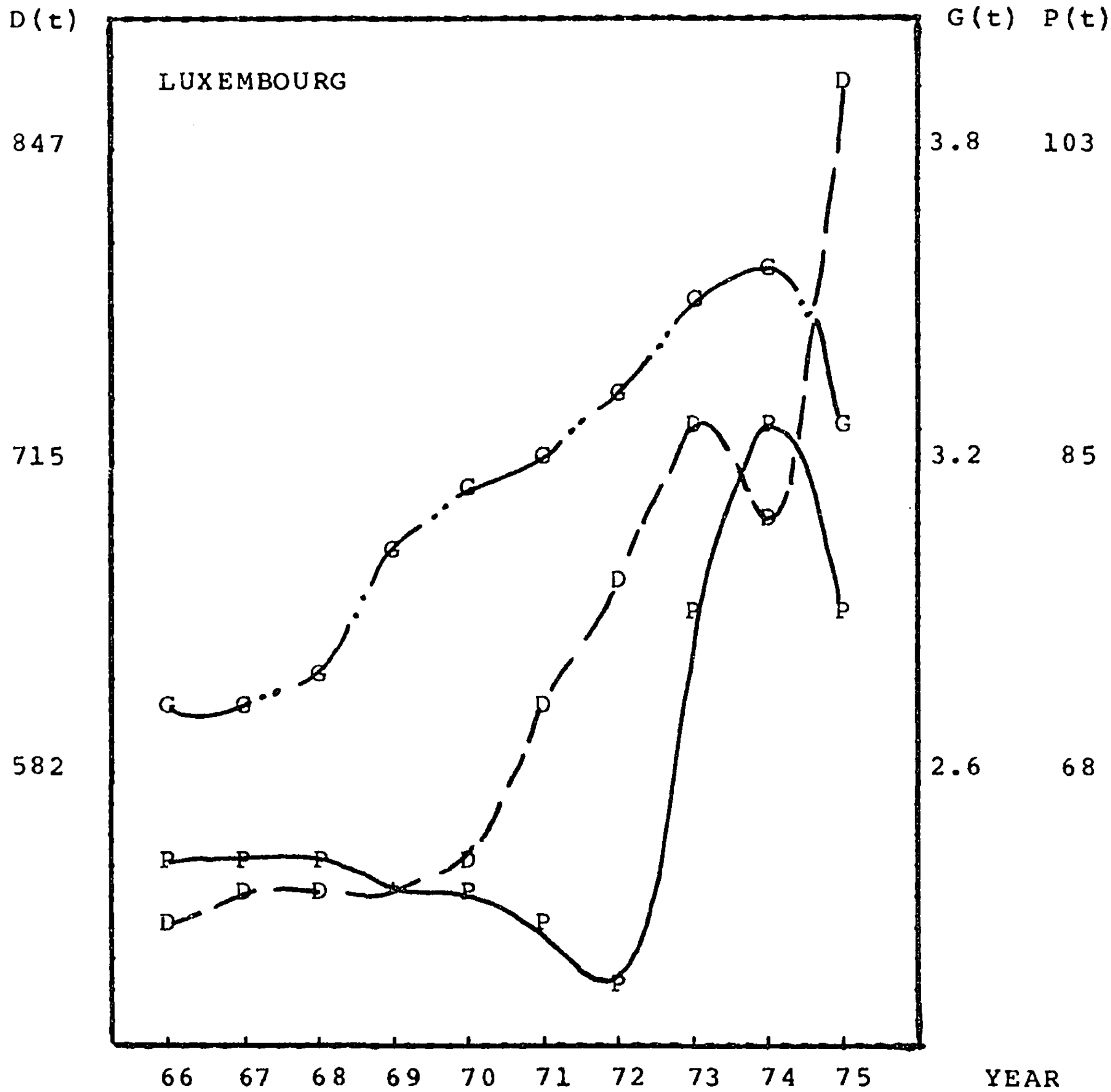


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

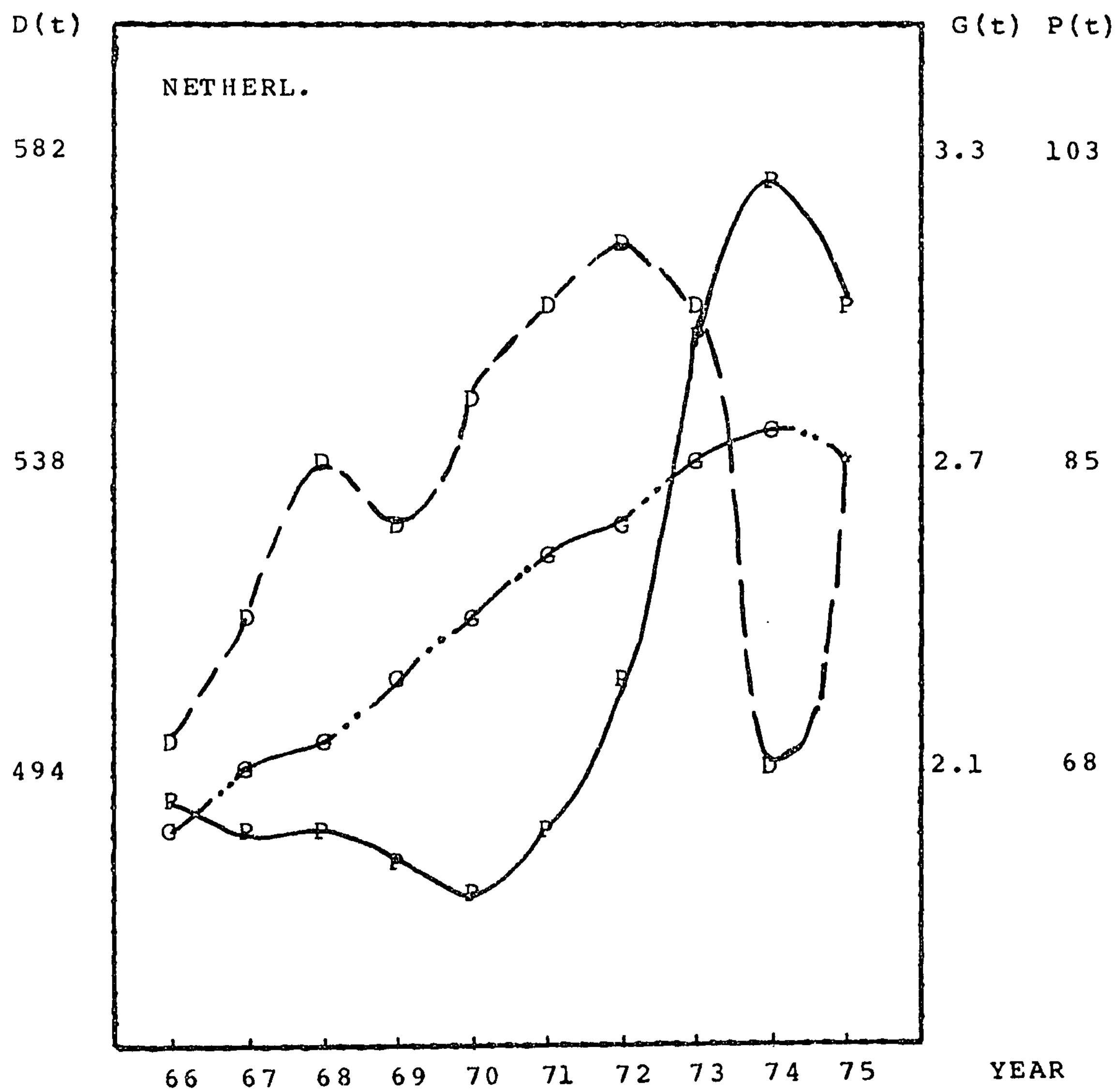
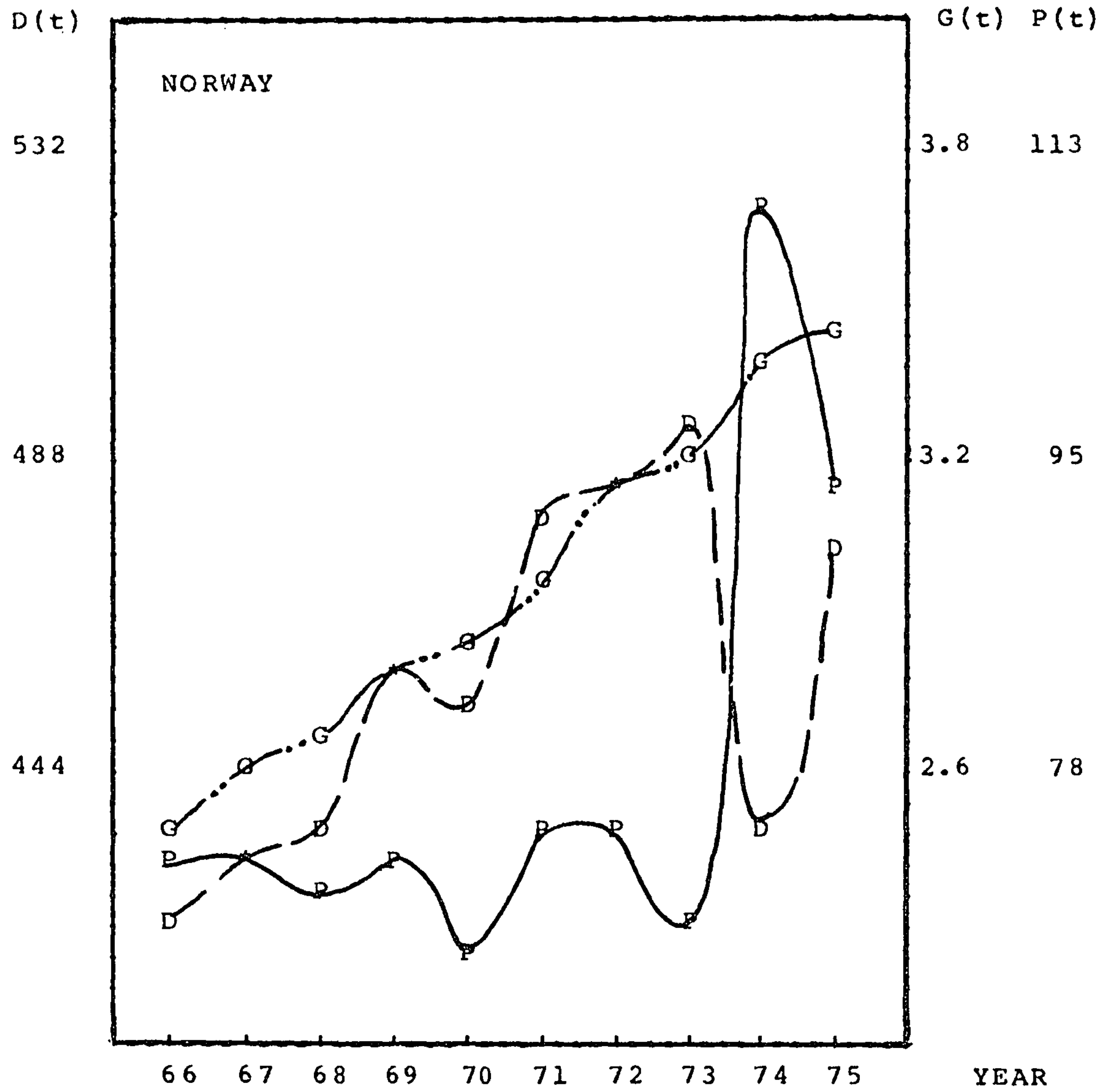


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES



TIME PLOTS VARIOUS COUNTRIES

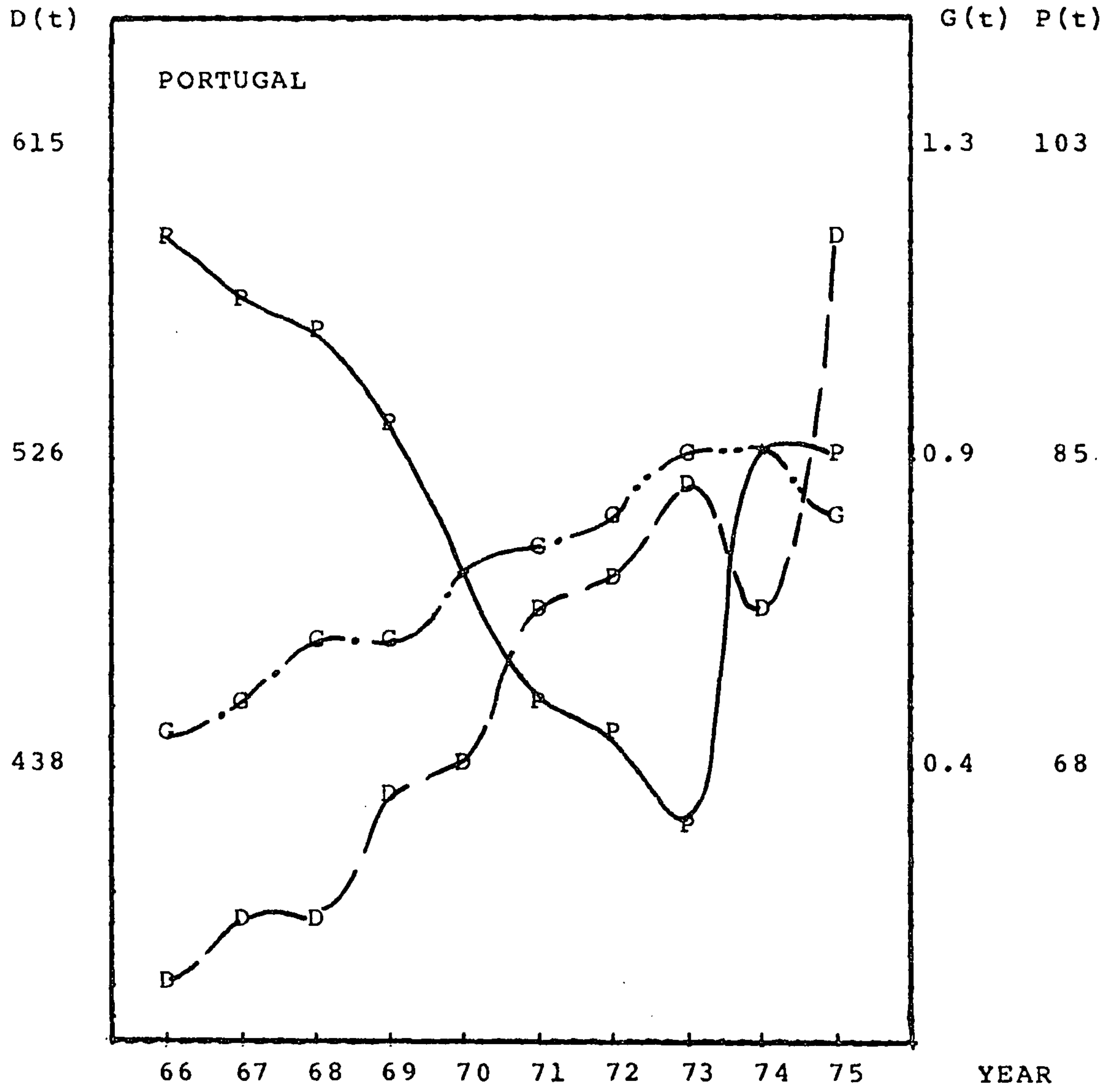


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

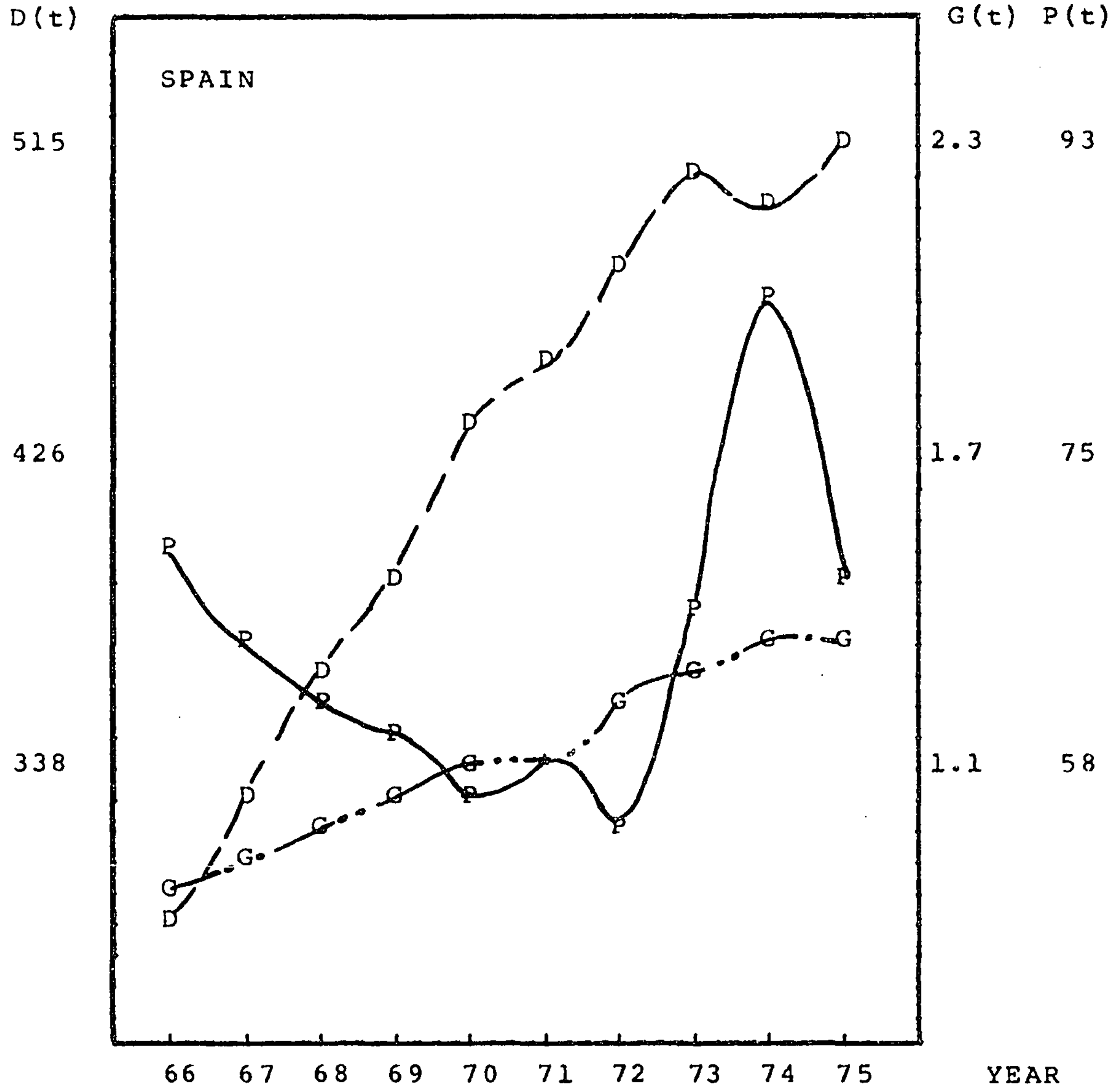


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

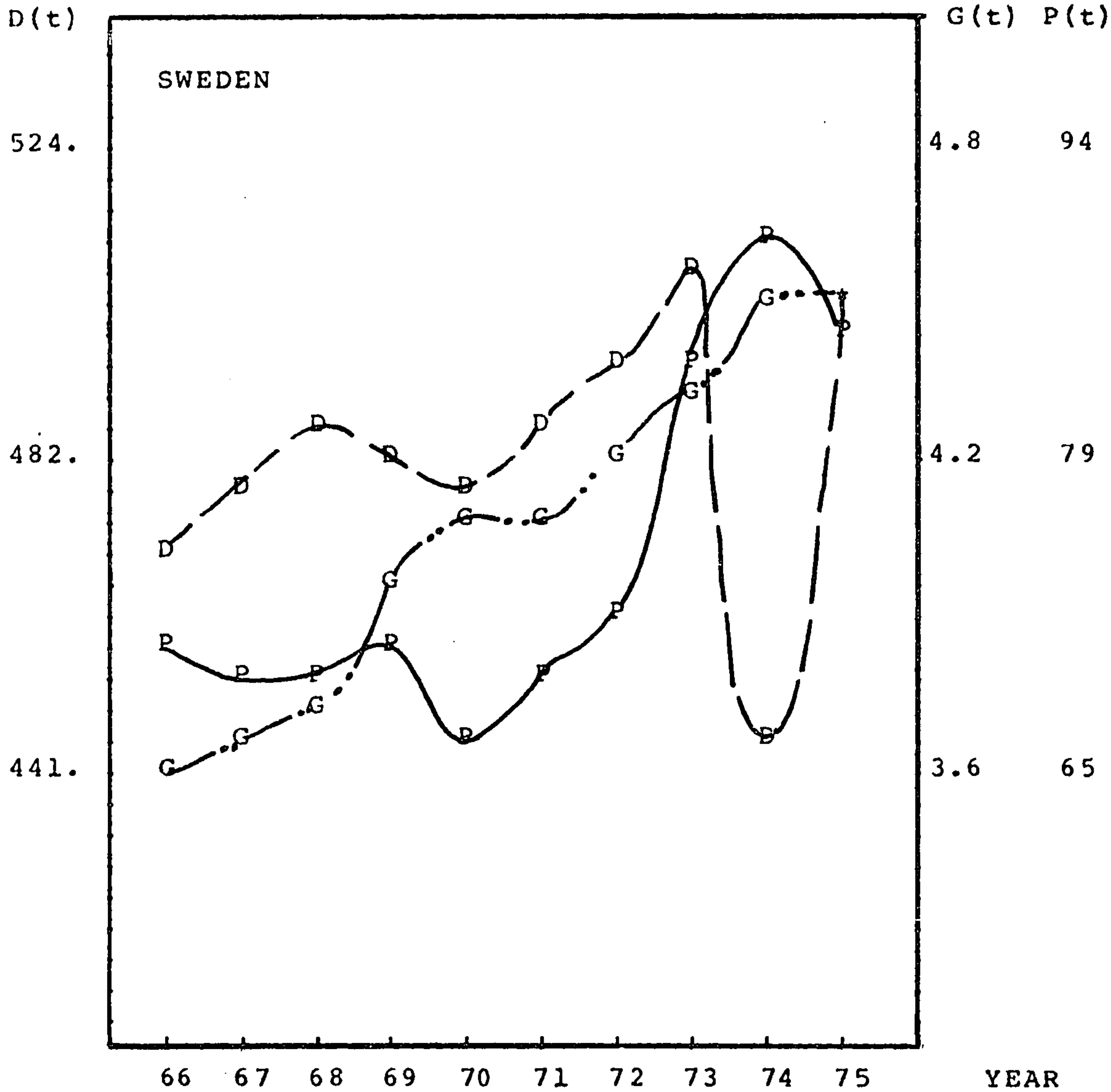


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

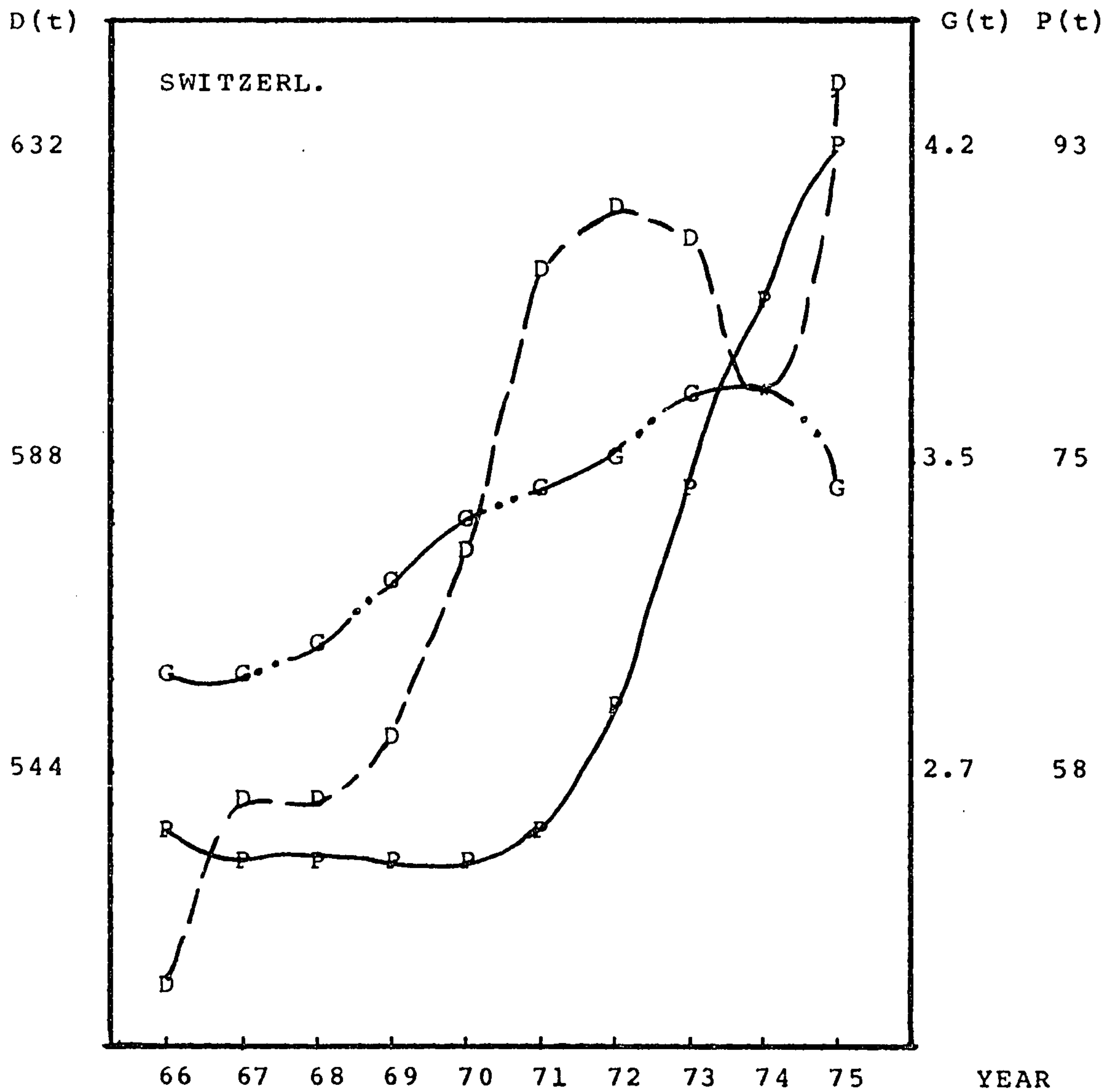


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

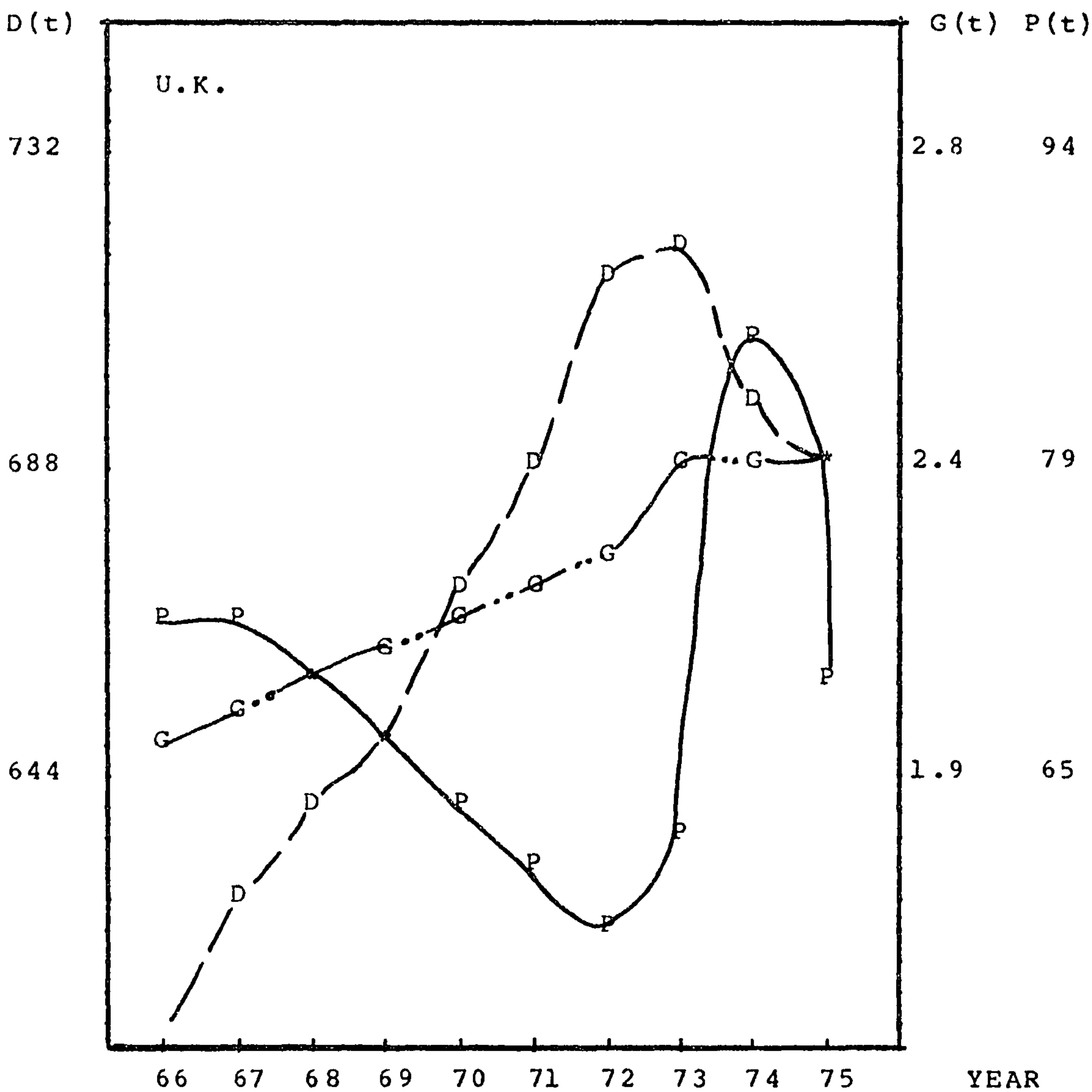


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES

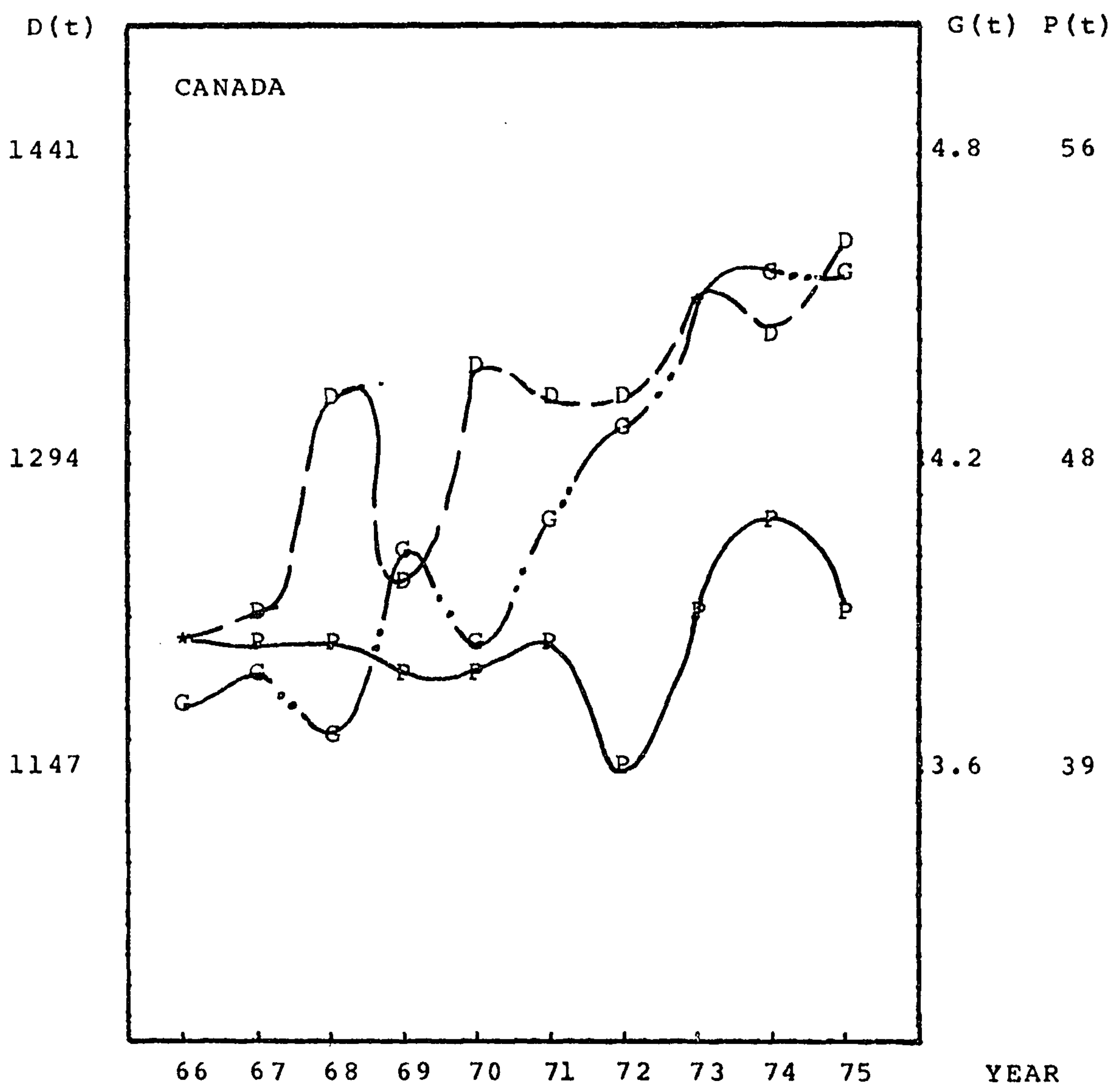
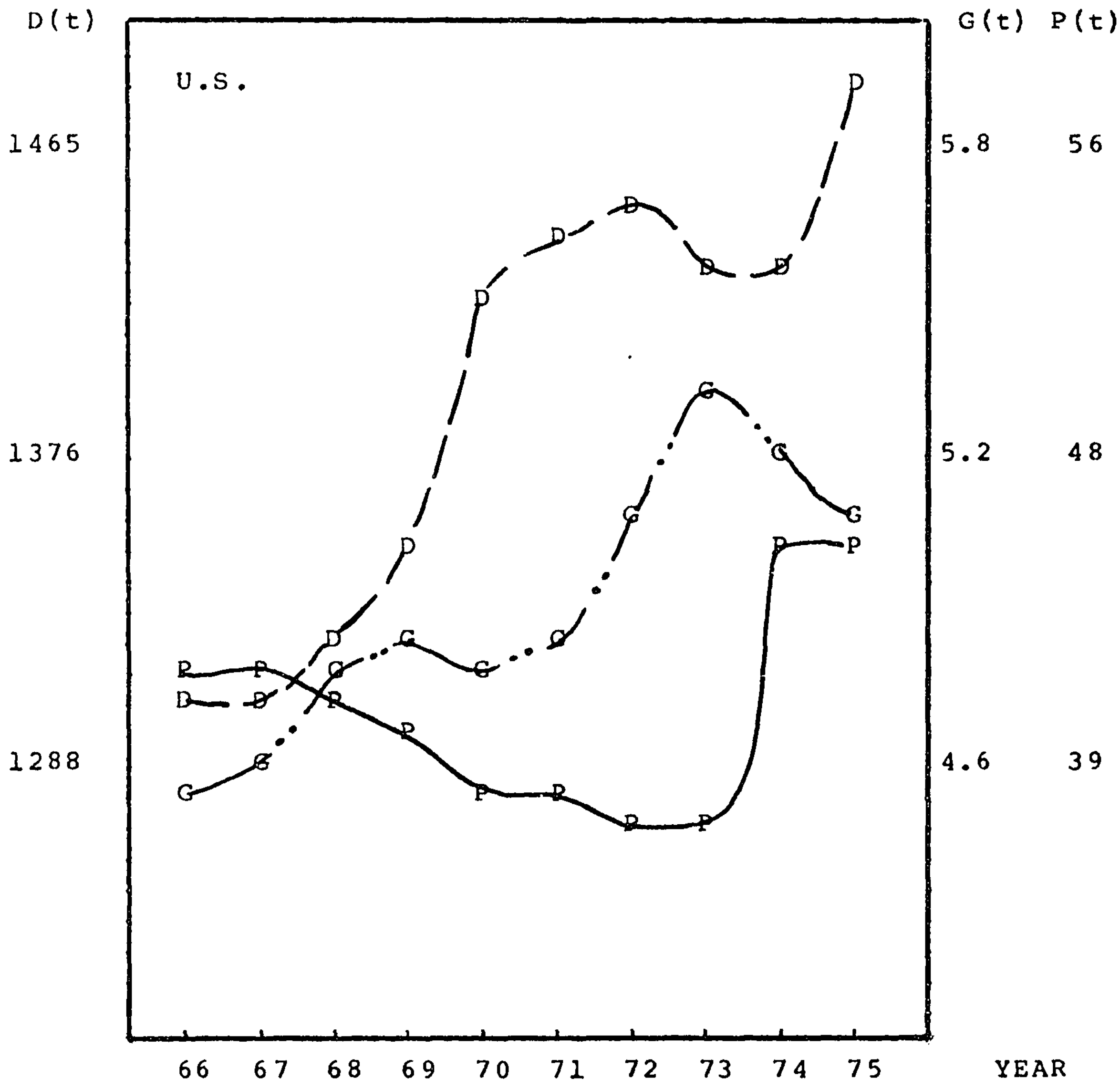


FIGURE II.1 CONTD.

TIME PLOTS VARIOUS COUNTRIES



worth noting that D(t) was minimum at maximum G(t) and maximum P(t).
This could be indicative of the predominant price influence at these specific price levels.

3. It might be argued that the substantial reduction in demand intensity can be attributed to several factors in addition to or other than price increase. Among the possible factors are :

i. The perception of the eminence of the energy crisis that characterized the embargo era.

ii. Conscious efforts to conserve energy in order to meet the political challenge.

iii. Government sponsored regulatory programs, short of rationing, such as imposing speed limits or assigning certain times for the sale of gasoline, might have inconvenienced the consumers, thus reducing demand.

All the above factors are reasonable and probably had some effect. The problem is to assess how much influence can be attributed to price increase and how much to other factors.

Another difficulty arises from the fact that in almost all of the countries, prices decreased in real terms between 1974 and 1975, while demand increased. This makes it impossible to determine whether the 1973-74 demand dip was a temporary immediate reaction to the suddenness of the price increase that would have disappeared anyway, or if the decline was price induced.

In an attempt to answer the above questions, cross section data for all countries were considered at different years. The cross sectional demand intensity did not show the familiar downward sloping demand behavior when price was considered as the independent variable. Using the ratio of current price to current per capita GNP, P.F., as the explanatory variable brought the behavior closer to the economic demand pattern. Demand per capita was then examined as a function of the price factor P.F. and the resulting pattern was quite rational, from an economic theory stand point.

The cross section analysis discussed above is explained in chapter three.

ANALYSIS TECHNIQUE: STEPWISE REGRESSION

Stepwise regression anlysis is used to test the hypothesized models. A good exposition of the method can be found in Draper and Smith (1966, pp. 171-173) who recommend it as the best of the variable selection procedures. In this method, independent variables are entered sequentially into the model according to their corresponding contribution to the response, measured by the partial F criterion. At each stage, the resulting model is reexamined and any variable that provides insignificant contribution is removed from the model.

MULTICOLLINEARITY

In estimating the model coefficients, the stepwise regression algorithm uses Ordinary Least Squares (OLS) as the method of estimation. One of the basic assumptions of OLS regression, applied to the general linear model, is that no linear dependence exists among the explanatory variables. Such dependence is referred to, in econometrics, as multicollinearity and results in "biasing" the estimates of the model parameters, leading to a drop in the estimation precision (Johnston, 1972, p. 160).

While dropping some independent variables which appear as highly correlated with the rest might seem as a cure to the problem, it should be noted that the omission of a variable which belongs to the "correct" equation (which is unfortunately not known a priori) can be the source of a different kind of bias (Christ, 1966, p. 388).

Multicollinearity can also lead to a distortion of the statistical significance of the estimates, leading the investigator to drop variables incorrectly from the analysis, thus causing the problems described above.

The most efficient cure to multicollinearity is to work with large data sets, hence, having substantially high degrees of freedom (the covariances among the estimated parameters are inversely proportional to the sample size).

Unfortunately, short span is almost a characteristic of time series data, and causes a major problem to researchers (Houthaker, 1966, p. 6), with the possible exception of archeologists. Trying to extend their data base, investigators resort to Cross-Section data to make up for the short time series (Stone, 1954), yet facing the problems of interpretation and specification (Meyer, 1957, pp. 380-393).

Christ (1966, p. 389), a highly distinguished econometrician, states that multicollinearity is no disadvantage in predictive models if the joint distribution of the explanatory variables remains unchanged in the forecast period.

In view of the above difficulties and uncertainties, a priori theory coupled with subjective judgement is unavoidable in such an analysis, and in modelling in general, for that matter (Christ, 1962, p. 389; Shannon, 1975, pp. 211-212; Plog, 1974, pp. 150-153).

MULTICOLLINEARITY IN THE PRESENT MODEL

In order to investigate the existence of multicollinearity among the explanatory variables employed in the present research, a principal component analysis was performed on the time series data of the fifteen OECD countries.

Table II.3 depicts a computer print out of the analysis conducted for Austria. The table displays the correlation coefficients matrix, the eigenvalues, the cumulative proportion of total variance and the eigenvectors of the principal components. The correspondence of the variables to the variable numbers given in the table is as follows, in an ascending order: G(t-1), G(t), g(t), D(t-1), d(t), P(t-1), P(t), p(t) and N(t).

The following observations can be made about table II.3:

1. The correlation coefficients matrix shows an extremely strong correlations between both the current and the lagged GNP per capita on the one hand and the number of cars on the other.

2. As may be expected, the current values of the per capita GNP and the price variables are strongly correlated with their corresponding lagged values. It is well known that the introduction of lagged variables presents a dynamic element in the model at the expense of introducing serial correlations.

3. The eigenvalues together with the values of the cumulative proportion of total variance indicate that the dimensionality of the system is at most equal to 4. The latter values show that all the variance in the system is accounted for by only four principal components, the first three of which account for 95% of the variance.

TABLE II.3

PRINCIPAL COMPONENT ANALYSIS FOR AUSTRIA

CORRELATION COEFFICIENT MATRIX

	1	2	3	4	5	6	7	8	9
1	1.0000	.9827	-.3017	.8578	-.6792	.6386	.8112	.7343	.9929
2	.9827	1.0000	-.1215	.9233	-.6531	.5012	.7141	.7538	.9753
3	-.3017	-.1215	1.0000	.1477	.2412	-.8150	-.6715	-.1059	-.2919
4	.8578	.9233	.1477	1.0000	-.6653	.2855	.5654	.7920	.8465
5	-.6792	-.6531	.2412	-.6653	1.0000	-.7305	-.7913	-.4743	-.6559
6	.6386	.5012	-.8150	.2855	-.7305	1.0000	.9190	.3172	.6271
7	.8112	.7141	-.6715	.5654	-.7913	.9190	1.0000	.6631	.7802
8	.7343	.7538	-.1059	.7920	-.4743	.3172	.6631	1.0000	.6852
9	.9929	.9753	-.2919	.8465	-.6559	.6271	.7802	.6852	1.0000

EIGENVALUES

6.1929130	1.8252964	.5488470	.3904964	.0309693	.0076375
.0035340	.0003053	.0000010			

CUMULATIVE PROPORTION OF TOTAL VARIANCE

.69	.89	.95	1.00	1.00	1.00	1.00	1.00
1.00							

EIGENVECTORS

	1	2	3	4	5	6	7	8	9
1	.3887	.0961	.1386	.3008	.1401	.3613	.0185	.2816	.7072
2	.3734	.2276	.0911	.2927	.2169	.4772	.1748	-.0919	-.6332
3	-.1596	.6425	-.3771	-.0242	.5568	-.2687	.1613	.0139	.1019
4	.3334	.3983	-.1028	-.0291	-.6810	-.2308	.4473	.0334	.0231
5	-.3230	.0676	.7641	.2450	.1119	-.2559	.4110	-.0134	.0177
6	.3029	-.4744	-.1739	.0503	.2601	-.3757	.3302	.5491	-.1761
7	.3686	-.2667	.0061	-.2596	.2488	-.0881	.3225	-.7116	.2135
8	.3087	.2392	.4345	-.7176	.1313	-.0392	-.2252	.2588	-.0853
9	.3814	.0981	.1293	.4214	.0149	-.5480	-.5571	-.1896	-.0605

4. Lagged demand intensity is strongly correlated with both the lagged and the current GNP per capita and the number of cars.

The above observations indicate strong mulicollinearity among some of the explanatory variables and may suggest the use of the principal components as explanatory variables instead. This behavior was typical for all other countries.

While regression on the principal components might be useful for purely predictive purposes, it makes any economic or behavioral interpretation of the results impossible. For example, the demand elasticity with respect to any of the principal components would be economically and behaviorally meaningless measure. The reason is obviously the fact that each principal component is a weighted linear combination of all the explanatory variables.

Based on the above analysis, the original explanatory variables of the model were retained and several modifications of the linear model were formulated by separating current from lagged variables and experimenting on the resulting versions by adding or deleting highly correlated variables. Analysis of the resulting formulations served in assessing the effects of multicollinearity. The research methodology is explained in the remainder of this chapter and in chapter III.

It should be pointed out that ridge regression analysis which generates deliberately biased estimators is another good technique for use in situations, like the present model, where the number of variables is large. A good exposition of the ridge regression approach is given in the book edited by Thompson and Foster (1973, pp. 68-123).

RESEARCH METHODOLOGY

The following methodology was followed in the current research:

1. Four different models were hypothesized.

2. Time series data for 15 different countries of the OECD were fitted to the models using stepwise regression analysis.

3. Based on the regression results, the first model was found satisfactory and was further analyzed.

4. Price- and GNP-elasticities of demand were calculated for each country for the various years.

5. The ratio of motor gasoline price in U.S. cents per gallon to the GNP per capita in thousand dollars (P.F.) was suggested as a possible causal influence behind the variability of demand elasticities among various countries. The range of P.F. was subdivided into intervals of 5 units each and average demand elasticities corresponding to each

interval were calculated.

6. Average elasticities were fitted for different functional forms of the variable P.F. and a best least squares fit was chosen.

7. In order to assess the sensitivity of the results to multicollinearity, two versions of the linear model were considered further. In the first version all lagged variables were removed; in the second version, all current variables were dropped and the lagged included.

8. Steps 2 and 4 through 6 were repeated for each of the two versions described in 7 above, once with N(t) included and once without it.

9. Cross sectional data of the fifteen OECD countries were further analyzed in order to gain more insight into the variability of demand over countries.

10. The results of all the previous steps were analyzed, compared and concluded in the form of viable limiting ranges for the various elasticity measures as functions of P.F.

11. The estimated elasticity functions were used to retrospectively forecast demand levels in France, Ireland and Japan. The resulting forecasts showed acceptable accuracy.

12. Finally, two simulation runs were performed. The first run was exploratory; assuming different growth rates in per capita GNP and price levels, scenarios of likely demand behavior were generated. The second simulation was normative demonstrating the use of the research findings as a policy tool. Starting with a specific demand policy; President Carter's energy proposal was used; and assuming that price is the policy control mechanism, a price profile till the year 1990 was generated, which would achieve the consumption goals.

CHAPTER III

TIME SERIES ANALYSIS

Tables III.1 through III.4 display the time series regression results of models I through IV, in two rows for each country. The first row gives the regression estimates of the model parameters and the square of the multiple correlation coefficient (R-SQR.) . The second row contains the F-values associated with these estimates.

As mentioned in chapter II, nine possible explanatory variables were assumed in each model. The stepwise regression algorithm was then used to find those variables with the highest correlative association with demand. It should be pointed out that d(t) was defined in terms of D(t-1) and D(t), and the same is true for g(t) and p(t). Therefore, any one of these triplets (e.g. D(t-1), D(t) and d(t)) is completely collinear.

For the above reason, and in order to improve the precision of the estimates by reducing multicollinearity, the following steps were followed:

1. d(t) was excluded from runs where D(t) was the dependent variable, and vice versa.

2. In choosing the "best" regression equation, the choice was made among models which did not have the

TABLE III.1

REGRESSION COEFFICIENTS FOR MODEL I

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	a(9)	R-SQR
AUSTRIA	486.37	0.00	0.00	0.00	0.00	0.00	0.00	-2.13	135.70	211.04	0.92
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	72.12	35.55	
BELGIUM	597.37	0.00	0.00	161.77	-0.48	0.00	0.00	-2.26	137.86	117.21	0.99
	0.00	0.00	0.00	69.62	0.10	0.00	0.00	0.13	18.04	6.07	
DENMARK	847.27	-123.41	0.00	0.00	0.00	0.00	0.00	-1.19	68.01	127.54	0.[illegible]2
	0.00	45.17	0.00	0.00	0.00	0.00	0.00	0.39	45.98	80.58	
GERMANY	308.05	640.36	-658.13	1410.91	0.24	0.00	0.00	-1.40	94.17	15.12	0.99
	0.00	289.70	262.82	738.81	0.08	0.00	0.00	0.14	17.90	3.14	
ITALY	508.64	-232.19	0.00	-1095.53	1.03	0.00	0.00	-2.49	0.00	10.99	0.98
	0.00	163.11	0.00	390.89	0.37	0.00	0.00	0.39	0.00	6.86	
LUXEMBOURG	104.39	3239.06	-3137.29	8447.60	1.28	0.00	0.00	-8.20	483.97	-21.51	0.99
	0.00	155.83	156.30	492.12	0.09	0.00	0.00	0.44	24.09	6.77	
NETHERL.	991.83	-44.26	-207.08	0.00	0.00	0.00	0.00	-3.19	311.46	128.87	0.99
	0.00	44.34	42.33	0.00	0.00	0.00	0.00	0.19	26.43	11.75	
NORWAY	508.93	0.00	97.05	1372.27	-0.64	0.00	0.00	-3.15	69.79	155.50	0.99
	0.00	0.00	21.78	226.17	0.12	0.00	0.00	0.33	18.87	35.51	

TABLE III.1 CONTD.

REGRESSION COEFFICIENTS FOR MODEL I

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	a(9)	R-SQR
PORTUGAL	318.44	165.25	0.00	-204.95	0.00	0.00	-0.58	0.00	-248.36	120.26	0.99
	0.00	135.03	0.00	104.46	0.00	0.00	0.84	0.00	27.65	49.60	
SPAIN	139.81	0.00	290.91	-257.45	0.33	0.00	0.00	-2.44	68.69	0.00	0.99
	0.00	0.00	71.69	76.89	0.15	0.00	0.00	0.33	18.55	0.00	
SWEDEN	1174.69	0.00	0.00	417.63	-1.35	0.00	0.00	-2.16	320.35	42.29	0.96
	0.00	0.00	0.00	141.82	0.18	0.00	0.00	0.34	38.32	7.92	
SWITZERL.	22.34	210.15	0.00	0.00	0.00	0.00	0.00	-1.33	0.00	0.00	0.91
	0.00	34.90	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	
U.K.	250.35	0.00	0.00	0.00	0.77	0.00	0.00	-1.27	0.00	0.00	0.98
	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.28	0.00	0.00	
CANADA	538.81	0.00	0.00	-1321.16	0.98	0.00	-10.82	0.00	0.00	0.00	0.94
	0.00	0.00	0.00	148.46	0.12	0.00	3.71	0.00	0.00	0.00	
U.S.	161.98	0.00	0.00	-671.61	0.90	0.00	0.00	0.00	0.00	0.00	0.89
	0.00	0.00	0.00	277.65	0.14	0.00	0.00	0.00	0.00	0.00	

TABLE III.2

REGRESSION COEFFICIENTS FOR MODEL II

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	a(9)	R-SQR
AUSTRIA	0.6470	0.1998	0.0000	-1.4090	-0.0008	0.0000	0.0000	-0.0066	0.3900	0.0000	0.9800
	0.0000	0.0620	0.0000	0.5680	0.0003	0.0000	0.0000	0.0008	0.0670	0.0000	
BELGIUM	1.3490	0.0000	0.0000	0.4290	-0.0034	0.0000	0.0006	-0.0053	0.3620	0.2579	0.9900
	0.0000	0.0000	0.0000	0.0001	0.0002	0.0000	0.0017	0.0015	0.1164	0.0150	
DENMARK	2.1214	-0.1310	0.0000	0.0000	-0.0027	0.0000	0.0000	-0.0033	0.1439	0.0000	0.9100
	0.0000	0.0290	0.0000	0.0000	0.0004	0.0000	0.0000	0.0009	0.0900	0.0000	
GERMANY	0.8390	0.0000	-0.1360	-0.5160	-0.0018	0.0000	0.0000	-0.0023	0.1355	0.0404	0.9900
	0.0000	0.0000	0.0510	0.1740	0.0003	0.0000	0.0000	0.0004	0.0323	0.0000	
ITALY	0.1760	0.0000	0.0000	-1.1390	0.0000	0.0000	0.0000	0.0000	-0.2430	-0.0089	0.9600
	0.0000	0.0000	0.0000	0.2000	0.0000	0.0000	0.0000	0.0000	0.0290	0.0000	
LUXEMBOURG	0.1454	4.3260	-4.1530	10.9960	0.0003	0.0000	0.0000	-0.0120	0.6866	-0.0309	0.9900
	0.0000	0.0460	0.0465	0.1460	0.0001	0.0000	0.0000	0.0001	0.0072	0.0020	
NETHERL.	1.8390	0.0000	-0.4070	0.0000	-0.0020	0.0000	0.0000	-0.0059	0.5910	0.2198	0.9900
	0.0000	0.0000	0.0943	0.0000	0.0003	0.0000	0.0000	0.0004	0.0488	0.0264	
NORWAY	1.1020	0.0000	0.2170	2.9678	-0.0036	0.0000	0.0000	-0.0067	0.1550	0.3260	0.9900
	0.0000	0.0000	0.0390	0.4070	0.0002	0.0000	0.0000	0.0006	0.0340	0.0640	

TABLE III.2 CONTD.

REGRESSION COEFFICIENTS FOR MODEL II

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	a(9)	R-SQR
PORTUGAL	0.5703	0.0000	0.5940	-0.7830	-0.0024	0.0000	0.0000	0.0000	-0.4760	0.2020	0.9800
	0.0000	0.0000	0.2430	0.2930	0.0007	0.0000	0.0000	0.0000	0.0690	0.1250	
SPAIN	0.3994	0.0000	0.9450	-0.9670	-0.0023	0.0000	-0.0034	-0.0031	0.0000	0.0000	0.9800
	0.0000	0.0000	0.1830	0.1810	0.0004	0.0000	0.0007	0.0005	0.0000	0.0000	
SWEDEN	2.3990	0.0000	0.0000	0.0000	-0.0048	0.0000	0.0000	-0.0042	0.6310	0.0899	0.9800
	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0007	0.0770	0.0000	
SWITZERL.	0.1960	0.7227	-0.3590	0.0000	-0.0017	0.0000	-0.0064	0.0000	0.0000	0.0000	0.9600
	0.0000	0.0700	0.0570	0.0000	0.0003	0.0000	0.0008	0.0000	0.0000	0.0000	
U.K.	0.4982	-0.1390	0.0000	-0.5414	0.0000	0.0000	0.0000	-0.0024	0.0492	0.0000	0.8800
	0.0000	0.0290	0.0000	0.3560	0.0000	0.0000	0.0000	0.0010	0.0489	0.0000	
CANADA	0.4440	0.0000	-0.0200	-1.0350	0.0000	0.0000	0.0640	-0.0716	2.9760	0.0000	0.9800
	0.0000	0.0000	0.0135	0.0784	0.0000	0.0000	0.0310	0.0299	1.2640	0.0000	
U.S.	0.0252	0.0000	0.0000	-0.6990	0.0000	0.0000	0.0000	0.0000	-0.2070	0.0000	0.8900
	0.0000	0.0000	0.0000	0.0012	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	

TABLE III.3

REGRESSION COEFFICIENTS FOR MODEL III

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	a(9)	R-SQR
AUSTRIA	7.9306	0.0000	0.0000	-1.2979	0.0000	0.0000	-0.3781	0.0000	0.0000	0.4741	0.9500
	0.0000	0.0000	0.0000	0.5928	0.0000	0.0000	0.0978	0.0000	0.0000	0.0483	
BELGIUM	10.4270	0.0000	0.0000	0.0000	-0.4996	0.0000	0.0000	-0.3829	0.2807	0.5631	0.9800
	0.0000	0.0000	0.0000	0.0000	0.1594	0.0000	0.0000	0.0409	0.0635	0.0516	
DENMARK	11.8990	-0.8285	0.0000	0.0000	-0.5426	0.0000	0.0000	-0.3084	0.2608	0.3203	0.9700
	0.0000	0.1944	0.0000	0.0000	0.1877	0.0000	0.0000	0.0615	0.0800	0.1446	
GERMANY	5.4075	0.0000	-0.6445	-0.3709	0.0000	0.0000	-0.1587	0.0000	0.0000	0.8002	0.9900
	0.0000	0.0000	0.1622	0.1713	0.0000	0.0000	0.0245	0.0000	0.0000	0.0925	
ITALY	7.9239	0.0000	-1.1621	0.0000	0.0000	0.0000	-0.2232	-0.4281	0.0000	0.8069	0.9700
	0.0000	0.0000	0.5052	0.0000	0.0000	0.0000	0.1300	0.0747	0.0000	0.2155	
LUXEMBOURG	1.3622	1.0531	-0.7465	0.0000	0.8628	0.0000	7.2637	-7.4530	6.5386	0.0000	0.9900
	0.0000	0.3691	0.3344	0.0000	0.1937	0.0000	1.2986	1.2418	1.1096	0.0000	
NETHERL.	11.0193	0.0000	-1.0180	0.0000	-0.4226	0.0000	-0.4436	0.0000	0.2631	0.6654	0.9600
	0.0000	0.0000	0.4606	0.0000	0.2206	0.0000	0.0598	0.0000	0.0911	0.1588	
NORWAY	11.8920	0.0000	0.6057	3.3990	-0.6949	0.0000	-0.1145	-0.4082	0.0000	0.3241	0.9900
	0.0000	0.0000	0.1778	0.7317	0.1739	0.0000	0.0599	0.0387	0.0000	0.0884	

TABLE III.3 CONTD.

REGRESSION COEFFICIENTS FOR MODEL III

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	a(9)	R-SQR
PORTUGAL	6.2790	0.0000	0.0000	-0.2986	0.0000	0.0000	0.0000	0.0000	-0.3946	0.3312	0.9600
	0.0000	0.0000	0.0000	0.0770	0.0000	0.0000	0.0000	0.0000	0.0391	0.0113	
SPAIN	3.1438	0.0000	0.0000	0.0000	0.5792	0.0000	0.0000	-0.1771	0.0000	0.1519	0.9900
	0.0000	0.0000	0.0000	0.0000	0.1864	0.0000	0.0000	0.0435	0.0000	0.0920	
SWEDEN	15.6915	-0.3030	0.0000	0.6372	-1.2921	0.0000	0.0000	-0.3435	0.6718	0.3841	0.9600
	0.0000	0.5200	0.0000	0.5316	0.2975	0.0000	0.0000	0.0618	0.0925	0.3053	
SWITZERL.	6.0169	1.3809	0.0000	-0.7934	0.0000	0.0000	0.0000	-0.3088	0.0000	0.0000	0.9700
	0.0000	0.1499	0.0000	0.2906	0.0000	0.0000	0.0000	0.0757	0.0000	0.0000	
U.K.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
CANADA	1.0309	1.1039	-1.1501	0.0000	1.0755	0.0000	-0.3899	0.0000	0.0000	0.0000	0.9600
	0.0000	0.1633	0.2900	0.0000	0.3129	0.0000	0.1314	0.0000	0.0000	0.0000	
U.S.	0.6796	0.0000	0.0000	-0.7553	0.9488	0.0000	0.0000	-0.0766	-0.1638	0.0000	0.9800
	0.0000	0.0000	0.0000	0.1136	0.0752	0.0000	0.0000	0.0579	0.0495	0.0000	

TABLE III.4

REGRESSION COEFFICIENTS FOR MODEL IV

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	a(9)	R-SQR
AUSTRIA	1.2767	0.0000	0.0000	-1.1940	0.0000	0.0000	0.0000	-0.2892	0.0000	0.0000	0.7300
	0.0000	0.0000	0.0000	0.6650	0.0000	0.0000	0.0000	0.0695	0.0000	0.0000	
BELGIUM	10.0800	0.0000	0.0000	0.0000	-1.4420	0.0000	0.5820	-0.9615	0.8070	0.5357	0.9900
	0.0000	0.0000	0.0000	0.0000	0.1640	0.0000	0.4040	0.4060	0.3720	0.0560	
DENMARK	11.7600	-1.1073	0.0000	-0.6241	-1.4384	0.0000	0.0000	-0.3665	0.3275	0.5314	0.[illegible]800
	0.0000	0.2120	0.0000	0.3193	0.1450	0.0000	0.0000	0.0588	0.0718	0.1580	
GERMANY	4.9509	-0.6846	0.0000	-1.0956	-0.9117	0.0000	0.0000	-0.1634	0.1223	0.7929	0.9800
	0.0000	0.2262	0.0000	0.1862	0.1510	0.0000	0.0000	0.0355	0.0396	0.1344	
ITALY	3.1634	0.0000	0.0000	0.0000	-0.6915	0.0000	-2.4972	2.6746	-2.5220	0.1928	0.9900
	0.0000	0.0000	0.0000	0.0000	0.1257	0.0000	0.2854	0.3399	0.2834	0.0502	
LUXEMBOURG	0.6748	0.2097	0.0000	-0.7759	0.0000	0.0000	8.1096	-8.3170	7.2481	0.0000	0.9800
	0.0000	0.1022	0.0000	0.3314	0.0000	0.0000	1.3036	1.2555	1.1174	0.0000	
NETHERL.	10.8565	0.0000	-0.9685	0.0000	-1.4124	0.0000	-0.4244	0.0000	0.2518	0.6422	0.9800
	0.0000	0.0000	0.4171	0.0000	0.1998	0.0000	0.0541	0.0000	0.0825	0.1438	
NORWAY	9.2879	0.6268	0.0000	2.5231	-1.4006	0.0000	-1.1361	0.8064	-0.9407	0.2011	0.9900
	0.0000	0.0998	0.0000	0.7000	0.1562	0.0000	0.4011	0.4736	0.3713	0.0684	

TABLE III.4 CONTD.

REGRESSION COEFFICIENTS FOR MODEL IV

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	a(9)	R-SQR
PORTUGAL	2.8965	0.0000	0.0000	-1.3375	-0.2536	0.0000	-0.2791	0.0000	-0.6760	0.0000	0.9500
	0.0000	0.0000	0.0000	0.2219	0.2387	0.0000	0.2123	0.0000	0.1029	0.0000	
SPAIN	7.7785	0.0000	-0.2682	0.0000	-1.1816	0.0000	0.0000	-0.3100	0.2235	0.5882	0.9900
	0.0000	0.0000	0.1733	0.0000	0.1588	0.0000	0.0000	0.0426	0.0377	0.0836	
SWEDEN	15.9140	0.0000	0.0000	0.8402	-2.3868	0.0000	0.0000	-0.3209	0.6430	0.2114	0.9900
	0.0000	0.0000	0.0000	0.2963	0.1802	0.0000	0.0000	0.0539	0.0813	0.0396	
SWITZERL.	0.8982	0.4067	0.0000	-1.5346	0.0000	0.0000	-0.3202	0.0000	-0.3780	0.0000	0.8400
	0.0000	0.1991	0.0000	0.3814	0.0000	0.0000	0.0978	0.0000	0.1862	0.0000	
U.K.	0.7317	-0.2742	0.0000	-0.2953	0.0000	0.0000	0.0000	-0.1171	0.0000	0.0000	0.8700
	0.0000	0.0516	0.0000	0.2378	0.0000	0.0000	0.0000	0.0369	0.0000	0.0000	
CANADA	-2.5020	0.0000	-0.4589	-1.2210	0.4984	0.0000	9.5236	-9.6278	9.6690	0.0000	0.9900
	0.0000	0.0000	0.1439	0.0997	0.2172	0.0000	2.7630	2.6690	2.6950	0.0000	
U.S.	2.2458	0.0000	-0.7409	0.0000	0.0000	0.0000	0.0000	0.0000	-0.1830	0.0000	0.9100
	0.0000	0.0000	0.1062	0.0000	0.0000	0.0000	0.0000	0.0493	0.0420	0.0000	

"triplets" appearing simaltaneously, unless such models showed highly insignificent parameter estimates. Notably, the models not containing the triplets displayed higher statistical significance of the parameter estimates in most cases.

Tables III.1 through III.4 distinctly indicate that, while the values of R-SQR. were generally high for all four models, the statistical significance of the estimates (measured by the F-values) was much better for model I.

Model I was therefore adopted and further analyzed.

Further analysis of the model was designed for the purpose of exploring the tendency of the estimates of the model parameters to vary upon deleting various variables. Such variability can serve as a measure of the regression sensitivity to multicollinearity among the explanatory variables. The analysis was systematically pursued by considering the following different modifications of model I:

Model I.1: Model I with lagged variables removed.

In this version of the model, the lagged variables were removed resulting in the following mathematical form:

$$D(t)=a(0)+a(2).G(t)+a(3).g+a(6).P(t)+a(7).p+a(8).N(t) \quad [3.1]$$

Note that the parameter subscripts of model I, with

TABLE III.5

REGRESSION COEFFICIENTS FOR MODEL I.1

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
AUSTRIA	759.71	0.00	-306.96	0.00	0.00	0.00	-2.98	270.32	474.14	0.97
	0.00	0.00	8.30	0.00	0.00	0.00	36.97	16.14	25.24	
BELGIUM	474.32	0.00	-65.24	0.00	0.00	0.00	-1.79	120.34	134.44	0.98
	0.00	0.00	3.87	0.00	0.00	0.00	80.27	21.74	33.54	
DENMARK	1016.52	0.00	-192.92	0.00	0.00	0.00	-2.38	160.25	239.45	0.96
	0.00	0.00	18.39	0.00	0.00	0.00	36.18	11.32	9.63	
GERMANY	475.41	0.00	-104.32	0.00	0.00	0.00	-1.04	64.14	26.11	0.98
	0.00	0.00	16.04	0.00	0.00	0.00	20.39	10.39	84.22	
ITALY	586.02	0.00	0.00	0.00	0.00	0.00	-2.38	0.00	17.21	0.96
	0.00	0.00	0.00	0.00	0.00	0.00	20.81	0.00	81.28	
LUXEMBOURG	-199.63	0.00	276.62	-1702.58	0.00	0.00	0.00	0.00	0.00	0.87
	0.00	0.00	26.28	20.78	0.00	0.00	0.00	0.00	0.00	
NETHERL.	979.74	0.00	-236.44	0.00	0.00	0.00	-3.27	320.85	123.67	0.99
	0.00	0.00	60.36	0.00	0.00	0.00	359.37	164.20	137.95	
NORWAY	351.15	0.00	0.00	1005.77	0.00	0.00	-1.62	0.00	211.64	0.95
	0.00	0.00	0.00	5.57	0.00	0.00	45.89	0.00	100.63	

TABLE III.5 CONTD.

REGRESSION COEFFICIENTS FOR MODEL I.1

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
PORTUGAL	244.05	0.00	194.95	-296.59	0.00	0.00	0.00	-234.24	125.20	0.99
	0.00	0.00	6.62	7.76	0.00	0.00	0.00	109.11	9.06	
SPAIN	137.67	0.00	449.93	-315.61	0.00	0.00	-3.09	95.76	0.00	0.99
	0.00	0.00	1735.51	10.59	0.00	0.00	222.78	25.89	0.00	
SWEDEN	878.09	0.00	-208.52	329.25	0.00	0.00	-1.93	246.38	236.68	0.81
	0.00	0.00	7.79	1.01	0.00	0.00	6.27	10.09	10.16	
SWITZERL.	238.66	0.00	135.07	-1176.12	0.00	0.00	-3.35	183.79	74.28	0.99
	0.00	0.00	7.78	26.62	0.00	0.00	51.79	6.99	3.66	
U.K.	350.08	0.00	217.89	0.00	0.00	0.00	-2.39	60.92	0.00	0.96
	0.00	0.00	89.26	0.00	0.00	0.00	19.58	3.89	0.00	
CANADA	1608.41	0.00	0.00	612.49	0.00	0.00	-13.61	441.56	35.43	0.94
	0.00	0.00	0.00	15.89	0.00	0.00	5.90	6.75	47.14	
U.S.	2415.68	0.00	-229.23	0.00	0.00	0.00	-18.88	292.74	7.72	0.96
	0.00	0.00	11.19	0.00	0.00	0.00	22.47	5.58	46.48	

that of d(t) removed, were maintained in the current and subsequent models for the ease of inter model comparisons.

Table III.5 contains the regression results of model I.1. The zero columns in the table (and the tables of the subsequent models) correspond to the originally hypothesized variables which are absent in the current model.

Model I.2: Model I.1 With N(t) Removed

Due to the high correlation of N(t) with several of the model variables, it was removed in the current version of model I resulting in the following model:

$$D(t)=a(0)+a(2).G(t)+a(3).g+a(6).P(t)+a(7).p \qquad [3.2]$$

The regression results of model I.2 are displayed in table III.6.

Model I.3: Model I With Current Variables Removed

Removing the current variables from model I resulted in model I.3 having the following mathematical form:

$$D(t)=a(0)+a(1).G(t-1)+a(3).g+a(4).D(t-1)+a(5).P(t-1)+a(7).p \qquad [3.3]$$

Table III.7 contains the regression coefficients of model I.3.

Model I.4: Model I.3 With N(t) Added And D(t-1) Removed

Again, N(t) was inserted in model I.3 due to its strong correlation with the explanatory variables resulting in the

TABLE III.6

REGRESSION COEFFICIENTS FOR MODEL I.2

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
AUSTRIA	283.03	0.00	228.41	0.00	0.00	0.00	-1.13	0.00	0.00	0.81
	0.00	0.00	22.20	0.00	0.00	0.00	4.60	0.00	0.00	
BELGIUM	315.12	0.00	122.21	0.00	0.00	0.00	-2.12	0.00	0.00	0.88
	0.00	0.00	50.79	0.00	0.00	0.00	5.72	0.00	0.00	
DENMARK	810.86	0.00	-50.24	0.00	0.00	0.00	-1.34	0.00	0.00	0.86
	0.00	0.00	14.87	0.00	0.00	0.00	11.71	0.00	0.00	
GERMANY	180.73	0.00	127.32	-558.55	0.00	0.00	-0.77	0.00	0.00	0.85
	0.00	0.00	16.15	6.69	0.00	0.00	1.76	0.00	0.00	
ITALY	179.32	0.00	235.29	0.00	0.00	0.00	0.00	-136.54	0.00	0.89
	0.00	0.00	53.03	0.00	0.00	0.00	0.00	15.05	0.00	
LUXEMBOURG	-199.63	0.00	276.82	-1702.58	0.00	0.00	0.00	0.00	0.00	0.87
	0.00	0.00	26.26	20.78	0.00	0.00	0.00	0.00	0.00	
NETHERL.	418.10	0.00	108.85	0.00	0.00	0.00	-1.98	88.13	0.00	0.69
	0.00	0.00	8.02	0.00	0.00	0.00	9.30	1.39	0.00	
NORWAY	309.68	0.00	99.65	0.00	0.00	0.00	-1.87	0.00	0.00	0.90
	0.00	0.00	64.25	0.00	0.00	0.00	3.89	0.00	0.00	

TABLE III.6 CONTD.

REGRESSION COEFFICIENTS FOR MODEL I.2

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
PORTUGAL	186.21	0.00	418.21	-599.37	0.00	0.00	0.00	-263.48	0.00	0.98
	0.00	0.00	305.76	124.91	0.00	0.00	0.00	72.51	0.00	
SPAIN	137.67	0.00	449.93	-315.61	0.00	0.00	-3.09	95.76	0.00	0.99
	0.00	0.00	1736.00	10.59	0.00	0.00	222.78	25.90	0.00	
SWEDEN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SWITZERL.	-30.71	0.00	247.39	-1463.59	0.00	0.00	-2.94	0.00	0.00	0.97
	0.00	0.00	93.74	39.07	0.00	0.00	20.89	0.00	0.00	
U.K.	253.54	0.00	238.40	0.00	0.00	0.00	-1.65	0.00	0.00	0.94
	0.00	0.00	94.89	0.00	0.00	0.00	12.79	0.00	0.00	
CANADA	785.83	0.00	134.98	-780.98	0.00	0.00	0.00	0.00	0.00	0.83
	0.00	0.00	19.85	13.87	0.00	0.00	0.00	0.00	0.00	
U.S.	564.54	0.00	171.59	-674.81	0.00	0.00	0.00	0.00	0.00	0.69
	0.00	0.00	10.77	2.11	0.00	0.00	0.00	0.00	0.00	

following form for model I.4:

$$D(t)=a(0)+a(1).G(t-1)+a(3).g+a(5).P(t-1)+a(7).p+a(8).N(t) \quad [3.4]$$

The results of the stepwise regression of D(t) on the explanatory variables in model I.4 are displayed in table III.8.

Model I.5: Model I.3 With D(t-1) Removed

An examination of table III.7 reveals that D(t-1) has coefficients for only four out of the fifteen OECD countries. It was decided to remove it and to study the resulting effects on the parameter estimates. Model I.5 has the following form:

$$D(t)=a(0)+a(1).G(t-1)+a(3).g+a(5).P(t-1)+a(7).p \quad [3.5]$$

Table III.9 contains the regression coefficients of model I.5.

The elasticities of demand with respect to the current and the lagged prices and per capita GNP were then calculated using formulae 2.7, 2.8, 2.15 and 2.16. The results were as follows:

THE P(t) ELASTICITY OF DEMAND

Results Of Model I

The elasticities of demand intensity with respect to current prices, E(D(t),P(t)), were calculated for the OECD

TABLE III.7

REGRESSION COEFFICIENTS FOR MODEL I.3

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
AUSTRIA	357.59	233.51	0.00	0.00	0.00	-2.29	0.00	0.00	0.00	0.85
	0.00	37.48	0.00	0.00	0.00	8.02	0.00	0.00	0.00	
BELGIUM	305.36	124.48	0.00	318.98	0.00	0.00	0.00	-2.09	0.00	0.89
	0.00	47.62	0.00	3.58	0.00	0.00	0.00	23.18	0.00	
DENMARK	788.44	-51.41	0.00	0.00	0.00	0.00	0.00	-1.06	0.00	0.87
	0.00	17.45	0.00	0.00	0.00	0.00	0.00	7.00	0.00	
GERMANY	147.66	135.89	0.00	0.00	0.00	0.00	0.00	-0.75	0.00	0.83
	0.00	20.10	0.00	0.00	0.00	0.00	0.00	1.80	0.00	
ITALY	319.63	283.88	0.00	0.00	0.00	0.00	0.00	-2.38	0.00	0.92
	0.00	69.62	0.00	0.00	0.00	0.00	0.00	17.97	0.00	
LUXEMBOURG	-221.04	282.80	0.00	-775.65	0.00	0.00	0.00	0.00	0.00	0.88
	0.00	28.50	0.00	3.79	0.00	0.00	0.00	0.00	0.00	
NETHERL.	696.33	234.10	0.00	0.00	-0.96	-3.15	0.00	0.00	0.00	0.80
	0.00	9.86	0.00	0.00	3.75	12.27	0.00	0.00	0.00	
NORWAY	259.12	113.68	0.00	1114.99	0.00	0.00	0.00	-2.13	0.00	0.93
	0.00	75.73	0.00	5.09	0.00	0.00	0.00	45.88	0.00	

TABLE III.7 CONTD.

REGRESSION COEFFICIENTS FOR MODEL I.3

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
PORTUGAL	-113.62	604.72	0.00	0.00	0.00	5.03	0.00	-3.27	0.00	0.98
	0.00	187.09	0.00	0.00	0.00	50.08	0.00	38.94	0.00	
SPAIN	139.82	335.97	0.00	0.26	0.00	1.38	0.00	-1.33	0.00	0.99
	0.00	23.16	0.00	3.24	0.00	17.68	0.00	86.47	0.00	
SWEDEN	1246.02	46.78	0.00	570.96	-1.66	-4.62	0.00	2.40	0.00	0.95
	0.00	20.78	0.00	9.45	48.06	47.27	0.00	15.65	0.00	
SWITZERL.	-48.27	252.40	0.00	-581.57	0.00	0.00	0.00	-2.95	0.00	0.97
	0.00	100.64	0.00	11.74	0.00	0.00	0.00	22.54	0.00	
U.K.	250.35	0.00	0.00	0.00	0.77	0.00	0.00	-1.26	0.00	0.98
	0.00	0.00	0.00	0.00	268.53	0.00	0.00	20.15	0.00	
CANADA	693.97	155.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79
	0.00	30.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
U.S.	71.37	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.75
	0.00	0.00	0.00	0.00	30.58	0.00	0.00	0.00	0.00	

TABLE III.8

REGRESSION COEFFICIENTS FOR MODEL I.4

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
AUSTRIA	496.43	0.00	0.00	0.00	0.00	-2.30	0.00	0.00	210.80	0.90
	0.00	0.00	0.00	0.00	0.00	12.53	0.00	0.00	60.69	
BELGIUM	407.10	0.00	0.00	0.00	0.00	-1.94	0.00	-87.59	94.46	0.95
	0.00	0.00	0.00	0.00	0.00	42.15	0.00	13.58	111.57	
DENMARK	1023.00	-222.73	0.00	-530.75	0.00	-2.18	0.00	0.00	23.80	0.95
	0.00	23.16	0.00	5.25	0.00	14.91	0.00	0.00	12.50	
GERMANY	465.44	-86.74	0.00	-419.00	0.00	-1.07	0.00	0.00	23.80	0.98
	0.00	8.17	0.00	30.64	0.00	33.01	0.00	0.00	51.54	
ITALY	698.67	0.00	0.00	-419.56	0.00	-3.59	0.00	-239.83	18.06	0.96
	0.00	0.00	0.00	2.94	0.00	12.42	0.00	28.63	62.94	
LUXEMBOURG	-221.00	282.80	0.00	-775.70	0.00	0.00	0.00	0.00	0.00	0.88
	0.00	28.49	0.00	3.79	0.00	0.00	0.00	0.00	0.00	
NETHERL.	1108.30	-319.97	0.00	-652.90	0.00	-3.51	0.00	75.29	154.10	0.98
	0.00	41.23	0.00	20.75	0.00	149.74	0.00	7.12	78.67	
NORWAY	319.52	0.00	0.00	1164.10	0.00	-1.23	0.00	-116.09	208.92	0.95
	0.00	0.00	0.00	3.47	0.00	14.70	0.00	30.11	74.17	

TABLE III.8 CONTD.

REGRESSION COEFFICIENTS FOR MODEL I.4

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
PORTUGAL	225.80	234.33	0.00	-145.20	0.00	0.00	0.00	-238.50	109.81	0.99
	0.00	7.47	0.00	7.10	0.00	0.00	0.00	114.14	6.03	
SPAIN	349.06	135.43	0.00	0.00	0.00	-3.01	0.00	-78.96	38.11	0.99
	0.00	2.10	0.00	0.00	0.00	677.47	0.00	90.97	12.55	
SWEDEN	835.89	-177.74	0.00	-397.02	0.00	-2.34	0.00	0.00	216.42	0.70
	0.00	4.91	0.00	2.12	0.00	7.65	0.00	0.00	6.63	
SWITZERL.	113.36	215.24	0.00	-744.20	0.00	-3.75	0.00	0.00	0.00	0.94
	0.00	286.84	0.00	32.11	0.00	52.92	0.00	0.00	0.00	
U.K.	613.56	0.00	0.00	0.00	0.00	-3.07	0.00	-71.45	19.01	0.98
	0.00	0.00	0.00	0.00	0.00	149.08	0.00	26.13	378.70	
CANADA	1923.71	-118.75	0.00	-877.78	0.00	-14.94	0.00	0.00	61.19	0.96
	0.00	2.31	0.00	15.98	0.00	11.48	0.00	0.00	11.81	
U.S.	2276.25	-196.49	0.00	-1125.63	0.00	-17.28	0.00	-401.52	7.00	0.96
	0.00	3.93	0.00	7.94	0.00	14.68	0.00	13.25	16.20	

TABLE III.9

REGRESSION COEFFICIENTS FOR MODEL I.5

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
AUSTRIA	357.60	233.51	0.00	0.00	0.00	-2.30	0.00	0.00	0.00	0.85
	0.00	37.48	0.00	0.00	0.00	8.02	0.00	0.00	0.00	
BELGIUM	327.85	130.33	0.00	0.00	0.00	-2.39	0.00	-146.93	0.00	0.83
	0.00	27.95	0.00	0.00	0.00	13.63	0.00	8.49	0.00	
DENMARK	808.27	-64.69	0.00	0.00	0.00	-7.92	0.00	0.00	0.00	0.83
	0.00	26.76	0.00	0.00	0.00	3.40	0.00	0.00	0.00	
GERMANY	205.89	123.00	0.00	-339.09	0.00	-0.92	0.00	0.00	0.00	0.86
	0.00	23.89	0.00	2.18	0.00	2.62	0.00	0.00	0.00	
ITALY	288.90	273.54	0.00	0.00	0.00	-1.82	0.00	-195.79	0.00	0.93
	0.00	40.96	0.00	0.00	0.00	4.94	0.00	16.75	0.00	
LUXEMBOURG	-221.04	282.79	0.00	-775.65	0.00	0.00	0.00	0.00	0.00	0.88
	0.00	28.49	0.00	3.79	0.00	0.00	0.00	0.00	0.00	
NETHERL.	440.20	111.59	0.00	0.00	0.00	-2.27	0.00	0.00	0.00	0.65
	0.00	7.19	0.00	0.00	0.00	8.17	0.00	0.00	0.00	
NORWAY	299.78	103.61	0.00	0.00	0.00	-1.74	0.00	-121.85	0.00	0.88
	0.00	39.18	0.00	0.00	0.00	13.88	0.00	24.56	0.00	

TABLE III.9 CONTD.

REGRESSION COEFFICIENTS FOR MODEL I.5

	a(0)	a(1)	a(2)	a(3)	a(4)	a(5)	a(6)	a(7)	a(8)	R-SQR
PORTUGAL	164.79	441.27	0.00	-244.10	0.00	0.00	0.00	-265.04	0.00	0.99
	0.00	420.10	0.00	24.09	0.00	0.00	0.00	100.14	0.00	
SPAIN	110.36	477.28	0.00	167.90	0.00	-3.11	0.00	107.06	0.00	0.99
	0.00	4088.19	0.00	5.83	0.00	545.39	0.00	107.18	0.00	
SWEDEN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SWITZERL.	113.36	215.23	0.00	-744.20	0.00	-3.75	0.00	0.00	0.00	0.98
	0.00	286.84	0.00	32.11	0.00	52.92	0.00	0.00	0.00	
U.K.	388.60	224.96	0.00	0.00	0.00	-3.05	0.00	-118.87	0.00	0.98
	0.00	147.34	0.00	0.00	0.00	26.29	0.00	24.73	0.00	
CANADA	693.97	155.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79
	0.00	30.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
U.S.	600.00	164.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68
	0.00	16.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

countries for the various years. The results are displayed in table III.10. It can be seen from the table that the elasticity coefficients vary over a wide range for the different countries, which makes intercountry comparisons nonmeaningful. The difficulty of intercountry comparisons, as far as demand elasticities are concerned, has been concluded by several researchers for various commodities (see e.g. Bridge, 1971, p. 129).

By introducing the ratio of price to per capita GNP; P.F.; as a parameter, a distinct pattern emerges for the elasticity behavior in different countries.

A main contribution of this thesis is the introduction of P.F. as a parameter, which establishes a basis for intercountry comparisons.

It may be observed, for example, that the highest elasticity values (largest negative values) appear for Portugal which has the highest values of P.F., while price elasticities of zero are associated with the lowest P.F. values in the U.S. and Canada. The elasticity pattern as a function of P.F. shows some anomalies, yet, when the elasticity values were averaged over countries, the resulting behavior appeared quite reasonable from an economic-theoretic point of view.

The range of P.F. was subdivided into 5-unit intervals, and the price elasticity values were averaged over the various countries for each interval of P.F.

Table III.11 displays the average elasticities of

TABLE III.10

VARIOUS ELASTICITIES OF DEMAND: MODEL I

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),P(t-1))	E(D(t),G(t))	E(D(t),G(t-1))	P.F.
AUSTRIA	1966	0.0177	-0.2387	0.0000	0.0000	37.4713
	1967	0.0166	-0.2167	0.0000	0.0000	35.3043
	1968	0.0234	-0.2168	0.0000	0.0000	32.6784
	1969	0.0264	-0.2145	0.0000	0.0000	30.4778
	1970	0.0288	-0.2072	0.0000	0.0000	27.5389
	1971	0.0329	-0.1987	0.0000	0.0000	26.2562
	1972	0.0323	-0.1975	0.0000	0.0000	26.1395
	1973	0.0290	-0.2463	0.0000	0.0000	33.8805
	1974	-0.0523	-0.2592	0.0000	0.0000	41.0596
	1975	-0.1091	-0.2121	0.0000	0.0000	46.5348
BELGIUM	1966	-0.0656	-0.3204	0.3943	-0.3943	32.5023
	1967	-0.0534	-0.3046	0.3712	-0.3712	31.2907
	1968	-0.0469	-0.2887	0.3575	-0.3575	29.6498
	1969	-0.0422	-0.2816	0.3597	-0.3597	27.2332
	1970	-0.0349	-0.2738	0.3482	-0.3482	25.1306
	1971	-0.0292	-0.2861	0.3371	-0.3371	25.0253
	1972	-0.0391	-0.2909	0.3315	-0.3315	25.7732
	1973	-0.0841	-0.3702	0.3492	-0.3492	32.0615
	1974	-0.2058	-0.3313	0.3630	-0.3630	34.3375
	1975	-0.1715	-0.2149	0.3046	-0.3046	28.4217
DENMARK	1966	-0.0499	-0.1148	0.0000	-0.5692	29.7962
	1967	-0.0421	-0.1121	0.0000	-0.5633	27.7794
	1968	-0.0356	-0.1125	0.0000	-0.5898	24.9544
	1969	-0.0281	-0.1175	0.0000	-0.6196	22.6526
	1970	-0.0256	-0.1187	0.0000	-0.6872	21.3133
	1971	-0.0215	-0.1238	0.0000	-0.7036	20.9046
	1972	-0.0228	-0.1244	0.0000	-0.7347	20.1246
	1973	-0.0286	-0.1574	0.0000	-0.7667	24.6841
	1974	-0.0756	-0.1562	0.0000	-0.8644	28.0058
	1975	-0.0801	-0.1180	0.0000	-0.8071	25.7859

TABLE III.10 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),P(t-1))	E(D(t),G(t))	E(D(t),G(t-1))	P.F.
GERMANY	1966	-0.0075	-0.1426	-0.6175	0.0000	24.3985
	1967	-0.0044	-0.1380	-0.5811	0.0000	24.5907
	1968	-0.0044	-0.1378	-0.6281	0.0000	22.7256
	1969	-0.0027	-0.1360	-0.6581	0.0000	21.1622
	1970	-0.0019	-0.1294	-0.6677	0.0000	19.7428
	1971	0.0007	-0.1317	-0.6297	0.0000	20.8861
	1972	-0.0090	-0.1304	-0.6347	0.0000	22.0462
	1973	-0.0291	-0.1811	-0.6845	0.0000	30.8353
	1974	-0.0882	-0.1263	-0.7110	0.0000	30.2865
	1975	-0.0712	-0.1050	-0.6125	0.0000	28.8675
ITALY	1966	-0.3999	0.0000	-2.2922	1.6827	57.7092
	1967	-0.3842	0.0000	-2.2217	1.5976	53.9667
	1968	-0.3731	0.0000	-2.0859	1.4523	52.4713
	1969	-0.3665	0.0000	-2.0486	1.4000	50.1333
	1970	-0.3495	0.0000	-1.9778	1.3143	47.1221
	1971	-0.3797	0.0000	-1.8654	1.1932	52.0690
	1972	-0.3672	0.0000	-1.7944	1.1475	51.7416
	1973	-0.3304	0.0000	-1.8476	1.1876	44.2021
	1974	-0.5217	0.0000	-1.9953	1.2208	61.1969
	1975	-0.3968	0.0000	-1.6670	0.9517	54.2663
LUXEMBOURG	1966	-0.0398	-0.9024	-0.0373	-15.4790	22.9779
	1967	-0.0302	-0.8874	-0.2575	-14.8251	23.0221
	1968	-0.0319	-0.8872	-0.2684	-15.4514	22.1241
	1969	-0.0288	-0.8938	-0.8846	-16.1502	20.4934
	1970	-0.0260	-0.8465	-2.0602	-15.0316	19.3175
	1971	-0.0051	-0.7677	-2.3716	-13.3086	18.6520
	1972	0.0106	-0.6794	-2.3971	-12.4095	17.0909
	1973	0.0593	-0.8862	-2.6887	-11.4750	22.0920
	1974	-0.2172	-0.7988	-3.5802	-11.8692	24.8848
	1975	-0.2219	-0.4765	-2.7585	-8.3199	23.8558

TABLE III.10 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),P(t-1))	E(D(t),G(t))	E(D(t),G(t-1))	P.F.
NETHERL.	1966	0.1894	-0.6104	-0.8282	-0.1744	32.9950
	1967	0.1965	-0.6023	-0.8370	-0.1712	31.4689
	1968	0.1894	-0.5764	-0.8457	-0.1717	29.7091
	1969	0.1878	-0.5644	-0.9059	-0.1836	26.9871
	1970	0.2030	-0.5627	-0.9130	-0.1863	25.5761
	1971	0.2143	-0.5862	-0.9216	-0.1907	26.2032
	1972	0.2022	-0.6156	-0.9335	-0.1941	28.7442
	1973	0.1690	-0.6958	-0.9982	-0.2031	34.2620
	1974	0.0359	-0.6894	-1.1525	-0.2427	36.8145
	1975	-0.0180	-0.5373	-1.0314	-0.2245	34.9556
NORWAY	1966	-0.3810	-0.1670	3.9449	-3.3725	29.5221
	1967	-0.3700	-0.1599	3.8999	-3.3160	27.9846
	1968	-0.3627	-0.1590	3.8542	-3.2555	26.8773
	1969	-0.3477	-0.1538	3.7135	-3.1200	26.0571
	1970	-0.3253	-0.1420	3.7092	-3.0961	23.5069
	1971	-0.3308	-0.1612	3.5566	-2.9548	25.2107
	1972	-0.3441	-0.1434	3.5646	-2.9424	24.1635
	1973	-0.3158	-0.1316	3.4888	-2.8582	21.8789
	1974	-0.5475	-0.2515	4.0441	-3.2940	32.8516
	1975	-0.4963	-0.1243	3.6606	-2.9561	27.1676
PORTUGAL	1966	-0.6291	0.4754	-0.5598	0.7768	188.7500
	1967	-0.6132	0.4701	-0.5595	0.7773	170.6964
	1968	-0.6058	0.4671	-0.5724	0.8059	149.0645
	1969	-0.5378	0.4158	-0.4936	0.7290	134.0308
	1970	-0.5154	0.4017	-0.5081	0.7519	112.1831
	1971	-0.4681	0.3738	-0.4516	0.6932	95.9474
	1972	-0.4789	0.3941	-0.4526	0.7065	83.7711
	1973	-0.4526	0.3756	-0.4375	0.7016	71.5217
	1974	-0.6749	0.5971	-0.4169	0.7296	95.5385
	1975	-0.4156	0.3315	-0.3106	0.5635	105.4756

TABLE III.10 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),P(t-1))	E(D(t),G(t))	E(D(t),G(t-1))	P.F.
SPAIN	1966	-0.3720	-0.2152	-0.0367	0.9288	78.4725
	1967	-0.2936	-0.1911	0.0226	0.7986	70.3617
	1968	-0.2357	-0.1747	0.0451	0.7259	63.4694
	1969	-0.2005	-0.1658	0.0733	0.6831	57.7308
	1970	-0.1663	-0.1468	0.1083	0.6182	51.3761
	1971	-0.1522	-0.1539	0.1356	0.5853	50.6228
	1972	-0.1426	-0.1358	0.1628	0.5651	45.5984
	1973	-0.1598	-0.1638	0.2048	0.5410	51.7252
	1974	-0.2383	-0.1694	0.2560	0.5331	61.5912
	1975	-0.2143	-0.1073	0.2700	0.4927	50.2701
SWEDEN	1966	0.3224	-0.6473	0.9072	-0.9072	19.6731
	1967	0.3448	-0.6617	0.8853	-0.8853	19.1689
	1968	0.3464	-0.6590	0.8786	-0.8786	18.7447
	1969	0.3474	-0.6621	0.9074	-0.9074	17.8308
	1970	0.3313	-0.6324	0.8969	-0.8969	16.3902
	1971	0.3710	-0.6784	0.8531	-0.8531	16.9927
	1972	0.3551	-0.6697	0.8595	-0.8595	17.2601
	1973	0.3810	-0.7435	0.8505	-0.8505	19.6697
	1974	0.3205	-0.7528	0.9642	-0.9642	20.0200
	1975	0.2382	-0.6047	0.8321	-0.8321	18.9667
SWITZERL.	1966	-0.1420	0.0000	0.0000	1.1971	18.3110
	1967	-0.1327	0.0000	0.0000	1.1588	17.9136
	1968	-0.1326	0.0000	0.0000	1.1670	17.3806
	1969	-0.1298	0.0000	0.0000	1.1798	16.5833
	1970	-0.1223	0.0000	0.0000	1.1778	15.8209
	1971	-0.1203	0.0000	0.0000	1.1374	16.1329
	1972	-0.1338	0.0000	0.0000	1.1587	17.7797
	1973	-0.1612	0.0000	0.0000	1.1993	20.7072
	1974	-0.1881	0.0000	0.0000	1.2711	22.9918
	1975	-0.1949	0.0000	0.0000	1.1995	27.5425

TABLE III.10 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),P(t-1))	E(D(t),G(t))	E(D(t),G(t-1))	P.F.
U.K.	1966	-0.1539	0.0000	0.0000	0.0000	36.2178
	1967	-0.1457	0.0000	0.0000	0.0000	35.3366
	1968	-0.1381	0.0000	0.0000	0.0000	33.2891
	1969	-0.1316	0.0000	0.0000	0.0000	31.4558
	1970	-0.1210	0.0000	0.0000	0.0000	29.4521
	1971	-0.1116	0.0000	0.0000	0.0000	27.2187
	1972	-0.1031	0.0000	0.0000	0.0000	25.4847
	1973	-0.1092	0.0000	0.0000	0.0000	25.6653
	1974	-0.1556	0.0000	0.0000	0.0000	35.5041
	1975	-0.1278	0.0000	0.0000	0.0000	29.2720
CANADA	1966	0.0000	0.0000	-1.2056	1.2056	11.5845
	1967	0.0000	0.0000	-1.0910	1.0910	11.3968
	1968	0.0000	0.0000	-0.9687	0.9687	11.6087
	1969	0.0000	0.0000	-1.1756	1.1756	10.4025
	1970	0.0000	0.0000	-0.9364	0.9364	10.8247
	1971	0.0000	0.0000	-1.0452	1.0452	10.4083
	1972	0.0000	0.0000	-1.0343	1.0343	9.1241
	1973	0.0000	0.0000	-1.0194	1.0194	9.7761
	1974	0.0000	0.0000	-0.9840	0.9840	10.1441
	1975	0.0000	0.0000	-0.9303	0.9303	9.5991
U.S.	1966	0.0000	0.0000	-0.5411	0.5411	9.2958
	1967	0.0000	0.0000	-0.5206	0.5206	9.0803
	1968	0.0000	0.0000	-0.5249	0.5249	8.5741
	1969	0.0000	0.0000	-0.5031	0.5031	8.1786
	1970	0.0000	0.0000	-0.4625	0.4625	8.0167
	1971	0.0000	0.0000	-0.4741	0.4741	7.9365
	1972	0.0000	0.0000	-0.4847	0.4847	7.3405
	1973	0.0000	0.0000	-0.4896	0.4896	6.9271
	1974	0.0000	0.0000	-0.4592	0.4592	8.7170
	1975	0.0000	0.0000	-0.4415	0.4415	8.8275

TABLE III.11

AVERAGE ELASTICITIES FOR DIFFERENT RANGES OF P.F.: MODEL I

P.F.-RANGE	E(D(t),P(t))	E(D(t),P(t-1))	E(D(t),G(t))	E(D(t),G(t-1))
5- 10	*******	*******	-0.60656	0.60656
10- 15	*******	*******	-1.05807	1.05807
15- 20	0.10508	-0.41909	0.01870	-2.02219
20- 25	-0.06856	-0.33892	-0.09990	-4.20248
25- 30	-0.08542	-0.21535	0.63020	-0.75950
30- 35	-0.04548	-0.31305	0.02697	-0.34656
35- 40	-0.06417	-0.19080	-0.19208	-0.04045
40- 45	-0.19135	-0.12960	-0.92380	0.59380
45- 50	-0.20040	-0.11597	-0.60500	0.62647
50- 55	-0.29601	-0.05718	-1.09643	0.99795
55- 60	-0.30020	-0.08290	-1.10945	1.18290
60- 65	-0.33190	-0.11470	-0.56473	0.82660
65- 70	*******	*******	*******	*******
70- 75	-0.37310	0.09225	-0.20745	0.75010
75- 80	-0.37200	-0.21520	-0.03670	0.92880
80- 85	-0.47890	0.39410	-0.45260	0.70650
85- 90	*******	*******	*******	*******
90- 95	*******	*******	*******	*******
95-100	-0.57150	0.48545	-0.43425	0.71140
100-105	*******	*******	*******	*******
105-110	-0.41560	0.33150	-0.31060	0.56350
110-115	-0.51540	0.40170	-0.50810	0.75190
115-120	*******	*******	*******	*******
120-125	*******	*******	*******	*******
125-130	*******	*******	*******	*******
130-135	-0.53780	0.41580	-0.49360	0.72900
135-140	*******	*******	*******	*******
140-145	*******	*******	*******	*******
145-150	-0.60580	0.46710	-0.57240	0.80590
150-155	*******	*******	*******	*******
155-160	*******	*******	*******	*******
160-165	*******	*******	*******	*******
165-170	*******	*******	*******	*******
170-175	-0.61320	0.47010	-0.55950	0.77730
175-180	*******	*******	*******	*******
180-185	*******	*******	*******	*******
185-190	-0.62910	0.47540	-0.55980	0.77680
190-195	*******	*******	*******	*******
195-200	*******	*******	*******	*******

demand intensity with respect to current prices for different intervals of the ratio P.F. The table reveals a distinct inverse relationship between the values of P.F. and E(D(t),P(t)); a result in good agreement with basic economic theory.

In order to find a functional relationship between E(D(t),P(t)) and R, the following seven functional forms were fitted to the values in table III.11 via O.L.S.:

1. E=A+B.(P.F.) [3.6]

2. E=A.EXP(B.(P.F.)) [3.7]

3. E=A.(P.F.) [3.8]

4. E=A+(B/P.F.) [3.9]

5. E=1/(A+B.(P.F.)) [3.10]

6. E=P.F./(A+B.(P.F.)) [3.11]

7. E=A+B.LOG(P.F) [3.12]

where A and B are constants.

The results of the curve fitting are displayed in table III.12.

Based on the results in table III.12, the relationship between E(D(t),P(t)) and R is assumed to be as follows:

E1=E(D(t),P(t))=-.74+(24.37/P.F.) [3.13]

TABLE III.12

CURVE FIT RESULTS OF E(D(t),P(t)) VS. P.F.: MODEL I

CURVE TYPE	INDEX OF DETERMINATION	A	B
1. $E=A+B.(P.F.)$	.831	-.106	-3.26
2. $E=A.EXP.(B.(P.F.))$	CAN'T FIT		
3. $E=A.(P.F.)^{B}$	CAN'T FIT		
4. $E=A+(B/P.F.)$	.937	-.738	24.37
5. $E=1/(A+B.(P.F.))$	.464	-5.92	.0030
6. $E=R/(A+B.(P.F.))$	.785	-277.5	.645
7. $E=A+B.Log(P.F.)$	.924	.991	-.317

STANDARD ERROR ESTIMATES

CURVE TYPE	REGRESSION	A	B
1.	.007	.004	.00004
2.	0	0	0
3.	0	0	0
4.	.004	.002	1.69
5.	1.55	.895	.0009
6.	.981	38.79	.579
7.	.005	.108	.002

Results Of Model I.1

Table III.13 displays the various annual elasticities for the fifteen OECD countries.

Comparing the values with those in table III.10, the following observations may be made:

The elasticity estimates for Austria, Belgium, the Netherlands, Norway, Portugal and Switzerland show a slight positive shift with respect to those of model I. While the estimates remained virtually unchanged for Germany and Italy; Denmark, Spain and the U.K. showed a negative shift, and Luxembourg , a rather large positive shift.

The most appreciable shift in the elasticity estimates was associated with the U.S. and Canada which gave negative elasticities quite sizable for the corresponding values of P.F.

From an economic theory premise, model I is more acceptable than the current model.

In order to even out possible anomalous estimates, such as those of the U.S. and Canada, the elasticity values were again averaged over the countries for the various P.F. intervals, giving the results in table III.14.

It can be seen from table III.14 that the first two values of E(D(t),P(t)) are rather high compared to the rest. The third value of .099 is small and anomalous compared to the rest, and to the "rational" economic behavior.

TABLE III.13

VARIOUS ELASTICITIES OF DEMAND: MODEL I.1

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
AUSTRIA	1966	0.1663	-0.8501	37.4713
	1967	0.1517	-0.8166	35.3043
	1968	0.1613	-0.8531	32.6784
	1969	0.1641	-0.8896	30.4778
	1970	0.1631	-0.9336	27.5389
	1971	0.1639	-0.9097	26.2562
	1972	0.1622	-0.9107	26.1395
	1973	0.1867	-0.9242	33.8805
	1974	0.0805	-1.0932	41.0596
	1975	-0.0269	-0.9949	46.5348
BELGIUM	1966	-0.0259	-0.3435	32.5023
	1967	-0.0176	-0.3309	31.2907
	1968	-0.0137	-0.3273	29.6498
	1969	-0.0105	-0.3438	27.2332
	1970	-0.0054	-0.3553	25.1306
	1971	0.0001	-0.3643	25.0253
	1972	-0.0073	-0.3703	25.7732
	1973	-0.0365	-0.4098	32.0615
	1974	-0.1360	-0.4523	34.3375
	1975	-0.1183	-0.3931	28.4217
DENMARK	1966	-0.0603	-0.8999	29.7962
	1967	-0.0456	-0.9038	27.7794
	1968	-0.0324	-0.9661	24.9544
	1969	-0.0156	-1.0466	22.6526
	1970	-0.0101	-1.1021	21.3133
	1971	-0.0001	-1.1311	20.9046
	1972	-0.0026	-1.1908	20.1246
	1973	-0.0027	-1.2269	24.6841
	1974	-0.0974	-1.3473	28.0058
	1975	-0.1198	-1.2507	25.7859

TABLE III.13 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.1

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
GERMANY	1966	-0.0076	-0.6175	24.3985
	1967	-0.0045	-0.5811	24.5907
	1968	-0.0045	-0.6281	22.7256
	1969	-0.0028	-0.6581	21.1622
	1970	-0.0020	-0.6677	19.7428
	1971	0.0006	-0.6297	20.8861
	1972	-0.0091	-0.6347	22.0462
	1973	-0.0293	-0.6845	30.8353
	1974	-0.0884	-0.7110	30.2865
	1975	-0.0713	-0.6125	28.8675
ITALY	1966	-0.3824	0.0000	57.7092
	1967	-0.3674	0.0000	53.9667
	1968	-0.3568	0.0000	52.4713
	1969	-0.3504	0.0000	50.1333
	1970	-0.3342	0.0000	47.1221
	1971	-0.3631	0.0000	52.0690
	1972	-0.3511	0.0000	51.7416
	1973	-0.3159	0.0000	44.2021
	1974	-0.4989	0.0000	61.1969
	1975	-0.3794	0.0000	54.2663
LUXEMBOURG	1966	0.0000	-1.8491	22.9779
	1967	0.0000	-1.7506	23.0221
	1968	0.0000	-1.8245	22.1241
	1969	0.0000	-1.8515	20.4934
	1970	0.0000	-1.6094	19.3175
	1971	0.0000	-1.3745	18.6520
	1972	0.0000	-1.2646	17.0909
	1973	0.0000	-1.1259	22.0920
	1974	0.0000	-1.0911	24.8848
	1975	0.0000	-0.7419	23.8558

TABLE III.13 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.1

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
NETHERL.	1966	0.1953	-0.9456	32.9950
	1967	0.2025	-0.9557	31.4689
	1968	0.1951	-0.9656	29.7091
	1969	0.1935	-1.0343	26.9871
	1970	0.2091	-1.0424	25.5761
	1971	0.2207	-1.0522	26.2032
	1972	0.2084	-1.0658	28.7442
	1973	0.1745	-1.1397	34.2620
	1974	0.0380	-1.3158	36.8145
	1975	-0.0175	-1.1776	34.9556
NORWAY	1966	-0.2821	2.4718	29.5221
	1967	-0.2728	2.4303	27.9846
	1968	-0.2686	2.3861	26.8773
	1969	-0.2582	2.2867	26.0571
	1970	-0.2406	2.2692	23.5069
	1971	-0.2533	2.1656	25.2107
	1972	-0.2510	2.1566	24.1635
	1973	-0.2303	2.0948	21.8789
	1974	-0.4113	2.4142	32.8516
	1975	-0.3195	2.1666	27.1676
PORTUGAL	1966	-0.5933	-0.5439	188.7500
	1967	-0.5783	-0.5329	170.6964
	1968	-0.5713	-0.5235	149.0645
	1969	-0.5073	-0.4232	134.0308
	1970	-0.4861	-0.4212	112.1831
	1971	-0.4415	-0.3486	95.9474
	1972	-0.4516	-0.3278	83.7711
	1973	-0.4269	-0.2877	71.5217
	1974	-0.6365	-0.2385	95.5385
	1975	-0.3919	-0.1806	105.4756

TABLE III.13 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.1

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
SPAIN	1966	-0.4448	0.2411	78.4725
	1967	-0.3484	0.2911	70.3617
	1968	-0.2771	0.3026	63.4694
	1969	-0.2335	0.3325	57.7308
	1970	-0.1925	0.3658	51.3761
	1971	-0.1737	0.3974	50.6228
	1972	-0.1638	0.4331	45.5984
	1973	-0.1822	0.4903	51.7252
	1974	-0.2810	0.5670	61.5912
	1975	-0.2584	0.5757	50.2701
SWEDEN	1966	0.2076	-0.8792	19.6731
	1967	0.2258	-0.8978	19.1689
	1968	0.2275	-0.9172	18.7447
	1969	0.2281	-0.9881	17.8308
	1970	0.2174	-1.0663	16.3902
	1971	0.2471	-1.0738	16.9927
	1972	0.2339	-1.0818	17.2601
	1973	0.2479	-1.1088	19.6697
	1974	0.1927	-1.3244	20.0200
	1975	0.1376	-1.2094	18.9667
SWITZERL.	1966	-0.0071	-1.5482	18.3110
	1967	0.0007	-1.4337	17.9136
	1968	0.0058	-1.4622	17.3806
	1969	0.0059	-1.4336	16.5833
	1970	0.0065	-1.3209	15.8209
	1971	0.0106	-1.2075	16.1329
	1972	-0.0058	-1.1556	17.7797
	1973	-0.0520	-1.1506	20.7072
	1974	-0.1266	-1.1640	22.9918
	1975	-0.1712	-0.9833	27.5425

TABLE III.13 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.1

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
U.K.	1966	-0.1917	0.7317	36.2178
	1967	-0.1794	0.7103	35.3366
	1968	-0.1691	0.7146	33.2891
	1969	-0.1583	0.7203	31.4558
	1970	-0.1425	0.7079	29.4521
	1971	-0.1275	0.7062	27.2187
	1972	-0.1134	0.6970	25.4847
	1973	-0.1162	0.7331	25.6653
	1974	-0.1733	0.7547	35.5041
	1975	-0.1698	0.7520	29.2720
CANADA	1966	-0.1221	0.5589	11.5845
	1967	-0.1190	0.5058	11.3968
	1968	-0.1081	0.4491	11.6087
	1969	-0.1115	0.5450	10.4025
	1970	-0.0972	0.4341	10.8247
	1971	-0.0989	0.4846	10.4083
	1972	-0.0946	0.4795	9.1241
	1973	-0.0733	0.4726	9.7761
	1974	-0.1225	0.4562	10.1441
	1975	-0.1271	0.4313	9.5991
U.S.	1966	-0.3852	-0.7941	9.2958
	1967	-0.3803	-0.8049	9.0803
	1968	-0.3672	-0.8259	8.5741
	1969	-0.3449	-0.8225	8.1786
	1970	-0.3100	-0.7688	8.0167
	1971	-0.3021	-0.7750	7.9365
	1972	-0.2927	-0.8073	7.3405
	1973	-0.2858	-0.8539	6.9271
	1974	-0.3502	-0.8385	8.7170
	1975	-0.3781	-0.7881	8.8275

TABLE III.14

AVERAGE ELASTICITIES FOR DIFFERENT RANGES OF P.F.: MODEL I.1

P.F.-RANGE	E(D(t),P(t))	E(D(t),G(t))
5- 10	-0.28396	-0.51505
10- 15	-0.11133	0.49053
15- 20	0.09937	-1.18502
20- 25	-0.03197	-0.71063
25- 30	-0.04931	0.04637
30- 35	-0.00034	-0.37303
35- 40	-0.03140	-0.13097
40- 45	-0.11770	-0.54660
45- 50	-0.17497	-0.18727
50- 55	-0.29750	0.18292
55- 60	-0.30795	0.16625
60- 65	-0.35233	0.28987
65- 70	*******	*******
70- 75	-0.38765	0.00170
75- 80	-0.44480	0.24110
80- 85	-0.45160	-0.32780
85- 90	*******	*******
90- 95	*******	*******
95-100	-0.53900	-0.29355
100-105	*******	*******
105-110	-0.39190	-0.18060
110-115	-0.48610	-0.42120
115-120	*******	*******
120-125	*******	*******
125-130	*******	*******
130-135	-0.50730	-0.42320
135-140	*******	*******
140-145	*******	*******
145-150	-0.57130	-0.52350
150-155	*******	*******
155-160	*******	*******
160-165	*******	*******
165-170	*******	*******
170-175	-0.57830	-0.53290
175-180	*******	*******
180-185	*******	*******
185-190	-0.59330	-0.54390
190-195	*******	*******
195-200	*******	*******

TABLE III.15

CURVE FIT RESULTS OF E(D(t),P(t)) VS. P.F.: MODEL I.1

CURVE TYPE	INDEX OF DETERMINATION	A	B
1. $E=A+B.(P.F.)$	.781	-.003	-3.7E-3
2. $E=A.EXP.(B.(P.F.))$	CAN'T FIT		
3. $E=A.(P.F.)^{B}$	CAN'T FIT		
4. $E=A+(B/P.F.)$	.863	-.634	17.461
5. $E=1/(A+B.(P.F.))$	6.53E-2		
6. $E=R/(A+B.(P.F.))$	9.67E-2		
7. $E=A+B.Log(P.F.)$	.910	1.003	-.315

STANDARD ERROR ESTIMATES

CURVE TYPE	REGRESSION	A	B
1.	.009	.005	.00005
2.	0	0	0
3.	0	0	0
4.	.008	.003	1.69
5.	669.7	306.6	3.206
6.	658.38	14195.5	287.9
7.	.006	.103	.002

Neglecting the first three ranges, the elasticity behavior seems in good agreement with basic economic theory.

After deleting the first three ranges of P.F., a curve fit performed on values in table III.14 yielded the results in table III.1.

The curve fitting of E versus P.F. for model I.1 yields the following functional form:

$$E2=1.003-.315 \ Log(P.F.) \qquad [3.14]$$

Results Of Model I.2

The annual elasticities of demand for the fifteen OECD countries resulting from model I.2 are displayed in table III.16.

A comparison with the results of models I and I.1 reveals the following:

Compared to the other two models, there is a rather strong negative bias in the estimates for Austria, Belgium, Denmark, Germany, the Netherlands, Portugal, Sweden, Switzerland and the U.K. The estimates for Spain were identical to those of model I.1 while the U.S. and Canada showed zero elasticities similar to model I. The estimates for Italy were slightly on the positive side compared to models I and I.1. Luxembourg aquired zero elasticities similar to those of model I.1 while the values for Norway shifted negatively relative to those of I.1 getting closer to the estimates of model I.

TABLE III.16

VARIOUS ELASTICITIES OF DEMAND: MODEL I.2

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
AUSTRIA	1966	-0.1178	0.6326	37.4713
	1967	-0.1066	0.6077	35.3043
	1968	-0.1031	0.6348	32.6784
	1969	-0.1002	0.6619	30.4778
	1970	-0.0951	0.6947	27.5389
	1971	-0.0883	0.6769	26.2562
	1972	-0.0880	0.6777	26.1395
	1973	-0.1158	0.6877	33.8805
	1974	-0.1660	0.8135	41.0596
	1975	-0.1712	0.7403	46.5348
BELGIUM	1966	-0.3628	0.6435	32.5023
	1967	-0.3364	0.6198	31.2907
	1968	-0.3154	0.6131	29.6498
	1969	-0.3043	0.6440	27.2332
	1970	-0.2901	0.6655	25.1306
	1971	-0.2963	0.6825	25.0253
	1972	-0.3101	0.6936	25.7732
	1973	-0.4269	0.7676	32.0615
	1974	-0.5047	0.8473	34.3375
	1975	-0.3631	0.7364	28.4217
DENMARK	1966	-0.1862	-0.2344	29.7962
	1967	-0.1744	-0.2354	27.7794
	1968	-0.1675	-0.2516	24.9544
	1969	-0.1647	-0.2726	22.6526
	1970	-0.1631	-0.2870	21.3133
	1971	-0.1642	-0.2946	20.9046
	1972	-0.1665	-0.3101	20.1246
	1973	-0.2104	-0.3195	24.6841
	1974	-0.2621	-0.3509	28.0058
	1975	-0.2240	-0.3257	25.7859

TABLE III.16 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.2

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
GERMANY	1966	-0.1119	-0.5429	24.3985
	1967	-0.1062	-0.4829	24.5907
	1968	-0.1060	-0.5319	22.7256
	1969	-0.1035	-0.4689	21.1622
	1970	-0.0979	-0.3928	19.7428
	1971	-0.0977	-0.3156	20.8861
	1972	-0.1039	-0.3008	22.0462
	1973	-0.1568	-0.2923	30.8353
	1974	-0.1600	-0.2519	30.2865
	1975	-0.1314	-0.2114	28.8675
ITALY	1966	-0.2721	0.6548	57.7092
	1967	-0.2589	0.6728	53.9667
	1968	-0.2528	0.6720	52.4713
	1969	-0.2439	0.6908	50.1333
	1970	-0.2317	0.7009	47.1221
	1971	-0.2569	0.6891	52.0690
	1972	-0.2222	0.6706	51.7416
	1973	-0.1967	0.7063	44.2021
	1974	-0.3443	0.8056	61.1969
	1975	-0.1842	0.6910	54.2663
LUXEMBOURG	1966	0.0000	-1.8491	22.9779
	1967	0.0000	-1.7506	23.0221
	1968	0.0000	-1.8245	22.1241
	1969	0.0000	-1.8515	20.4934
	1970	0.0000	-1.6094	19.3175
	1971	0.0000	-1.3745	18.6520
	1972	0.0000	-1.2646	17.0909
	1973	0.0000	-1.1259	22.0920
	1974	0.0000	-1.0911	24.8848
	1975	0.0000	-0.7419	23.8558

TABLE III.16 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.2

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
NETHERL.	1966	-0.0891	0.4353	32.9950
	1967	-0.0820	0.4400	31.4689
	1968	-0.0777	0.4445	29.7091
	1969	-0.0746	0.4762	26.9871
	1970	-0.0645	0.4799	25.5761
	1971	-0.0655	0.4844	26.2032
	1972	-0.0829	0.4907	28.7442
	1973	-0.1307	0.5247	34.2620
	1974	-0.2112	0.6058	36.8145
	1975	-0.1932	0.5421	34.9556
NORWAY	1966	-0.3256	0.5878	29.5221
	1967	-0.3149	0.5996	27.9846
	1968	-0.3100	0.6147	26.8773
	1969	-0.2980	0.6095	26.0571
	1970	-0.2777	0.6295	23.5069
	1971	-0.2924	0.6180	25.2107
	1972	-0.2897	0.6389	24.1635
	1973	-0.2659	0.6476	21.8789
	1974	-0.4748	0.7702	32.8516
	1975	-0.3688	0.7234	27.1676
PORTUGAL	1966	-0.6674	-1.0660	188.7500
	1967	-0.6505	-1.0426	170.6964
	1968	-0.6427	-1.0200	149.0645
	1969	-0.5706	-0.8191	134.0308
	1970	-0.5468	-0.8121	112.1831
	1971	-0.4966	-0.6665	95.9474
	1972	-0.5080	-0.6217	83.7711
	1973	-0.4802	-0.5384	71.5217
	1974	-0.7160	-0.4366	95.5385
	1975	-0.4409	-0.3316	105.4756

TABLE III.16 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.2

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
SPAIN	1966	-0.4448	0.2411	78.4725
	1967	-0.3484	0.2911	70.3617
	1968	-0.2771	0.3026	63.4694
	1969	-0.2335	0.3325	57.7308
	1970	-0.1925	0.3658	51.3761
	1971	-0.1737	0.3974	50.6228
	1972	-0.1638	0.4331	45.5984
	1973	-0.1822	0.4903	51.7252
	1974	-0.2810	0.5670	61.5912
	1975	-0.2584	0.5757	50.2701
SWEDEN	1966	0.0000	0.0000	19.6731
	1967	0.0000	0.0000	19.1689
	1968	0.0000	0.0000	18.7447
	1969	0.0000	0.0000	17.8308
	1970	0.0000	0.0000	16.3902
	1971	0.0000	0.0000	16.9927
	1972	0.0000	0.0000	17.2601
	1973	0.0000	0.0000	19.6697
	1974	0.0000	0.0000	20.0200
	1975	0.0000	0.0000	18.9667
SWITZERL.	1966	-0.3129	-1.4656	18.3110
	1967	-0.2924	-1.3439	17.9136
	1968	-0.2922	-1.3660	17.3806
	1969	-0.2861	-1.3186	16.5833
	1970	-0.2695	-1.1841	15.8209
	1971	-0.2651	-1.0593	16.1329
	1972	-0.2949	-0.9906	17.7797
	1973	-0.3553	-0.9690	20.7072
	1974	-0.4145	-0.9622	22.9918
	1975	-0.4295	-0.8030	27.5425

TABLE III.16 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.2

COUNTRY	YEAR	E(D(t),P(t))	E(D(t),G(t))	P.F.
U.K.	1966	-0.2007	0.8006	36.2178
	1967	-0.1901	0.7772	35.3366
	1968	-0.1802	0.7819	33.2891
	1969	-0.1716	0.7882	31.4558
	1970	-0.1579	0.7745	29.4521
	1971	-0.1456	0.7727	27.2187
	1972	-0.1345	0.7626	25.4847
	1973	-0.1425	0.8021	25.6653
	1974	-0.2029	0.8258	35.5041
	1975	-0.1667	0.8228	29.2720
CANADA	1966	0.0000	-0.2976	11.5845
	1967	0.0000	-0.2292	11.3968
	1968	0.0000	-0.1985	11.6087
	1969	0.0000	-0.2529	10.4025
	1970	0.0000	-0.1661	10.8247
	1971	0.0000	-0.2035	10.4083
	1972	0.0000	-0.1792	9.1241
	1973	0.0000	-0.1579	9.7761
	1974	0.0000	-0.1283	10.1441
	1975	0.0000	-0.1146	9.5991
U.S.	1966	0.0000	0.0508	9.2958
	1967	0.0000	0.0794	9.0803
	1968	0.0000	0.0908	8.5741
	1969	0.0000	0.1102	8.1786
	1970	0.0000	0.1108	8.0167
	1971	0.0000	0.1038	7.9365
	1972	0.0000	0.1173	7.3405
	1973	0.0000	0.1473	6.9271
	1974	0.0000	0.1663	8.7170
	1975	0.0000	0.1463	8.8275

Table III.17 displays the average elasticities for different ranges of P.F. The fitted curve to the results of model I.2 is given by equation 3.15 below

E3=P.F./(-153.26-.719 P.F.) [3.15]

Figure III.1 depicts a plot of the three functional forms of of E(D(t),P(t)) versus P.F. It should be observed that these functions are defined for the specified ranges of P.F. only, i.e. P.F. values between 15 and 190. It is assumed that the price elasticity of demand intensity for motor gasoline is zero for P.F. values below 15.

It is in this researcher's opinion that an P.F. value around 15 is a good indication of the range for which the widely accepted assumption of price-inelastic demand might hold.

THE P(t-1) ELASTICITY OF DEMAND

The elasticities of demand with respect to lagged prices, calculated from the different models were as follows:

Results Of Model I

The annual elasticities of demand intensity for the fifteen OECD countries are displayed in table III.10. These values were calculated from the regression coefficients in table III.1 by applying formulae 2.15 and 2.16.

We can see from the table that while E(D(t),P(t-1))

FIGURE III.1

PLOTS OF THE THREE ESTIMATED ELASTICITY FUNCTIONS

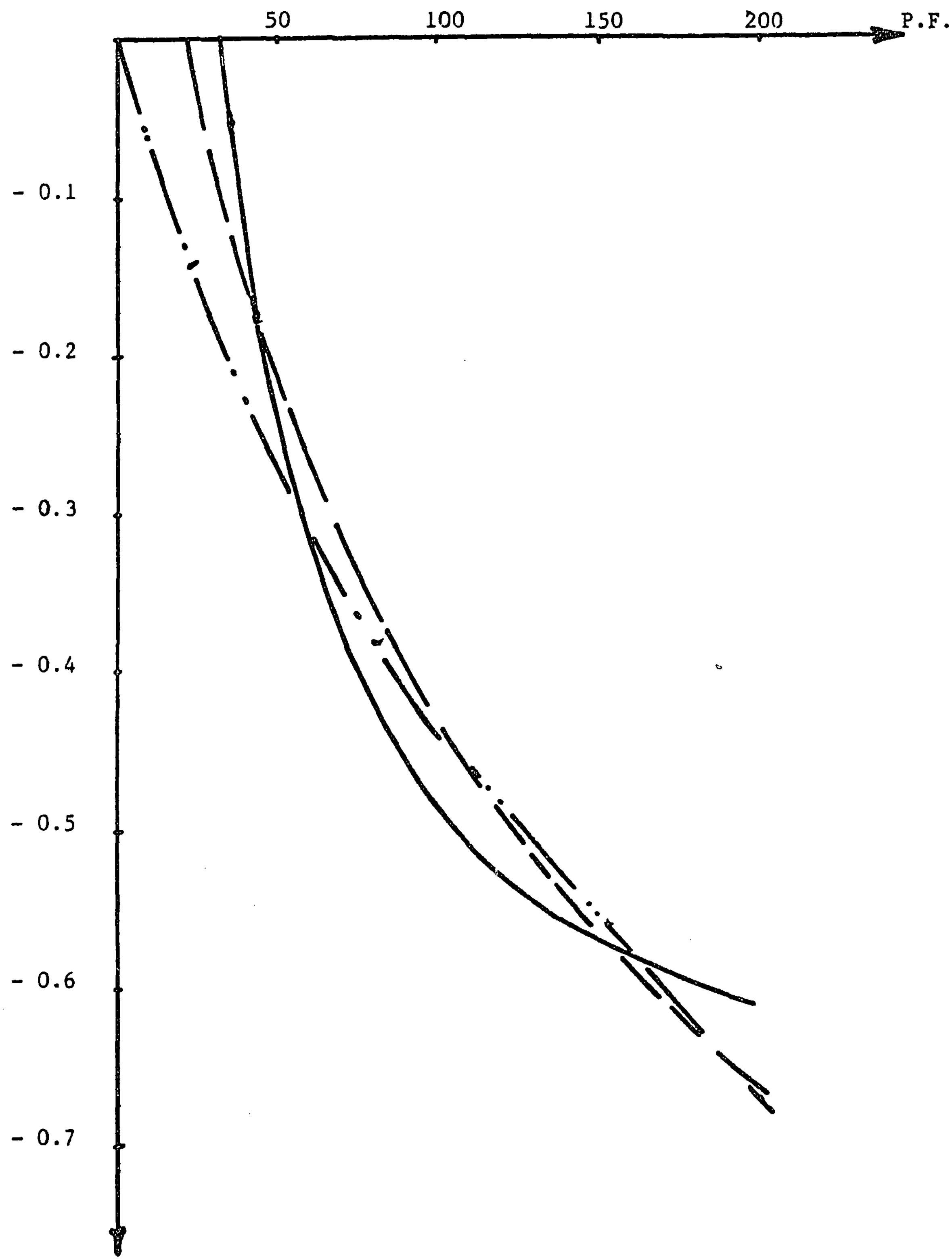


TABLE III.17

AVERAGE ELASTICITIES FOR DIFFERENT RANGES OF P.F.: MODEL I.2

P.F.-RANGE	E(D(t),P(t))	E(D(t),G(t))
5- 10	*******	0.05164
10- 15	*******	-0.21087
15- 20	-0.10555	-0.66847
20- 25	-0.13075	-0.58513
25- 30	-0.21227	0.45119
30- 35	-0.22427	0.53755
35- 40	-0.17155	0.70828
40- 45	-0.18135	0.75990
45- 50	-0.18890	0.62477
50- 55	-0.22257	0.59155
55- 60	-0.25280	0.49365
60- 65	-0.30080	0.55840
65- 70	*******	*******
70- 75	-0.41430	-0.12365
75- 80	-0.44480	0.24110
80- 85	-0.50800	-0.62170
85- 90	*******	*******
90- 95	*******	*******
95-100	-0.60630	-0.55155
100-105	*******	*******
105-110	-0.44090	-0.33160
110-115	-0.54680	-0.81210
115-120	*******	*******
120-125	*******	*******
125-130	*******	*******
130-135	-0.57060	-0.81910
135-140	*******	*******
140-145	*******	*******
145-150	-0.64270	-1.02000
150-155	*******	*******
155-160	*******	*******
160-165	*******	*******
165-170	*******	*******
170-175	-0.65050	-1.04260
175-180	*******	*******
180-185	*******	*******
185-190	-0.66740	-1.06600
190-195	*******	*******
195-200	*******	*******

TABLE III.18

CURVE FIT RESULTS OF E(D(t),P(t)) VS. P.F.: MODEL I.2

CURVE TYPE	INDEX OF DETERMINATION	A	B
1. E=A+B.(P.F.)	.874	-.009	-.0004
2. E=A.EXP.(P.F.)	CAN'T FIT		
3. $E=A.(P.F.)^{B}$	CAN'T FIT		
4. E=A+(B/P.F.)	.686	-.598	11.63
5. E=1/(A+B.(P.F.))	.645	-6.54	.0036
6. E=R/(A+B.(P.F.))	.895	-153.26	-.719
7. E=A+B.Log(P.F.)	.884	.750	-.269

STANDARD ERROR ESTIMATES

CURVE TYPE	REGRESSION	A	B
1.	.007	.003	.00003
2.	0	0	0
3.	0	0	0
4.	.112	.004	1.85
5.	1.38	.588	.0006
6.	.750	12.39	.292
7.	.006	.010	.002

values were generally strongly negative for most countries, the elasticities calculated for Portugal were unreasonably large.

The averaged elasticity values for various ranges of R displayed in table III.11 clearly indicate an irregular and economically unreasonable behavior.

It should be pointed out that, in calculating E(D(t),P(t-1)) by formula 2.15, the partial derivative of D(t) with respect to P(t) was assumed zero. It is for this reason and in order to avoid any possible interference of the current prices that model I.3 was formulated with lagged variables alone.

The following section gives the results of model I.3.

Results Of Model I.3

Table III.19 contains the calculated values of the annual elasticities of demand with respect to P(t-1) as calculated from model I.3. Table III.20 displays the elasticity values averaged over the various ranges of P.F. The results in both tables III.19 and III.20 indicate that elasticities as calculated from model I.3 share the same features as those calculated from model I.

Results of Model I.4

Tables III.21 and III.22 display the various annual elasticities for the different countries and the averaged values over P.F.intervals, respectively. The results are still not acceptable. The introduction of N(t) to model I.4

TABLE III.19

VARIOUS ELASTICITIES OF DEMAND: MODEL I.3

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
AUSTRIA	1966	-0.2383	0.6343	37.4713
	1967	-0.2226	0.6058	35.3043
	1968	-0.2115	0.6110	32.6784
	1969	-0.2060	0.6429	30.4778
	1970	-0.1980	0.6623	27.5389
	1971	-0.1777	0.6579	26.2562
	1972	-0.1684	0.6542	26.1395
	1973	-0.1714	0.6688	33.8805
	1974	-0.2657	0.7998	41.0596
	1975	-0.3114	0.7733	46.5348
BELGIUM	1966	0.0049	-0.1370	32.5023
	1967	0.0046	-0.1174	31.2907
	1968	0.0044	-0.1068	29.6498
	1969	0.0043	-0.0948	27.2332
	1970	0.0042	-0.0466	25.1306
	1971	0.0043	0.0079	25.0253
	1972	0.0044	0.0189	25.7732
	1973	0.0056	0.0478	32.0615
	1974	0.0050	0.1177	34.3375
	1975	0.0033	0.1662	28.4217
DENMARK	1966	0.0018	-0.2371	29.7962
	1967	0.0017	-0.2347	27.7794
	1968	0.0018	-0.2457	24.9544
	1969	0.0018	-0.2581	22.6526
	1970	0.0018	-0.2862	21.3133
	1971	0.0019	-0.2931	20.9046
	1972	0.0019	-0.3060	20.1246
	1973	0.0025	-0.3194	24.6841
	1974	0.0024	-0.3601	28.0058
	1975	0.0018	-0.3362	25.7859

TABLE III.19 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.3

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
GERMANY	1966	0.0017	0.7859	24.3985
	1967	0.0016	0.7628	24.5907
	1968	0.0016	0.7650	22.7256
	1969	0.0016	0.8022	21.1622
	1970	0.0015	0.8278	19.7428
	1971	0.0015	0.8073	20.8861
	1972	0.0015	0.8039	22.0462
	1973	0.0021	0.8524	30.8353
	1974	0.0015	0.9207	30.2865
	1975	0.0012	0.8219	28.8675
ITALY	1966	0.0047	0.7452	57.7092
	1967	0.0045	0.7630	53.9667
	1968	0.0044	0.7746	52.4713
	1969	0.0043	0.7930	50.1333
	1970	0.0040	0.8112	47.1221
	1971	0.0045	0.8219	52.0690
	1972	0.0039	0.7909	51.7416
	1973	0.0034	0.8069	44.2021
	1974	0.0060	0.9468	61.1969
	1975	0.0032	0.8745	54.2663
LUXEMBOURG	1966	0.0000	2.9303	22.9779
	1967	0.0000	2.8479	23.0221
	1968	0.0000	2.9158	22.1241
	1969	0.0000	3.0433	20.4934
	1970	0.0000	3.0006	19.3175
	1971	0.0000	2.7393	18.6520
	1972	0.0000	2.5426	17.0909
	1973	0.0000	2.3695	22.0920
	1974	0.0000	2.5646	24.8848
	1975	0.0000	1.9398	23.8558

TABLE III.19 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.3

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
NETHERL.	1966	-0.4255	0.9222	32.9950
	1967	-0.4020	0.9055	31.4689
	1968	-0.3846	0.9082	29.7091
	1969	-0.3882	0.9711	26.9871
	1970	-0.3578	0.9853	25.5761
	1971	-0.3471	1.0086	26.2032
	1972	-0.3620	1.0267	28.7442
	1973	-0.4155	1.0743	34.2620
	1974	-0.5919	1.2838	36.8145
	1975	-0.5883	1.1876	34.9556
NORWAY	1966	0.0051	-2.0939	29.5221
	1967	0.0049	-2.0392	27.9846
	1968	0.0049	-1.9674	26.8773
	1969	0.0047	-1.8671	26.0571
	1970	0.0043	-1.8174	23.5069
	1971	0.0049	-1.7218	25.2107
	1972	0.0044	-1.6923	24.1635
	1973	0.0040	-1.6065	21.8789
	1974	0.0077	-1.8368	32.8516
	1975	0.0038	-1.5981	27.1676
PORTUGAL	1966	1.3528	0.7941	188.7500
	1967	1.2595	0.7971	170.6964
	1968	1.2210	0.8543	149.0645
	1969	1.0750	0.8613	134.0308
	1970	1.0014	0.8922	112.1831
	1971	0.8309	0.8839	95.9474
	1972	0.7480	0.9293	83.7711
	1973	0.6794	0.9665	71.5217
	1974	0.6896	1.1442	95.5385
	1975	0.7410	0.9255	105.4756

TABLE III.19 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.3

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
SPAIN	1966	0.3614	0.9614	78.4725
	1967	0.2996	0.9173	70.3617
	1968	0.2502	0.8533	63.4694
	1969	0.2178	0.8225	57.7308
	1970	0.1927	0.7999	51.3761
	1971	0.1710	0.7954	50.6228
	1972	0.1660	0.7850	45.5984
	1973	0.1534	0.8017	51.7252
	1974	0.1884	0.8710	61.5912
	1975	0.2249	0.8804	50.2701
SWEDEN	1966	-0.7333	-0.8915	19.6731
	1967	-0.6891	-0.8582	19.1689
	1968	-0.6723	-0.8486	18.7447
	1969	-0.6767	-0.8776	17.8308
	1970	-0.6814	-0.8419	16.3902
	1971	-0.6393	-0.7745	16.9927
	1972	-0.6532	-0.7888	17.2601
	1973	-0.6640	-0.7765	19.6697
	1974	-0.8817	-0.8672	20.0200
	1975	-0.8283	-0.7210	18.9667
SWITZERL.	1966	0.0056	2.5915	18.3110
	1967	0.0054	2.4715	17.9136
	1968	0.0054	2.5066	17.3806
	1969	0.0053	2.5177	16.5833
	1970	0.0050	2.4548	15.8209
	1971	0.0050	2.3365	16.1329
	1972	0.0053	2.3398	17.7797
	1973	0.0057	2.3991	20.7072
	1974	0.0055	2.5118	22.9918
	1975	0.0051	2.2812	27.5425

TABLE III.19 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.3

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
U.K.	1966	0.0020	0.0000	36.2178
	1967	0.0020	0.0000	35.3366
	1968	0.0019	0.0000	33.2891
	1969	0.0019	0.0000	31.4558
	1970	0.0018	0.0000	29.4521
	1971	0.0017	0.0000	27.2187
	1972	0.0017	0.0000	25.4847
	1973	0.0019	0.0000	25.6653
	1974	0.0025	0.0000	35.5041
	1975	0.0015	0.0000	29.2720
CANADA	1966	0.0000	0.4329	11.5845
	1967	0.0000	0.4736	11.3968
	1968	0.0000	0.4436	11.6087
	1969	0.0000	0.4636	10.4025
	1970	0.0000	0.4668	10.8247
	1971	0.0000	0.4537	10.4083
	1972	0.0000	0.4779	9.1241
	1973	0.0000	0.4860	9.7761
	1974	0.0000	0.5154	10.1441
	1975	0.0000	0.5069	9.5991
U.S.	1966	0.0000	0.0000	9.2958
	1967	0.0000	0.0000	9.0803
	1968	0.0000	0.0000	8.5741
	1969	0.0000	0.0000	8.1786
	1970	0.0000	0.0000	8.0167
	1971	0.0000	0.0000	7.9365
	1972	0.0000	0.0000	7.3405
	1973	0.0000	0.0000	6.9271
	1974	0.0000	0.0000	8.7170
	1975	0.0000	0.0000	8.8275

TABLE III.20

AVERAGE ELASTICITIES FOR DIFFERENT RANGES OF P.F.: MODEL I.3

R-RANGE	E(D(t),P(t-1))	E(D(t),G(t-1))
5- 10	*******	0.11314
10- 15	*******	0.46423
15- 20	-0.30996	0.94750
20- 25	-0.03346	0.82229
25- 30	-0.07445	-0.08172
30- 35	-0.14906	0.36623
35- 40	-0.17438	0.42065
40- 45	-0.13115	0.80335
45- 50	-0.04713	0.78983
50- 55	0.07668	0.80953
55- 60	0.11125	0.78385
60- 65	0.14820	0.89037
65- 70	*******	*******
70- 75	0.48950	0.94190
75- 80	0.36140	0.96140
80- 85	0.74800	0.92930
85- 90	*******	*******
90- 95	*******	*******
95-100	0.76025	1.01405
100-105	*******	*******
105-110	0.74100	0.92550
110-115	1.00140	0.89220
115-120	*******	*******
120-125	*******	*******
125-130	*******	*******
130-135	1.07500	0.86130
135-140	*******	*******
140-145	*******	*******
145-150	1.22100	0.85430
150-155	*******	*******
155-160	*******	*******
160-165	*******	*******
165-170	*******	*******
170-175	1.25950	0.79710
175-180	*******	*******
180-185	*******	*******
185-190	1.35280	0.79410
190-195	*******	*******
195-200	*******	*******

TABLE III.21

VARIOUS ELASTICITIES OF DEMAND: MODEL I.4

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
AUSTRIA	1966	-0.2392	0.6343	37.4713
	1967	-0.2235	0.6058	35.3043
	1968	-0.2124	0.6110	32.6784
	1969	-0.2068	0.6429	30.4778
	1970	-0.1987	0.6623	27.5389
	1971	-0.1784	0.6579	26.2562
	1972	-0.1691	0.6542	26.1395
	1973	-0.1721	0.6688	33.8805
	1974	-0.2668	0.7998	41.0596
	1975	-0.3126	0.7733	46.5348
BELGIUM	1966	-0.0786	0.6707	32.5023
	1967	-0.0597	0.6435	31.2907
	1968	-0.0524	0.6263	29.6498
	1969	-0.0505	0.6434	27.2332
	1970	-0.0435	0.6700	25.1306
	1971	-0.0203	0.7042	25.0253
	1972	-0.0138	0.7041	25.7732
	1973	0.0294	0.7709	32.0615
	1974	-0.1610	0.8725	34.3375
	1975	-0.2776	0.8029	28.4217
DENMARK	1966	-1.1479	-0.2983	29.7962
	1967	-1.0771	-0.2953	27.7794
	1968	-1.0515	-0.3092	24.9544
	1969	-0.9922	-0.3248	22.6526
	1970	-0.9989	-0.3602	21.3133
	1971	-0.9623	-0.3688	20.9046
	1972	-0.9856	-0.3851	20.1246
	1973	-0.9901	-0.4019	24.6841
	1974	-1.3693	-0.4531	28.0058
	1975	-1.4506	-0.4231	25.7859

TABLE III.21 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.4

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
GERMANY	1966	-0.1362	1.4985	24.3985
	1967	-0.1265	1.4141	24.5907
	1968	-0.1279	1.4807	22.7256
	1969	-0.1240	1.4984	21.1622
	1970	-0.1191	1.4825	19.7428
	1971	-0.1084	1.3888	20.8861
	1972	-0.1142	1.3805	22.0462
	1973	-0.1278	1.4562	30.8353
	1974	-0.1930	1.5131	30.2865
	1975	-0.1693	1.3262	28.8675
ITALY	1966	0.1007	0.7180	57.7092
	1967	0.0890	0.7353	53.9667
	1968	0.0944	0.7464	52.4713
	1969	0.0830	0.7641	50.1333
	1970	0.0715	0.7817	47.1221
	1971	0.1201	0.7919	52.0690
	1972	0.0547	0.7621	51.7416
	1973	0.0144	0.7775	44.2021
	1974	0.2254	0.9123	61.1969
	1975	-0.0789	0.8426	54.2663
LUXEMBOURG	1966	0.0000	2.9302	22.9779
	1967	0.0000	2.8478	23.0221
	1968	0.0000	2.9157	22.1241
	1969	0.0000	3.0433	20.4934
	1970	0.0000	3.0005	19.3175
	1971	0.0000	2.7393	18.6520
	1972	0.0000	2.5425	17.0909
	1973	0.0000	2.3694	22.0920
	1974	0.0000	2.5646	24.8848
	1975	0.0000	1.9398	23.8558

TABLE III.21 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.4

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
NETHERL.	1966	-0.3066	0.4396	32.9950
	1967	-0.2897	0.4316	31.4689
	1968	-0.2771	0.4329	29.7091
	1969	-0.2798	0.4629	26.9871
	1970	-0.2579	0.4697	25.5761
	1971	-0.2501	0.4808	26.2032
	1972	-0.2609	0.4894	28.7442
	1973	-0.2994	0.5121	34.2620
	1974	-0.4265	0.6120	36.8145
	1975	-0.4239	0.5661	34.9556
NORWAY	1966	-0.0084	0.5890	29.5221
	1967	-0.0169	0.5970	27.9846
	1968	-0.0127	0.6177	26.8773
	1969	-0.0062	0.6088	26.0571
	1970	-0.0305	0.6364	23.5069
	1971	0.0371	0.6189	25.2107
	1972	-0.0191	0.6366	24.1635
	1973	-0.0349	0.6524	21.8789
	1974	0.1580	0.7652	32.8516
	1975	-0.1871	0.7326	27.1676
PORTUGAL	1966	0.6714	1.2463	188.7500
	1967	0.6543	1.2480	170.6964
	1968	0.6465	1.3052	149.0645
	1969	0.5740	1.2164	134.0308
	1970	0.5500	1.2562	112.1831
	1971	0.4995	1.1829	95.9474
	1972	0.5110	1.2172	83.7711
	1973	0.4830	1.2263	71.5217
	1974	0.7202	1.3315	95.5385
	1975	0.4435	1.0453	105.4756

TABLE III.21 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.4

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
SPAIN	1966	-1.1405	0.7614	78.4725
	1967	-0.9647	0.7835	70.3617
	1968	-0.8286	0.7399	63.4694
	1969	-0.7421	0.7240	57.7308
	1970	-0.6566	0.7341	51.3761
	1971	-0.6184	0.7491	50.6228
	1972	-0.5798	0.7474	45.5984
	1973	-0.5938	0.7868	51.7252
	1974	-0.6813	0.8904	61.5912
	1975	-0.6695	0.9301	50.2701
SWEDEN	1966	0.0000	0.0000	19.6731
	1967	0.0000	0.0000	19.1689
	1968	0.0000	0.0000	18.7447
	1969	0.0000	0.0000	17.8308
	1970	0.0000	0.0000	16.3902
	1971	0.0000	0.0000	16.9927
	1972	0.0000	0.0000	17.2601
	1973	0.0000	0.0000	19.6697
	1974	0.0000	0.0000	20.0200
	1975	0.0000	0.0000	18.9667
SWITZERL.	1966	-0.4081	2.7025	18.3110
	1967	-0.3786	2.5684	17.9136
	1968	-0.3730	2.6092	17.3806
	1969	-0.3659	2.6168	16.5833
	1970	-0.3485	2.5374	15.8209
	1971	-0.3211	2.4067	16.1329
	1972	-0.3336	2.4000	17.7797
	1973	-0.3805	2.4551	20.7072
	1974	-0.4697	2.5625	22.9918
	1975	-0.4921	2.3040	27.5425

TABLE III.21 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.4

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
U.K.	1966	-0.1863	0.7442	36.2178
	1967	-0.1677	0.7227	35.3366
	1968	-0.1643	0.7169	33.2891
	1969	-0.1534	0.7299	31.4558
	1970	-0.1378	0.7175	29.4521
	1971	-0.1221	0.7129	27.2187
	1972	-0.1008	0.7039	25.4847
	1973	-0.0716	0.7162	25.6653
	1974	-0.0358	0.7792	35.5041
	1975	-0.2387	0.7861	29.2720
CANADA	1966	0.0000	0.4329	11.5845
	1967	0.0000	0.4736	11.3968
	1968	0.0000	0.4436	11.6087
	1969	0.0000	0.4636	10.4025
	1970	0.0000	0.4668	10.8247
	1971	0.0000	0.4537	10.4083
	1972	0.0000	0.4779	9.1241
	1973	0.0000	0.4860	9.7761
	1974	0.0000	0.5154	10.1441
	1975	0.0000	0.5069	9.5991
U.S.	1966	0.0000	0.5414	9.2958
	1967	0.0000	0.5681	9.0803
	1968	0.0000	0.5709	8.5741
	1969	0.0000	0.5811	8.1786
	1970	0.0000	0.5614	8.0167
	1971	0.0000	0.5464	7.9365
	1972	0.0000	0.5538	7.3405
	1973	0.0000	0.5858	6.9271
	1974	0.0000	0.6161	8.7170
	1975	0.0000	0.5805	8.8275

TABLE III.22

AVERAGE ELASTICITIES FOR DIFFERENT RANGES OF P.F.: MODEL I.4

R-RANGE	E(D(t),P(t))	E(D(t),G(t))
5- 10	*******	*******
10- 15	*******	*******
15- 20	*******	-0.70652
20- 25	-0.02913	-0.63579
25- 30	-0.13433	-0.05347
30- 35	-0.13801	-0.08527
35- 40	-0.10263	*******
40- 45	-0.14105	*******
45- 50	-0.04017	0.12283
50- 55	-0.11438	0.14591
55- 60	-0.06590	0.22275
60- 65	0.01420	0.27370
65- 70	*******	*******
70- 75	-0.09260	-0.00010
75- 80	0.33540	0.60570
80- 85	-0.51100	-0.53910
85- 90	*******	*******
90- 95	*******	*******
95-100	-0.60985	-0.51725
100-105	*******	*******
105-110	-0.44350	-0.36990
110-115	-0.55000	-0.60520
115-120	*******	*******
120-125	*******	*******
125-130	*******	*******
130-135	-0.57400	-0.58790
135-140	*******	*******
140-145	*******	*******
145-150	-0.64650	-0.68180
150-155	*******	*******
155-160	*******	*******
160-165	*******	*******
165-170	*******	*******
170-175	-0.65430	-0.66640
175-180	*******	*******
180-185	*******	*******
185-190	-0.67140	-0.66680
190-195	*******	*******
195-200	*******	*******

resulted in model I.5 whose results are discussed in the next section.

Results of Model I.5

The annual elasticities of demand and their average values over intervals of P.F. are shown in tables III.23 and III.24 respectively. The same shortcomings of previous models seem to be shared by the current one and the elasticity values estimated are still considered unreasonable.

It is concluded that according to the employed models, the current prices appear to be better parameters for determining demand elasticities than lagged prices.

THE G(t) ELASTICITY OF DEMAND

Studying the possible influence of the per capita GNP on demand intensity in various countries yielded the following results:

Results Of Model I

Table III.10 contains the annual elasticities of demand for the fifteen OECD countries with respect to current GNP per capita, E(D(t),G(t)). It can be seen from the table that the elasticity coefficients vary intensively and irregularly over a wide range. The negative values calculated for seven of the fifteen countries indicate unreasonable economic behavior and are contradictory to

TABLE III.23

VARIOUS ELASTICITIES OF DEMAND: MODEL I.5

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
AUSTRIA	1966	-0.2393	0.0000	37.4713
	1967	-0.2236	0.0000	35.3043
	1968	-0.2125	0.0000	32.6784
	1969	-0.2069	0.0000	30.4778
	1970	-0.1988	0.0000	27.5389
	1971	-0.1785	0.0000	26.2562
	1972	-0.1692	0.0000	26.1395
	1973	-0.1722	0.0000	33.8805
	1974	-0.2669	0.0000	41.0596
	1975	-0.3127	0.0000	46.5348
BELGIUM	1966	-0.1367	0.0000	32.5023
	1967	-0.1178	0.0000	31.2907
	1968	-0.1083	0.0000	29.6498
	1969	-0.1051	0.0000	27.2332
	1970	-0.0976	0.0000	25.1306
	1971	-0.0817	0.0000	25.0253
	1972	-0.0775	0.0000	25.7732
	1973	-0.0606	0.0000	32.0615
	1974	-0.2059	0.0000	34.3375
	1975	-0.2739	0.0000	28.4217
DENMARK	1966	-0.3160	-0.0822	29.7962
	1967	-0.2965	-0.0783	27.7794
	1968	-0.2894	-0.0873	24.9544
	1969	-0.2731	-0.1078	22.6526
	1970	-0.2750	-0.2557	21.3133
	1971	-0.2649	-0.2850	20.9046
	1972	-0.2713	-0.3178	20.1246
	1973	-0.2725	-0.3820	24.6841
	1974	-0.3769	-0.4856	28.0058
	1975	-0.3993	-0.4564	25.7859

TABLE III.23 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.5

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
GERMANY	1966	-0.1577	0.4710	24.3985
	1967	-0.1465	0.4073	24.5907
	1968	-0.1481	0.4857	22.7256
	1969	-0.1436	0.4422	21.1622
	1970	-0.1379	0.3776	19.7428
	1971	-0.1255	0.2979	20.8861
	1972	-0.1322	0.2936	22.0462
	1973	-0.1480	0.3019	30.8353
	1974	-0.2236	0.2522	30.2865
	1975	-0.1960	0.1947	28.8675
ITALY	1966	-0.0931	0.8779	57.7092
	1967	-0.1020	0.8509	53.9667
	1968	-0.0847	0.7988	52.4713
	1969	-0.0977	0.7846	50.1333
	1970	-0.1073	0.7575	47.1221
	1971	-0.0385	0.7144	52.0690
	1972	-0.1304	0.6872	51.7416
	1973	-0.1824	0.7076	44.2021
	1974	0.0755	0.7641	61.1969
	1975	-0.3531	0.6384	54.2663
LUXEMBOURG	1966	0.0000	2.9304	22.9779
	1967	0.0000	2.8480	23.0221
	1968	0.0000	2.9159	22.1241
	1969	0.0000	3.0434	20.4934
	1970	0.0000	3.0007	19.3175
	1971	0.0000	2.7394	18.6520
	1972	0.0000	2.5426	17.0909
	1973	0.0000	2.3696	22.0920
	1974	0.0000	2.5647	24.8848
	1975	0.0000	1.9399	23.8558

TABLE III.23 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.5

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
NETHERL.	1966	-0.6212	0.0650	32.9950
	1967	-0.5931	0.0819	31.4689
	1968	-0.5674	0.0344	29.7091
	1969	-0.5686	-0.0291	26.9871
	1970	-0.5343	-0.1061	25.5761
	1971	-0.5280	-0.1828	26.2032
	1972	-0.5517	-0.2307	28.7442
	1973	-0.6307	-0.2485	34.2620
	1974	-0.8256	-0.4140	36.8145
	1975	-0.7850	-0.4407	34.9556
NORWAY	1966	0.0657	-2.8609	29.5221
	1967	0.0567	-2.8129	27.9846
	1968	0.0593	-2.7617	26.8773
	1969	0.0616	-2.6467	26.0571
	1970	0.0394	-2.6264	23.5069
	1971	0.0954	-2.5066	25.2107
	1972	0.0481	-2.4961	24.1635
	1973	0.0318	-2.4246	21.8789
	1974	0.2197	-2.7943	32.8516
	1975	-0.0789	-2.5076	27.1676
PORTUGAL	1966	0.6041	0.7043	188.7500
	1967	0.5888	0.7053	170.6964
	1968	0.5817	0.7366	149.0645
	1969	0.5165	0.6835	134.0308
	1970	0.4949	0.7057	112.1831
	1971	0.4495	0.6625	95.9474
	1972	0.4598	0.6808	83.7711
	1973	0.4346	0.6845	71.5217
	1974	0.6481	0.7388	95.5385
	1975	0.3991	0.5787	105.4756

TABLE III.23 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.5

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
SPAIN	1966	-0.5319	0.3879	78.4725
	1967	-0.4259	0.3701	70.3617
	1968	-0.3376	0.3443	63.4694
	1969	-0.2775	0.3318	57.7308
	1970	-0.2453	0.3227	51.3761
	1971	-0.1895	0.3209	50.6228
	1972	-0.2002	0.3166	45.5984
	1973	-0.1395	0.3234	51.7252
	1974	-0.2092	0.3513	61.5912
	1975	-0.3628	0.3551	50.2701
SWEDEN	1966	-0.3689	-0.4627	19.6731
	1967	-0.3465	-0.4963	19.1689
	1968	-0.3380	-0.5042	18.7447
	1969	-0.3402	-0.5161	17.8308
	1970	-0.3427	-0.6073	16.3902
	1971	-0.3212	-0.6776	16.9927
	1972	-0.3283	-0.6504	17.2601
	1973	-0.3335	-0.6591	19.6697
	1974	-0.4437	-0.7969	20.0200
	1975	-0.4172	-0.7920	18.9667
SWITZERL.	1966	-0.4081	2.7025	18.3110
	1967	-0.3786	2.5685	17.9136
	1968	-0.3730	2.6092	17.3806
	1969	-0.3659	2.6169	16.5833
	1970	-0.3485	2.5374	15.8209
	1971	-0.3211	2.4067	16.1329
	1972	-0.3336	2.4000	17.7797
	1973	-0.3805	2.4551	20.7072
	1974	-0.4697	2.5626	22.9918
	1975	-0.4921	2.3041	27.5425

TABLE III.23 CONTD.

VARIOUS ELASTICITIES OF DEMAND: MODEL I.5

COUNTRY	YEAR	E(D(t),P(t-1))	E(D(t),G(t-1))	P.F.
U.K.	1966	-0.2658	0.0000	36.2178
	1967	-0.2447	0.0000	35.3366
	1968	-0.2380	0.0000	33.2891
	1969	-0.2258	0.0000	31.4558
	1970	-0.2069	0.0000	29.4521
	1971	-0.1888	0.0000	27.2187
	1972	-0.1659	0.0000	25.4847
	1973	-0.1434	0.0000	25.6653
	1974	-0.1315	0.0000	35.5041
	1975	-0.2969	0.0000	29.2720
CANADA	1966	-0.5341	0.4710	11.5845
	1967	-0.5261	0.3639	11.3968
	1968	-0.4847	0.3055	11.6087
	1969	-0.5161	0.4278	10.4025
	1970	-0.4656	0.2663	10.8247
	1971	-0.4709	0.3486	10.4083
	1972	-0.4769	0.3230	9.1241
	1973	-0.4252	0.3069	9.7761
	1974	-0.4831	0.2610	10.1441
	1975	-0.4930	0.2317	9.5991
U.S.	1966	-0.2535	0.2607	9.2958
	1967	-0.2502	0.1945	9.0803
	1968	-0.2478	0.1984	8.5741
	1969	-0.2360	0.1497	8.1786
	1970	-0.2109	0.1052	8.0167
	1971	-0.1792	0.1424	7.9365
	1972	-0.1932	0.1515	7.3405
	1973	-0.1751	0.1214	6.9271
	1974	-0.1024	0.0344	8.7170
	1975	-0.2638	0.0472	8.8275

TABLE III.24

AVERAGE ELASTICITIES FOR DIFFERENT RANGES OF P.F.: MODEL I.5

R-RANGE	E(D(t),P(t-1))	E(D(t),G(t-1))
5- 10	-0.22318	-0.78439
10- 15	*******	-0.70300
15- 20	*******	-1.08928
20- 25	-0.02775	-0.65055
25- 30	-0.07620	0.13421
30- 35	-0.05533	-0.24618
35- 40	-0.03400	-0.22345
40- 45	-0.17275	-0.35380
45- 50	-0.18770	-0.25250
50- 55	-0.31495	-0.44743
55- 60	-0.33425	-0.43895
60- 65	-0.33340	-0.25470
65- 70	*******	*******
70- 75	-0.32710	-0.15495
75- 80	-0.24730	*******
80- 85	-0.45980	-0.32060
85- 90	*******	*******
90- 95	*******	*******
95-100	-0.54880	-0.30770
100-105	*******	*******
105-110	-0.39910	-0.22010
110-115	-0.49490	-0.36000
115-120	*******	*******
120-125	*******	*******
125-130	*******	*******
130-135	-0.51650	-0.34970
135-140	*******	*******
140-145	*******	*******
145-150	-0.58170	-0.40560
150-155	*******	*******
155-160	*******	*******
160-165	*******	*******
165-170	*******	*******
170-175	-0.58880	-0.39640
175-180	*******	*******
180-185	*******	*******
185-190	-0.60410	-0.39660
190-195	*******	*******
195-200	*******	*******

practical observations. Such negative coefficients suggest that an increase in the per capita GNP is associated with a decrease in demand intensity which contradicts with figures II.1. The positive elasticity values of around 4, calculated for Norway, are excessively high. The figures in chapter II show an almost equal growth rates of both demand intensity and GNP per capita implied by the almost parallel trends of their graphs. This suggests an almost unitary positive elasticity. The average elasticities displayed in table III.11 reflect the unreasonable behavior just discussed. It is possible that the estimates were strongly biased under the influence of other variables in the model.

For the above reasons, the other models were formulated as described earlier in the chapter and the results were as follows:

Results Of Model I.1

The annual values of E(D(t),G(t)) and their averages for the different ranges of P.F. as calculated from model I.1 are displayed in tables III.13 and III.14. As can be seen from the tables, the elasticities were still mostly negative despite the U.K. and Canada showing positive values close to the expected magnitudes.

Results Of Model I.2

Tables III.16 and III.17 contain the annual elasticity values and their averages for ranges of P.F. as calculated from model I.2. Referring to table III.16, the following observations can be made:

Positive demand elasticities of reasonable magnitudes appeared for Austria, Belgium, Italy, the Netherlands, Norway and the U.K. The coefficients were negligible for the U.S., zero for Sweden, positive but low for Spain and negative for the rest.

Referring to the expected "rational" economic behavior, the results of this model are improved over the previous two, still not accepatble yet.

THE G(t-1) ELASTICITY OF DEMAND

Due to the unacceptable findings about E(D(t),G(t)) that were described in the preceding section, it was decided to examine E(D(t), G(t-1)) for a possible delayed influence of the per capita GNP. The results are described in what follows:

Results Of Model I

Table III.10 shows that the elasticity values with respect to per capita GNP with a one year time lag are positive for six out of the fifteen OECD countries, zero for three and negative for six of them. As can be seen from table III.1, the extremely large negative values calculated for Luxembourg are obviously a consequence of including the triplet (G(t-1), G(t) and g) in the estimated model. As it was explained earlier, other steps generated by the stepwise regression program which did not include the triplet were statistically highly insignificant.

The influence of the large negative coefficients of Luxembourg is reflected in the values corresponding to the P.F-ranges between 15 and 25 in table III.11. Ignoring this range of P.F., table III.11 indicates a more reasonable behavior for the influence of per capita GNP on demand.

It can also be seen from the table that E(D(t),G(t-1)) does not appear to be a function of P.F., rather it fluctuates around a fixed value. For the above reason, the average elasticities were averaged giving a value of $.68 \pm .35$.

Results of Model I.3

The removal of current variables from model I resulted in the annual elasticities of demand given in table III.19. We see from the table that nine countries showed positive elasticities, four countries showed negative elasticities and two countries showed zero elasticities. The averages over the intervals of P.F. are displayed in table III.20 and again indicate a rather constant reference value. The overall average elasticity calculated by this model was $.73 \pm .29$.

Results of Model I.4

The annual elasticities and their averages, as caculated from model I.4 are displayed in table III.21 and III.22. The tables show predominantly positive elasticity coefficients. Actually, only Denmark showed negative elasticity values. The overall average elasticity calculated from table III.22 was .96± .29.

Results of Model I.5

As may be seen from tables III.23 and III.24, The specific formulation of model I.4 reduced the overall average elasticity to .47±.35.

It was concluded from the above analysis that the elasticity of demand intensity, averaged over countries, with respect to the per capita GNP lagged by one year, falls in the range 0.7±0.3.

CHAPTER IV.

CROSS SECTION ANALYSIS, MODEL VALIDATION AND CONCLUSIONS OF THE REGRESSION ANALYSIS

CROSS SECTION ANALYSIS

The time series analysis described in Chapter III indicated rational functional dependence of the elasticity of demand per GNP, averaged over the countries considered, on the ratio of current price to current per capita GNP, P.F. This finding suggested that P.F. itself might be a good explanatory variable of demand behavior within defined limits. The investigation was therefore further extended by analyzing the data of the various countries cross sectionally for each of the years 1965-1975.

Cross sectional plots of D(t) versus the current price, P(t), were first considered. Figure IV.1 depicts a scatter plot of the data for the year 1970. It is clear that the figure does not indicate the regular downward sloping pattern expected for the relationship between price and demand.

The annual cross sectional data of D(t) versus P(t) were fitted via OLS for the various functional forms. The results for the years 1970 and 1975 are displayed in figures IV.2 and IV.3 and tables IV.1 and IV.2. These results are representative of the findings for the rest of the years and

FIGURE IV.1

SCATTER DIAGRAM OF D(t) VS. P(t) FOR 1970

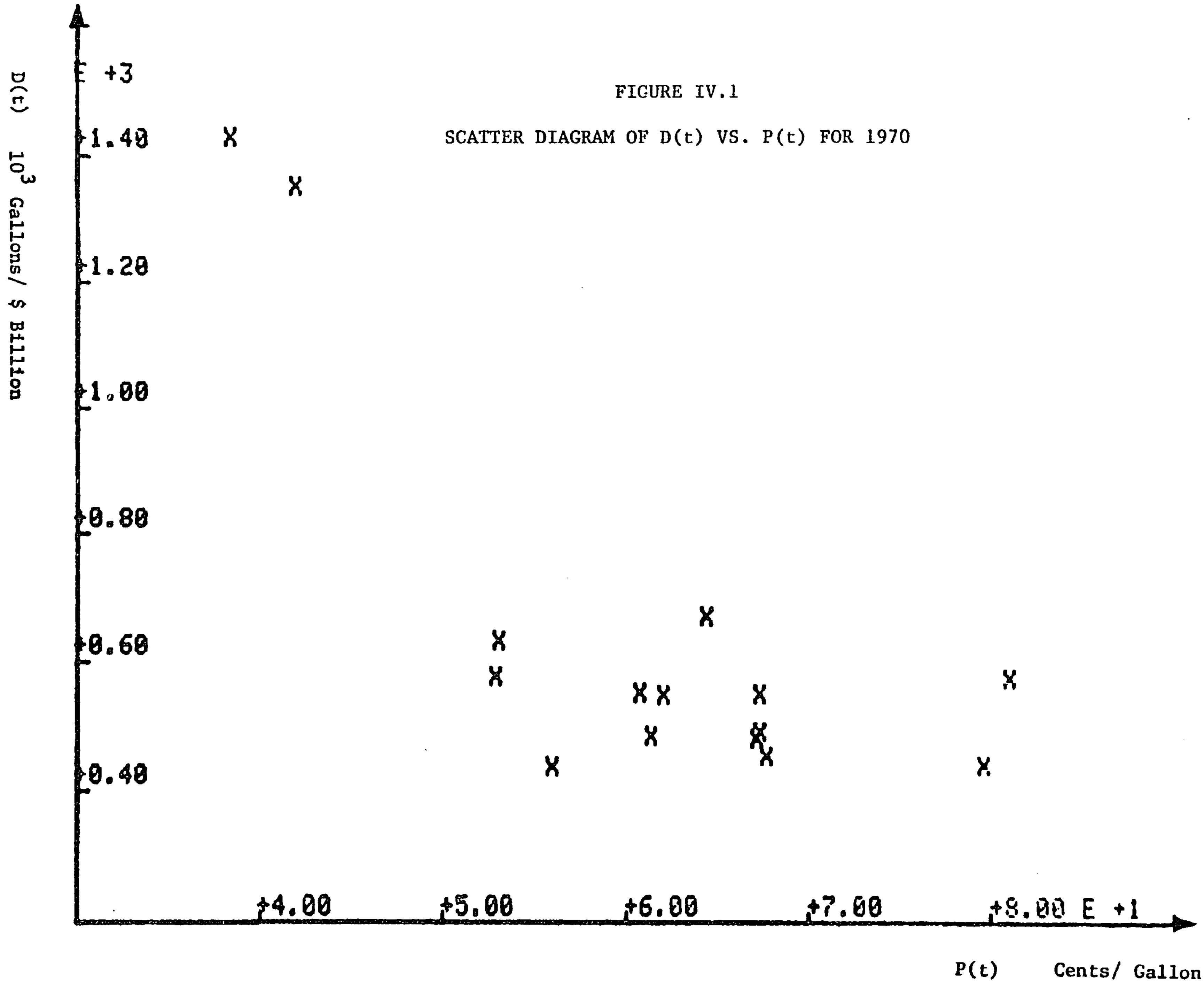


TABLE IV.1

CURVE FIT OF D(t) VS. P(t) FOR 1970

EQUATION	A	B	R-SQUARE	MAX DEVIATION
Y = A*X	9.51184	0.00000	INSIGNIF.	1063.03549
Y = A + B*X	1862.65810	-19.79267	0.56721	325.67034
Y = A*EXP(B*X)	2471.48974	- 0.02304	0.62365	412.46303
Y = 1/(A + B*X)	-0.00006	0.00003	0.55373	504.12056
Y = A + B/X	-565.81487	71602.62938	0.76133	276.35351
Y = A + B*LOG(X)	5706.21105	-1234.26515	0.67168	301.40974
$Y = A*X^B$	209510.82327	-1.42836	0.73893	345.65480
Y = X/(A + B*X)	-0.10417	0.00352	0.80276	387.41893

FIGURE IV.2

BEST FIT OF D(t) VS. P(t) FOR 1970

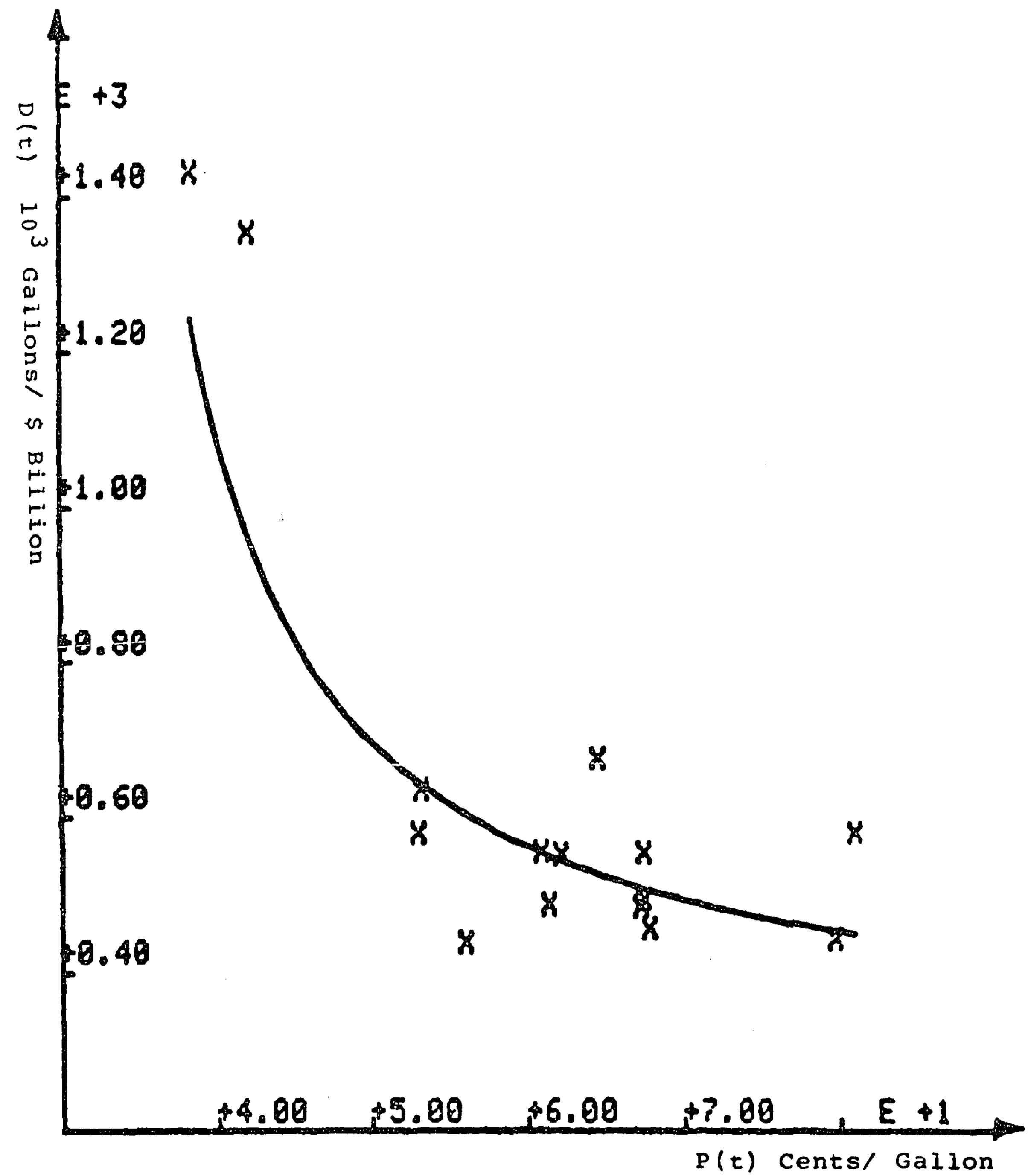


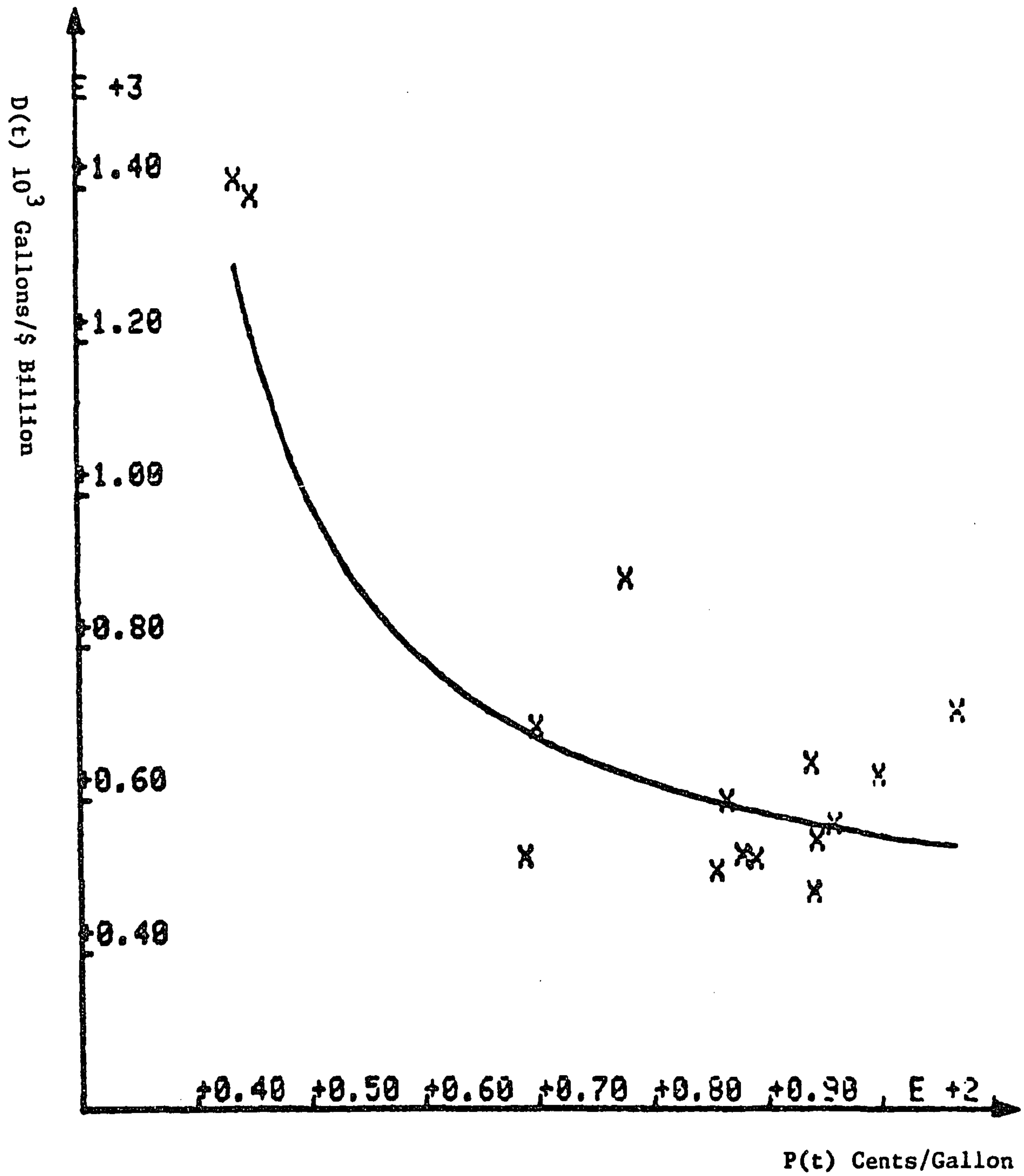
TABLE IV.2

CURVE FIT OF D(t) VS. P(t) FOR 1975

EQUATION	A	B	R-SQUARE	MAX DEVIATION
Y = A*X	7.58193	0.00000	INSIGNIF.	1077.38940
Y = A + B*X	1770.02411	-12.87228	0.64563	361.02049
Y = A*EXP(B*X)	2092.97356	- 0.01390	0.69827	280.88550
Y = 1/(A + B*X)	0.00025	0.00002	0.65032	357.71053
Y = A + B/X	-126.27528	64278.95194	0.80425	284.57220
Y = A + B*LOG(X)	4876.65543	-951.15938	0.73682	328.64902
$Y = A*X^B$	60460.28737	-1.02915	0.78647	253.49503
Y = X/(A + B*X)	-0.08093	0.00263	0.83678	255.03143

FIGURE IV.3

BEST FIT OF D(t) VS. P(t) FOR 1975



confirm the lack of good fit which was originally apparent from a mere visual inspection of figure IV.1.

In the next step of the analysis, D(t) was regressed against the price factor P.F. for the same functional forms. Again, the data showed no good fit for the various years as indicated by the results of the regression for the year 1970 displayed in figures IV.4 and IV.5 and table IV.3.

When demand per capita, DC(t), was introduced instead of the demand per GNP, the plots showed the expected rational economic behavior. Figure IV.6 depicts a scatter plot of DC(t) versus P.F. taken cross sectionally for the fifteen OECD countries for the year 1965. The behavior depicted in the figure is representative of that found for all years between 1965 and 1975.

The cross section data of DC(t) were regressed against P.F. for the years 1965 through 1975, employing the various functional forms previously described. The results of the OLS curve fittings for the years 1965, 1970 and 1975 are given in tables IV.4 through IV.6 and figures IV.7 through IV.9. An analysis of the fitted equations for the various years did not indicate a regular detectable pattern of a temporal shift in the cross sectional demand curve.

Table IV.7 summarizes the curve fitting results of DC(t) versus P.F. for the years 1965 through 1975. The table shows that the exponential function gave quite satisfactory results for all the years with R-SQR. values above 0.90.

FIGURE IV.4

SCATTER DIAGRAM OF D(t) VS. P.F. FOR 1970

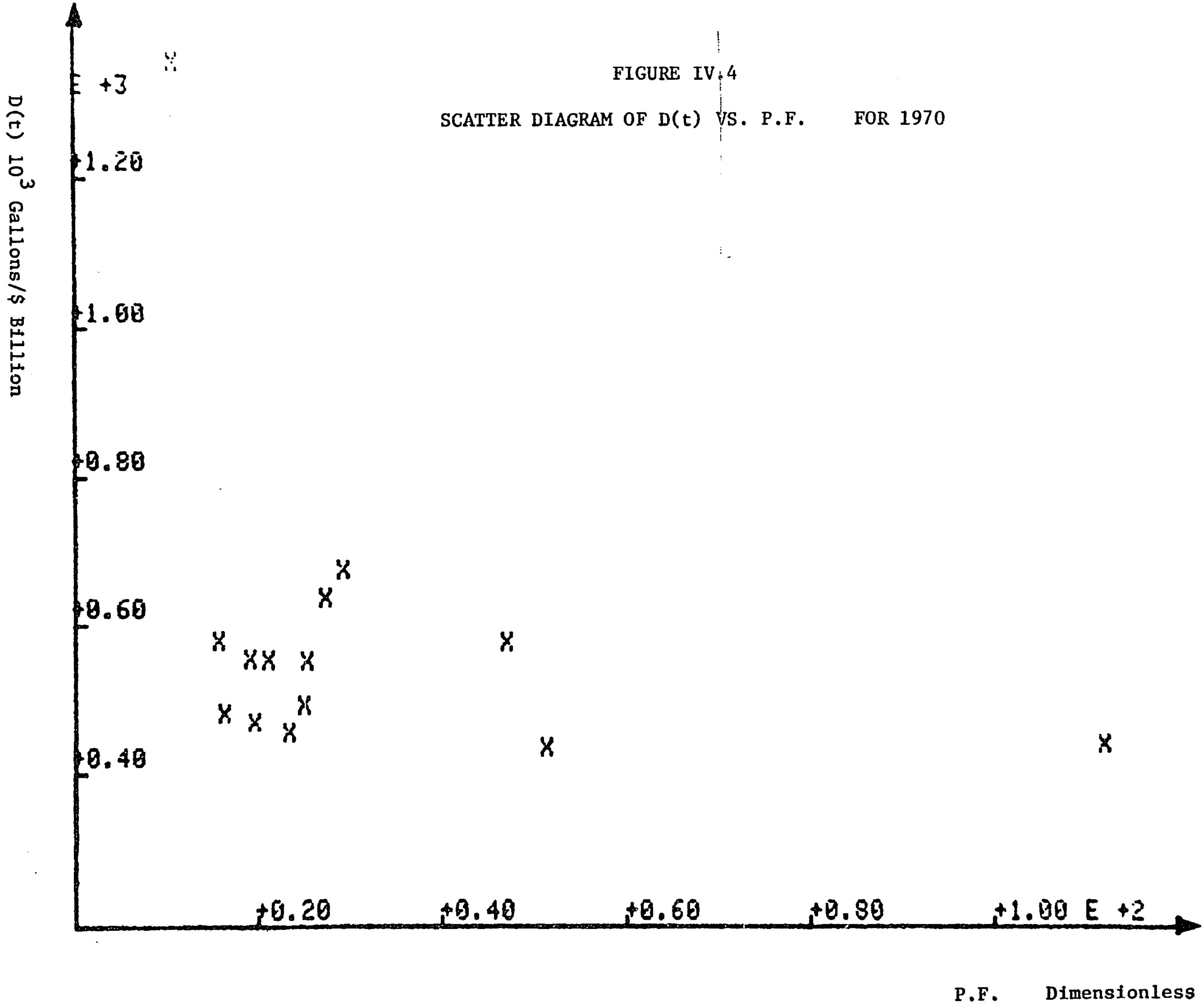


FIGURE IV.5

BEST FIT OF D(t) VS. P.F. FOR 1970

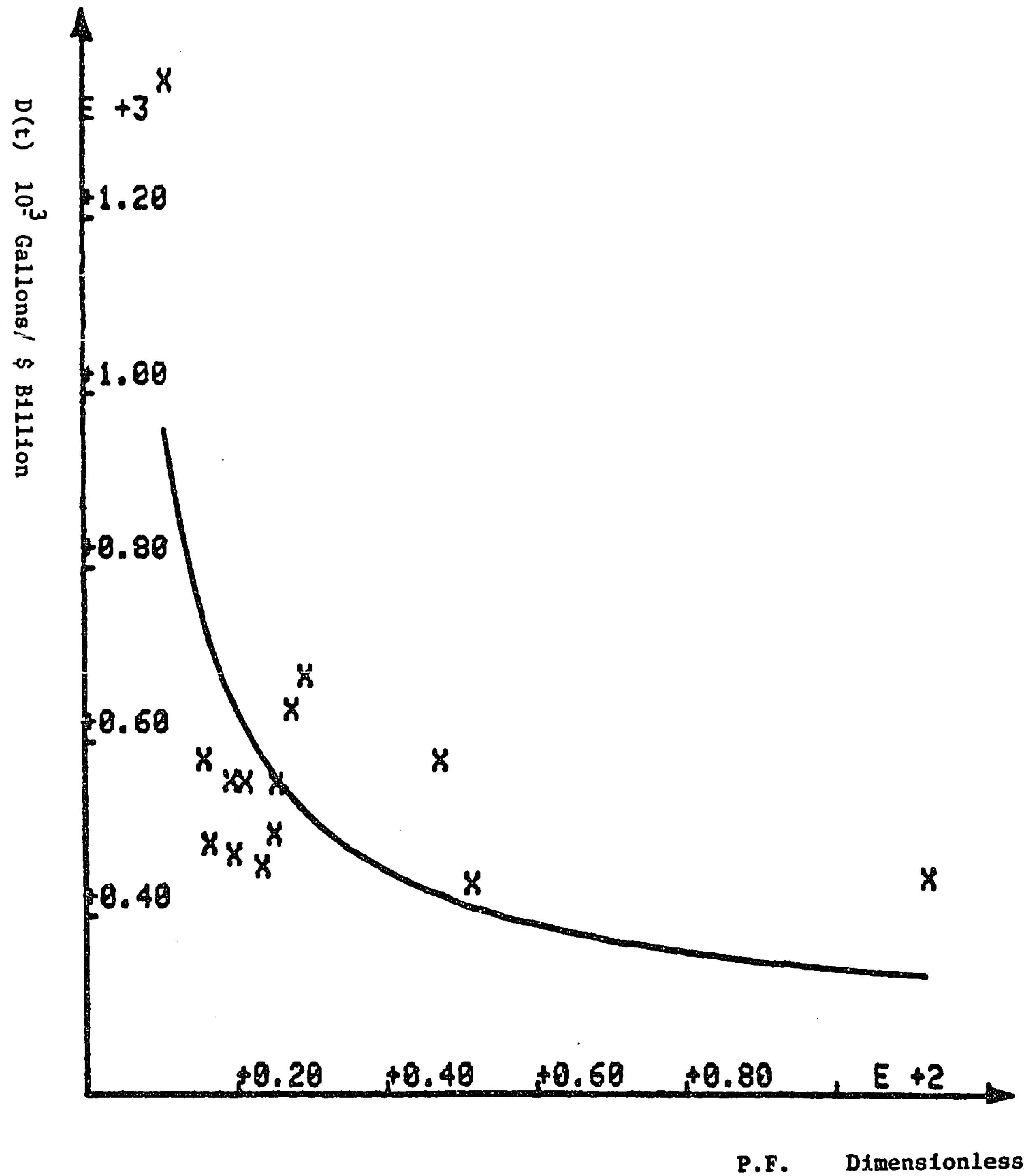


TABLE IV.3

CURVE FIT OF D(t) VS. P.F. FOR 1970

EQUATION	A	B	R-SQUARE	MAX DEVIATION
Y = A*X	10.41256	0.00000	INSIGNIF	1238.99404
Y = A + B*X	683.41394	-2.95721	0.10845	700.30786
Y = A*EXP(B*X)	643.43928	-0.00422	0.09783	737.00539
Y = 1/(A + B*X)	0.00162	0.00001	0.06846	760.80552
Y = A + B/X	263.79402	7505.95831	0.46007	394.52492
Y = A + B*LOG(X)	1226.69596	-194.92058	0.24189	589.28723
$Y = A*X^B$	1282.06099	-0.25190	0.24183	648.08484
Y = X/(A + B*X)	-0.01221	0.00236	0.44228	542.64534

FIGURE IV.6

SCATTER DIAGRAM OF DC(t) VS. P.F. FOR 1965

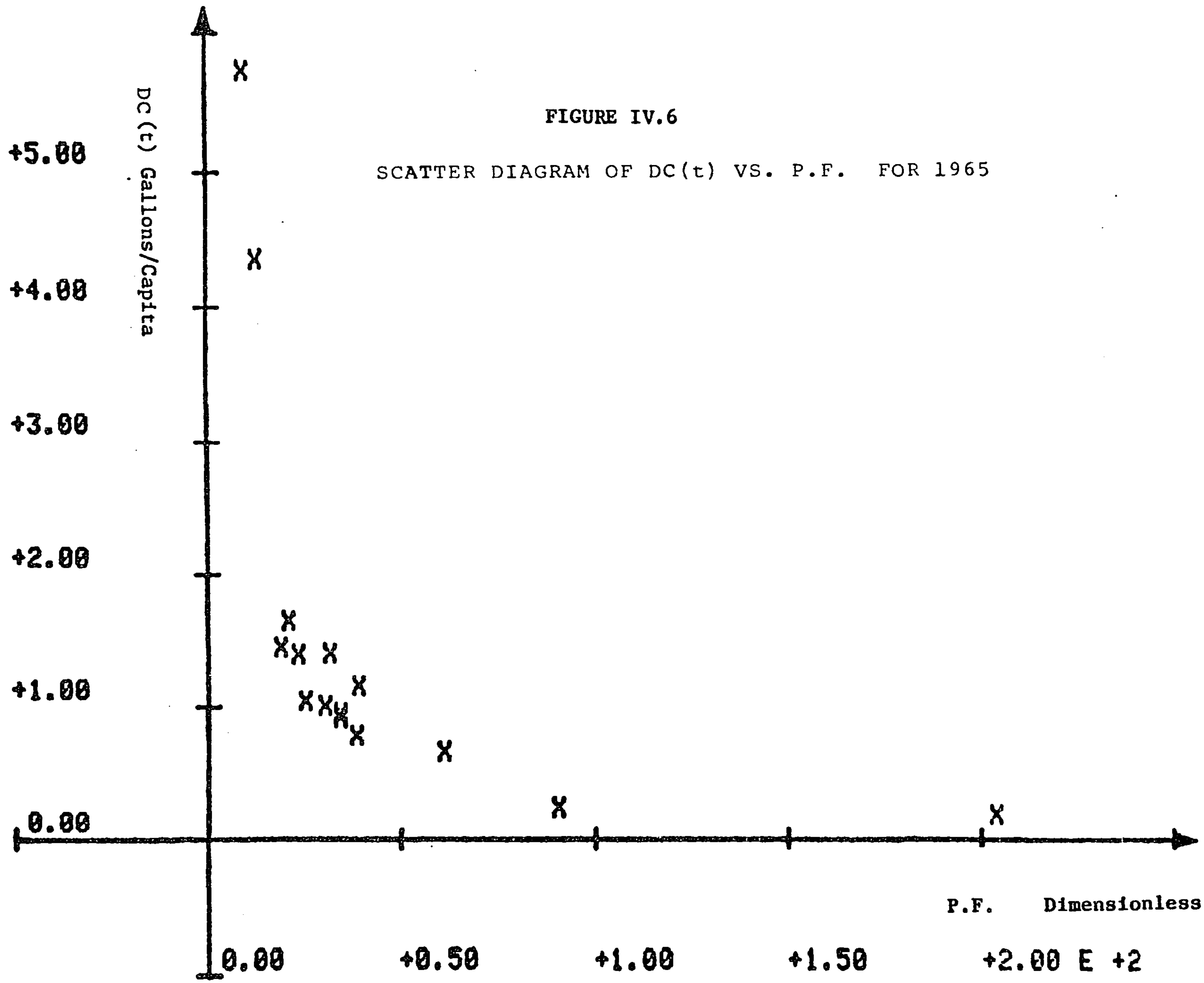


TABLE IV.4

CURVE FIT OF DC(t) VS. P.F.(t) FOR 1965

EQUATION	A	B	R-SQUARE	MAX DEVIATION
Y = A*X	0.00868	0.00000	INSIGNIF.	5.64058
Y = A + B*X	2.19480	-0.01488	0.22642	3.67758
Y = A*EXP(B*X)	2.08819	-0.01493	0.27431	3.93307
Y = 1/(A + B*X)	0.05143	0.02957	0.61024	2.80554
Y = A + B/X	-0.65631	57.61963	0.91273	0.91143
Y = A + B*LOG(X)	6.91988	-1.54400	0.58458	2.33640
$Y = A*X^B$	58.17761	-1.14451	0.86178	1.47721
Y = X/(A + B*X)	-39.25105	2.86733	INSIGNIF.	9.79562

FIGURE IV.7

BEST FIT OF DC(t) VS. P.F. FOR 1965

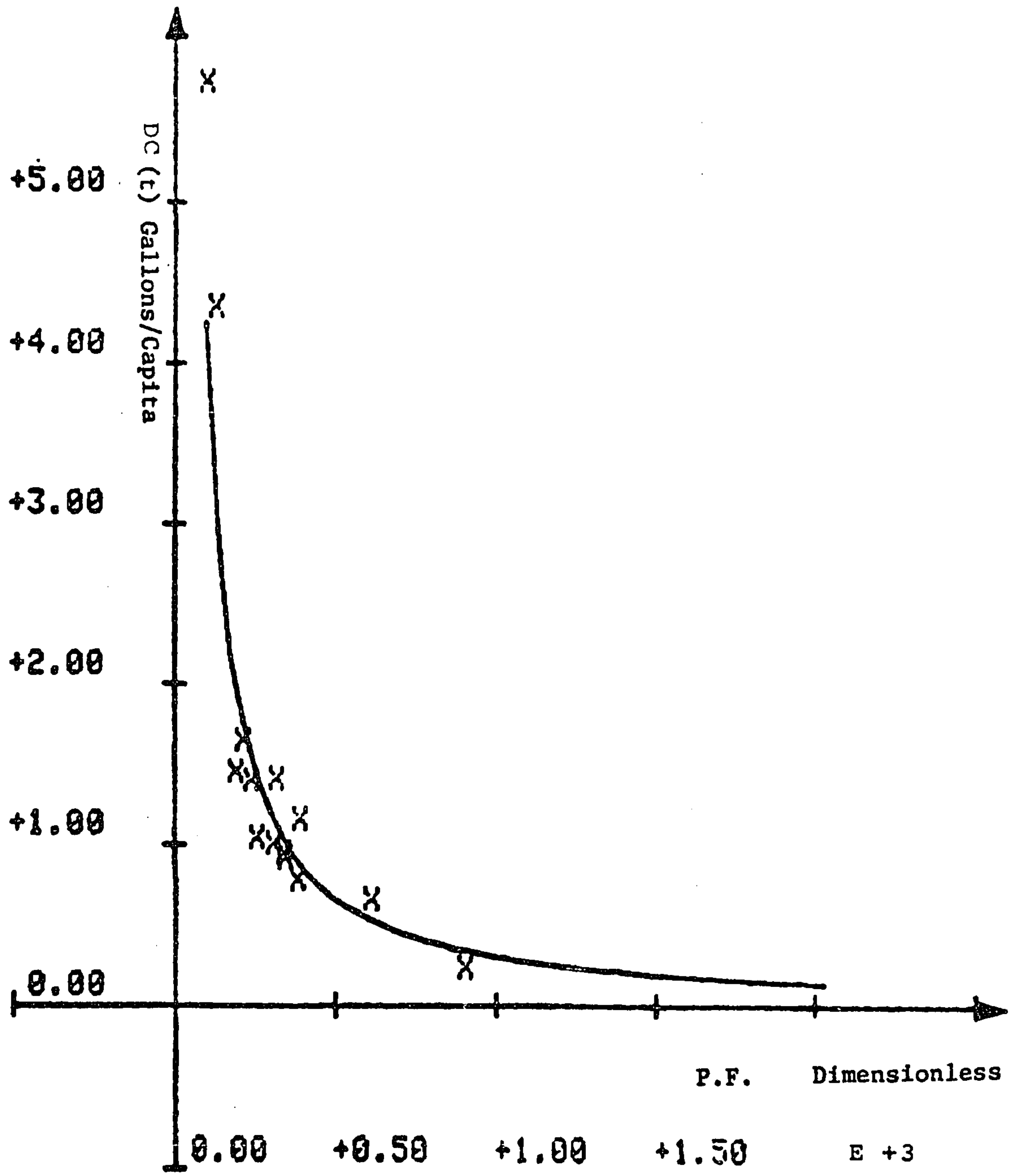


TABLE IV.5

CURVE FIT OF DC(t) VS. P.F.(t) FOR 1970

EQUATION	A	B	R-SQUARE	MAX DEVIATION
Y = A*X	0.02448	0.00000	INSIGNIF.	6.64377
Y = A + B*X	3.07157	-0.03652	0.28517	4.06122
Y = A*EXP(B*X)	3.15514	-0.02474	0.36413	4.25259
Y = 1/(A + B*X)	-0.00993	0.02943	0.75994	2.41553
Y = A + B/X	-0.83621	57.46327	0.91587	0.85588
Y = A + B*LOG(X)	8.86153	-2.16066	0.62687	2.47602
$Y = A*X^B$	56.67845	-1.13967	0.87211	1.55380
Y = X/(A + B*X)	-18.63709	1.78894	INSIGNIF.	9.61726

FIGURE IV.8

BEST FIT OF DC(t) VS. P.F. FOR 1970

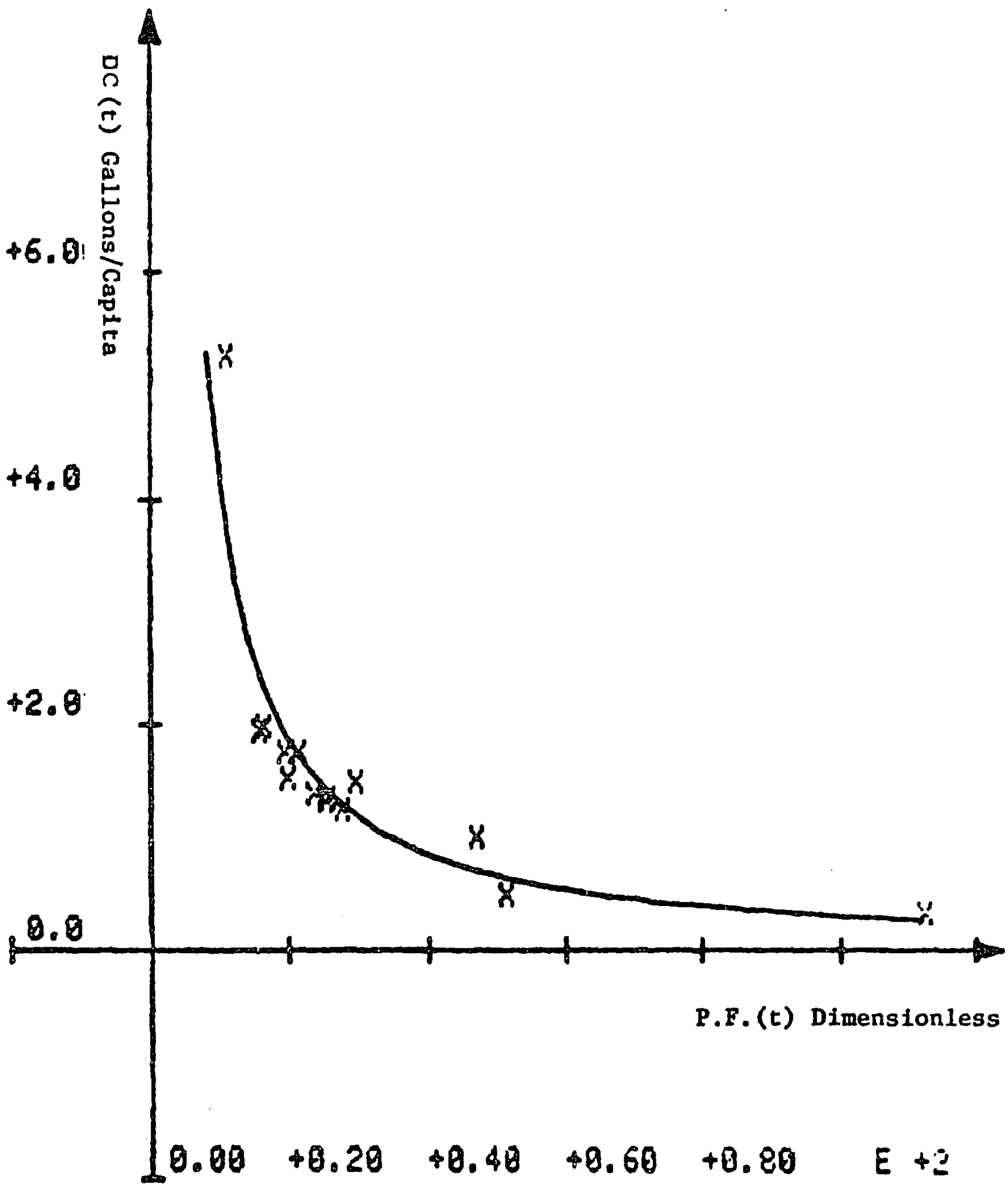


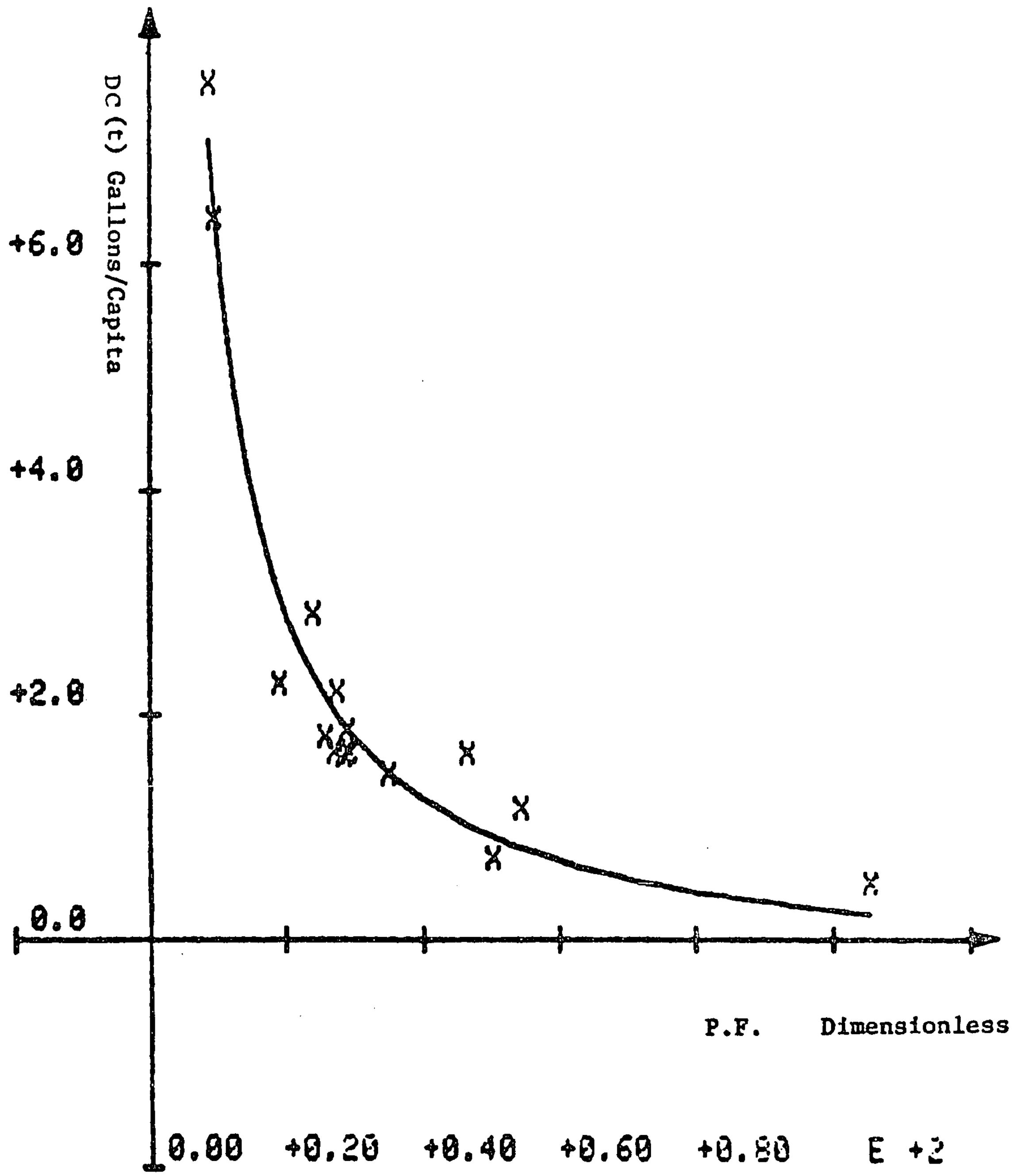
TABLE IV.6

CURVE FIT OF DC(t) VS. P.F. FOR 1975

EQUATION	A	B	R-SQUARE	MAX DEVIATION
Y = A*X	0.03174	0.00000	INSIGNIF.	7.29278
Y = A + B*X	4.18401	-0.05274	0.39222	3.85460
Y = A*EXP(B*X)	4.40461	-0.02508	0.50680	4.04325
Y = 1/(A + B*X)	-0.00178	0.01940	0.90651	1.67142
Y = A + B/X	-0.40680	66.22100	0.95943	0.81158
Y = A + B*LOG(X)	11.64299	-2.75993	0.76388	1.94094
$Y = A*X^B$	66.40670	-1.06464	0.94933	1.03858
Y = X/(A + B*X)	-11.10941	1.13390	INSIGNIF.	49.03310

FIGURE IV.9

BEST FIT OF DC(t) VS. P.F. FOR 1975



Despite the fact that the exponential function ranked second best for all but one of the eleven years, as may be seen from table IV.7, it was adopted because of its perfect interpretability. The exponent of P.F. is nothing but the elasticity of DC(t) with respect to P.F.

The exponents of P.F. estimated for the various years were averaged, yielding an average elasticity of $-1.125 \pm .023$. This value was used as the measure of the elasticity of per capita demand to the price factor P.F. in various countries.

It was concluded from the preceding cross section analysis that the per capita demand in the various countries examined in the present work displays rational economic behavior versus the corresponding price factor P.F. The demand function was thus assumed exponential in P.F. with an elasticity of -1.125 ± 0.023.

Contrary to the convention followed in the economics literature, the price related variable (P.F.) was plotted on the horizontal axis.

MODEL VALIDATION

The findings of the time series and cross section analyses described in Chapter III and the preceding section of this chapter were used for retrospective forecasting of the demand for motor gasoline in the OECD countries that were not included in the analysis, viz. France, Ireland and Japan.

TABLE IV.7

CROSS-SECTIONAL DEMAND ESTIMATES: VARIOUS COUNTRIES

YEAR	ESTIMATED FUNCTION	R-SQR
1965	$D' = -0.656 + (57.62 / P.F.)$	0.913
	$D' = 58.178\ (P.F.)^{-1.145}$	0.862
1966	$D' = 54.983\ (P.F.)^{-1.128}$	0.922
	$D' = -0.640 + (56.11 / P.F.)$	0.916
1967	$D' = -0.641 + (56.01 / P.F.)$	0.931
	$D' = 55.915\ (P.F.)^{-1.128}$	0.928
1968	$D' = -0.708 + (57.19 / P.F.)$	0.924
	$D' = 57.028\ (P.F.)^{-1.134}$	0.923
1969	$D' = -0.706 + (55.36 / P.F.)$	0.935
	$D' = 52.116\ (P.F.)^{-1.11}$	0.929
1970	$D' = -0.836 + (57.463 / P.F.)$	0.916
	$D' = 56.678\ (P.F.)^{-1.140}$	0.872
1971	$D' = -0.796 + (58.643 / P.F.)$	0.939
	$D' = 60.348\ (P.F.)^{-1.140}$	0.932
1972	$D' = -0.625 + (56.035 / P.F.)$	0.969
	$D' = 60.939\ (P.F.)^{-1.130}$	0.943
1973	$D' = -0.313 + (57.023 / P.F.)$	0.971
	$D' = 76.312\ (P.F.)^{-1.147}$	0.944
1974	$D' = -0.317 + (65.359 / P.F.)$	0.964
	$D' = 69.391\ (P.F.)^{-1.071}$	0.923
1975	$D' = -0.407 + (66.22 / P.F.)$	0.959
	$D' = 66.407\ (P.F.)^{-1.065}$	0.949

Starting with the 1965 demand level, the annual values of P.F. and the GNP were substituted in the various formulae estimated in the thesis to predict the demand levels for the succeeding years through 1975. These elasticity functions, estimated by the time series analysis, are repeated below for the ease of reference:

$$E1=-.74+(24.37/P.F.) \qquad [4.3]$$

$$E2=1.003-0.315\ \ln.(P.F.) \qquad [4.4]$$

$$E3=P.F./(-153.26-0.719\ P.F.) \qquad [4.5]$$

The prediction results were as follows:

Forecasts Based On Time Series Results

The three elasticity functions estimated by time series analysis were used to calculate the annual intensity of demand for motor gasoline given the corresponding values of current and lagged GNP and prices. Two of the three estimated exponents of the lagged GNP per capita ,viz. 0.4 and 0.7, were used in the calculations.

The demand levels forecasted by the three elasticity functions for each of the two exponents of G(t-1) for France, Ireland and Japan are displayed in tables IV.8 through IV.10, respectively.

Tables IV.8 through IV.10 indicate the following:

1. France: The G(t-1) exponent of 0.4 yielded better results reflected by the lower percentage

TABLE IV.8

TIME SERIES FORECASTS FOR FRANCE

(LAGGED GNP EXPONENT = 0.7)

	ACTUAL	FORECASTS					
YEAR	D(t)	D1(t)	ERROR 1(%)	D2(t)	ERROR 2(%)	D3(t)	ERROR 3(%)
1968	495.59	498.38	00.01	499.47	00.01	500.94	00.01
1969	490.31	512.71	04.57	516.27	05.30	520.25	06.11
1970	499.21	524.39	05.04	531.53	06.47	538.24	07.82
1971	514.31	548.34	06.62	556.91	08.28	564.64	09.79
1972	530.08	567.85	07.13	575.73	08.61	583.13	10.01
1973	546.55	614.28	12.39	591.59	08.24	581.85	06.46
1974	512.99	659.47	28.55	626.18	22.06	609.79	18.87
1975	541.82	671.40	23.93	632.86	16.80	612.75	13.09

(LAGGED GNP EXPONENT = 0.4)

1968	495.59	490.47	-0.01	491.54	-0.01	492.99	-0.01
1969	490.31	498.82	01.74	502.28	02.44	506.16	03.23
1970	499.21	504.58	01.08	511.45	02.45	517.90	03.74
1971	514.31	517.27	00.58	525.36	02.15	532.65	03.57
1972	530.08	528.06	-0.38	535.39	01.00	542.27	02.30
1973	546.55	564.07	03.21	543.24	-0.61	534.29	-2.24
1974	512.99	589.66	14.95	559.89	09.14	545.24	06.29
1975	541.82	596.42	10.08	562.18	03.67	544.32	00.46

deviations from the actual values. The least errors were provided by the elasticity function E3. The errors ranged from -2.24% to +6.29%, with all but one deviation being positive.

2. Ireland: The best forecasts for Ireland were provided by the elasticity function E1 together with an exponent of 0.4 for G(t-1). Six of the errors were positive and two assumed negative values. The percentage deviation from the actual demand levels ranged between -3.58% and +3%. It may be noted that the elasticity function E3 together with a G(t-1) exponent of 0.7, which gave the best results for France, yielded an error in the range of -10.78% to +0.01% in the case of Ireland.

3. Japan: The elasticity function E3 together with a G(t-1) exponent of 0.4 provided the least forecast errors. All forecasted values were positively biased with percentage errors ranging from +4.76% to +13.31%.

Although three countries is too small a sample to generalize from, the results indicate that forecasts of the levels of demand intensity based on the elasticity function E3 and assuming demand to be proportional to the 0.4 power of the per capita GNP lagged by one year, yield results as

TABLE IV.9

TIME SERIES FORECASTS FOR IRELAND

(LAGGED GNP EXPONENT = 0.7)

ACTUAL		FORECASTS					
YEAR	D(t)	D1(t)	ERROR 1(%)	D2(t)	ERROR 2(%)	D3(t)	ERROR 3(%)
1968	820.10	829.63	00.01	827.83	00.01	828.20	00.01
1969	866.81	874.10	00.84	869.65	00.33	871.10	00.50
1970	912.56	939.91	03.00	932.97	02.24	936.43	02.62
1971	946.12	969.71	02.49	962.69	01.75	965.98	02.10
1972	958.90	996.85	03.96	988.61	03.10	994.93	03.76
1973	1031.5	994.53	-3.58	984.63	-4.54	983.40	-4.66
1974	1034.3	1033.2	-0.11	1022.3	-1.17	1023.5	-1.05
1975	1031.5	1050.6	01.85	1039.5	00.77	1038.8	00.71

(LAGGED GNP EXPONENT = 0.4)

YEAR	D(t)	D1(t)	ERROR 1(%)	D2(t)	ERROR 2(%)	D3(t)	ERROR 3(%)
1968	820.10	827.36	00.01	825.56	00.01	825.93	00.01
1969	866.81	860.16	-0.77	855.78	-1.27	857.21	-1.11
1970	912.56	904.24	-0.91	897.57	-1.64	900.90	-1.28
1971	946.12	919.78	-2.78	913.13	-3.49	916.25	-3.16
1972	958.90	941.20	-1.85	933.43	-2.66	939.40	-2.03
1973	1031.5	930.65	-9.77	921.38	-10.7	920.23	-10.8
1974	1034.3	956.37	-7.54	946.28	-8.51	947.44	-8.40
1975	1031.5	962.40	-6.70	952.24	-7.69	951.59	-7.75

TABLE IV.10

TIME SERIES FORECASTS FOR JAPAN

(LAGGED GNP EXPONENT = 0.7)

ACTUAL		FORECASTS					
YEAR	D(t)	D1(t)	ERROR 1(%)	D2(t)	ERROR 2(%)	D3(t)	ERROR 3(%)
1968	409.79	426.43	00.04	426.14	00.04	426.94	00.04
1969	421.30	464.87	10.34	465.20	10.42	467.39	10.94
1970	432.92	511.98	18.26	515.20	19.01	520.49	20.23
1971	441.89	550.16	24.50	553.27	25.20	558.70	26.43
1972	436.88	598.21	36.93	583.75	33.62	577.91	32.28
1973	444.44	624.75	40.57	599.82	34.96	586.54	31.97
1974	444.85	664.35	49.34	615.92	38.46	585.12	31.53
1975	475.04	711.41	49.76	660.55	39.05	630.39	32.70
(LAGGED GNP EXPONENT = 0.4)							
1968	409.79	416.82	00.02	416.53	00.02	417.32	00.02
1969	421.30	438.97	04.19	439.29	04.27	441.35	04.76
1970	432.92	464.22	07.23	467.14	07.90	471.94	09.01
1971	441.89	483.78	09.48	486.51	10.10	491.29	11.18
1972	436.88	512.40	17.29	500.02	14.45	495.02	13.31
1973	444.44	527.02	18.58	505.98	13.85	494.77	11.33
1974	444.85	548.44	23.29	508.47	14.30	483.04	08.58
1975	475.04	573.36	20.70	532.37	12.07	508.07	06.95

close as within .01% of the actual values and with a maximum absolute deviation of less than 13.5%.

For the purpose of forecasting demand for motor gasoline, which is a complex variable governed by interacting social, cultural, and economic factors, the above accuracy is quite satisfactory.

Forecasts Based On The Cross Section Results

The per capita demand function estimated via cross section analysis was utilized for the retrospective prediction of gasoline demand levels in France, Ireland and Japan.

In calculating the forecasted values for each of the three control countries, the following procedure was followed:

1. An exponential demand function of the following form was assumed:

$$DC(t)=A\ P.F. \qquad [4.4]$$

2. The 1965 values of DC(t) and P.F. were used to calculate A.

3. The forecast of DC(t) for each succeeding year was found by substituting the corresponding value of P.F. into the estimated demand function.

Tables IV.11 through IV.13 display the forecasting results with the resulting percentage errors. The tables show the following:

1. The forecasts for France had percentage errors in the range -21.3% to +15.2% with a smallest value of +1.9%. Seven of the forecasts were positively deviated from the actual values.

2. The error range was smaller for Ireland. The predicted values lied within -8.6% to +11.9% of the actual values.

3. The highest prediction errors were associated with Japan where the forecasted values lied within -29% to +22.3%.

It can be seen from the validation results that the forecasts which were based on the cross section formulae had bigger associated percentage errors than those based on the time series findings.

SUMMARY OF THE REGRESSION ANALYSIS

The findings of chapters III and IV are summed up in the following paragraphs:

1. The investigation started out with time series analysis of four hypothesized models. The first model; a linear function; was found statistically more significant and thus chosen for further analysis.

TABLE IV.11

CROSS-SECTION FORECASTS FOR FRANCE

YEAR	D (ACTUAL)	D (FORECAST)	ERROR (%)
1966	1.069	1.090	001.9
1967	1.147	1.169	001.9
1968	1.232	1.279	003.7
1969	1.303	1.472	011.5
1970	1.392	1.642	015.2
1971	1.496	1.747	014.4
1972	1.616	1.821	011.3
1973	1.741	1.536	-13.3
1974	1.669	1.428	-16.9
1975	1.737	1.367	-21.3

TABLE IV.12

CROSS-SECTION FORECASTS FOR IRELAND

YEAR	D (ACTUAL)	D (FORECAST)	ERROR (%)
1966	0.864	0.851	-1.5
1967	0.936	0.921	-1.6
1968	1.019	1.050	03.0
1969	1.123	1.193	05.9
1970	1.203	1.319	08.8
1971	1.287	1.352	04.8
1972	1.355	1.538	11.9
1973	1.501	1.382	-8.6
1974	1.490	1.457	-2.3
1975	1.465	1.373	-6.7

TABLE IV.13

CROSS-SECTION FORECASTS FOR JAPAN

YEAR	D (ACTUAL)	D (FORECAST)	ERROR (%)
1966	0.505	0.518	002.5
1967	0.617	0.614	-00.5
1968	0.648	0.755	014.2
1969	0.737	0.893	017.5
1970	0.828	1.066	022.3
1971	0.888	1.123	020.0
1972	0.942	1.022	007.8
1973	1.038	0.985	-05.1
1974	1.014	0.719	-29.0
1975	1.094	0.800	-26.8

2. Strong mutual correlations among the explanatory variables were detected through principal components analysis and consequently, five versions of the chosen model were formed by deleting various variables and were analyzed to check the sensitivity of the model to multicollinearity.

3. The results indicated reasonable elasticity values of demand intensity with respect to current prices and per capita GNP lagged with one year. It was concluded that current prices and per capita GNP lagged by one year were good indicators of the determinants of the elasticity of demand.

4. The ratio of current price to current GNP per capita was introduced. It was labelled as the price factor and denoted P.F. The elasticity values for the various countries displayed rational behavior when averaged over ranges of P.F.

5. The time series analysis resulted in the following estimated functions for the elasticity of demand intensity with respect to current prices :

$$E1=-0.74+(24.37/P.F.) \quad [4.3]$$

$$E2=1.003-0.315 \ln.(P.F.) \quad [4.4]$$

$$E3=P.F./(-153.26-0.719\ P.F.) \quad [4.5]$$

for P.F. ranging from 15 to 190. E(D(t),P(t)) was assumed equal to zero for values of P.F. less than 15.

6. The intensity of demand for motor gasoline was found, through time series analysis, proportional to the lagged per capita GNP, raised to the power of 0.7 ± 0.3.

7. Cross sectional analysis of the annual data for the various countries revealed sound economic behavior of the per capita demand for motor gasoline, DC(t), versus the price factor P.F.

8. An exponential demand function in P.F. was estimated via the cross section analysis with an elasticity (exponent of P.F.) of $-1.125 \pm .023$.

9. Using the time series findings for retrospective forecasting of various demand levels in France, Ireland, and Japan yielded better results than the cross sectionally estimated demand function.

10. The time series elasticity function E3 together with an 0.4 exponent of G(t-1) yielded the best over all results. with absolute forecast errors below 13.5%.

CHAPTER V.

POLICY IMPLICATIONS OF THE RESEARCH FINDINGS

The policy implications of the present research and its applicability as a decision making tool are demonstrated in this chapter via two simulation models.

The first is an exploratory simulation which incorporates the findings of the time series analysis together with an extrapolation of the historical growth trends of the per capita GNP and the gasoline prices in the U.S. to predict the levels of future demand for motor gasoline till the year 1990. Several scenarios were built around the base run described in the preceding paragraph by making various assumptions about the growth rates.

The chapter is concluded with a normative simulation where, starting with the demand reductions desired in President Carter's energy program and assuming price to be the only policy mechanism to control demand, a price profile is heuristically found which would achieve the target levels.

THE EXPLORATORY RUN

Figures V.1 and V.2 depict the historical trends in the per capita GNP, in constant 1970 dollars per person, and the price factor P.F., respectively, for the years 1965

FIGURE V.1

HISTORICAL TREND OF REAL GNP/CAP.

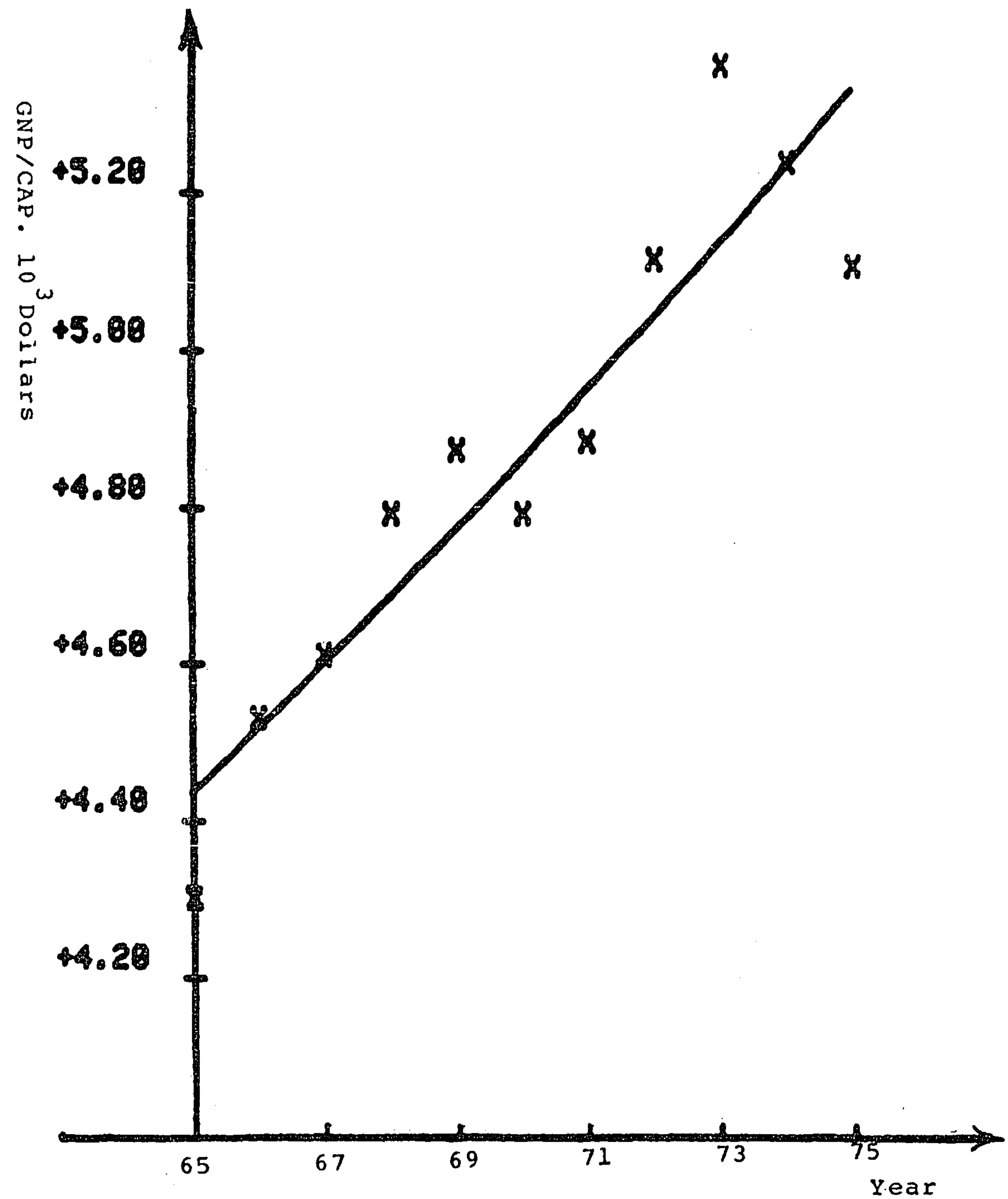


TABLE V.1

REGRESSION RESULTS OF GNP/CAP. TREND

EQUATION	A	B	R-SQUARE	MAX DEVIATION
Y = A*X	0.72070	0.00000	INSIGNIF.	4.30000
Y = A + B*X	4.42955	0.08791	0.85738	0.21718
Y = A*EXP(B*X)	4.43624	0.01824	0.84778	0.22365
Y = 1/(A + B*X)	0.22514	-0.00379	0.83602	0.24153
Y = A + B/X	CAN'T FIT			
Y = A + B*LOG(X)	CAN'T FIT			
Y = $A*X^B$	CAN'T FIT			
Y = X/(A + BX)	CAN'T FIT			

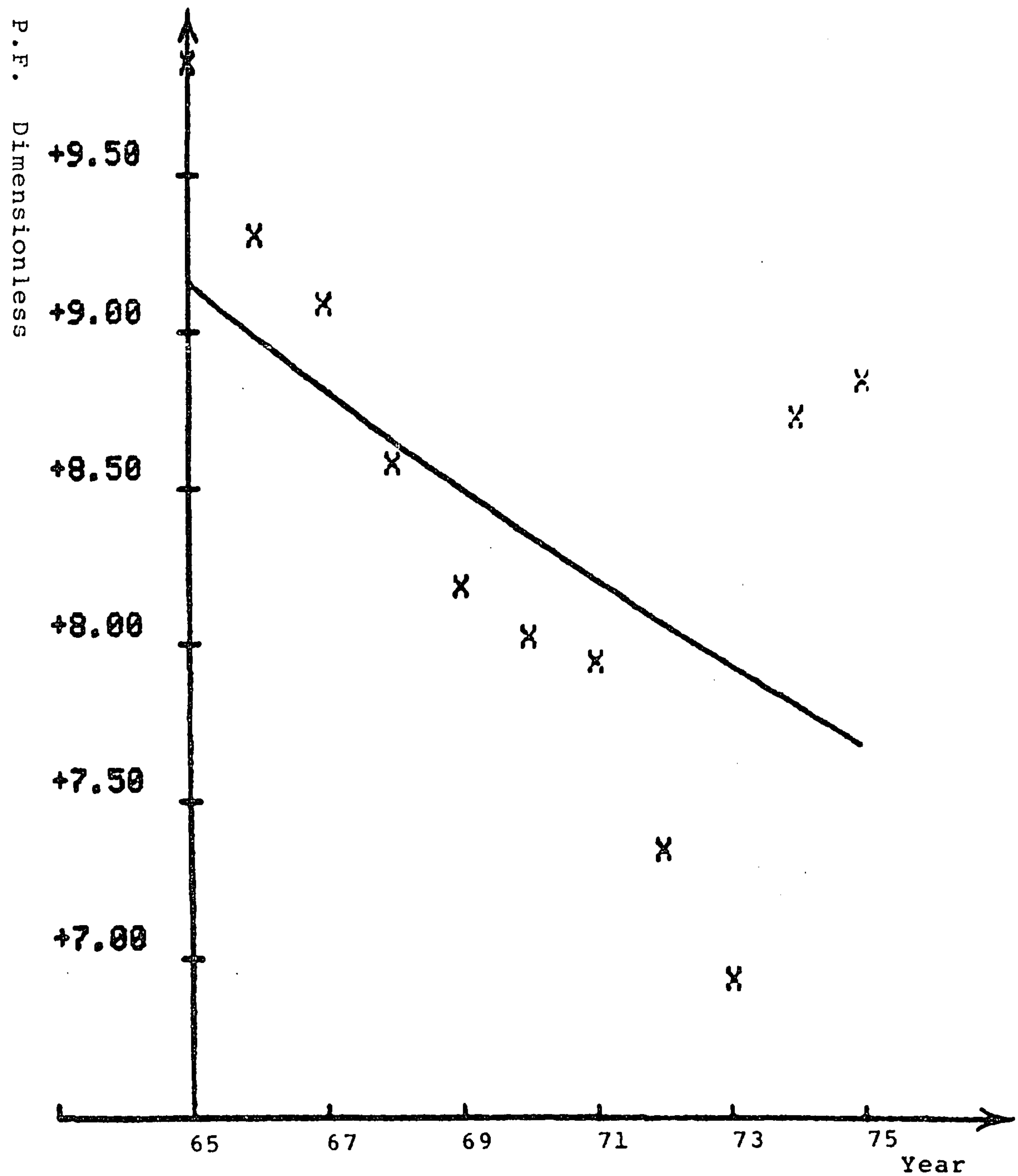
TABLE V.2

REGRESSION RESULTS OF PRICE FACTOR TREND

EQUATION	A	B	R-SQUARE	MAX DEVIATION
Y = A*X	1.16139	0.00000	INSIGNIF.	9.84000
Y = A + B*X	9.18250	-0.15039	0.33879	1.14941
Y = A*EXP(B*X)	9.16875	-0.01775	0.35582	1.15036
Y = 1/(A + B*X)	0.10921	0.00211	0.36917	1.15580
Y = A + B/X	CAN'T FIT			
Y = A + B*LOG(X)	CAN'T FIT			
$Y = A*X^{B}$	CAN'T FIT			
Y = A/(A + B*X)	CAN'T FIT			

FIGURE V.2

HISTORICAL TREND OF THE PRICE FACTOR



through 1975. Tables V.1 and V.2 display the regression results of the two trends.

Table V.1 indicates good fit of the historical data both to the linear and the exponential functions. The latter was chosen in order to facilitate comparison of the growth rates of the different variables.

Figure V.1 indicates an exponential trend with an annual growth rate of 1.824% in real per capita GNP for the specified period, despite a slight decrease for the years 1974 and 1975.

Figure V.2 displays a poor fit of the trend equation to the P.F. data. It is obvious from the figure that the historical changes would better fit two discontinous trends. The first of these is a decreasing trend between the years 1965 and 1973, while the second is an increasing trend starting 1973. This discontinuity can be explained by the relative price increase after 1973 coupled with the drop in the per capita GNP displayed in figure V.1.

Figure V.3 depicts the historical change in gasoline prices, in constant 1970 dollars. It shows that the price of motor gasoline has been decreasing in real terms till 1974.

The assumptions about future prices of motor gasoline were made exogenously, independently of the historical trend, for the following reasons:

1. The historical trend is not expected to prevail in

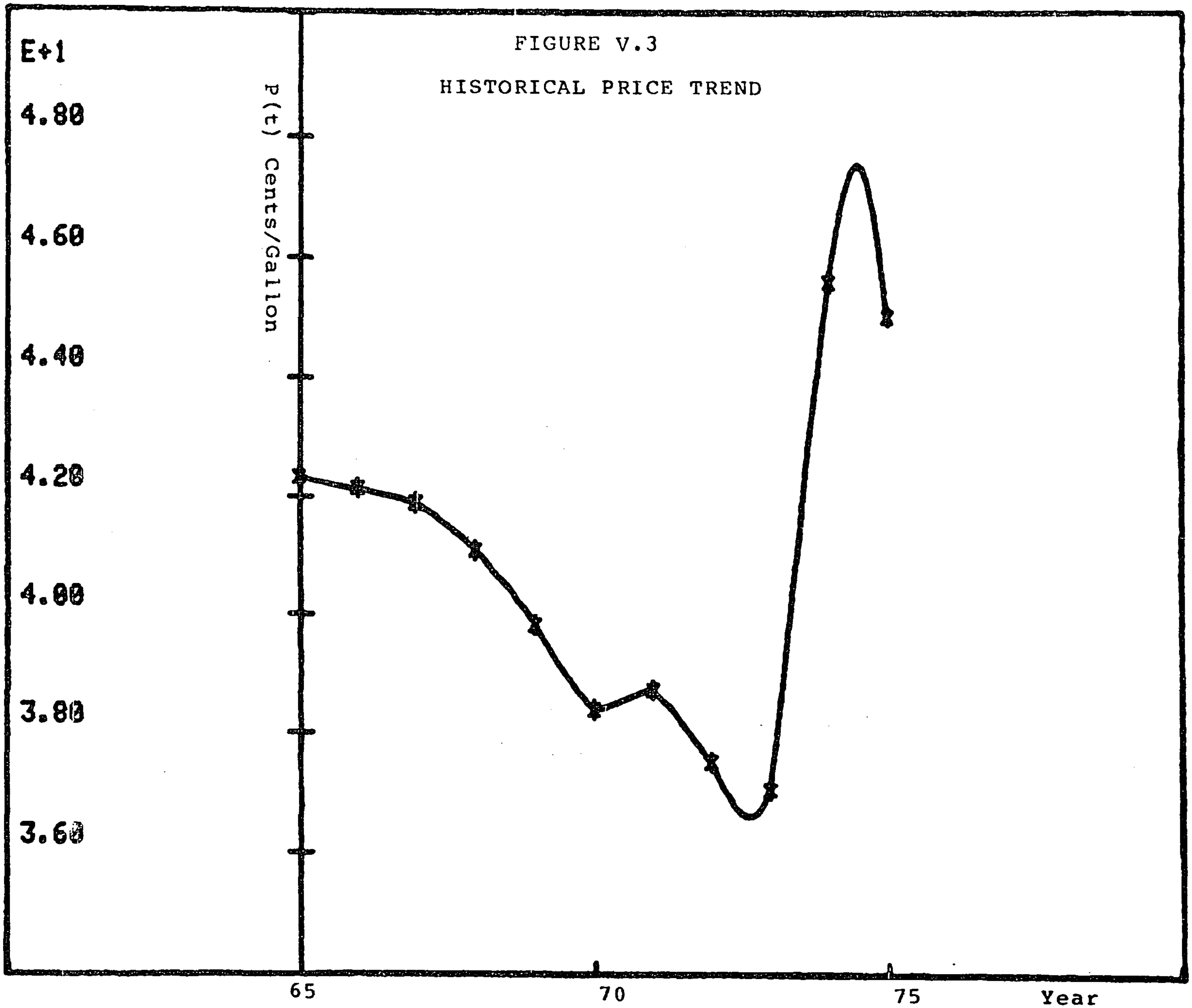


FIGURE V.3

HISTORICAL PRICE TREND

the future.

2. The trend of decreasing prices is of little interest to the questions addressed in this thesis.

Based on the estimated trends, the following runs were made:

<u>Base Run</u>

In the base run, the following assumptions were made:

1. GNP per capita will grow at its historical rate of 1.824 % annually during the forecast period.

2. During the same period, price will grow at an annual rate of 5%.

Starting with the 1975 values of D(t), G(t) and P(t), future demand of motor gasoline per GNP was generated by the following algorithm:

1. The historical demand intensity for motor gasoline was regressed against time yielding the results displayed in table V.3 and depicted in figure V.4. The demand intensity was found increasing exponentially at about 2% per annum, between 1965 and 1975. This historical trend was extended into the future.

2. Utilizing the two assumptions of the base run,

TABLE V.3

HISTORICAL GROWTH OF DEMAND INTENSITY

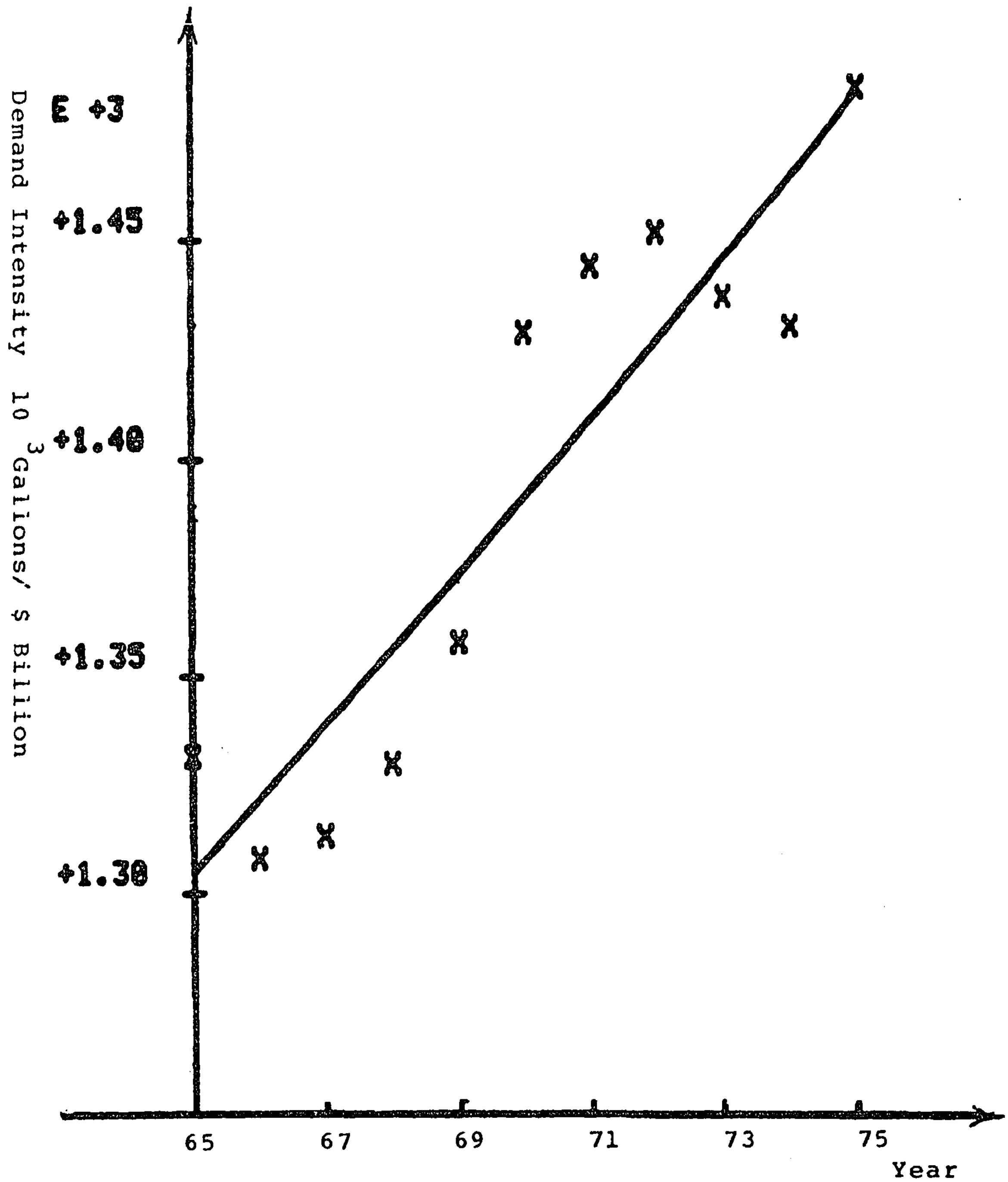
CURVE TYPE	INDEX OF DETERMINATION	A	B
1.E=A+B.(P.F.)	.926	1291	28.209
2.E=A.EXP.(B.(P.F.))	.8327	1304.5	0.013
3.$E=A.(P.F.)^{B}$	CAN'T FIT		
4.E=A+(B/P.F.)	CAN'T FIT		
5.E=1/(A+B.(P.F.))	.9289	7.73E-04	-1.49E-05
6.E=R/(A+B.(P.F.))	CAN'T FIT		
7.E=A+B.Log(P.F.)	CAN'T FIT		

STANDARD ERROR ESTIMATES

CURVE TYPE	REGRESSION	A	B
1.	18.9315	12.8996	3.5777
2.	1.357E-02	1.0093	2.564E-03
3.	0	0	0
4.	0	0	0
5.	9.736E-06	6.63E-06	1.840E-06
6.	0	0	0
7.	0	0	0

FIGURE V.4

HISTORICAL TREND OF DEMAND INTENSITY



future prices and per capita GNP were calculated.

3. P(t) and G(t) were used to calculate the price factor at year t; P.F. The elasticity function E3(t) was then calculated from the knowledge of P.F.

4. From the definition of elasticity, the following relations were derived:

$$E(t)=(D(t+1)-D(t))/(P(t+1)-P(t)) \quad [5.1]$$

Therefore

$$D(t+1)=(((P(t+1)-P(t))/P(t)).E(t)+1).D(t) \quad [5.2]$$

5. Time series analysis in chapter III showed that the demand intensity for motor gasoline was also proportional to the lagged per capita GNP raised to the 0.4 power.

6. Using steps 4 and 5 above, the following formula was derived to generate the level of the demand intensity in year t+1 :

$$D(t+1)=(((P(t+1)-P(t))/P(t)).E(t)+1).(G(t-1)/G(t-2))^{0.4}D(t) \quad [5.3]$$

Table V.4 displays the results of the base run.

The table reveals that under the assumptions of the base run, future demand would follow its historical trend

TABLE V.4

POLICY SIMULATION: BASE RUN

YEAR	P(t)	P.F.	DT(t)	D(t)	RED(t)
1976	47.27	9.10	1514.18	1514.18	0.00
1977	49.63	9.38	1545.55	1545.55	0.00
1978	52.12	9.67	1577.56	1577.56	0.00
1979	54.72	9.97	1610.23	1610.23	0.00
1980	57.46	10.28	1643.58	1643.58	0.00
1981	60.33	10.60	1677.62	1677.62	0.00
1982	63.35	10.93	1712.37	1712.37	0.00
1983	66.52	11.27	1747.83	1747.83	0.00
1984	69.84	11.62	1784.03	1784.03	0.00
1985	73.33	11.98	1820.98	1820.98	0.00
1986	77.00	12.35	1858.70	1858.70	0.00
1987	80.85	12.74	1897.20	1897.20	0.00
1988	84.89	13.13	1936.49	1936.49	0.00
1989	89.14	13.54	1976.60	1976.60	0.00
1990	93.59	13.96	2017.54	2017.54	0.00

TABLE V.5

POLICY SIMULATION: HIGH PRICE GROWTH RATE

1976	49.52	9.53	1514.18	1514.18	0.00
1977	54.47	10.30	1545.55	1545.55	0.00
1978	59.92	11.12	1577.56	1577.56	0.00
1979	65.91	12.01	1610.23	1610.23	0.00
1980	72.51	12.98	1643.58	1643.58	0.00
1981	79.76	14.02	1677.62	1677.62	0.00
1982	87.73	15.14	1712.37	1712.37	0.00
1983	96.50	16.35	1747.83	1709.00	-2.22
1984	106.15	17.66	1784.03	1704.45	-4.46
1985	116.77	19.08	1820.98	1698.66	-6.72
1986	128.45	20.61	1858.70	1691.55	-8.99
1987	141.29	22.26	1897.20	1683.04	-11.29
1988	155.42	24.04	1936.49	1673.07	-13.60
1989	170.96	25.97	1976.60	1661.57	-15.94
1990	188.06	28.05	2017.54	1648.45	-18.29

DT= TREND DEMAND RED= DEMAND REDUCTION (%)

with no effect due to price increases.

The base run indicates that, with the price growing at about three times the rate of the GNP per capita, demand will remain unaffected till the year 1990. A faster growth rate of the price of gasoline was therefore examined in the second run.

High Price Growth Rate.

In this run, price was assumed to grow at 10% per annum while per capita GNP was growing at its historical rate. This makes price grow about six times faster than the GNP per capita. Table V.5 displays the forecasted values of this case.

It can be seen that under the assumptions of this run, demand intensity starts dropping below its historical trend by 1983 where the drop is 2%. The reduction in demand per GNP increases gradually to reach 18.3% BY 1990.

The assumption of an expanding economy was then examined in a third run where the GNP per capita was allowed to grow faster than its historical trend.

Expanding Economy.

In this third run, the GNP per capita was assumed to grow at 1.5 times its historical rate or at a rate of 2.74% per annum. The price growth rate was maintained at 10% annually. The run yielded the results displayed in table V.6.

Table V.6 shows that under the assumptions of the

TABLE V.6

POLICY SIMULATION: EXPANDING ECONOMY

Year	P(t)	P.F.(t)	DT(t)	D(t)	RED(t)
1976.	49.52	9.45	1514.18	1514.18	0.00
1977.	54.47	10.12	1545.55	1545.55	0.00
1978.	59.92	10.83	1577.56	1577.56	0.00
1979.	65.91	11.59	1610.23	1610.23	0.00
1980.	72.51	12.41	1643.58	1643.58	0.00
1981.	79.76	13.29	1677.62	1677.62	0.00
1982.	87.73	14.22	1712.37	1712.37	0.00
1983.	96.50	15.22	1747.83	1747.83	0.00
1984.	106.15	16.30	1784.03	1750.56	-1.88
1985.	116.77	17.45	1820.98	1752.21	-3.78
1986.	128.45	18.68	1858.70	1752.73	-5.70
1987.	141.29	19.99	1897.20	1752.03	-7.65
1988.	155.42	21.40	1936.49	1750.06	-9.63
1989.	170.96	22.91	1976.60	1746.74	-11.63
1990.	188.06	24.53	2017.54	1741.99	-13.66

present run, demand would start falling at 1.88 % in 1984 with the drop increasing gradually to reach 13.66 % by the year 1990.

It is clear from the above illustrations that any sets of assumptions can be introduced to the main model thus providing useful insights into the implications of various economic policies. In this light, the section of President Carter's energy program pertaining to the transportation sector was examined.

PRESIDENT CARTER'S ENERGY PROGRAM THE TRANSPORTATION SECTOR

As stated in the publication by the Executive Office of the President (1977, p. 35), the policies of the President's program pertaining to transportation may be summarized in the following points:

1. A national goal to reduce gasoline consumption by 10% by the year 1985.

2. One provision for achieving this goal is through a graduated excise tax on new automobiles with low fuel efficiency together with graduated rebates for new cars with "mileage better than the standard".

3. A second provision is to establish "annual targets for gasoline consumption, backed by a standby tax on gasoline".

4. The gasoline tax is to go into effect starting 1979. In any one year, a tax of 5 cents per gallon is imposed for each 1% excess of consumption over the target for the preceding year. The same tax would be removed if a target consumption is met.

5. A maximum tax of 5 cents can be imposed in any one year, and the maximum over all tax cannot exceed 50 cents.

Since the expert opinions cited on page 13 of this thesis cast doubts on the feasibility of improved specific fuel consumption per car earlier than 1985, and since the present investigation pertains to the consumers behavior in regards to gasoline consumption, the policy simulation was designed in such a way as to address the following question:

If the President's consumption goals of motor gasoline were to be achieved through the gasoline tax alone, what would the neccessary price profile be till the year 1985?

The policy simulation run was thus conducted under the following assumptions:

1. The GNP per capita and the demand per GNP will grow at their historic rate throughout the forecast period.

2. The price of gasoline will remain constant till

1978, then it will start increasing at a constant rate to achieve the consumption goal. Price will remain constant through 1990 at the level attained in 1985.

The simulation was done heuristically by trying different rates of price increase. A 22% annual rate of growth of the price of motor gasoline was found to achieve the prescribed goal. Table V.7 displays the results.

It may be observed that the annual price increases starting 1978, well exceeded the 5 cents per gallon limit called for in the President's program. One may also observe the time lag built into the system which is reflected by the fact that reduction in gasoline consumption would start in 1983 with the gradual "tax" of 22% introduced in 1979. A drastic sudden increase of gasoline price would have to be effected if the consumers conservation efforts were to start immediately. With an expanding economy, the increases would obviously have to be more drastic.

TABLE V.7

POLICY SIMULATION: NORMATIVE RUN

YEAR	P(t)	P.F.	DT(t)	D(t)	RED(t)
1976	45.02	8.59	1514.18	1514.18	0.00
1977	45.02	8.36	1545.55	1545.55	0.00
1978	45.02	8.14	1577.56	1577.56	0.00
1979	54.92	9.66	1610.23	1610.23	0.00
1980	67.01	11.47	1643.58	1643.58	0.00
1981	81.75	13.62	1677.62	1677.62	0.00
1982	99.73	16.17	1712.37	1712.37	0.00
1983	121.68	19.20	1747.83	1693.74	-3.09
1984	148.44	22.79	1784.03	1668.98	-6.45
1985	181.10	27.06	1820.98	1637.35	-10.08
1986	181.10	26.33	1858.70	1655.25	-10.95
1987	181.10	25.63	1897.20	1673.35	-11.80
1988	181.10	24.94	1936.49	1691.64	-12.64
1989	181.10	24.27	1976.60	1710.13	-13.48
1990	181.10	23.62	2017.54	1728.82	-14.31

CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In the following sections, the methodology followed in this research is summarized, together with the findings and recommendations for future extensions of the work.

SUMMARY

This research investigates the size and determinants of the elasticity of demand for motor gasoline.

As has been mentioned in chapter I, distinguished researchers have noted the need for the current research. They strongly emphasize that the mere indications of a consumers' demand pattern for energy products, which approaches rational economic behavior or which lends itself to economic and behavioral theory, would be a contribution to the field of energy modeling.

In this light, the findings of the current research are presented.

Throughout this investigation, basic economic theory and econometric techniques were combined with subjective judgements, in order to ensure the reasonableness of the findings.

In order to account for the differences in GNP levels among countries, demand intensity, defined as the total demand of motor gasoline in any one year divided by the GNP for that year, was used instead of pure demand.

Data of the twenty member Organization for Economic Cooperation and Development (OECD) were utilized in the analysis. Two of the countries, Greece and Turkey, had incomplete data and were therefore excluded from the analysis.

In order to examine the accuracy of the research findings, three of the countries, France, Ireland and Japan; were kept out of the analysis.

Analysis of the time series data of the remaining fifteen countries revealed an elasticity of demand per GNP for motor gasoline with respect to current prices and the per capita GNP lagged by one year.

The ratio of current price to current GNP per capita was, to the best of my knowledge, introduced in this research and proposed as an explanatory parameter for the variability across countries of the elasticity of demand intensity with respect to the different parameters. Because it measures an "effective" price, this ratio was called the price factor and was labelled P.F.

It turned out that P.F. established the basis for inter-country comparisons of time series results.

The analysis resulted in the following three functional relationships between the elasticity of demand intensity for motor gasoline and the price factor P.F. :

$$E1(P.F.)=-0.74+(24.37/P.F.) \quad [6.1]$$

$$E2(P.F.)=1.003-0.315 \ln.(P.F.) \quad [6.2]$$

$$E3(P.F.)=P.F./(-153.26-0.719\ P.F.) \quad [6.3]$$

Demand intensity was found elastic with respect to the GNP per capita, lagged by one year. The elasticity coefficient fell in the range of 0.7+0.3.

Based on the findings of the time series analysis, it was hypothesized that the ratio P.F. itself might provide an efficient explanatory variable for the demand behavior in various countries. Consequently, cross section data of the fifteen OECD countries , for the years 1965 through 1975, were further analyzed.

Cross section analysis revealed that the per capita demand, rather than the demand per GNP, displayed rational economic demand behavior as a function of P.F. An elasticity of -1.125+0.023 was estimated for the demand per capita with respect to P.F.

The research findings were validated and the estimated formulae verified by retrogressively forecasting the annual demand levels in France, Ireland and Japan, for the period 1965-1975. Both time series and cross sectional findings were utilized.

The best retrospective forecasts resulted from utilizing formula 6.3 together with an elasticity coefficient of 0.4 with respect to the lagged per capita

GNP. The maximum forecast errors were below 13.5%.

The investigation was concluded by a policy simulation run for the U.S. A price profile until the year 1990 was generated which would achieve the conservation goals indicated in President Carter's energy program. The policy run indicated that the taxes that would be neccessary to achieve the consumption goals are much higher than the 5 cents per gallon annual ceiling proposed in the President's program.

Under the assumptions of the various models described in chapter III the conclusions given in the next section were drawn.

CONCLUSIONS

1. The time series demand for motor gasoline per unit of GNP shows distinct elasticity with respect to prices and GNP per capita for various countries.

2. The "Price Factor" P.F., defined as the price of motor gasoline in cents per gallon to the per capita GNP in thousand dollars, shows a distinct relationship to the different elasticities. The price elasticity of demand averaged over countries, is a decreasing function of the price factor over a range of P.F. values extending from 15 to 190. Below P.F. equals 15, the elasticity is negligibly small and is assumed zero. P.F. is an important

explanatory parameter for the demand elasticities. Without the introduction of P.F., the elasticity values appear to vary irregularly over countries.

3. The demand intensity was found elastic with respect to per capita GNP with a one year time lag. The estimated elasticity coefficient lied in the range of 0.7+0.3.

4. The elasticity function given by equation 6.1 together with a demand elasticity of 0.4 with respect to the lagged GNP per capita, generate acceptable forecasts for demand levels in France, Ireland and Japan for the period 1965 to 1975. Some of the forecasted values came as close as within less than one per cent of the actual, while the maximum error lied below 13.5%.

5. Assuming that the demand behavior derived from the analysis will apply to the U.S. for the years 1975-1990, it appears that the size of the gasoline tax schedule proposed in President Carter's energy program will be too small to achieve the desired consumption goals.

Recommendations For Future Research

It is my opinion that the following recommendations would enhance and extend the research investigated in this thesis.

1. As time elapses, longer time series would be available to work with which would increase the precision of the parameter estimates.

2. I suggest that the inclusion of more developing countries at varying stages of economic development might reveal a functional dependence of the demand elasticity on the stage of development. It is felt that the behavior might show a logistic variation with the stage of development. It is suspected that detailed data will be lacking for most developing countries. Data problems are seen as the major obstacle to the suggested investigation.

3. The current work may also be further generalized in several steps. First extending the same investigation to other energy sectors. Second, by viewing the whole energy sector in a macroeconomic context of the whole economy. Then, in a still more general context, behavioral and cultural considerations may be incorporated in a holistic complex.

4. Some of the possible behavioral and cultural considerations could be:

   a. The difference in life styles among different countries, reflected in the varying degrees of urbanization, scatter versus clustering of cities, habits of energy consumption, etc...

b. In the transportation sector, the significance of the private car to Americans and the possibility that it symbolizes personal freedom and privacy could make the cutoff threshold of (P.F.) higher than that suggested in this research. On the other hand, the materialistic outlook of the american consumer might compensate for the above effect. It would be interesting, yet definitely difficult to investigate such influences.

c. The effects of the social awareness of eminent energy crises or the lack of conviction thereof would definitely influence the consumers' decision to consume energy. An investigation of the state of the public opinion would provide an indication of likely trends in consumer behavior.

6. Using the cultrual, social and behavioral considerations mentioned above as inputs, in addition to the investigated price responsiveness, to a holistic macroeconomic model that includes all energy sectors would, in our opinion, provide useful insights into the prospect of attaining national goals with respect to energy consumption.

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