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An Econometric Study of the Demand for Gasoline in the Gulf Cooperation Council Countries

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AN ECONOMETRIC STUDY OF THE DEMAND FOR GASOLINE IN THE GULF COOPERATION COUNCIL COUNTRIES

by M Nagy Eltony* and Mohammad Almahmeed

I INTRODUCTION

Reliable and accurate estimation of price and income elasticities of demand for gasoline are important ingredients for long-run energy planning and policy formation. The purpose of this study is to develop and estimate a model for gasoline demand for Gulf Cooperation Council (G.C.C.) countries. The model is capable of producing short-run and long-run price and income elasticities.

Since the first oil price hike in 1973, a great deal of attention has been directed toward the demand for gasoline especially in the industrialized countries, Dahl (1978); Gallini (1983); Kouris (1983); Baltagi and Griffin (1983); Drollas (1984); Lin, Botsas and Monroe (1985); Hsing (1990); Gallini, Berkowitz, Miller and Wolfe (1990); Eltony (1993). Few studies have been directed toward the demand for gasoline in developing countries, Wolf, Relles and Navarro (1981); Ibrahim and Hurst (1989) and Garbacz (1989).

In terms of primary energy consumption, the G.C.C.'s energy needs are met by oil, natural gas and electricity. Oil without any doubt is the largest energy source consumed and gasoline is the most important oil product. However, very few studies have been directed towards analyzing G.C.C. energy demand, Al-Sahlawi (1988a-b and 1991), and

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* Dr Eltony completed his Ph.D. at the University of Surrey in 1990 and is the author of another SEEDS paper, "A Model for Passenger Car Gasoline Demand in Canada" SEEDS 58 (vide list on back cover for further details).

Narasimham (1990) and yet there has been no attempt to model and estimate G.C.C. gasoline demand. This study attempts to address this gap.

II THE MODEL

Following the convention of the earlier models, gasoline demand is modelled as the outcome of a utility-maximization process, conditional on vehicle choice. The solution of such a model yields:

$$GS = F (Pg, Y, S, GSt\text{-}1) \quad (1)$$

Which give the gasoline consumption per capita (GS) where:

Pg = Price of gasoline
Y = Per capita personal disposable income
S = Stock of automobiles per capita
GSt-1 = First order lagged consumption of gasoline

The most important advantage of this specification is its ability to capture the time-phase nature of the total adjustment to change in prices and income. This approach also corrects for the lack of data in the G.C.C. member states on the changes in the characteristics of fleet of automobiles i.e. fuel economy and size of cars. It also provides direct estimates of long-run price elasticity given this data limitation.

Former studies have encountered a problem of a highly subsidized price of gasoline which made the estimation of the price of elasticity a very difficult task, Al-Sahlawi (1991). In this study the demand function is estimated using pooled time series and cross sectional data from the different G.C.C.member states. This disaggregate approach is utilized since country variations in prices and consumption patterns provide valuable information for disentangling the effects of price and income

changes on the demand and then obtaining significant estimates of the price elasticity.

Also, a different intercept term is used for each Gulf State to allow for differences in urbanization, climate, and availability of public transportation.

Moreover, a number of studies have utilized the percentage of population of driving age, 16 to 65, (POP), as an indicator for demographic changes. This variable was also included in our specification. A log-linear relationship for equation (1) can be written as:

$$\text{Ln GS} = \text{Ai} + \text{B1 Ln Pg} + \text{B2 Ln Y} + \text{B3 Ln S} + \text{B4 Ln POP} + \text{B5 Ln GSt-1} \quad (2)$$

i = Bahrain, UAE, S Arabia, Oman, Qatar, Kuwait.

III THE DATA[1]

The sources of data concerning the consumption of gasoline in each country were obtained from various issues of the Economic Report of the G.C.C. and the annual statistical books of the respective countries.

There are several sources for data on GDP. The data for GDP in constant dollars was obtained from various issues of the Arab Unified Report published by the Arab Fund for Social and Economic Development, and also from several issues of the Arab National Income and Expenditure Accounts published by the Arab Monetary Fund. Furthermore, the annual Economic Report of the G.C.C. was the source of valuable information on GDP deflators by sector for each G.C.C. member.

There were only two sources used for gasoline prices. The first source is the proceedings of the Fourth and the Third Arab Energy Conference,

published by the Organization of Arab Exporting Countries (OAPEC). The second source is the annual statistical books of each G.C.C. member country.

The main sources for the Consumer Price Index (CPI) are the Economic Report of the G.C.C. and several issues of the Arab Unified Report.

The exchange rate data of the G.C.C. countries' currencies against U.S. Dollars were obtained from several issues of the International Financial Statistics published by the International Monetary Fund.

The sources of data on population were the Annual Economic Report of the G.C.C.

The data on the percentage of driving age population are obtained from several issues of the Arab Unified Report and the United Nation Statistical Year Book.

Finally, the sources of data on car registration (stocks of cars) are the Annual Statistical books of the respective countries and the United Nations Statistical YearBook.

IV THE RESULTS

a) Short-Run Elasticities:

An error component model, which allows separate country intercepts[2], is estimated using pooled time series and cross section country data for the period from 1975 to 1989. This technique was first developed by Balestra and Nerlove (1966).The need for a technique of this sort is created because the model contains a lagged dependent variable, and in such circumstances ordinary least-squares methods produce biased estimates of the parameters. Further, this method is mainly chosen because it provided a means for taking account of between countries fluctuations while ordinary least squares did not. Also, and most

critical, error components techniques are known to provide the best estimate of the adjustment parameter.

Different lag structure of the dependent variable and price of gasoline have been tested, with no significant improvement over those of the simple one time period lag, (GSt-1) and (Pgt-1).

Another specification of the model is also estimated and the results are reported in Table 1. The stock of cars per capita (S) was dropped from the estimated equation. The reasoning for this is that the percentage of population in the driving age and the stocks of cars are basically reflecting the same changes.

All the estimated coefficients for both equations have the correct signs and are all statistically significant at 5%level. The adjusted R-square (R^2) is considered to be high.

In equation (1), the one important finding is that the percentage of driving age population is more statistically significant than either income or prices. It has the largest coefficient size and it also has the highest t-value.

The price variable has a negative sign and is statistically significant but the size of the coefficient indicates that gasoline demand is price inelastic in the short run. The income variable has a positive sign but is inelastic even though its size is larger than that of the price. The coefficient of the stocks of cars variables gives a positive sign and is also highly significant. Finally,the lagged dependent variable is positive and also statistically significant.

In equation (2), the income coefficient is greater than the coefficient in equation (1) but remains inelastic in the short run. As for the price elasticity of demand, no change has been found except the size of the coefficient is slightly larger than in equation (1). It amounts to about -0.11.The lagged dependent variable's coefficient is larger too. Further,

the coefficient for percentage of driving age population is also larger than equation (1) and it remains highly significant.

Table 1 Parameter Estimates for Gasoline Consumption

Country	Bahrain	U.A.E.	S. Arabia	Oman	Qatar	Kuwait
1. LGS	9.091	8.703	6.9705	8.4032	9.6426	8.4533
*	(13.6)	(12.7)	(10.6)	(13.5)	(13.3)	(12.6)
2. LGS	9.092	8.003	5.578	7.9724	9.673	7.907
		(11.6)	(10.2)	(7.78)	(10.9)	(11.4)	(10.1)

	LY	LPg_{t-1}	LPOP	LS	LGS_{t-1}
1. LGS	0.2091	-0.0944	0.7168	0.1829	0.1039
	(3.168)	(-2.735)	(6.841)	(5.551)	(1.992)
	R^2-Adj. = 0.947	**S.E.R = 0.106**	**$F_{(10,78)}$ = 159.06**		
2. LGS	0.4099	-0.1092	1.1019		0.1498
	(6.324)	(-2.703)	(11.9)		(2.478)
	R^2-Adj. = 0.927	**S.E.R = .1253**	**$F_{(9,79)}$ = 125.8**		

* T-Statistics are in the parentheses

b) Long-Run Elasticity:
Table 2 gives the computed values of the long-run elasticities from the two equations for the main variables[3].

In the first equation, the long-run income elasticity of demand is inelastic. Also, in the second equation, income remains inelastic but its size is doubled. Furthermore, the long-run elasticities indicated that if income is expected to rise in the future, its long-run elasticity will become smaller and approaches zero.

On the other hand, the long-run price elasticity of demand in both equations is inelastic. However, the result suggests that the demand for gasoline will become increasingly elastic as price increases. That is the price will become a more important determinant of gasoline demand.

Table 2 Estimated Long-Run Elasticity (1985 = 100)

	Equation (1)	Equation (2)
Income	0.233	0.482
Price of Electricity	0.105	0.128

c) Regional Analysis
The results presented in this paper reflected the estimation of the demand functions over all the G.C.C. member states without any attempt to differentiate by region. The model was, however, fitted to a

number of different groupings of the gulf states. There is somewhat more homogeneity when it comes to gasoline pricing policies between Kuwait, Saudi Arabia, and Qatar as one group and Bahrain, U.A.E and Oman as another group. This grouping is based only on prices of gasoline charged at the pump. The first group represents the countries that highly subsidize gasoline consumption and are also the most urbanized countries among G.C.C. members.The second group depicts the countries that do not subsidize gasoline consumption. The gasoline prices at the pump in this group follow international market trends closely. The equation for Bahrain especially, the least oil endowed country among the G.C.C. members, gives the highest short-run gasoline price elasticity in the gulf. The estimated elasticity of -.5 percent is comparable to those of the industrial nations.

This regional analysis has led to some interesting results as presented in Table 3. The first three equations in Table 3 suggest that for both price and income the short-run elasticities are larger in absolute magnitude for the free market and less urbanized group than for the highly subsidized and more urbanized group.

Although equation 3 includes Bahrain, U.A.E and Oman, it gives a short-run price elasticity similar to that of equation 1 in Table 1. This indicates that the results of pooling all the G.C.C. Countries in Table 1 capture mainly consumption variability from the second group as the first group's consumption did not significantly respond to changes in explanatory variables. Furthermore, the coefficient on the lagged dependent variable is smaller for the less urbanized group and increases as the degree of urbanization increases.This result suggest that in the more urbanized gulf countries, owning and operating a car has become an integral part of living in these societies which contributes to making the gasoline demand price inelastic.

Table 3 Parameter Estimates for Regional Gasoline Consumption

Country	Bahrain	U.A.E.	S. Arabia	Oman	Qatar	Kuwait
1. LGS *	11.041 (15.0)					
2. LGS		8.814 (19.8)		8.7654 (18.2)		
3. LGS	10.177 (9.71)	9.254 (8.75)		9.0980 (9.47)		
4. LGS			14.167 (17.6)		12.729 (16.5)	12.186 (15.9)

	LY	LPg_{t-1}	LPOP	LS	LGS_{t-1}
1. LGS	0.1213 (1.543)	-0.4995 (-3.342)	1.8143 (8.782)		
	R^2-Adj. = 0.945 S.E.R = 0.037 $F_{(3,10)}$ = 57.64 DW = 1.83				
2. LGS	0.4219 (4.714)	-0.3033 (-3.587)	0.9769 (15.2)		
	R^2-Adj. = 0.980 S.E.R = .1607 $F_{(4,25)}$ = 313.3 DW = 1.82				
3. LGS	0.3873 (3.303)	-0.0953 (-1.957)	1.0018 (10.6)		0.0597 (1.856)
	R^2-Adj. = 0.951 S.E.R = .2307 $F_{(6,37)}$ = 120.3				
4. LGS	0.2783 (3.10)	-0.0393 (-2.39)	0.933 (6.07)	0.0433 (0.78)	0.163 (3.86)
	R^2-Adj. = 0.964 S.E.R = .5888 $F_{(6,37)}$ = 169.2				

V CONCLUSIONS

Based on a review of all the estimated coefficients, driving age and population growth in the G.C.C. countries are important determinants of gasoline demand. This is not surprising as the consumption of gasoline has increased since the economic boom following the 1973 oil price hike and consequently, population growth has accelerated in all G.C.C.countries during this period.

The results indicate that demand for gasoline is neither price nor income elastic in the short or the long-run. This was expected since the price of gasoline is highly subsidized and personal disposable incomes have doubled in most G.C.C.countries since the oil prices hike of 1973. However, one important feature of the results which should be mentioned here is that for the first time the gasoline prices coefficient has a negative sign. The argument that gasoline is a small part of the cost of owning and operating a car in the gulf states is of questionable relevance. Most of this cost consists of depreciation, insurance, and license fees and is largely independent of utilization. In all gulf states, the absence of reliable public transportation leaves no other alternatives than using own cars. Also, the harsh climate conditions especially in the summer, induces consumers to buy larger cars equipped with air conditioning which means less fuel efficient cars in the fleet. In fact some calculations from Dubai have suggested that gasoline accounts for as much as 45 percent of the variable cost of car operation.

Furthermore, the long-run elasticities indicated that if income is expected to rise in the future, its long-run elasticity will become smaller and approach zero. On the other hand, the long run elasticity of price is inelastic at low price levels and will become increasingly elastic as price increases. That is, price will become a more important determinant of gasoline demand as real price of gasoline increases.

In other studies, demand is generally found to be price inelastic[4]. However, it is difficult to make any direct comparison between these analyses due to the wide variety of models and data sources. The question here is, "does the stock of cars respond to changes in the price of gasoline?".

The results of this study and those of others suggest that price plays a role in determining gasoline consumption in the long-run. This is demonstrated by the relatively larger price coefficient.

Further, it should be remembered that demand responds relatively slowly to changes in the causal factors, and consequently any adaptation of present life-style consumption will also be very gradual. If prices increase over the next few years in response to decreasing government subsidies and/or to increasing fuel and/or production costs, or in response to privatization drive, the growth of gasoline demand will gradually decrease from the present rate. No accelerated growth of population or income is expected to be large enough to offset this effect.

Finally, In this paper we have shown that the growth in gasoline demand can be attributed to rising incomes and falling relative prices during the 1970's and most of 1980's.The role of falling relative prices in this period has often gone unrecognized. The results from the regional analysis indicate that rising prices in the second group of Gulf States are already reducing demand. Thus we conclude that,in the G.C.C. countries, the market mechanism by itself, appears to be capable of bringing about the necessary adjustments in demand for gasoline.

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NOTES

1. A graphical representation of all key variables are given in the Appendix.

2. Pindyck and Rubinfeld, Econometric Models and Economic Forecasts, 1981 by McGraw-Hill. 252 -255.

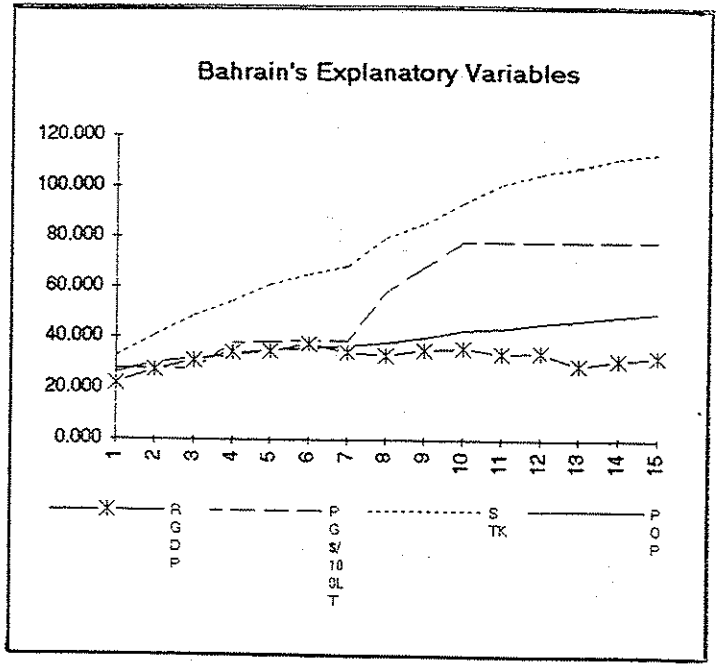
3. The formula used for the calculations is as follows:

   Long-run elasticity is: Bj / (1-Bx)

   Where:
   Bj is the estimated coefficient of variables.
   Bx is the estimated coefficient for the lagged dependent.

4. Al-Sahlawi (1988b and 1991).

APPENDIX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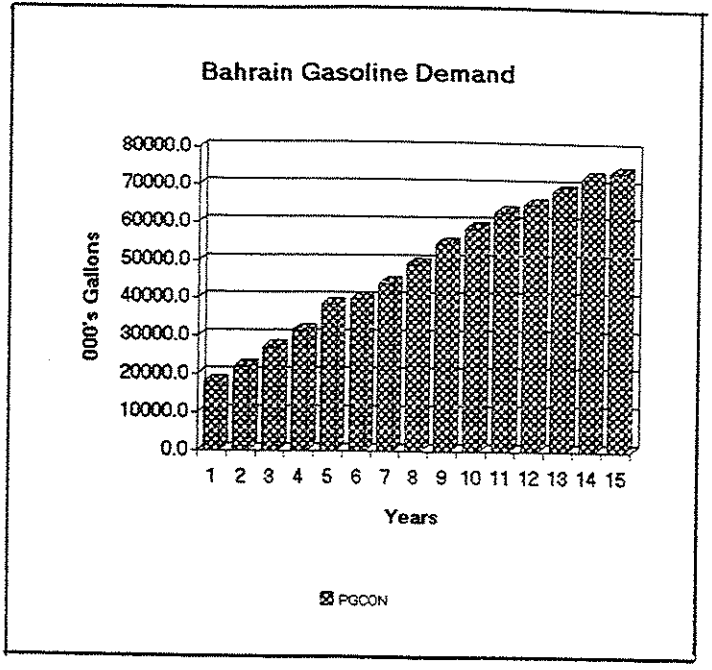
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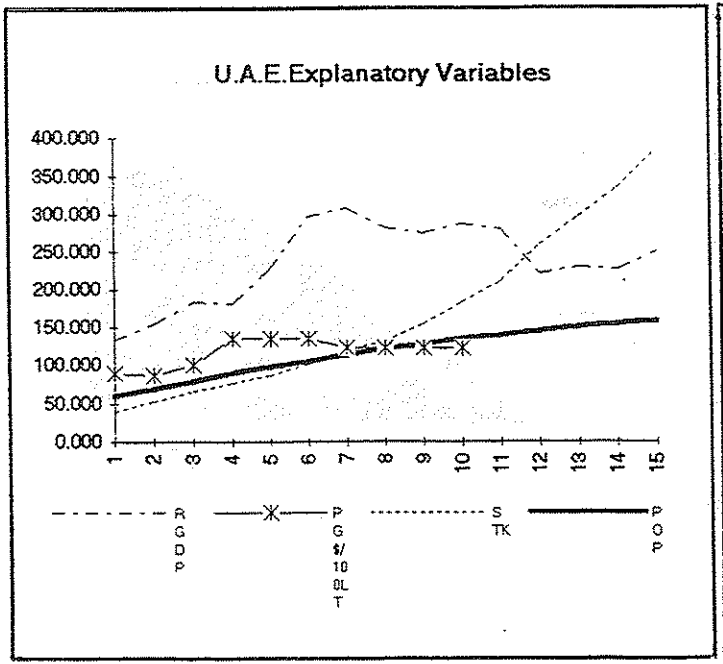
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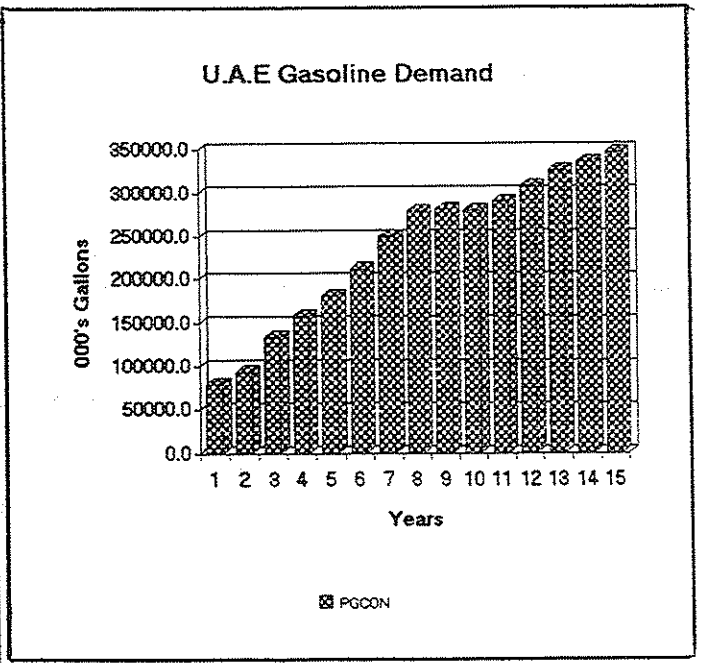
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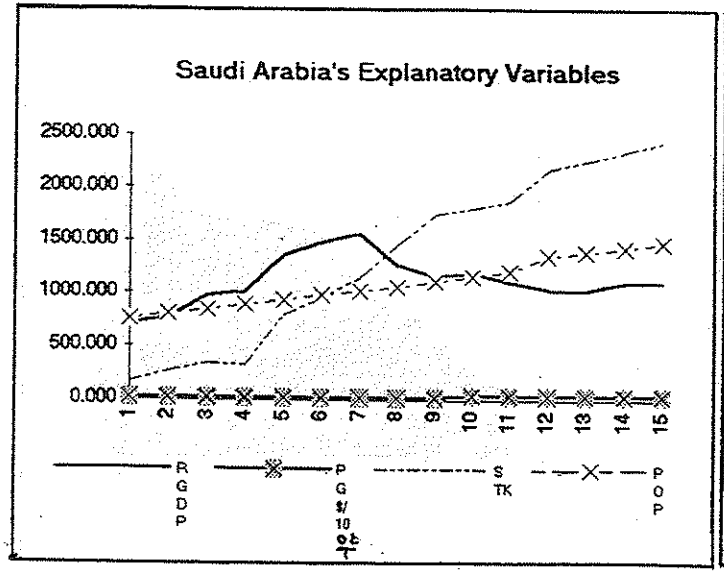
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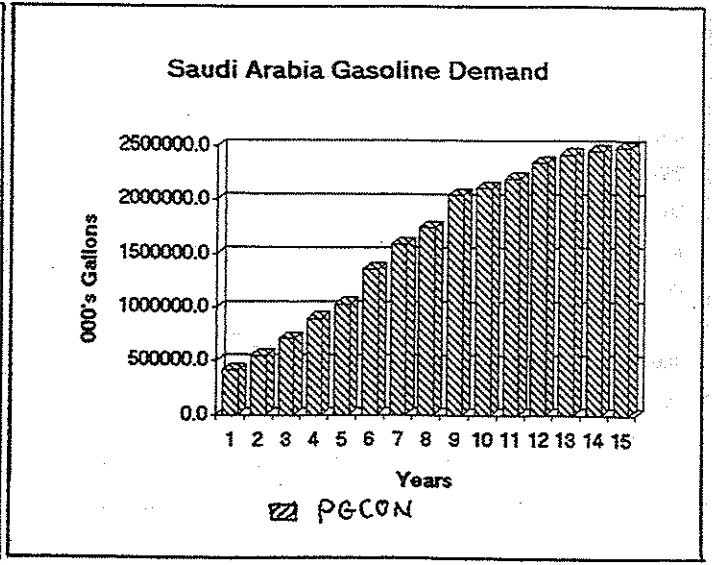
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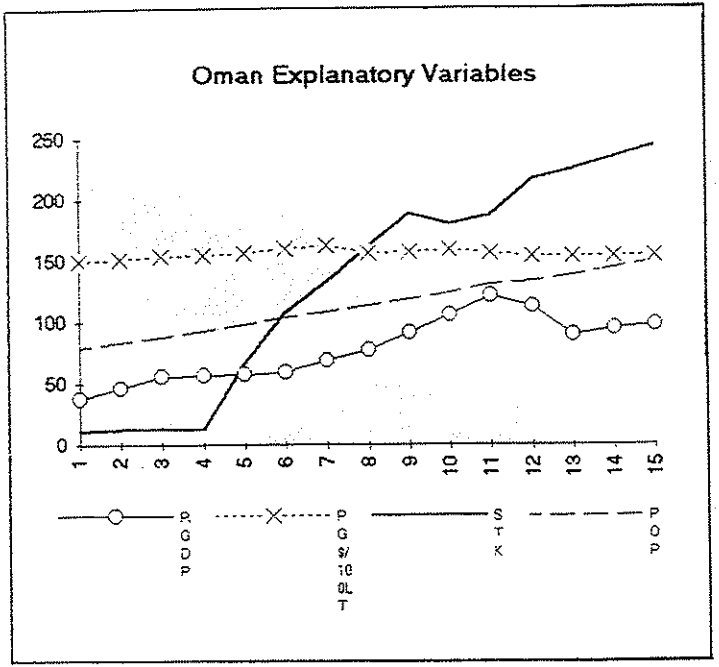
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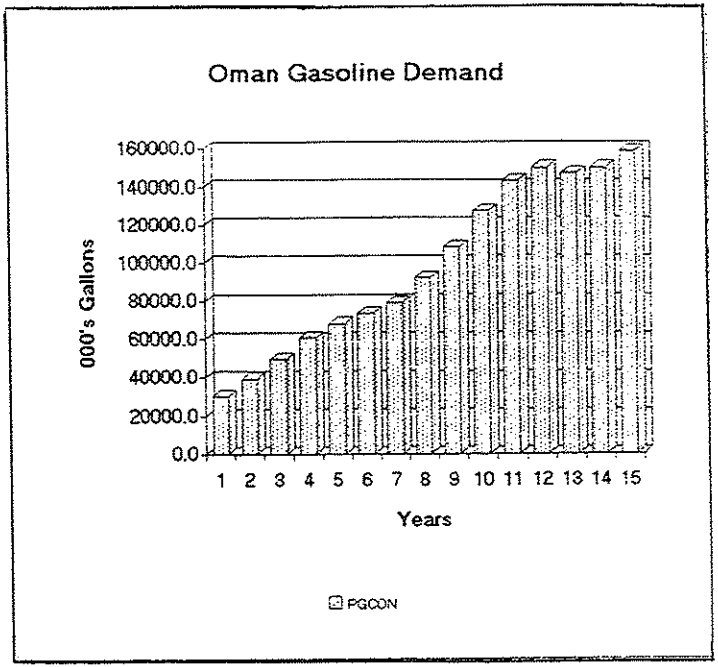
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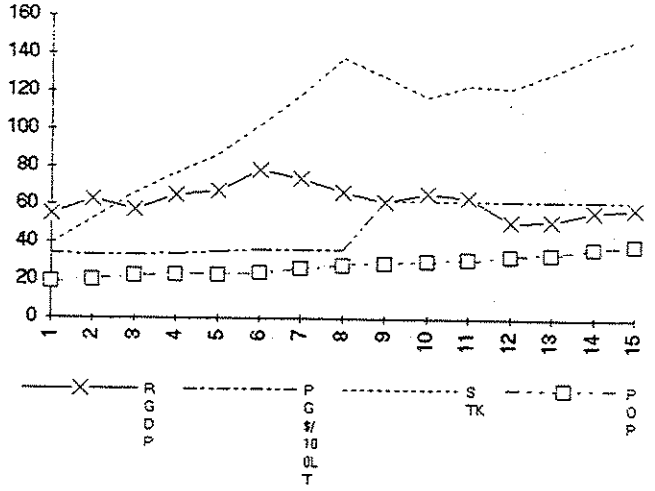

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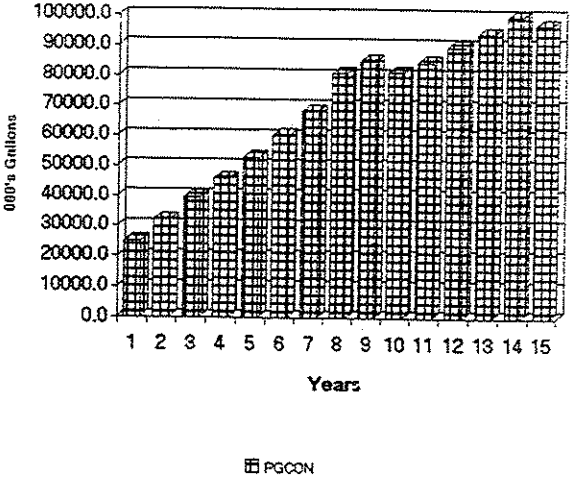

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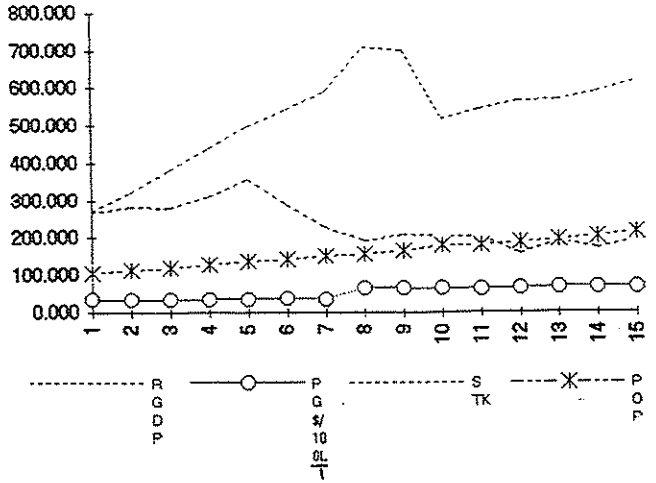

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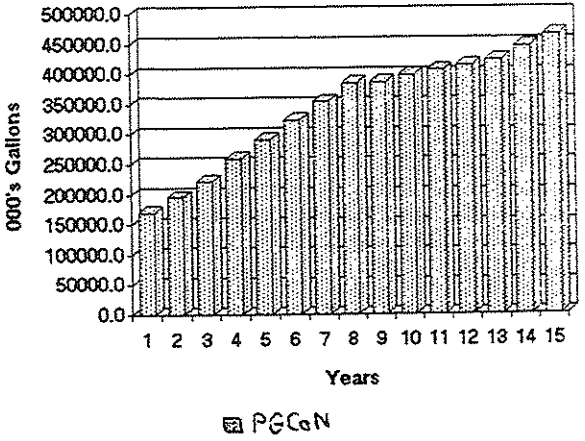

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