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AN ECONOMETRIC ANALYSIS OF RESIDENTIAL DEMAND FOR NATURAL GAS.

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An Econometric Analysis of Residential Demand for Natural Gas.

INTRODUCTION

Natural Gas was first discovered in the province of Baluchistan indeed, in all Pakistan in 1952, and its supply to Karachi for commercial use began in 1955 through the Karachi Gas Company (KGC) [5]. Since the very beginning it has found favour with the consumers as the most convenient and effective and cheap source of energy in the market. Its assuredly continuous supply is another factor behind its extensive and popular use. The consumption of natural gas in urban Karachi rose from 54 million cubic feet in 1961 to 2747 million cubic feet in 1976. In 1961 domestic sector consumed only 0.5% of the total supplied by KGC but in 1976, this amount rose to 7.9% [17].

The original purpose of this study is to estimate elasticity of demand for natural gas; to find out what factors affect the demand for Natural Gas. Although natural gas is currently being supplied to a fairly large number of settlements, the area selected by us for this study is urban Karachi for which the largest time series of required data are available in Pakistan.

The reason for using time series data in this study is that a cross-section analysis, except under rather hereoic assumptions, will not provide information on the influence of price, which may be of importance in longterm projections. Moreover, it is being increasingly realised that the income elasticities provided by cross-section and time-series analysis are conceptually different and that the latter are probably more suitable for projections over time [3].

Model

The demand for natural gas is function of the demand for stock of gas appliances. This in turn is a function of per capita income, price of gas, and the price of kerosene oil which is a very close and easily available substitute of gas. The form of the function is

$$G = G(W)$$

$$W = W(Y, P_g, P_k)$$

Hence $$G = G(W(Y, P_g, P_k))$$

$$= F(Y, P_g, P_k)$$

Where G = Total gas consumption

W = Stock of gas appliances

Y = Per capita income

P_g = Price of gas.

P_k = Price of Kerosene.

The whole population of Karachi is not using the gas. Only those people are using it who have gas connections. Therefore, instead of total gas consumption, multiple of per capita gas consumption by the intensity of population using the gas is used.

Thus

$$\frac{G}{U} \cdot \frac{U}{P} = F(Y, P_g, P_k).$$

Or $$g = F(Y, P_g, P_k)$$

Where U = number of people using gas.

P = total population

and $$g = \frac{G}{P}.$$

We estimate two types of functions, one without time trend and the other with the time tend, to see whether there are changes taking place with the passage of time. The linear forms of the functions which are to be estimated are as follows ;

(1) $G = a_o + a_1 Y + a_2 P_g + a_3 P_k$

(2) $G = b_o + b_3 P_k + b_4 T$

DATA SOURCES

The data for the consumption of demestic sector in Karachi area, during different time periods, were obtained from the Directorate of Natural Gas, Government of Pakistan. The figures for population during different years were calculated with the help of the Censuses of 1961 and 1972 [10]. The growth rate of the populations was found by the following formula [2].

$$P_n = Po\ (\ 1 + r\ )^n$$

Where P_n = Population in the final year,

P_o = Population in the base year,

r = rate of growth of population,

n = number of years.

The figures of population for various years were them generated by using this growth rate. The figures for the prices of natural gas during different time periods were taken from the Gazette of the Government of Pakistan [11, 12, 13, 14, 15, 16] and for kerosene from the 25 Years of Pakistan in Statestics, 1947-1972, Statistical Year Book 1974, Statistical Year Book 1975, and Pakistan Economic Survey 1976-77. The figures for per capita income were also taken from the same publications.

All these figures were in current prices. Therefore, these had to be converted into constant prices in order to avoid the effect of money illusion. The problem was to find a consumer price index to convert these current figures into constant figures. But, for the whole series a single. Price index was not available. Different consumer price indices were available for different years and with the help of all these a single price index was generated with the base year 1959-60 (see Appendix).

The prices of natural gas and kerosene were converted into a single unit, viz 1000 CFT of gas, giving equal quantities of heat in terms of BTUS. Table 1 was used for this purpose [4].

Table No. 1

	Average calorific value in terms of BTUS	Full equivalent to 1000 CFT of gas
Gas	975 / CFT	1000 CFT
Kerosene	154517 / Gallon	6.31 Gallons

Results

The results for both the functions come out to be statistically insignificant. The first function gives positive sign for all the variables, viz, per capita income (Y), price of gas (P_g) and price of kerosene (P_K). The R^2 for this function is 0.71, F-ratio is 7.6 and DW is 1.019. With the addition of the time trend as a variable changes take place in the results. The signs of Y and P_k become negative and that of P_g remains the same i.e. positive. The R^2 increases to 0.966, F-ratio to 57.49 and DW to 1.023.

The positive sign for P_g shows that there is something wrong with the estimation and what we have estimated can be anything but the demand curve. In such conditions it is always advisable to have a close look at the data to understand the problem. Hence in figure I, the quantity consumed and the price of the gas have been plotted on the X-axis and Y-axis respectively. The scatter shows that for the first five years the real price of gas goes on decreasing and the quantity consumed goes on increasing. In the sixth year the real price increases and for the next four years it goes on falling. During all this period the quantity consumed increases. In the eleventh and twelfeth year the price increases and in the thirteenth year it falls. But the quantity consumed continues to increase as in the past. Thus it seems that a shift in the demand is taking place and the curve estimated is not the true demand curve. Hence we add two dummy variables in the model.

The form of the function becomes

$$g = C_o + Cy + C_2 P_g + C_3 P_k + C_4 D_1 + C_5 D_2$$

Year	Price Index	Market price of Natural Gas per 1000 CFT in current prices(Rs.)	Cost of Gas Equivalent to 1000 CFT of gas in current price (Rs)	Deflated price of gas (Rs)	Market price of Kerosene per pint in current prices (Rs)	Cost of Kerosene Equivalent 1000 CFT of gas in current prices (Rs)	Deflated price of Kerosene (Rs)	Per Capita income in current prices (Rs)	Deflated per Capita income (Rs)
1964-65	108-38	3.70	3.70	3.41	0.18	9.08	8.38	410	378
1965-66	111.71	3.70	3.70	3.31	0.19	9.59	8.58	438	392
1966-67	122.99	3.70	3.70	3.00	0.25	12.62	10.26	481	391
1967-68	127.77	3.70	3.70	2.89	0.25	12.62	9.88	499	390
1968-69	128.07	3.70	3.70	2.88	0.25	12.62	9.85	532	415
1969-70	129.33	6.40	6.40	4.95	0.25	12.62	9.76	726	561
1970-71	133.65	6.40	6.40	4.79	0.26	13.12	9.81	740	553
1971-72	139.71	6.40	6.40	4.58	0.31	15.65	11.20	774	554
1972-73	145.49	6.40	6.40	4.40	0.32	16.15	11.10	933	641
1973-74	175.38	6.40	6.40	3.92	0.36	18.17	10.36	1186	676
1974-75	219.52	10.00	10.00	4.56	0.49	24.74	11.27	1447	659
1975-76	250.03	13.76	13.76	5.50	0.75/bottle.	28.40	11.36	1465	586
1976-77	272.03	13.76	13.76	5.05	0.76/	29.15	10.72	1439	529

*Note. Price of Kerosene for 1968-69 was not available, It has been generated by taking the average of 1968-69 and 1969-70 prices of Kerosene.

Table No. 3

Per Capita Gas Consumption

Year	Total Gas Consumption in 1,000 CFT.	Population	Per Capita Gas Consumption (in 1,000 CFT)
1964-65	344,000	1991100	0.1727688
1965-66	439,000	2136455	0.2054805
1966-67	538,000	2292421	0.2346863
1967-68	597,000	2459774	0.2427052
1968-69	659,000	2639343	0.2496833
1969-70	783,000	2832021	0.2764810
1970-71	914,000	3038766	0.3007799
1971-72	1134,000	3260603	0.3477884
1972-73	1326,000	3498635	0.3790049
1973-74	1653,000	3754044	0.4403251
1974-75	1864,000	4029098	0.4627494
1975-76	2447,000	4322158	0.5661523
1976-77	2747,000	4637686	0.5923212

	Constant	Y	P_g
I			
Coefficient	-0.64314	.00011402	.061119
T-ratio		0.31966	1.550
Sig. Level		4.3 %	84.4 %
Elasticity		0.171	.731
II			
Coefficient	0.324	-.00033	.00508
T-ratio		2.316	.313
Sig. Level		0-95078	.23807
Elasticity		-.499	.0688
III			
Coefficient	.3222	.0006248	-.0654
T-ratio		2.52	-1.96
Sig. Level		96 %	91 %
		.93	-.87

Table No. 4

Estimate & Coefficient for the Regressions.

P_k	T	D_1	D_2	R^2	F-ratio	DW.
.066344				0.71	7.6	1.019
1.857						
90.3 %						
1.96						
-.01306	.04337			0.966	57.49	1.023
-.781	7.6646					
.54309	.99994					
-.387						
.02301		-.356	-.2805	.976	59.22	2.492
1.82		-3.47	-8.62			
88.9%		99. %	99.99%			
.68						

Where

D_1 = 1 for the first five observation,

= o for other and

D_2 = 1 for sixth to 11th observations,

= 0 for rest.

The results which we get for this function are quite significant. All the variables have appropriate signs. The R^2 is .976, F-ratio is 59.22 and DW is 2.492. The T-ratio for income is 2.52, for P_g-1.96 and for P_k-1.82. These significant levels for these variable are 96%, 91% and 88.9 % respectively. The income elasticity is 0.93, price elasticity is -0.78 and cross elasticity is 0.68. It seems to be a good demand curve as all the coefficients are significant and all the variables have appropriate signs. But there is no available evidence of any factors which cause a demand curve to shift. Hence our analysis is not correct and we are misinterpreting the regression analysis. This forces us to study the market conditions in the gas sector.

The market conditions are such that both price and supply of gas, are administered one. The government fixes the price and the gas companies have their own policy of providing new connections to a specific number of consumers. The supply is constrained by the amount available. This analysis shows something which can be better explained by Figure II. The equilibrium points represent the supply and price equilibrium points. At price P_1, the quantity consumed in q_1. In fact this is the amount which is being supplied by the gas company. The actual amount demanded is a

beyond this point and it lies on a hypothetical demand curve represented by DD^1. Thus $E_1 q_1$ is the excess demand or, in other words this is the amount which has been curtailed due to rationing. The same is true about all the points representing the equilibrium points of price and the quantity consumed. The dotted lines which show the distance between the observed points and the hypothetical demand curve represent the amount which should be consumed when all those who have applied for gas connection get it.

Conclusion

The demand curve which has been estimated with the given data is not the true demand curve. By taking it as a demand curve for gas one is ignoring the true market. If we take into account the number of those people who have applied for gas connection alongwith those who have already got it, our estimates would reflect the true demand curve.

The price of gas is below the price of the other fuels which could be used as a substitute for it. Therefore, the peoples preference is for gas. If the Government wants to curtail the consumption of gas, it should either increase the price of gas or decrease the price of other substitutes so that the two are brought to the same level, thus making it less attractive for those who are creating new demand for it.

Appendix

The price index for this study has been generated on the basis of four different types of indices as follows.

I. Consumer price index for industrial worker with the base year 1961 for year 1959-60 to 1970-71 (Table A-I) [7].

II. Consumer price index for Government and commercial employees (clerical) in Karachi with the base year 1956 for years 1956-57 to 1970-71 (Table A-II) [7].

III. Consumer price index for clerical wage earner with the base year 1961 for 1959-60 to 1970-71(Table A-III) [7].

IV. Consumer price index for the monthly income group Rs. 501-1000 with the base year 1969-70 for years 1969-70 to 1974-75 (Table A-IV) [8, 9]. In 1975-76, a 13.9 % increase took place on the previous year's consumer price index and in 1976-77 a further increase of 6.8 % took place [6]. With the help of this information figures for 1975-76 and 1976-77 were generated. These were on the base year 1969-70.

The first three indices were converted to the base Year 1959-60 and their average was calculated. Thus we got a series of figures with the base year 1959-60 for the years 1959-60 to 1969-70. The fourth index was on the base 1969-70. This was to be converted to the base 1959-60; for this purpose the figures for 1969-70 at the base 1959-60 from the average of the first three indices was used and then the figures for 1969-70 onward were calculated.

Table No. 4-I

Consumer's Price index for industrial workers by expenditure groups

Base 1961== 1000

Year	Price index (1960-61=100)	Price index (1959-60=100)
1959-60	98.49	100.00
1960-61	100.00	101.53
1961-62	99.87	101.40
1962-63	98.92	100.44
1963-64	99.50	101.02
1964-65	104.58	106.18
1965-66	108.83	110.50
1966-67	120.03	121.87
1967-68	124.81	126.72
1968-69	124.87	126.78
1969-70	125.20	127.12
1970-71	129.46	131.44

Table A- II

Consumers' price index for government and commercial employes (clerical) in Karachi by expenditure groups : House-hold operations.

(Base : 1956 = 100)

Year	Price index 1956 =100	Price index 1959-60 =100
1956-57	101.49	-
1957-58	102.13	-
1958-59	98.14	-
1959-60	99.65	100.00
1960-61	101.17	101.53
1961-62	101.10	101.46
1962-63	101.56	101.92
1963-64	102.12	102.48
1964-65	109.19	109.58
1965-66	112.06	112.45
1966-67	123.39	123.82
1967-68	128.20	128.65
1968-69	128.57	129.02
1969-70	130.29	130.75
1970-71	130.63	131.09

Table A-III

Consumers Price index for clerical wage earners : Housing and Household operation

Year	Price index 1961=100	Price index 1959-60=100
1959-60	98.49	100.00
1960-61	100.00	101.53
1961-62	100.20	101.74
1962-63	100.24	101.78
1963-64	100.94	102.49
1964-65	107.73	109.38
1965-66	110.50	112.19
1966-67	121.44	123.30
1967-68	126.10	127.93
1968-69	126.46	128.40
1969-70	128.15	130.11
1970-71	128.46	130.43

Table No. A-IV

Combined consumer Price index for income group Rs.501---1000.*

Year	Price index 1969-70	Price index 1959-60=100
1969-71	100	129.33
70-71	103.34	133.65
71-72	108.03	139.71
72-73	112.50	145.49
73-74	135.61	175.38
74-75	169.74	219.52
75-76	193.33	250.03
76.77	210.34	272.03

Table A-V

Final consumer price index for Housing and Household operation.

Year	Price index 1959-60=100
1959-60	100.00
1960-61	101.53
1961-62	101.53
1962-63	101.71
1963-64	101.99
1964-65	108.38
1965-66	111.71
1966-67	122.99
1967-68	127.77
1968-69	128.07
1969-70	129.33
1970-71	133.65
1971-72	139.71
1972-73	145.49
1973-74	175.38
1974-75	219.52
1975-76	250.03
1976-77	272.03

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