Determinants of Gas Energy Consumption in Pakistan: An Econometric Analysis (1971-2006)

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DETERMINANTS OF GAS ENERGY CONSUMPTION IN PAKISTAN: AN ECONOMETRIC ANALYSIS (1971-2006)

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ABSTRACT

The paper evaluates the determinants of gas energy consumption in Pakistan during 1971-2006 using econometric techniques. Time series data ranging from 1971 to 2006 has been taken from Economic Survey of Pakistan (Statistical Supplement, 2006-07). For the analysis of the data, Augmented Dickey Fuller (ADF) test, Jhonson Co-integration test (likelihood ratio statistic) and the method of ordinary least square have been used. The results indicate that 1% each increase in the gas energy consumption in the household, cement, fertilizer, power and industry sector brings 1.04%, 1.03%, 0.95%, 0.97% and 1.37% change in the total energy consumption respectively. The coefficients of all the explanatory variables are statistically significant at both 5% and 1% level of significance. It is recommended to increase the gas energy supply to meet the requirement in the household and industry sector.

Key words: Determinants; gas; energy; consumption; econometric; analysis

INTRODUCTION

In Pakistan, the major sources of energy are oil, gas, petroleum products, coal and electricity. The consumption of these sources is alarming since its independence when there was no gas natural gas available since its inception. Gas is consumed in various sectors of the economy mainly household, cement, fertilizer, power, industry and commercial consumption. The consumption of gas among these areas showed increasing trend in the history of Pakistan.

The facts and figures reveal that the energy consumption by the household has increased from 2261 million cubic feet in 1971-72 to 185533 million cubic feet in 2006-07 in

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Pakistan. The commercial gas consumption has increased from 1945 million cubic feet in 1971-72 to 31375 million cubic feet in 2006-07. The gas consumption in cement sector has increased from 16399 million cubic feet in 1971-72 to 14686 million cubic feet in 2006-07. The gas consumption in fertilizer sector has increased from 22286 million cubic feet in 1971-72 to 193682 million cubic feet in 2006-07. The gas consumption in power sector has increased from 40793 million cubic feet in 1971-72 to 433672 million cubic feet in 2006-07. The gas consumption in industrial sector has increased from 27830 million cubic feet in 1971-72 to 306600 million cubic feet in 2006-07. While the total gas consumption in Pakistan has increased from 111514 million cubic feet in 1971-72 to 1221994 million cubic feet in 2006-07 (Statistical Supplement, 2006-07).

There is shortage of studies to explore the determinants of energy consumption in literature. However, some researchers attempted to study the issue from various angles. Evrendilek and Ertekin (2003) focused on the potential of renewable energy sources in Turkey and assessed to meet the growing energy demand. The results indicated that chase and execution of sustainability-based energy policy could provide about 90% and 35% of Turkey's total energy supply and consumption projected in 2010, respectively. Chang *et al.* (2000) presented a review on the energy production, consumption and prospect of renewable energy in China. The results showed that biomass was the most promising renewable energy resources with persist great potential for development. In China, biomass energy consumption was approximately twenty percent of the primary energy consumption. Ramachandra *et al.* (2000) studied the Present and prospective role of bioenergy in regional energy system in Uttara Kannada district of Western Ghats. They expressed the possibility of hydropotential for fulfilling the requirements of the region.

They estimated the hydroenergy potentials of streams in the Bedthi and Aghnashini river catchments to be about 720 and 510 million kWh, respectively. McCarroll et al. (1979) studied the food intake and energy expenditure in cold weather military training. They pointed out that energy expenditure (activity) is the primary determinant for the requirements of food.

In the present study attempt has been made to explore the major determinants of gas energy consumption in Pakistan during 1971-2006 using econometric techniques.

MATERIALS AND METHODS

The present study has been conducted in the year 2008 to assess the determinants of gas energy consumption in Pakistan during 1971-2006 using econometric techniques. Time series data ranging from 1971 to 2006 has been taken from Economic Survey of Pakistan (Statistical Supplement, 2006-07). Augmented Dickey Fuller (ADF) test has been used for checking the stationarity of the data. The Akaike Information Criterion (AIC) has been used to select the optimum ADF lag. Variables which were non-stationary at level have been made stationary after taking first difference and second difference. Furthermore, the Johenson Co-integration test has been used to detect the long-term relationship among the series. To this end, the Likelihood Ratio (LR) statistic is used. To assess the determinants of gas energy consumption in Pakistan, the following model was estimated using the method of ordinary least square.

$$TEC = b_o + b_1 HHEC + b_2 ECC + b_3 ECF + b_4 ECP + b_5 ECI \quad (1)$$

Where

TEC = Total Gas Energy Consumption (million cubic feet) in Pakistan

HHEC = Household Gas Energy Consumption (million cubic feet) in Pakistan

ECC = Energy Consumption in Cement sector (million cubic feet) in Pakistan

ECF = Energy Consumption in fertilizer sector (million cubic feet) in Pakistan

ECP = Energy Consumption in power sector (million cubic feet) in Pakistan

ECI = Energy Consumption in Industry (million cubic feet) in Pakistan

A statistical package Eview has been used for deriving the results.

RESULTS AND DISCUSSION

The ADF test results have been presented in Table I and II. In Table I, the stationarity of the data has been checked including intercept and not trend while both intercept and trend have been included in Table II. Variables which are not stationary at level have been made stationary after taking the first difference denoted by I(1) and then the second difference i.e. I(2) if needed. The values given in the brackets are the optimum lags selected on the basis of AIC criterion (i.e the lag t which the AIC value is minimum). According to Table I, the variables ECI is stationary at level. First differences have been taken for the variables HHEC, ECC and ECF to make it stationary while the second differences have been taken for the variables TEC and ECP.

Including both intercept and trend, again the variable ECI is stationary at level. The variables HHEC and ECF have been made stationary after taking the first difference while for the TEC, ECC and ECP the second differences have been taken to make these stationary (Table II).

Table I: ADF test results for stationarity (including intercept and not trend)

Variables	I(0)		I(1)		I(2)		Result
	Test statistics	Critical value	Test statistics	Critical value	Test statistics	Critical value	
TEC	3.298[0] [1]	-3.63	-3.3651[0]	-3.64	-6.4394[2]	-3.66	I(2)
HHEC	1.1679[2]	-3.64	-6.4106[0]	-3.64			I(1)
ECC	-1.941[0]	-3.64	-4.2142[0]	-3.64			I(1)
ECF	-0.533 [0]	-3.63	-5.581 [0]	-3.64			I(1)
ECP	-0.637 [1]	-3.64	-3.486 [0]	-3.64	-4.563 [2]	-2.95	I(2)
ECI	7.286 [0]	-3.63					I(0)

[1] Figures in square brackets besides each statistics represent optimum lags, selected using the minimum AIC value.

Table II: ADF test results for stationarity (including both intercept and trend)

Variables	I(0)		I(1)		I(2)		Result
	Test statistics	Critical value	Test statistics	Critical value	Test statistics	Critical value	
TEC	0.296[0] [2]	-4.24	-3.993[0]	-4.25	-6.411[2]	-4.28	I(2)
HHEC	2.055[2]	-3.26	-8.171[0]	-4.25			I(1)
ECC	-2.102[1]	-4.25	-3.473[0]	-4.27	-7.388 [0]	-4.26	I(2)
ECF	-2.525 [0]	-4.24	-5.686 [0]	-4.25			I(1)
ECP	-2.457 [1]	-4.25	-3.389 [0]	-4.25	-6.930 [0]	-4.26	I(2)
ECI	-5.590 [0]	-4.24					I(0)

[2] Figures in square brackets besides each statistics represent optimum lags, selected using the minimum AIC value.

Furthermore, the regression results may be spurious due to no co-integration among the series. To this end the Jhonson Co-integration test has been used. The likelihood ratios statistic values are given in Table III (including no trend and no intercept) and in Table IV (including both intercept and trend), which indicates the long-term relationship among the variables of the study and rejects the hypothesis of no co-integration. Because most of the absolute values of the LR ratios are greater than their relevant critical values.

Table III Johansson Co-integration test results including no intercept and no trend

	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.705543	102.9089	82.49	90.45	None **
0.540799	61.33971	59.46	66.52	At most 1 *
0.488637	34.87866	39.89	45.58	At most 2
0.211621	12.07570	24.31	29.75	At most 3
0.108346	3.991304	12.53	16.31	At most 4
0.002711	0.092298	3.84	6.51	At most 5

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

Table IV Johansson Co-integration test results including both intercept and trend

	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.805718	159.5348	114.90	124.75	None **
0.740422	103.8278	87.31	96.58	At most 1 **
0.484129	57.97209	62.99	70.05	At most 2
0.378378	35.46755	42.44	48.45	At most 3
0.350681	19.30318	25.32	30.45	At most 4
0.127079	4.620942	12.25	16.26	At most 5

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

Regression results with TEC as dependent variable while HHEC, ECC, ECF, ECP and ECI are as independent variables are given in Table V. The results indicate that 1% increase in the gas energy consumption in the household sector brings 1.04% increase in total gas energy consumption in Pakistan. Similarly, 1% increase in the gas energy consumption in the cement sector leads to increase total gas energy consumption by 1.03%. On similar pattern, 1% each increase in the gas energy consumption in fertilizer,

power and industry sector leads to increase total gas energy consumption by 0.95%, 0.97% and 1.37% respectively. The coefficients of all the explanatory variables are statistically significant at both 5% and 1% level of significance. The model is also best fitted as indicated by the high value of R-squared (0.999) and adjusted R-squared (0.999), showing that the included explanatory variables are entirely responsible for changes in total exports in Pakistan. Durbin-Watson value (2.15) suggests that there is no problem of autocorrelation.

Table V Regression results of gas energy consumption function

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11125.37	5387.255	-2.065129	0.0476
HHEC	1.035588	0.063365	16.34321	0.0000
ECC	1.027692	0.181924	5.649015	0.0000
ECF	0.952752	0.064008	14.88486	0.0000
ECP	0.965956	0.021198	45.56859	0.0000
ECI	1.366752	0.044679	30.59073	0.0000
R-squared	0.999821	Adjusted R-squared		0.999791
Durbin-Watson stat	2.153325	Prob(F-statistic)		0.000000

Table VI depicts the values of variance decomposition of the six variables, showing how the variance of each one of the series is decomposed during a period of ten years. The first group of columns in Table VI is referred to total gas energy consumption (TEC). Those values of standard errors that total gas energy consumption explain by itself lies between 20% to 100% with values declining slowly. HHEC is the second variable explaining most of the variation in TEC ranging from 0.11% to 7.79%. ECC variation ranges from 8.98% to 9.94%. ECF explaining 1.89% to 40.42% variation in TEC. ECP explaining 0.70% to 18.25% variation in TEC and ECI explaining 1.40% to 3.44% variation in TEC. On similar pattern, variances decomposition values of HHEC, ECC, ECF, ECP and ECI are given in Table VI.

Table VI Values of the Variances decomposition

Variance Decomposition of TEC:							
Period	S.E.	TEC	HHEC	ECC	ECF	ECP	ECI
1	22601.76	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	39041.52	86.91793	0.110188	8.975029	1.890421	0.698006	1.408423
3	51538.99	77.71277	0.790630	15.66981	2.437827	2.512591	0.876374
4	62114.44	73.30096	0.569372	18.55245	2.101373	4.468121	1.007723
5	71735.23	68.91822	0.505598	20.53717	1.577619	7.115063	1.346332
6	79776.44	62.84976	0.889653	22.27060	1.912032	10.28108	1.796872
7	88029.26	54.16421	2.037836	22.19291	5.120963	13.95417	2.529916
8	99664.99	42.69672	4.066626	19.47302	13.44448	17.08397	3.235186
9	118238.7	30.35378	6.274697	14.83254	26.40981	18.58803	3.541144
10	147076.8	20.15178	7.787934	9.940030	40.42526	18.25144	3.443558
Variance Decomposition of HHEC:							
Period	S.E.	TEC	HHEC	ECC	ECF	ECP	ECI
1	3563.046	8.304301	91.69570	0.000000	0.000000	0.000000	0.000000
2	4312.279	5.897385	78.12214	1.107332	8.010797	5.741700	1.120647
3	5425.136	4.451870	71.53761	0.733176	16.91141	5.547439	0.818491
4	6770.604	7.926642	54.04228	1.432267	24.16843	11.90487	0.525516
5	8723.111	10.26201	38.00698	3.512009	31.97897	15.69714	0.542876
6	11458.87	9.569128	25.68702	5.343603	38.76153	19.46398	1.174735
7	15185.37	6.859571	17.93443	5.648205	46.48810	21.12797	1.941732
8	20238.30	4.017847	13.38870	4.798468	54.01017	21.20770	2.577109
9	27111.32	2.326567	10.78309	3.436194	60.50976	20.03493	2.909466
10	36374.30	1.979406	9.283552	2.173652	65.36433	18.21490	2.984153
Variance Decomposition of ECC:							
Period	S.E.	TEC	HHEC	ECC	ECF	ECP	ECI
1	1969.951	6.730584	39.99028	53.27914	0.000000	0.000000	0.000000
2	2702.421	11.13841	36.08349	38.68543	13.99326	0.094383	0.005030
3	3373.190	8.379023	25.85843	25.31283	39.94046	0.253289	0.255972
4	4114.688	5.774792	17.52742	17.03502	59.19995	0.170275	0.292536
5	4907.165	5.120856	12.33848	12.00490	69.71528	0.445279	0.375208
6	5736.427	6.020130	9.256180	8.785215	73.83922	1.824686	0.274568
7	6660.869	7.190293	7.362652	6.654798	73.84004	4.575660	0.376558
8	7743.690	6.868592	6.216510	5.401962	72.32473	8.306830	0.881373
9	9123.746	5.145877	5.625937	4.472773	70.94560	12.01272	1.797093
10	11034.57	3.740947	5.501143	3.397680	70.15893	14.42570	2.775604
Variance Decomposition of ECF:							
Period	S.E.	TEC	HHEC	ECC	ECF	ECP	ECI
1	6935.024	7.180118	0.260927	1.453827	91.10513	0.000000	0.000000
2	9733.702	7.384294	1.006482	1.125254	88.26986	0.250823	1.963290
3	13000.44	10.60856	1.600231	0.737487	82.99227	2.889478	1.171971
4	16781.72	15.48075	2.758530	0.911932	73.59482	6.452410	0.801556
5	21109.85	16.67433	3.325605	2.132277	65.52046	11.40946	0.937863
6	26253.23	13.54934	3.882587	3.379583	61.47990	15.99603	1.712554
7	32934.60	8.965854	4.647867	3.651401	60.84868	19.05988	2.826310
8	42139.83	5.631349	5.493747	2.968406	62.57701	19.73783	3.591659
9	55031.66	4.677202	6.155954	1.941016	65.05009	18.39791	3.777827
10	72710.64	5.455176	6.509129	1.118671	67.24638	16.12144	3.549204

Variance Decomposition of ECP:							
Period	S.E.	TEC	HHEC	ECC	ECF	ECP	ECI
1	20369.39	86.71804	1.850415	0.815792	6.507344	4.108406	0.000000
2	34017.59	71.82920	2.887018	14.62214	7.327525	3.291169	0.042945
3	43314.07	59.94042	4.355941	23.00877	7.607777	4.762288	0.324808
4	48239.90	54.86840	4.083650	26.90493	6.576828	6.048415	1.517776
5	51054.41	51.51086	3.647966	28.53394	6.012591	7.752384	2.542254
6	53371.64	47.41426	3.842280	28.21988	7.932697	9.488618	3.102263
7	57238.20	41.34745	4.916534	25.14995	14.29948	10.92016	3.366422
8	64266.07	33.48220	6.498512	20.02021	25.03213	11.69170	3.275249
9	75367.94	25.46093	7.767947	14.55664	37.36613	11.91213	2.936220
10	91283.11	18.75841	8.286640	9.930451	48.55910	11.88504	2.580356
Variance Decomposition of ECI:							
Period	S.E.	TEC	HHEC	ECC	ECF	ECP	ECI
1	4333.593	18.61094	4.009618	6.999431	3.358452	39.02851	27.99305
2	6741.509	36.48662	2.000882	2.939111	17.91155	22.65018	18.01167
3	10329.34	49.72294	3.069682	2.175973	23.65176	10.87733	10.50231
4	14626.57	51.97080	2.767300	3.882799	29.59404	5.841053	5.944011
5	19354.60	49.96955	2.910409	5.860478	34.28040	3.372143	3.607028
6	23992.00	46.69817	2.817739	7.460940	38.41457	2.215076	2.393508
7	28404.64	43.20198	2.665411	8.506488	42.31258	1.594620	1.718923
8	32499.45	39.96836	2.460628	9.040253	45.95077	1.256706	1.323278
9	36363.06	37.06810	2.243031	9.170440	49.35163	1.088507	1.078298
10	40155.98	34.57525	2.034353	8.999685	52.40894	1.048096	0.933678
Ordering: TEC HHEC ECC ECF ECP ECI							

CONCLUSION AND RECOMMENDATIONS

The facts and figures indicate that the major determinants of gas energy consumption in Pakistan are household, cement, fertilizer, power and industry sectors. The results indicate that 1% each increase in the gas energy consumption in the household and cement sector brings 1.04% and 1.03% increase in total gas energy consumption in Pakistan respectively. Similarly, 1% each increase in the gas energy consumption in fertilizer, power and industry sector leads to increase total gas energy consumption by 0.95%, 0.97% and 1.37% respectively. The planners are recommended to increase the supply of gas energy so as to overcome the increasing pressure of gas energy consumption in different sectors in general and particularly in household and industry sector in Pakistan.

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