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Table 1. Time Series Data of the Variables in the Model

Year	E_t	y_t	p_t	P_t	k_t	X_t	cpi_t	XR_t	M_t	OXR_t
1974	111.8	9342.70	2029.935	572.4	1633.8	20922	28.2	73.65	810.0	67.63
1975	134.6	9227.80	1892.546	586.7	2453.0	21972	31.0	74.45	1145.0	67.64
1976	156.2	11254.30	1678.646	606.0	3328.8	21211	36.1	79.57	1593.0	70.22
1977	182.2	11183.80	1559.627	703.4	3231.0	21530	45.1	79.99	2097.0	70.62
1978	180.7	10070.80	1611.027	799.1	2623.0	18658	49.6	91.10	2578.0	70.48
1979	197.3	10543.10	1479.534	816.7	1815.8	20198	55.2	159.50	3550.0	70.48
1980	186.3	9323.10	1996.154	1361.4	1848.4	12496	68.2	234.25	4508.0	70.62
1981	195.0	9175.20	1594.615	1321.9	1724.2	12796	82.9	395.00	5236.0	78.33
1982	221.9	10335.40	1441.125	1441.1	1841.5	20334	100.0	475.00	6430.0	84.39
1983	267.9	11536.70	1248.061	1432.8	2551.1	20814	114.8	403.58	7514.0	87.20
1984	289.6	11587.10	1152.972	1460.8	2562.2	17024	126.7	610.67	7966.0	91.72
1985	316.3	11607.40	1079.541	1461.7	2153.3	14433	135.4	639.64	9002.0	88.05
1986	292.5	9861.70	922.799	1545.7	1645.9	7171	167.5	815.17	10722.0	76.81
1987	314.2	10019.80	945.587	2022.6	1360.2	11916	213.9	1134.60	12668.0	70.10
1988	316.4	9234.30	772.846	2130.7	1143.6	10709	275.7	954.17	15687.0	69.23
1989	346.5	9514.60	660.882	2139.9	1216.8	13081	323.8	1431.30	18753.0	800.00
1990	369.7	10664.90	706.387	2492.1	1378.8	19305	352.8	1525.80	22969.0	1200.00
1991	410.9	11824.80	738.597	3116.1	1942.9	18661	421.9	1535.20	28628.0	1300.00
1992	453.4	12477.80	668.186	3402.6	2077.3	19868	509.2	1624.50	35866.0	1498.00
1993	481.7	13071.00	722.442	4609.6	2133.4	18080	638.1	1968.80	48135.0	1810.00
1994	519.6	13280.40	690.680	6275.6	2206.3	19434	908.6	2602.20	61843.9	2808.00
1995	532.5	13884.00	653.816	8875.3	2277.2	18360	1357.6	2808.00	85072.2	2896.70
1996	576.4	14694.00	669.547	11197.5	2467.0	22391	1672.4	4500.00	116552.6	3007.50
1997	597.3	15194.40	725.281	14228.0	2461.6	18381	1961.7	6000.00	134286.3	3007.50
1998	638.0	15444.70	751.932	17701.0	2306.6	12982	2354.1	8000.00	170739.6	3007.50
GR 74-98	7.3	2.1	-4.1	14.3	1.4	-2.0	18.4	19.5	22.3	15.8
GR 88-98	7.0	5.1	-0.3	21.2	7.0	1.9	21.4	21.3	23.9	37.7
GR 93-98	5.6	3.3	0.8	26.9	1.6	-6.6	26.1	28.0	25.3	10.2

Notes:

E_t = Physical quantity demanded for energy, million barrels of oil equivalent

y_t = Real aggregate production (GDP), billions of 1361 Rials

p_t = Real weighted energy price, Rials per barrels of oil equivalent

P_t = Nominal weighted energy price, Rials per barrels of oil equivalent

k_t = Physical capital formation, billions of 1361 Rials

X_t = Export revenue in terms of millions of US Dollars

cpi_t = Consumer Price Index

XR_t = Market exchange rate, Rials per US Dollars

M_t = Liquidity, billions of 1361 Rials

OXR_t = Official exchange rate, Rials per US Dollars

GR denotes the average annual growth rate of the mentioned period.

1- The complete verson of this paper has been presented at The Young Economics conference 2000, 5th Spring meeting of Yong Economist, University of Oxford, 27th and 28th March.

2- National Iranian Oil Company (NIOC), Tehran, Iran, Email: mo-mazraati@yahoo.com

3- Ministry of Petroleum of Iran, Department of corporate Planning, Email: reza-f-a@yahoo.com

4- The war imposed by Iraq, stared in 1980 and ended in 1988.

5. CONCLUDING REMARKS

The empirical results of this study provide policy recommendation in the short and mid-term for Iranian energy authority.

The main concluding remarks of this study are as follows:

- inflation elasticities of liquidity, energy prices, and exchange rate show that liquidity has more impact on inflation, whereas the two last variables are in second and third level respectively.

Increasing real energy prices (reducing energy subsidies) have not considerable impact on energy demand in short run, whereas it has more in mid and long term.

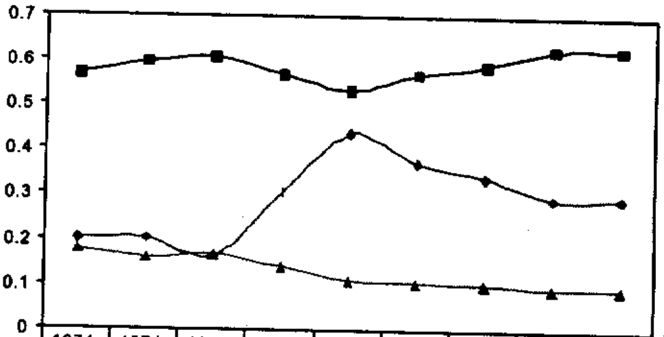
Sharp reduction in energy subsidies has harmful effect on economic growth. Therefore it is recommended to reduce energy subsidies gradually.

The model shows that income effect is more than price effect on the energy demand. The higher the demand income elasticity means the higher the energy intensity (the lower energy efficiency) in economy. Using non-price policies (Those policies that change infrastructures in economy, such as changing legislation for isolation of buildings, standardization, and applyig high technology, etc.), the energy intensity can be improved. This study shows that non-price policies have more effective results than price policies. Therefor it is highly recommended that government should focus on non-price policies in order to change inefficient energy use and improve energy intensity. Such an attempt will reduce the income elasticity of energy demand.

Market forces should determine price of goods and services including energy carries. It is not a responsibility of energy authority (government). Therefor pricing is not prior instrument for eliminating energy subsidies, though it is more convenient instrument to remove budget deficit.

Non-price policies can be handled by revenue come from reducing energy subsidies into the government budget. So our recommendation also helps economic allocation of resources in government activities.

Figure 5. Sensitivity of Elasticities to Sample Period



	1974-1990	1974-1991	1974-1992	1974-1993	1974-1994	1974-1995	1974-1996	1974-1997	1974-1998
Liquidity	0.5675	0.5957	0.6072	0.5675	0.5316	0.5687	0.5898	0.625	0.625
Energy Price	0.2018	0.203	0.1636	0.3064	0.4364	0.3719	0.3401	0.2933	0.2933
Exchange Rate	0.1772	0.159	0.1664	0.1397	0.1108	0.1068	0.1025	0.0928	0.0928

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pricing is not prior instrument for eliminating energy subsidies, though a more convenient one to remove budget deficit

test. Therefor, Lp_g is stationary or integrated of order zero, I(0).

As all four variables applied in the equation (8) are stationary and integrated of order zero, I(0), applying the traditional econometrics has reliable results (rao, 1994). As we discussed earlier, we have applied log-log specification, and rolled-up regression technique for capturing the dynamic effects of elimination of energy subsidies on inflation rate. This analyzes the effects of elimination of energy subsidies through upward price adjustment on inflation rate. Because of first order autoregressive scheme in the disturbance terms of the estimated equations, we have entered a one-lagged error term of the original estimation into the model. The interpretation of the estimated coefficient is just like the ECM model with some considerations.

The estimation result for the sample period 1974-1998 is as follows:

$$Lcpi_t = \underset{(-19.92)}{-3.43} + \underset{(6.71)}{0.62}\, LM_t + \underset{(1.58)}{0.09}\, LXR_t + \underset{(3.58)}{0.29}\, LP_t + \underset{(5.84)}{0.74}\, \hat{\theta}_{t-1} \tag{22}$$

$$\bar{R}^2 = 0.997, \quad DW = 1.71$$

Using whole sample, inflation elasticities of liquidity, nominal energy prices, and market exchange rate has been estimated as 0.62, 0.29, and 0.09 respectively. Figure 6 shows the results of the same regression for different samples, started for sample 1974-1990, up to 1974-1998. Generally speaking the inflation elasticity of liquidity is more than inflation elasticities of energy prices and market exchange rate. The latter has the lowest quantity. As it can be seen, when the liberalization policy started in early 90s by expanding domestic nominal energy prices, the inflation elasticity of energy prices starting to rise and reached to its peak. It has gradually started to turn back to a stable level, but higher than its value during 1974-1992. It indicates that in the recent years, the role of energy prices on inflation has become more important than before.

To sum up, any sharp reduction in energy subsidies (i.e. drastic increase in real energy prices) tighten economic growth by increasing the production cost and inflation. This can be accelerated by a reduction in the level of capital formation and export revenues, which the latter is closely, related to oil export incomes in Iran. Therefor avoiding harmful effects of elimination of subsidies on economic growth, the government should eliminate it gradually. Also it should be coincided with other macro policies such as liberalizing exchange rate, monetary/ fiscal policies to keep real energy prices not decreasing. In order to make price adjustment more efficient in the economy; the government should lead another class of policies to guide the industry, construction, and other productive sectors to improve the energy intensity. This can be executable by some infrastructural reforms in the legislation, standardization and etc. Although pricing is the easiest instrument for eliminating energy subsidies, that is not prior one to this end.

Fig. 4. Trend of Exchange Rate

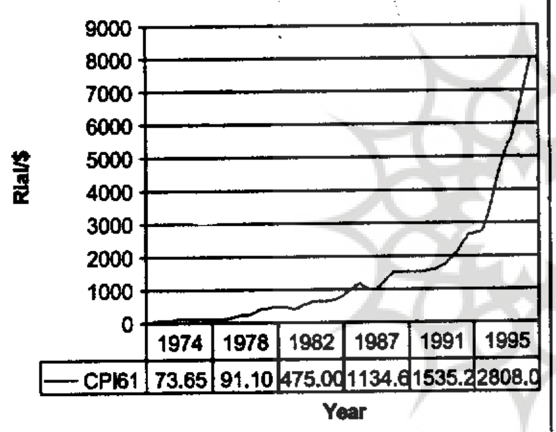
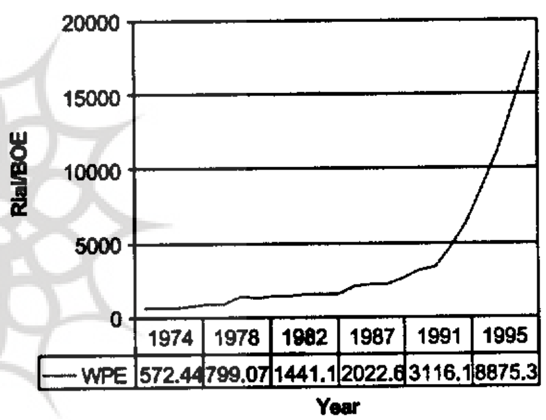


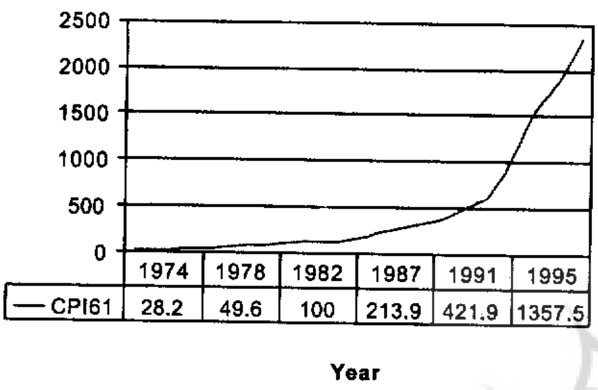
Fig. 5. Trend of Nominal Energy Price



well-defined dummy variable(s).

According to the variable $Lcpi$, different cases of the ADF test (with/ without intercept, trend, and/ or lagged variables) have had different results. In some cases the hypothesis has been accepted and in some others it has been rejected. R^2 and $\overline{R}^2$criteria for most of the cases are very low and there are autocorrelation for some estimated regressions. Figure 2, the trend of cpi, indicates that there is a structural change in the variable after 1993, in which the liberalization policies have been expanded. Therefore any probable change in the means during the time can be caused by such a structural change. The following regression has been used for testing the unit root, and structural change hypotheses:

Fig. 2. Trend of Consumer Price Index (1982=100)



$$Lcpi_t = \underset{(3.30)}{1.00} + \underset{(6.80)}{0.71}\, Lcpi_{t-1} + \underset{(2.86)}{0.05}\, Trend + \underset{(3.16)}{0.17}\, Dum1$$

$$\overline{R}^2 = 0.998,\quad DW = 1.72 \qquad (18)$$

where, $Dum1$ is equal 1 for 1993-1998 and zero for other years. The result shows that null hypothesis of unit root is rejected under t-student test. Therefore, $Lcpi$ is stationary or integrated of order zero, I(0).

The same analysis is valid for the variable LM_t, logarithm of liquidity. Diffirent models has been specified for the ADF test but no reliable model has been accepted for this purpose. Despite of weak results for the specified models according to the t-student values, R^2, $\overline{R}$, DW, and F criteria, all of them accept the hypothesis of unit root for LM_t. Ploting the trend of M_t in Figure 3 indicates an structural change in this variable. The following model has been selected for testing the hypothesis of structural change and unit root of the variable:

$$LM_t = \underset{(4.22)}{2.13} + \underset{(9.19)}{0.71}\, LM_{t-1} + \underset{(4.12)}{0.07}\, Trend + -\underset{(-4.62)}{0.20}\, Dum2$$

$$\overline{R}^2 = 0.999,\quad DW = 1.90 \qquad (19)$$

where, $Dum2$ is equal 1 for 1983-1998 and zero for other years. The result shows that null hypothesis of the unit root is rejected under t-student test. Therefore, LM is stationary or integrated of order zero, I(0).

Fig. 3. Trend of Liquidity

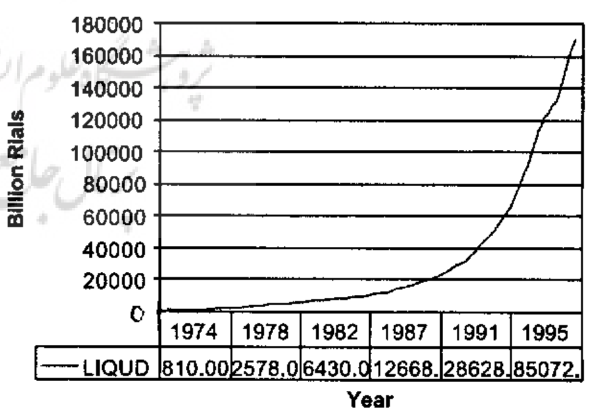


Figure 4 shows the trend of variable XR, the exchange rate. Again after trying several cases for ADF test and considering all the statistics the following model has been selected for testing structural change as well as unit root:

$$LXR_t = \underset{(3.31)}{1.72} + \underset{(4.28)}{0.58}\, LXR_{t-1} + \underset{(3.64)}{0.70}\, Trend + -\underset{(-3.51)}{0.33}\, Dum3 \qquad (20)$$

$$\overline{R}^2 = 0.987,\quad DW = 1.60$$

where, $Dum3$ is equal one for 1983, 1983, and 1988-1998 and zero for other years. The result shows that null hypothesis of the unit root is rejected under t-student test. Therefor, LXR is also stationary or integrated of order zero, I(0).

Finally the nominal energy prices, P_t, has been checked by many versions of ADF test, but non of the estimated models were reliable. Figure 5 shows thetrend of nominal energy price. The following model has been chosen to test the unit root hypothesis as well as structural change:

$$Lp_t = \underset{(1.94)}{0.38} + \underset{(35.1)}{0.96}\, Lp_{t-1} + \underset{(4.43)}{0.29}\, dum4$$

$$\overline{R}^2 = 0.992,\quad DW = 1.87 \qquad (21)$$

where, $Dum4$ is equal one for 1980, 1993-1998 and zero for other years. The result shows that null hypothesis of theunit root is rejected under t-student

sharp reduction in energy subsidies tightens economic growth by increasing production cost and inflation

different with respect to the time. Table 2 shows these reactions. This table indicates that the instant price elasticity of energy demand is -0.143, which indicates prompt reaction after imposing the policy. The interpretation is that, ceteris paribus, one percent increase in the real energy prices promptly decrease 0.143 percent energy demand that is relatively low. Because in short run households and firms are not able to adjust the combination of inputs and the technology. The reaction can be reflected in the cost price of production (cost push inflation) and/ or reducing the quantity demanded of energy. If the elasticity of demand for goods and services to be inelastic in market, the firms will have to decreas the level of their production that in turn reduce the demand for energy and other inputs. More over part of energy demand in industrial sector are captive energy demand, which is independent of production level. It could not be affected through energy prices.

the level of real production would cause 0.42 rise in the level of energy demand. The income elasticity of energy demand is a criterion of energy efficiency (energy intensity) which in turn is influenced by price and mainly non-price policies. The latter includes policies that change infrastructures in economy, such as changing legislation for isolation of buildings, standardization, and applying high technology, etc. So for, experiencing high level of energy conservation (low energy intensity in the world achieved when non-price policies have been mostly contributed.

The price elasticity of energy demand in mid-term and long-term are -0.163 and -2.368 respectively. In mid- and long-term, partial and full adjustments take place respectively. Then it means that economic agents will be able to change the structure, technology, and combination of production factors.

Capital formation and export revenues increase the production possibilities, which in turn increase

Table 3. Income (Real Production) Elasticities

Elasticity	Energy Price	Energy Demand	Capital Formation	Export revenues
Impulse	-	0.265	0.196	0.091
Mid-term	-0.043	-	0.220	0.102
Long-term	-0.801	-	0.839	0.390

Impulse income elasticity of energy demand is 0.42, which is about triple times more than price elasticity. It interprets that one percent increase in the level of energy demand. They can not take place in short rum. The energy demand elasticities of capital formation in mid-term and long-term are 0.092 and 1.740 respectively. The energy demand elasticities of export revenues in mid-term and long-term are 0.043 and 0.809 respectively. As it can be seen the total effect of capital formation and export revenues (as non-price variables) are more than the effects of energy price in long term.

Table 3 shows real production elasticities for energy demand, capital formation and export revenues, in short, mid-, and long-term they are 0.265, 0.196, and 0.091 respectively. Therefore, REal production has more sensitivity with respect to energy input than other two variables. Because of partial and perfect adjustments in mid-term and long-term respectively, energy demand indirectly influence real production.

The table 3 also shows income (real production) elasticity of energy price in mid- and long-term. In mid-term income elasticities for energy price, capital formation and export revenues, are -0.043, 0.220, and 0.102 respectively, whereas they are -0.801, 0.839, and 0.390, respectively in long run. So in long run one percent increase in real energy prices relatively decrease real production more than mid-term (about 0.8 percent). Limitation in energy input may cause a bottleneck in economic growth in the long run.

In short, the impact of reduction of energy subsidies via upward energy price adjustment is deferent in short, mid-, and long-term on energy demand and economic growth. In long run theses effects are more.

5.2 Inflation

Avoiding estimating a spurious regression, all the variables which is specified in equation (8) has been tested for acceptng/ rejecting the unit root hypothesis. To this end, DF or ADF tests have been applied. Wherever structural changes are seen in the time series, it has been tested by using a

$$cpi_t = \varphi(M_t, XR_t, P_t) \qquad (7)$$

where cpi_t is consumer price index, M_t is the amount of liquidity, and XR_t is the market exchange rate. The following equation is suggested to capture the behavior of the cpi :

$$Lcpi_t = \eta_0 + \eta_1 LM_t + \eta_2 LXR_t + \eta_3 LP_t + \theta_t \qquad (8)$$

where L denotes natural logarithm operator.

Therefor the system of equations that we would estimate contains equation (3), (6), and (8) as follows:

$$\begin{aligned} E_t &= \beta_0 + \beta_1 y_t + \beta_2 (P_t / cpi_t) + \beta_3 E_{t-1} + \varepsilon_t \\ y_t &= \lambda_0 + \lambda_1 E_t + \lambda_2 k_t + \lambda_3 X_t + \lambda_4 y_{t-1} + e_t \qquad (9) \\ Lcpi_t &= \eta_0 + \eta_1 LM_t + \eta_2 LXR_t + \eta_3 LP_t + \theta_t \end{aligned}$$

where the first two equations i.e. (3) and (6) are a system of simultaneous-equations, where as the first and the last one i.e. (3) and (8) are a system of recursive-equations. Therefor one should just consider the following system of simultaneous-equations and the equation (8):

$$\begin{aligned} E_t &= \beta_0 + \beta_1 y_t + \beta_2 p_t + \beta_3 E_{t-1} + \varepsilon_t \\ y_t &= \lambda_0 + \lambda_1 E_t + \lambda_2 k_t + \lambda_3 X_t \qquad (10) \\ &+ \lambda_4 y_{t-1} + e_t \end{aligned}$$

It should be noted that although $p_t = P_t / cpi$ is an endogenous variable in the system (9), it is considered as a predetermined variable in the system (10). This simple postulate makes our further calculations very easier.

The system of simultaneous-equation (10) is identifiable and passes both rank and order conditions. In the next section all the statistical matters of the model is discussed.

4. EMPIRICAL RESULTS

In this section, first, an estimation result of the system of simultaneous equation (10) is discussed in sub-section 5.1; then, an estimation result of the inflation equation (8) is analyzed in sub-section 5.2. The Iranian economy faced with Islamic revolution (1978-79), imposed war (1980-1988), reconstruction, and liberalization (1988-1998) that caused some structural changes in macro-economic time series. Therefor the simple Dickey-Fuller (DF) or Augmented Dickey-Fuller (ADF) tests may spuriously conclude nonstationarity for the time series. In such cases, econometricians have proposed to apply dummy variables to distinguish unit root and structural breaks (e.g. Peron, 1989). This matter is seen in the following subsections. Policy implications of the model are also analyzed in this section.

5.1 Energy Demand and Real Production

The 2SLS estimation of the system (10) is as follows:

$$\begin{aligned} E_t &= \underset{(-0.32)}{-8.04} + \underset{(3.66)}{0.01} y_t - \underset{(-2.50)}{0.04} p_t + \underset{(10.63)}{0.80} E_{t-1} \\ \overline{R}^2 &= 0.993; \quad DW = 2.153 \\ y_t &= \underset{(3.20)}{2658.93} + \underset{(7.01)}{9.09} E_t + \underset{(4.00)}{1.06} k_t + \underset{(2.20)}{0.06} X_t + \underset{(1.83)}{0.22} y_{t-1} \qquad (11) \\ \overline{R}^2 &= 0.960; \quad DW = 2.028 \end{aligned}$$

Table 2. Energy Demand Elasticities

Elasticity	Energy Price	Income	Capital Formation	Export revenues
Impulse	-0.143	0.42	-	-
Mid-term	-0.163	-	0.092	0.043
Long-term	-2.368	-	1.740	0.809

Hint: Elasticities are calculated by $\varepsilon = \frac{\partial y}{\partial x} \cdot \frac{\bar{x}}{\bar{y}}$, where $\bar{x}$, and $\bar{y}$ are means.

where the t statistics are in the parenthesis. All the parameters are statisticaly reliable and the singes of the coefficients are consistent with economic theories.

Using ADF test of unit root, the residuals of both equations are integrated of order zero, I(0). Therefor each equation is cointegrated, and the traditional econometrics is applicable.

The reduced form of (11) is driven as follows:

$$\begin{aligned} E_t &= 27.504 - 0.470 p_t + 0.015 k_t + 0.001 X_t + 0.897 E_{t-1} + 0.003 y_{t-1} \\ y_t &= 2909.754 - 0.426 p_t + 1.195 k_t + 0.067 X_t + 8.154 E_{t-1} + 0.242 y_{t-1} \qquad (12) \end{aligned}$$

The final form of (11) is:

$$\begin{aligned} E_t &= 556.162 - 0.691 p_t + 0.275 k_t + 0.016 X_t \\ y_t &= 9851.57 - 8.024 p_t + 4.552 k_t + 0.256 X_t \qquad (13) \end{aligned}$$

On the base of the estimation results, - using a comparative-static analysis, one can analyze the impulse, mid-term, and long-term effects of a reduction in energy subsidies on energy demand and real production by increasing energy price in equation (11), (12), and (13).

Price of production factors, together with other market variables and current available technologies determine the level of different production factors in micro and macro level. Since technology is unchangeable in the short-term, any changes in input prices will cause a little substitution among production factors. So any drastically change in the price of inputs, including energy, may be act as a bottleneck in the process of production and ultimately will cause an economic stagflation.

When the government increases energy price for reducing subsidies, economic agents' response to this policy. The magnitude of the reaction is

non-price policies are more effective than price policies in improving energy intensity

transformation (1954), has been employed to construct the model. In the economic literature, several such models have been analyzed, including the flow and state adjustment models of Houthakker and Taylor (1970) and the model of Fisher and Keysen (1962).

Our proposed ad-hoc model contains three equations, including energy demand, real production, and inflation.

3.1 Energy Demand

a realistic examination of the role of elimination of energy subsidies via increasing energy prices in the physical energy demand, as one of the main purpose of the paper, calls for a functional form of the energy demand function that such a factor to influence physical demand independently and interactively. Aggregate desired demand for energy depends on historical real energy prices and real income or production (GDP). The general specification and as an initial hypothesis a linear from of the equation of the desired demand for energy is:

$$E_t^* = g(y_t, p_t) \cong \alpha_0 + \alpha_1 y_t + \alpha_2 p_t \qquad (1)$$

where E_t^* is the physical desired quantity demanded for energy, y_t is the real aggregate production (GDP) and p_t is the real weighted energy price ($p_t = P_t$ /cpi, which P_t is the nominal weighted energy price). Note that Equation (1) contains no technical relationship or behavioral disturbance term since it specifies only a desired relationship. The equilibrium energy consumption is unlikely to adjust fully to price and income changes within one year. The flow adjustment process can be modeled by a suitable Koyck transformation as follow:

$$E_t - E_{t-1} = \delta(E_t^* - E_{t-1}) \qquad (2)$$

where δ, such that $0<\delta\leq 1$, is known as the coefficient of adjustment and where $E_t - E_{t-1}$=change and $(E^*_t - E_{t-1})$= desired change. Substituting equation (1) in (2) and solving for E_t, and appending a disturbance term, one obtains an energy demend equation:

$$E_t = \beta_0 + \beta_1 y_t + \beta_2 p_t + \beta_3 E_{t-1} + \varepsilon_t \qquad (3)$$

where

$\beta_0 = \delta\alpha_0$, $\beta_1 = \delta\alpha_1$, $\beta_2 = \delta\alpha_2$, and $\beta_3 = (1-\delta)$.

3.2 Real Production

The impact of the policy of elimination of energy subsidies on economic growth, as one of the other purpose of the paper, can be captured by the real production function. A realistic examination of the role of energy demand in real economic growth calls for a functional form of the production function that such a factor to influence real income independently and interactively. A general functional form and as an initial hypothesis a linear specification of the real production function is specified below:

$$y_t^* = f(E_t, k_t, A) \cong \gamma_0 + \gamma_1 E_t + \gamma_2 k_t + \gamma_3 X_t$$
$$\gamma_0, \gamma_1, \gamma_2, \gamma_3 > 0 \qquad (4)$$

where y_t^* is desired level of production, k_t is the physical capital formation, A can be any vector of other related independent economic variables, such as X_t that has been introduced in the linear specification, as the export revenue in terms of US Dollar. Greater physical capital formation, energy demand, and export revenue stimulates higher real income, so $\partial y_t / \partial k_t, \partial y \ \partial E_t$ and $\partial y_t / \partial X_t > 0$.

The equilibrium real income is unlikely to adjust fully to capital formation and energy consumption changes within one year. Again the following flow adjustment process is introduced:

$$y_t - y_{t-1} = \xi(y_t^* - y_{t-1}) \qquad (5)$$

where ξ, such that $0 < \xi \leq 1$, is known as the coefficient of adjustment and where $y_t - y_{t-1}$ = actual change and $(y_t^* - y_{t-1})$ = desired change. Substituting equation (4) in (5) and solving for y_t, and appending a disturbance term, one obtains a real production function:

$$y_t = \lambda_0 + \lambda_1 E_t + \lambda_2 k_t + \lambda_3 X_t + \lambda_4 y_{t-1} + e_t \qquad (6)$$

where

$\lambda_0 = \xi\gamma_0$, $\lambda_1 = \xi\gamma_1$, $\lambda_2 = \xi\gamma_2$, $\lambda_3 = \xi\gamma_3$ and $\lambda_4 = (1-\xi)$.

3.3 Inflation

Consumer price index (cpi) is a good indicator to show inflation. Generally speaking, inflation is defined as the growth rate of cpi. The cpi mostly uses as the deflator for calculation of real prices from nominal prices as in the variable $p_t = P_t / cpi$ which P_t is the nominal weighted energy price. As we discussed earlier, directly depends on liquidity, exchange rate and energy prices. Therefor the general mathematical form of the cpi equation can be written as:

Supposing the market exchange rate as a realistic rate, total implicit energy subsidies in Iran has amounted 106.2 billions of US Dollars within 1990-1997, indicating an average of 13.3 billions of U.S. Dollars per year.

Figure 1 shows that in 1997, eectricity has got the highest share of total energy subsidies equal to 28 percent, where as gas oil and NG are in the secong and third level in this regard. The lowest share is for Jet fuel.

Figure 1. Share of implicit subsidies by Energy Carries (1997)

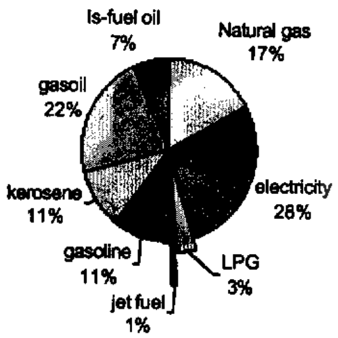


Table 1 in tha appendix indicates list of time series applied in this study. The average annual growth rates of the variales in three dfferent periods are given in the table. These periods include the whole period of the study (1974-1998), post Iran/Iraq war period[4] (1988-1998), and the period of 1993-1998 that we label it as liberalization period. These growth rates delineate an analytical description of the Iranian economy at a glance.

Average annual growth rate of energy demand was 7.3 percent for the whole period that its acceleration gradually decreased in the recent years, 7 and 5.6 percent for 1988-1998 and 1993-98 respectively. It is mainly because of evolution of the energy market in the recent years, and in part, due to upward energy price adjustments as well as lower economic growth. Despite of a rapid growth in the nominal energy price within 1993-1998 for reducing energy subsidies and reducing energy demand (a policy, which imposed by Iranian energy authority), the energy demand did not considerably decrease. The growth rate of energy demand in the same period was 5.6 percent. The quantitative impact of the energy price as well as other macro variables on energy demand isdiscussed in our proposed model in the following sections.

The economic growth has historically increased with 2.1 percent per year. It has been higher in the post-war period and liberalization period, 5.1 and 3.3 percent respectively. Activating available idle production capacity, especially in the industry sector, as weel as relatively high growth rate of capital formation and hard currency revenues has been the main reason for the high growth rate of the post-war period. The growth rates of capital formation and export revenues have been 7.0 and 1.9 percent respectiveley in that . period. The impulse, mid-term and long-term impacts of the capital formation, energy demand, and export revenues on the level of economic activity is explained by the estimated model in the following sections.

In Iran, Inflation has been influenced by numerous institutional and economic factors. The most important factors are variables like liquidity, energy price, and exchange rate as well as inflation expectations. The time series of such variables are available. There are many other factors that can not be quantified; though they have great deal of impacts on inflation rate, such as existent bottlenecks in the supply-side of the economy.

The annual growth rate of consumer price index (inflation) was 18.7 percent within 1974-1998. Where as it was 21.4 during post-war and liberalization periods respectively. The inflation rate reached to its peak level about 50 percent in 1995 (highlighted in the table 1). Meanwhile the annual growth rate of liquidity, exchange rate (Rial devaluation), and nominal energy prices were 22.3, 19.5, and 14.3 percent within 1974-1998, respectively. As can be seen these movements were on the same direction. Furthermore, in the liberalization period (1993-998) the annual growth rates of liquidity, exchange rate, and nominal energy prices were 25.3, 28.0, and 26.9 percent respectively. The movement of the above mentioned variables were coincided again. Liquidity has increased national demand together with supply side limitations, so that the economy has approached a stagflation situation. Currency devaluatin also affect inclation directly and indirectly via cost push and inflation expectations, respectively. Energy is widely used as a production factor and as a final commodity in household sector. Reduction of energy subsidies had direct impact on inflation through national cost function as well as household budget. It has indirect impact on inflation via inflation expectations. Our proposed model merely considered the direct effects of the above mentioned variables, and identify the magnitude of the effects of each one.

3. MATHEMATICAL AND THEORETICAL FRAMEWORK

The idea of the Analytical and mathematical specification of the constructed model is taken from Moroney's work (1992) with some modifications and complimentary parts. The method of so-called partial adjustment model provided by Marc Nerlove, which is a way of rationalizing the application of the Koyck

Market forces should determine price of goods and services

of energy subsidies, the subsidy is defined as a difference between domestic and international (or border) prices. So the international prices are considered as the opporunity costs of energy. We call the calculated subsidy on the base of this definition as an implicit subsidy.

Reducing energy subsidies by increasing nominal energy prices have several impacts on macroeconomic variables, such as inflation, energy demand, and economic growth.

There are some working paper on reduction of the financial loads of existent energy subsidies in developing counties that suggest opportunities for reforms (Kosmo, 1989). In the context of Iranian economy, there are some papers and research works to show the amount of subsidies paid by the government for the economic sectors and the economy as a whole (NECI, 1997 and 1999). Most of those papers give only an estimation of paid subsidies and least of them have an academic quantitative evaluation of the subject. In some of them, calculation of the amount of subsidies as well as the transparency of subsidy payments, have been discussed (e.g. Mazraati et al., 1997). Most of the studies have been confused in the effectiveness of pricing policies, due to exclusion of the role of essential non-price policies. They only suggest overall upward price adjustments, say toward border prices. However, one can find a research (Amirmoeini 1999), that has discussed about the distinguished effects of price and/of non-price based policies.

The advanced econometric works to substantiate interaction between macro variables and energy prices can be seen in some publiations (e.g. Moroney, 1992).

The organization of rest of the paper is a follows: Section 2 specifies the statistical reviews of the variables discussing in the paper. Section 3 presents the mathematical and theoretical framework of the study. Section 4 gives the empirical results of the constructed mode. Section 5 concludes the remarks.

2. STATISTICAL OVERVIEW

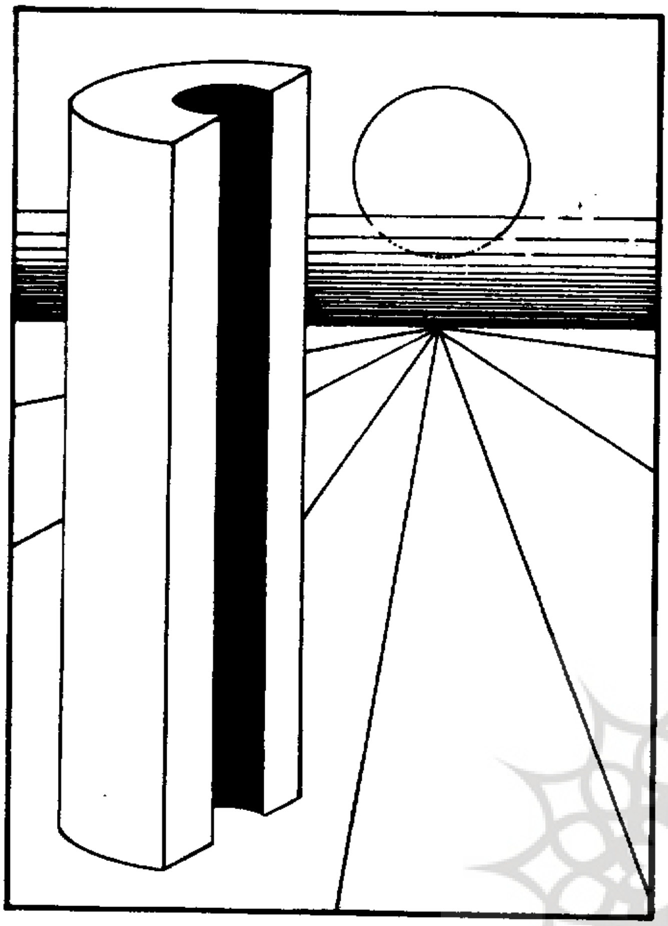
The estimation of the implicit energy subsidies in Iran on the base of teh above mentioned definition is influenced by many factors, including different exchange rates, applied approaches, and other assumptions. Therefore the calculated amounts of subsidies have had a wide range, among the different works.

Toral amount of implicit subsidy has been estimated in the range of 3.2 to 11.15 billion dollars in 1996. In that year, the amount of subsidies on petroleum products, electricity and natural gas were 7.3 , 2.5, and 1.35 billion dollars respectively for the upper case; and they were 1.15, 1.3, and 0.75 billion dollars respectively for the lower case (Payame-energy, 1997). In another research the amount of subsidy on petroleum products is estimated as 2.4 and 2.3 billion dollars for 1994 and 1995 respectively as the lower case versus 6.19 and 6.5 for the same years as the upper case (Mazraati, et. al. 1996). This research gives a sectoral estimation for implicit energy subsidy. It concludes that the amounts of paid subsidies were allocated between transportation, residential/commercial, industrial, power generation, and agricultural sectors in a descending order. In addition, the ratio of the subsidy over real GDP and government expenditure was estimated around 14.5 and 62.7 percent respectively, in 1996. Further more per capita energy subsidy was equal to 110 dollars.

Our independent estimation on implicit subsidies are based on the following assumptions:

* The Singapore FOB prices for Petroleum products are considered as the opportunity cost. It excludes the freight rates from Singapore market to the Persian Gulf. So our measuring may underestimate the subsidies for petroleum products.
* The End-Use pre-tax price of electricity in Turkey is used as opportunity cost of this carrier. This price is closed to the average price of electricity in OECD countries.
* Imported Natural Gas (NG) price in Netherlands is taken as its opportunity costs. That is committed NG price for exporting Iran's NG to Turkey 0.08 US Dollars).
* Calculation of subsidy on the base of out definition is closely dependent on exchange rates to express domestic energy prices in terms of US Dollars. Three relevant exchange rates, includng market, export, and official exchange rates have been applied in our estimations.
* The calculated energy subsidies are focused on final energy demand. Intermediate energy sectors has not been taken into account.

energy subsidies based on market, export, and official exchange rates have estimated about 15.02,. 13.64 Billions of US Dollars respectively in 1997.



Energy Subsidies, Energy Demand, Inflation, and Growth in Iran

An econometric approach[1]

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ABSTRACT

The purpose of this paper is to elaborate the impact of reducing energy subsidies on macro variables such as energy demand, economic growth, and inflation, in the context of Iranian economy. In order to substantiate the theoretical framework and structural/behavioral equations of the proposed mode, verious econometric techniques have been applied. The constructed model is able to explain impulse, mid-term effects of changes in policy variables, especially energy subsidies on economic growth and energy demand. The empirical results of this study provide insightful policy recommendation in the short and mid term for the Iranian energy authority.

JEL Code: C5, Q4
Key words: Subsidy; Energy; Demand; Growth; Inflation

1. INTRODUCTON

Government intervention in the economy not only disturbs market mechanism but also mostly makes harmful effects on some criticalvariables. In Iran, Energy subsidies due to government intervention in the energy market have had high financial loads on government budget. Reducing excess financial loads, increasing government income, promoting energy conservation and developing liberalization and privatization in the energy sector are the major goals for reduction and/or elimination of energy subsidies.

In economics, subsidy is defined as "A payment made by the government (of possibly by private individual) which forms a wedge between the price consumer pays and the costs incurred by producers, such that price is less than marginal costs" (Pearce, 1986). In Iran, government is monopolistically in charge of energy sector, and the market rules do not work to indicate market prices of energy sector, and the market rules do not work to indicate market prices of energy carriers. So using the above mentioned definition for calculation of energy subsidies is paractically impossible. In this study, in order to achieve a simple and specific definition