ESTIMATING THE DEMAND FUNCTION FOR GASOLINE AND DIESEL AND THE EFFECT OF SUBSIDY REMOVAL ON DEMAND RATE OF THESE PRODUCTS (CASE STUDY: IRAN)

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Abstract. Our aim in this study is to measure the effect of the policy of removing subsidy on the demand for gasoline and diesel, we have estimated the function of demand for the desired products using conventional econometric methods and applying Ordinary Least Square (OLS) technique and calculated price and income elasticity for them. It was determined that short-term price elasticity for gasoline and diesel was respectively -0.10 and -0.15 which was also consistent with theoretical foundations. Also, long-term price elasticity for petroleum and diesel is respectively a significant number of -0.42 and -0.49. Therefore, removal of subsides can play a role in controlling demand and reducing the growing process of their consumption.

Keywords: indirect subsidy, econometrics, ordinary least squares, price and income elasticity

1 Introduction

The present structure of production and petroleum and diesel consumption in the country is affected by political and social conditions of the past and different factors including economic structure of the country in one hand and public management in energy section in other hand to the consumers of these products regardless of income status and their role in national production. In other words, the government without achieving the goals of establishing subsidies has fueled to the inefficiency in consumption of these products by paying huge sums as subsidy to the consumers of these products. It is natural that the first step (but not the only step) of the government to rationalize the process of gasoline and diesel consumption is revision of the pricing policy of these products and as a result revising the policy of paying subsides to all consumers no matter what their situation is. However, it should be considered that discussing and commenting on the way of implementing the program of paying subsidy to the consumers is not in the field of this study and there should be an independent study in this area. In other words, here, we don't mention the conditions that recipients of subsidies should have to pay them subsidies and also mechanism of paying subsidies that need thorough investigations (Gujarati, 2003).

In this research, we have estimated the total demand for gasoline and diesel which is obtained from total demand for different parts.

Also, the important point is that in this research, the purpose of changing the amount of demand due to the policy of removing subsidies is the amount of reducing demand relating to the consumers.

Hence, in this research, we will estimate the demand model for gasoline and diesel in Iran after reviewing the studies in this field. After analyzing the estimated model, we will evaluate the reduction rate in demanding for petroleum and diesel due to the policy of removing subsidies.

2 Research Methodology

The documentary method in this research is applied to identify and collect data and statistical methods and econometric are used for analysis.

Data applied in this research is in form of time series data annually and for a period of 41 years from 1971 to 2011.

Since, in this study, we aim to measure the effect of the policy of removing subsidies on the demand for the main oil products, we will estimate the demand function for the desired product by the use of conventional econometric methods using OLS method and Eviews software and price and income elasticities will be calculated for them. Assuming other conditions to be constant, and to not change the structure of demand function of each product within the price increasing of that product, and according to the theory of demand, we will calculate the reduction rate in consumption of each product due to removing subsidies and pricing based on Persian Gulf Free On Board (FOB). The important point is that in this research, changing the amount of demand due to the policy of removing subsidies is the amount of demand reduction which is related to consumers.

3 Research literature

Theoretical basis of this research is based on microeconomics and theory of demand. Demand function in its general form shows the amount of the good that an individual will buy according to different prices of that good and his income.

Two important functions are derived from these functions,

1. Demand for each product is a function of price and income level.

2. The demand functions are homogeneous from zero degree with respect to price and income. This means that if all prices and income change to a same amount, there will be no change in the amount of demand.

In economic texts, other variables have been considered as factors affecting determination of demand level of consumer.

Usually, 4 important factors are named in this regard:

1. Price of the studied good as the most important determinant factor

2. The consumer's money income

3. Consumer tastes

4. Price of alternative and complementary goods

This can be written as follows:

$$Qx= f (Px,Y,Pc,Pz,T,\dots) \quad (1)$$

In which, Qx is the demand rate for the good x, Px is the price of good, y is money income, Pc is the substitute good price, Pz is the complimentary good price and T tastes and preferences.

The demand law says that assuming other conditions to be constant, if the price of a good increases, its' demand rate will be reduced. This means that except in extreme cases (Giffen good), if individual consumers want to maximize their satisfaction according to their limited money income, their individual demand and the price of good will move in the opposite direction. In other words, we will have:

3.1 Price elasticity of demand

It is defined as a relative sensitivity of the rate of demand towards changes in price. Price elasticity of demand is calculated by the following equation:

$$Exx=\partial(\ln X)/\partial(LNPx)=\partial X/\partial Px \times Px/X \quad (2)$$

* If the demand curve is descending, numerical value of this elasticity will be negative.

3.2 Income Elasticity of Demand

It is defined as the relative sensitivity of the rate of demand towards changes in income. Income elasticity of demand is calculated via below equation:

$$Exy=\partial(\ln X)/\partial(\ln Y)=\partial X/\partial Y \times Y/X \quad (3)$$

* If the good is normal, the demand for good is increased by increasing income.

Therefore, since our aim in this review is to measure the effect of the policy of removing subsidies on gasoline and diesel demand, we can see the effect of removing subsidy (pricing based on Persian gulf FOB instead of subsidized price) on demand for these products by estimating the demand function and determining the price elasticity.

4 Definitions and Concepts of subsidy

In dictionaries, subsidy or subside (in French) is mostly defined as free help and government financial donations to people from time to time and include:

A kind of government support from a certain stratum of society (or sometimes the entire community) in certain time periods or emergency in order to provide social welfare through reducing the costs.

There are also other definitions for subsidy in the following:

Subsidy is "direct or indirect payment of government, economic privilege or grant especial preference which is given to private institutions, households or other governmental departments in order to achieve the government desired goals.

Subsidy: it is a payment by the government (or by private persons) which creates a gap between the price that the customer pays and expenses that manufacturer will be incurred.

Subsidy: a transition from taxpayers to manufacturers or consumers of a particular good in order to influence on the behavior of suppliers through the mechanism of supply elasticity or demand elasticity in order to keep fix or low the price of certain goods.

Direct subsidy: it is the amount of costs that government pay directly to protect the interests of society for using the goods.

Indirect subsidy: it is a part of state aid which offers a good to the consumer with lower price than its' finishes expenses. The paying subsidy to gasoline and diesel is classified in this category.

4.1 Existing views on subsidies for oil products and our view in this research

A view that seems to be traditional-popular and usually has been discussed in the society is that Iran due to having rich oil reserves and these resources belong to all people of Iran, thus, the full payment of the cost of consuming products such as non-oil countries is not necessary.

The second view existing among the experts of the country in favor of the policy of paying subsidy to energy, especially oil products is according that Iran has oil reserves and resources and is an oil exporter, hence, the existence of these resources should be an advantage for the country domestic production which should be competitive using the advantage of cheap energy with similar foreign products which use expensive energy. Regarding the second view, it should be noted that although in the theory, such an advantage can be imaginable for competitiveness of locally manufactured goods with similar foreign goods; but having a look at the consuming structure of these products in Iran which more than 60% of these products are consumed in services parts, thus they have no role in production. About the rest, also due to lack of an efficient use of energy in our economic manufacturing section, energy consumption is non-working. On the other hand, lack of attention to the energy consumption in locally manufactured goods has also taken the possibility of exporting these goods from the domestic industry. For example, many of domestically produced cars would not be exportable to many parts of the world due to high gasoline consumption. The third view is that the lack of appropriate pricing of oil products and stabilization of their prices so that the real price of these products has been decreased sharply has led to unreasonable consumption of these products and if the growth of current consumption continues, Iran would be a net importer of oil for its domestic consumption in a very near future. Therefore, it is necessary to determine the price of these products synchronized with the international price and taken from consumers.

In this case, both the consumption of these products will be saving and growing demand will be controlled and also the efficiency of production system, especially industrial products will be increased by correcting the relative prices. The other hand, financial problems of Iranian Oil Company will be resolved and required resources will be supplied to invest in energy section. In short, these experts believe that subsidy of oil products should be completely removed and the economy will adapt to the new situation in long term.

4.2 The results of some estimated models about the price and income elasticities

As the following table 1, indicates, the short-term price elasticity calculated for motor gasoline demand is between -0.0048 and 0.39 in numerous studies. In these studies, long-term price elasticity of gasoline was between -0.033 to 1.15. In investigations, the rate of long-term price elasticity has been increased by getting closer to the present time. The range of changes for short-term income elasticity has been from 0.18 to 0.725 and between 0.56 and 1.89 for long-term income elasticity.

Table 1. The short-term price elasticity calculated for motor gasoline demand

	short-term price elasticity	**long-term price elasticity**	**short-term income elasticity**	**long-term income elasticity**
Plan and Budget Organization model	-0.38	-	0.72	-
Model of Mohammad Amin Kianian 38-57	-0.004	-0.032	0.23	0.91
Model of Mhammad Amin Kianian 39-68	-0.25	-0.59	0.24	0.56
Model of Salehi Esfahani (2009)	-0.07	-0.55	0.18	1.38
Model of Ali Arabmazar Yazdi	-0.18	-1.15	0.30	1.89
Model of Abbas Karimzadeh	-	-	0.31	0.75
Model of Mohammad Ali HAjimirzaei	-0.39	-	0.19	-

Below table 2 has provided the calculation of price and income elasticities of demand for gas oil, derived from studies done in the past. The table indicates that the change range of short-term price elasticity of these products is between -0.04 and 0.63. This

range for its' long-term price elasticity is from -0.2 to -0.59 which shows the low elasticity of these products in long-term and short-term towards the price. Short-term income elasticities show the figures between 0.17 and 2.78 and the figures between 0.15 and 6.6 for long-term.

Table 2. change range of short-term price elasticity of these products is between -0.04 and 0.63

	Short-term price elasticity	Long-term price elasticity	Short-term income elasticity	Long-term income elasticity
Model of Plan and Budget Organization	-0.16	-	0.79	-
Model of Mohammad Amin Kianian 38-57	-0.04	-0.59	0.17	2.34
Model of Mohammad Amin Kianian 39-68	-0.63	-0.21	0.44	0.15
Model of Salehi Efahani (2009)	-0.29	-0.54	0.48	0.49
Model of Ali Arab Mazar Yazdi	-0.24	-.058	0.39	0.95
Model of Abbas Karimzadeh	-	-	2.7	6.6
Model of Mohammad Ali Haji Mirzaei	-0.35	-	0.35	-

5 Demand model for gasoline and diesel and evaluate the effect of removing subsidies on demand value of these products

Given that removing subsidy of gasoline and diesel means to increase selling price of these products and since these products are known as normal goods, thus, we expect that the demand for these products face reduction by increasing the price of these products considering other factors constant; the reduction rate of demand in short-term depends on the size of price elasticity of these products (Pin Dyck, 1997).

If the good is normal, its' demand curve will be descending. Hence, the numerical value of price elasticity of demand for that good also should be negative. Given that our reviewing goods which means petroleum and diesel are normal goods, so we expect that their demand rate is reduced by increasing their price.

In this section, we will introduce the model and its' variables. The model applied in this research is in form of full two-way logarithm (log-log).

The overall shape for each of these products is as below. It can be found from the shape of model that this model has many similarities with fitted model.

$$\text{Log qijt} = \alpha \text{ ij} + \beta 1 \text{ Logyijt} + \beta 2 \text{ Log Pijt} + \beta 3 \text{ Log qijt-1} + \varepsilon \quad (4)$$

In which,

q: represents the use of each of these products in the country at t time. y: is gross domestic product. P: indicates the real price of the desired product. The real price of each product is obtained from dividing its' nominal price on the retail price index (cpi). qt-1: it shows the consumption of desired product in last year. This is entered into the model in order to convert the model to a dynamic model and considering the variables which have not been considered.

According to enter this variable (delayed dependent variable) in the model, our model can be classified with partial adjustment models.

In these models it is assumed that the effect of changes in independent variables is not reflected on dependent variables in real time, but also this is done with delay. One of characteristics of this model is that Durbin-Watson index (D.W) in these models tends to number 2 unrealistically and as a result, it makes it difficult to judge about presence or absence of autocorrelation. So, h-statistic is used to judge about the presence of autocorrelation which is calculated as follows:

$$h = (1-1/2\ d)\sqrt{n/1-n\ [\text{var}\ \beta 3]} \quad (5)$$

In this formula, d is statistic of Durbin-Watson and n is the number of observations. If the calculated h is in the range of $-1.96<h<1.96$, the autocorrelation assumption can be excluded.

In econometric studies, we should consider our expectations about the values and symbols of estimated parameters based on theoretical foundations.

According to theoretical foundations, it is expected that the sign β1 (income elasticity) be positive for each of these parameters. It is also expected that the sign β2 (price elasticity) occur with negative signs for them. About β3, since this coefficient can reflect the effect of consumption habits of consumers, it is expected to occur with positive sign.

Considering that in complete logarithmic models, coefficients represent elasticities, β1 and β2 coefficients indicate short-term income and price elasticities.

Data

The data used in this research for estimating demand function for the oil main products is from the type of time series and related to the years 1966-2006.

In this section, referring to our desired model, we will evaluate each of variables, the way of their calculation and the source which has been referred to for each data. Some variables have been considered which have been better descriptors for changes of demand value of petroleum and diesel in previous studies. We pointed out that our model is as follows:

$$\text{Log qijt} = \alpha \text{ ij} + \beta 1 \text{ Logyijt} + \beta 2 \text{ Log Pijt} + \beta 3 \text{ Log qijt-1} + \varepsilon \quad (6)$$

In which, q is the indicator of the product per capita consumption. For each product per capita consumption, we have used q instead of benq for gasoline and gasoq for diesel. Statistics of consuming these products have been extracted from available statistics of National Iranian Oil Company (2009) Consolidated Plan Management for the years 1966-2006. Also, consumption of these products are based on million liters per year (figure 1, 2, and 3).

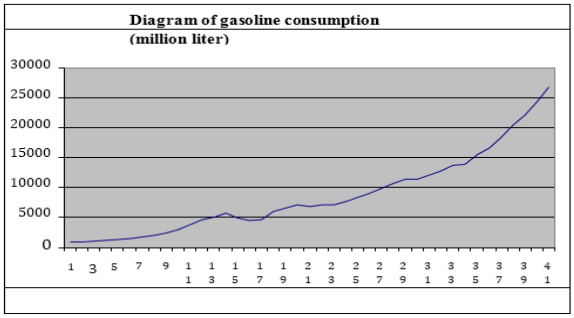

Figure 1. Diagram of gasoline consumption for the period 50 to 90 years (based on million liter).
Source: National Iranian Oil Company Consolidated Planning management

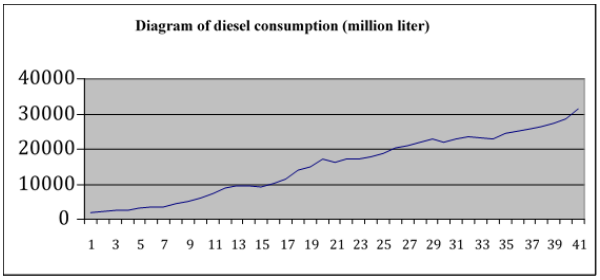

Figure 2. Diagram of diesel for the period 1970 to 2010 (based on million liter)
Source: National Iranian Oil Company Consolidated Planning Management

Also, we have used gdp capita instead of income y representing GDP per capita at constant price in 1997. These information are extracted from time series statistical collection of economic statistics of Central Bank.

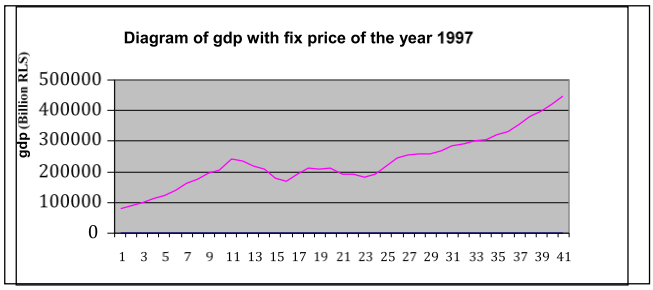

Figure 3. Diagram of GDP for the period 1970 to 2010 (in billion RLS)
Source: Central Bank

Figures (4, 5, and 6) related to qt-1 which in our model is benq1 for gasoline and gasoq1 for gas oil, are obtained according to the statistics of consumption with a one-year delay.

For the real price of each product, the nominal division of each product on the index of total price of the good and consuming services in urban areas has also been used (consumer price index). The data source is related to the nominal price of petroleum main products of Iranian Oil Company Consolidated Planning Management.

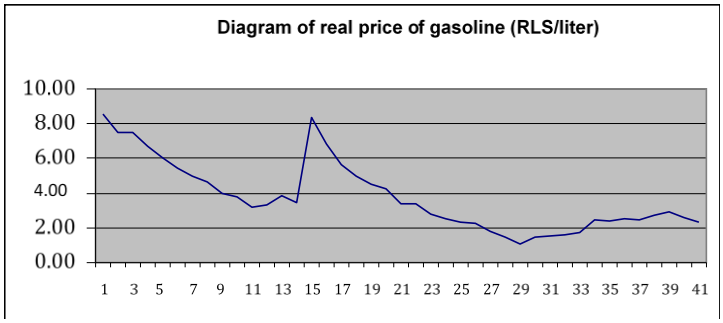

Figure 4. Diagram of the real price of petroleum for the period 1970 to 2010 (per RLS/liter)
Source: National Iranian Oil Company Consolidated Planning management

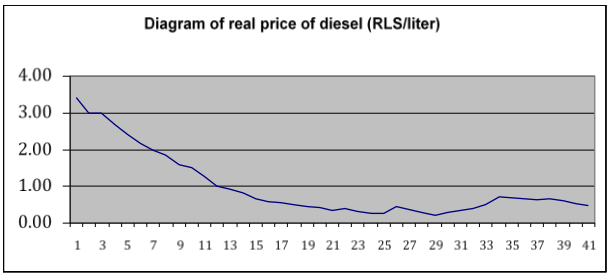

Figure 5. Diagram of diesel real price for the period between 1970 and 2010 (per RLS/liter)
Source: National Iranian Oil Company Consolidated Planning management

Thus, total figure of demand function of each of main oil products will be as following:

5.1 Demand function of petroleum

$$Lbenq = \alpha + \beta 1\ lgdp + \beta\ 2\ lbenp + \beta\ 3\ lbenq1 \quad (7)$$

In which,

L indicates the related variable logarithm. Benq: gasoline per capita consumption. gdp: Gross Domestic Product in constant prices of 1997. Benq1: per capita consumption of gasoline with a delay. Benp: real price of gasoline.

5.2 Demand function of diesel

$$Lgasoq = \alpha + \beta 1\ lgdp + \beta\ 2\ lgasop + \beta\ 3\ lgasoq1 \quad (8)$$

In which,

L: indicates related variable logarithm. gdp: GDP per capita in constant prices in 1997 Gasoq: per capita consumption of gas oil. Gasoq1: per capita consumption of gas oil with a delay. Gasop: real price of gas oil

5.3 Results of model estimation

In this part of study, we will evaluate the results of model estimation in demand for each of these products. Estimation of each of demand function based on ordinary least squares (OLS) method. These estimations are done using Eviews software. The estimation results for each of desired products are given below separately.

5.3.1 Estimation results of gasoline demand function

According to the available figures, the gasoline demand function has been fitted as follows:

$$Lbenq = 1.7282 + 0.3328\ lgdp + 0.7545\ lbenq1 - 0.1052\ lbenp - 0.9701ma(1) \quad (9)$$
$$D.W=2.26 \qquad R2=0.9842 \qquad h=1.15$$

Model interpretation:

As we can see, the t-statistic is significant for all explanatory variables at one percent of confidence level. R2 is also higher than 0.98. Durbin-Watson (D.W) statistic is close to 2, but since the model has time delay, it cannot be invoked due to the lack of autocorrelation. Hence, h-statistic should be applied. h-statistic for this model is equal to 1.15 and is indicative of lack of autocorrelation in the model due to being in the distance of $-1.96<h<1.96$.

* The numbers in parentheses are also indicator of standard deviation

* In the above model, short-term income elasticity is equal to 0.33 and price elasticity is also equal to -0.10 which will be discussed more in next sections.

* We have used bellow relations to calculate long-term price and income elasticities:

Coefficient of desired product with delay -1/ price coefficient of each product-long-term price elasticity

Coefficient of desired product with delay -1/ coefficient lgdp-long-term income elasticity

* We used the mentioned relations to calculate long-term price and income elasticities. Below table 3 indicates short-term and long-term income and price elasticities for gasoline:

Table 3. Short-term and long-term income and price elasticities of gasoline

Product name	Short-term price elasticity	Short-term income elasticity	Long-term price elasticity	Long-term income elasticity
gasoline	-0.1052	0.3328	-0.4285	1.09

Source: research findings

As is shown in above table 3, long-term income and price elasticities in this product is more than income and price elasticities of the product under the discussion. The long-term price elasticity of demand for gasoline is -0.42 which is a significant figure. The calculated income elasticity in long-term for demanding this product is about 1.09 which implies luxury of this product in economy of Iran.

* The model was under the following tests to evaluate the classic assumptions

1. We applied White test in order to detect heteroskedasticity and the assumption H0 based on homogeneity of variances was rejected. So, we used Eviews software to remove this problem and clicking heteroskedasticity.

2. We used Lagrange Multiplier (LM) test to detect autocorrelation and Moving Average cubic MA (3) was used to remove autocorrelation.

3. We used Dickey Fuller test to detect stability of explanatory variables of the model and found that these variables were stable with one time differencing and integration of all of them was

from first order or I(1). After Dickey Fuller test on the residues, we found that the integration was zero-order I(0).

* In this equation diesel is considered as the nearest substitute for gasoline and that is why the price of diesel has been entered into the model. But, it was observed in investigations that according to the figures available, gasoline and diesel cannot be replaced with each other. Hence, we removed the price of gas oil from the model.

5.3.2 Estimation results of diesel demand function

According to available figures, gas oil demand function is obtained as follows:

$$Lgasoq = 1.2952 + 0.3227\ lgdp + 0.6956\ lgasoq1 - 0.1505\ lgasop \quad (10)$$

D.W=2.12 R2=0.97 h=-0.42

- Model interpretation

According to the results obtained, t-statistic has almost significant reliability for all explanatory variables. R2 of the reviewing model is equal to 0.97. Durbin-Watson statistic for this equation is approximately equal to 2 but is not reliable, because delayed depended variable is used in the model. h-statistic for this model is equal to -0.42 and is indicative of lack of correlation in this regression because of being located between the distance of -1.96 and +1.96.

* In the above model, short-term income elasticity is equal to 0.32 and price elasticity is also equal to -0.15.

* The numbers in parentheses are indicator of standard deviation.

* We used the mentioned relations to calculate long-term price and income prices; the following table 4 indicates short-term and long-term income and price elasticities of diesel.

Table 4. Short-term and long-term income and price elasticities for diesel

Product name	Short-term price elasticity	Short-term income elasticity	Long-term price elasticity	Long-term income elasticity
Diesel	-0.1505	0.3227	-0.4944	1.06

Source: research findings

As can be seen in the above table, long-term income and price elasticities about this product is more than its' long-term income and price elasticities. Long-term price elasticity of diesel demand is -0.49 which is a significant figure. The calculated long-term income elasticity for demand of this product is about 1.06 which implies the luxury of this product in Iran economy.

The model was under below tests to review the classic assumptions:

1. White test was used in order to detect heteroskedasticity and the assumption H0 was approved based on consistency of variances.

2. The LM test was used to detect the autocorrelation and the assumption H0 was approved based on the lack of autocorrelation.

3. Dickey-Fuller test was used to detect stability of explanatory variables and concluded that these variables with one differencing which means that they were all integrated from the first order I(0). After Dickey-fuller test on residues, we found that the integration is from zero-order I(0).

* It is expected that petroleum be the nearest substitute for gas oil due to the more use of gas oil in transportation; but, since replacing gasoline with gas oil requires some changes in cars' system, this substitution cannot be done due to technical and economic limitations. Thus, the substitute variable in this demand equation is not intended.

6 Evaluate the effect of removing subsidies on demand for gasoline and diesel

Since in complete logarithmic models, coefficients indicate elasticity; therefore, in above models coefficients of lbenp and lgasop are indicative of price elasticities of demand.

Since the price elasticity indicates the percentage rate of change in demand rate of a good per one percent change in prices and also, removing subsidies of petroleum and diesel means to increase its' selling price. Hence, price elasticity of above models indicates that consumption rate of gasoline and diesel is with complete low elasticity compared with its' price. In other words, if the price of gasoline increases for one percent, its' demand value will be reduced in short-term only for 0.10 percent. But, it will be a significant value in long-term and will be equal to -0.42. But in long-term it will be significant and equal to -0.49.

7 Conclusion

In this research, since our goal was to evaluate the effect of the policy of removing subsidy on demand value of oil main products, we estimated the demand function for desired products by the use of econometric methods via OLS method and the use of Eviews software and price and income elasticity's were calculated for them. It was found that short-term price elasticity for gasoline and diesel were respectively equal to -0.10 and -0.15 and long-term price elasticity for them were respectively significant figures of -0.42 and -0.49. Then, assuming other conditions to be constant and in process of price increase of each product, the structure of its' demand function will not change. We calculated the reduction rate in consumption of each product due to removing subsidy and pricing based on Persian gulf FOB according to demand theory. It was clear that a significant value of consuming these products will be reduced by implementing this policy and thus greater financial resources will also be achieved. In addition to reduce the damaging environmental effect and so on, obtained resources can be spent on infrastructural investments and increasing development activities.

In fact, the lack of appropriate pricing of oil products and fixing their prices so that the real price of these products has been decreased sharply has led to unreasonable consumption of these products. If growth of current consumption continues, in a very near future, Iran would be a net importer of these products for domestic consumption and enormous amount of money would be spent on paying subsidy to these products. Hence, it is recommended to determine the price of these products synchronized with their international price and be taken from consumers. As a result, changing the price in order to make efficient the consumption of these product is essential in Iran despite many political and economic obstacles. In this case, both the consumption of these products will be saving and also the demand growth will be controlled. Efficiency of production system especially industrial production will be increased by correcting the relative prices and economy will also be adapted with new situation in long-term.

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