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Analyzing the Effects of the Iranian Energy Subsidy Reform Plan on Short-Run Marginal Generation Cost of Electricity Using Extended Input-Output Price Model

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ABSTRACT: Subsidizing energy in Iran has imposed high costs on country's economy. Thus revising energy prices, on the basis of a subsidy reform plan, is a vital remedy to boost up the economy. While the direct consequence of cutting subsidies on electricity generation costs can be determined in a simple way, identifying indirect effects, which reflect higher costs for input factors such as labor, is a challenging problem. In this paper, variables such as compensation of employees and private consumption are endogenized by using extended Input-Output (I-O) price model to evaluate direct and indirect effects of electricity and fuel prices increase on economic subsectors. The determination of the short-run marginal generation cost of electricity using I-O technique with taken into account the Iranian targeted subsidy plan's influences is the main goal of this paper. Marginal cost of electricity, in various scenarios of price adjustment of energy, is estimated for three conventional categories of thermal power plants. Our results show that the raising the price of energy leads to an increase in the electricity production costs. Accordingly, the production costs will be higher than 1000 Rials per kWh until 2014 as predicted in the beginning of the reform plan by electricity suppliers.

Keywords: Subsidy reform plan; Short-run marginal cost of electricity; Extended input-output model
JEL Classifications: C67; D57

1. Introduction

Nowadays subsidy payment on electrical energy must be managed to prevent any side effects particularly in developing countries (Dashti and Afsharnia, 2010). For instance, results of the study conducted by Lam (2004) indicate that electricity prices in China were highly subsidized and below the average total cost of generation and transmission. Similarly, electricity tariffs in Iran are below the average costs of generation due to assigned subsidies. Therefore, reconsideration of resource allocation necessitates the increase of the energy prices which in turn highly influences economic sectors, government budget, inflation, income distribution and social welfare. "These effects would take time (two to three years) to filter through the economy, with the consumers noticing initially the effect of the change in energy goods that they purchase (such as electricity). The initial impact and first round effects on the final prices are together known as the "direct" effect "(World Bank, 2003). However, direct effects are only one part of the consequences of the subsidy reform plan and there would also be "indirect" effects. The evaluation of direct and indirect consequences of price changes is a very complicated process because it requires studying the interaction effects of economic sectors.

An Input-Output table (I-O table) is a useful tool for analyzing such issues. In the extended input-output price model used in this research, some demand and supply components of an input-output table, such as private consumption and compensation of employees (salaries and wages), which are considered exogenous, are assumed to be variable (Bazzazan and Batley, 2003; Banouei, 1999). Therefore, using an extended price model, in which the interactions between economic sectors are included in the form of an algebraic matrix, direct and indirect effects of increases in electricity and fuel prices on different economic subsectors can be calculated. Hence, these effects of energy price rises would lead to the increase of the production costs of different commodities including electricity.

In other words, price increase of energy carriers influences their production costs. In the case of electricity, increasing fuel price results in increased fuel costs, chemical and non-chemical products price index and also labor costs, which consequently causes increased costs in power generation? Moreover, cost escalation leads to the increase of the marginal cost of each kWh of electricity. Thus, this research is aimed at predicting the direct and indirect effects of executing the subsidy reform policy based on indigenization of wages using the extended input-output price model and estimation of short-run marginal cost[1] of electricity in different probable adjustment scenarios, respect to conventional plants.

There have been broad categories of techniques, for instance Computable General Equilibrium models (CGE) and Input-output tables, which address how to evaluate the effects of price increases of oil products and electricity on macro economic variables. Survey of CGE model can be found in Uri and Boyd (1997), Clements et al. (2003), Bopp and Lady (1982). In the study conducted by Clements (2003), the influence of higher petroleum prices in Indonesia on different variables including aggregate price level, real growth and income distribution was considered in the form of a multi-sector CGE model. The results of this study imply that the short-term consequence of decreasing subsidies on oil products culminates in the rise of price levels and decrease of private consumption. However, another approach to estimate the effects of energy price adjustment is the input-output method, which introduced in 1951 by Leontief (1951). Input-output price model has been used by many people in various developing and developed countries. Jacobsen (2009) and Moradkhani (2010), investigated the influence of changing the energy prices on the prices of other commodities and household expenditures and also production costs in different subsectors of Malaysia.

On the other hand, many studies evaluated the effects of energy carriers’ price increase in Iran. Asadi Mehmandoosti (2009), Shahmoradi (2010), Abbasinezhad (2006), World Bank experts (2003) and Fetini (1999) evaluated the inflationary effects that resulted by omitting energy subsidies using an input-output model. The same technique was used in the analysis by Sharifi et al. (2009). In this study gradual increases of energy carriers’ prices to the level of border prices in three scenarios were considered. The results show that increasing the prices of energy affects the production costs in all sectors; this effect is higher in non-metal mineral products, forestry and oil products industries while the electricity price increase has dominant role in price inflation.

Although a large number of researches have been conducted on the evaluation of inflationary effects of energy price growth on non-energy subsectors, living costs and other variables, increasing the production cost of electricity and fuel products caused by the subsidy reform plan has rarely been considered. Therefore, in this paper, we present subsidy reform plan effects on electricity production costs, considering all direct and non- direct parameters.

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[1] The short-run marginal cost is the change in total cost resulting from a one-unit increase (or decrease) in the output of an existing production facility. “The short run” indicates that adjustments in the capital stock (the collection of power plants) are being ignored. Adjustments in the output of existing plants are being considered. In the short-run marginal cost, only variable costs are included (e.g. fuel costs, variable operating and maintenance costs, etc.). “The long run” indicates that adjustments in the capital stock are not only being considered but are assumed to have come to completion. The long-run marginal cost includes fixed costs, investment costs and operating costs. The marginal costs, defined in the MIT Dictionary of Modern Economics (1992), are “the extra cost of producing an extra unit of output”(International Energy Agency, Organization for Economic Co-operation and Development, 2005)

2. Data Description

In this study, one of the most recent input-output table of Iran, which was developed by the Ministry of Energy in 2006 is employed. This table is composed of 51- sectors and energy sector is divided to 7 sub-sectors according to such energy carries as Gasoline, kerosene, Gas oil, Fuel Oil, LPG, Electricity and Natural gas. Thus, 2006, when the table was provided, is considered as the base year in this work. In addition, energy prices for years 2010 and 2011, which are the first and second years of the Iranian targeted subsidy plan execution, was specified by the targeting Subsidies Organization and are represented in Table 1.

Table 1.Nominal Prices of Energy Carriers Before, During and After Plan Execution

	Gasoline (Rls/litre)	Kerosene (Rls/litre)	Gas oil (Rls/litre)	Fuel Oil (Rls/litre)	LPG (Rls/litre)	Electricity (Rls/kWh)	Natural gas (Rls/m^3)
2009*	1000	165	165	94.5	31.00	181.80	107.82
2010**	3400	1000	1500	2000	1000	430	731
2011**	4960	1000	1500	2000	1000	430	1200
2014***	10000	6025.5	5985	4490.1	6025.5	1000	2400

*: Before plan execution

**: During plan execution

***: Target prices

Source: Tavanir Company, own compilation

Moreover, according to the five-year economic development plan, 2014 is considered as the last year of plan execution and thereby, is chosen as the target year. So, the prices of energy carriers in 2014 have to be determined based on the subsidy reform policy to use in input-output model[2]. The suggested prices for gasoline, electricity, gas and other fuels in 2014 described in Table 1. Additionally, the prices of 2009 (the last year before plan execution) are presented in the table as a comparison to the other prices.

To develop appropriate scenarios for evaluating the effect of price increases in energy on the production costs of other economic sectors, two alternative adjustment paths is presented to lead domestic energy prices to the target prices. The scenarios spread the adjustment over five years. It must be noted that gradual price increase of carriers with a high growth at the beginning of the period (FL[3]) is probable and therefore, the following two scenarios are considered for the price rises until the end of 2014:

1. Scenario of gradual price increase with a high growth at the beginning of the period, by closing the gap by 40, 40 and 20 percent successively each year over the period 2011-2014.
2. Scenario of gradual price increase with a high growth at the beginning of the period, by closing the gap by 50, 25 and 25 percent successively each year over the period 2011-2014.

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[2] According to the policy, by the end of the plan, domestic prices of oil derivatives has to be not less than 90% of the prices in the Persian Gulf market (f.o.b). For instance, there are three gasoline prices in Iran. 1000 Rls/litre, 4000 Rls/litre for consumption beyond 60 liters/month and 7000 Rls/litre for consumption beyond the quota, except for public service cars which receive a higher quota. Weighted average price of gasoline in 2010 and 2011 has been determined based on these three types of prices and the average instance traversed by automobiles (Wikipedia)
For 2014, we assume the price of gasoline will reach 10000 Rls/litre by consulting with the experts of Iran National Oil Products Distribution Company. On the other hand, domestic price of natural gas has to be 75% of the average export price for the general population; 65% of the average export price for petrochemical companies for 10 years. Also electricity prices should be equal to production costs. We assume 2400 Rls/m^3 and 1000 Rls/kWh for natural gas and electricity prices, respectively. These prices are obtained after asking the expert's advise of Iranian National Oil and Gas Company and the Ministry of Energy.

[3] Forward Load

3. Theoretical Framework

This study uses the input- output table technique. Details about this method can be found in Valadkhani and William (2001), Miller and Blair (1985), Bazzazan (2003) and Banouei (1999) and is described as follows.

3.1. The Leontief Price Model

In input-output tables and in case of perfect competition for each industry, the price of each unit of output produced by the jth sector can be written as (Valadkhani and William, 2001; Miller and Blair, 1985):

$$P_j = \sum a_{ij} P_i + v_j \tag{1}$$

Where:

a_{ij} : technical input coefficient

v_j : the ratio of value added at market prices to output in the jth sector (v_j / X_j)

p_i : the price index for the ith sector (i = 1, 2,…, n)

Equation (1) can be transformed to matrix notation as:

$$P = A^{'} . P + v \tag{2}$$

And the following IO price system is obtained by re- arranging the above equation:

$$P = (I - A^{'})^{-1} . v \tag{3}$$

equation (3) is called Leontief price model. It should be noted that using the input-output table of the base year, the multiplication of (n x n) square Leontief Inverse Matrix $(\mathbf{I} - \mathbf{A}')^{-1}$ with the (n x 1) column vector of v gives the price column vector which all of its elements equals to one.

In an input-output table, if production sectors are classified in two groups of energy sectors and non-energy sectors, matrix equation (2) can be rewritten as (Bazzazan, 2003):

$$\begin{bmatrix} P_e \\ P_n \end{bmatrix} = \begin{bmatrix} A^{'}_{ee} & A^{'}_{en} \\ A^{'}_{ne} & A^{'}_{nn} \end{bmatrix} \times \begin{bmatrix} P_e \\ P_n \end{bmatrix} + \begin{bmatrix} V_e \\ V_n \end{bmatrix} \tag{4}$$

Where:

P_e :the vector of prices for energy sectors,

P_n : the vector of prices for non-energy sectors

$A^{'}_{ee}$: the transpose of a square matrix of inputs of energy sectors to energy outputs

$A^{'}_{en}$: the transpose of a matrix of inputs of non-energy sectors to energy output

$A^{'}_{ne}$: the transpose of a matrix of inputs of energy sectors to non-energy outputs

$A^{'}_{nn}$: the transpose of a square matrix of inputs of non-energy sectors to non-energy outputs

v_e : the vector of value added per unit for energy sectors

v_n : the vector of value added per unit for non-energy sectors

This system of equations can be rewritten as:

$$P_e = A^{'}_{ee} . P_e + A^{'}_{en} . P_n + v_e \tag{5}$$

$$P_n = A^{'}_{ne} . P_e + A^{'}_{nn} . P_n + \mathbf{v_n} \tag{6}$$

However, since energy prices are determined by the government, P_e is considered to be exogenous in calculations. Thus, the prices of non-energy products are calculated using only equation (6). Solving this equation based on P_n yields:

$$P_n = \left(I - A^{'}_{nn}\right)^{-1} . A^{'}_{ne} . P_e + \left(I - A^{'}_{nn}\right)^{-1} . v_n \tag{7}$$

Equation (7) gives the values of $\mathbf{P_n}$ provided that coefficients $\mathbf{P_e}$ and $\mathbf{v_n}$ are exogenous.

3.2. Extended Input–Output Price Model

Based on the equations presented in the price model, price rise of energy can lead to the growth of production costs in production sectors. Therefore, household expenditures will increase and labor forces will demand higher wages. In the next stage, escalation of wages will lead to the growth of production costs and the prices of different products. Thus, to evaluate the effects of increasing wages as a consequence of price alteration of energy carriers, equations belonging to household income have to be modeled endogenously. Consequently, according to the extended input-output price model, some components of demand and supply of the economy, such as private consumption, compensation of employees, etc., which was exogenous, assumed as endogenous variables. Therefore, endogenizing the wage, one row and one column have to be added to the technical input coefficients matrix. To this end, labor compensation row and private consumption column are used (Bazzazan and Batley, 2003; Banouei, 1999).

In the new form of matrix, price vector, shown by $\bar{P}$, contains (n+1) elements, which the first n elements belong to price of goods in energy and non-energy sectors and the $(n+1)^{th}$ element is related to price of household production (wages). So, $\bar{P}$ can be written as:

$$\bar{P} = \begin{bmatrix} P \\ w \end{bmatrix} \tag{8}$$

Thus, the price model in equation (2) can be rewritten as:

$$\begin{bmatrix} P \\ w \end{bmatrix} = \begin{bmatrix} A & \boldsymbol{h}_c \\ \boldsymbol{h}_w & \boldsymbol{h}_w^c \end{bmatrix}' \times \begin{bmatrix} P \\ w \end{bmatrix} + \begin{bmatrix} (ova) \\ (\boldsymbol{oph}) \end{bmatrix} \tag{9}$$

Where:

$\boldsymbol{h}_c$: column vector of household's (marginal) consumption propensities in different sectors

$\boldsymbol{h}_w$: row vector of income from employment coefficients, which is obtained by diving compensation of employees to the total output in each sector

$\boldsymbol{h}_w^c$: implies the share of household income paid for household services

: column vector of other value-added components

$op\boldsymbol{h}$: other payments by households such as rent, insurance, etc that is considered to be zero in this study. The matrix form of equation (9) is:

$$\bar{P} = \bar{A}'.\bar{P} + \overline{ova} \tag{10}$$

The sign (-) shows these variables in the new model. In the next stage, the row and the column added to the table can be considered as one of the non-energy sectors. In result, the new form for the equation (7) is:

$$\bar{P}_m = (I - \bar{A}_{mm})^{-1}.\bar{A}_{me}.\bar{P}_e + (I - A'_{mm})^{-1}.(\overline{ova})_m \tag{11}$$

Except for the fact that in this case, price vector and technical coefficients are defined:

$$\bar{P}_m = \begin{bmatrix} P_n \\ w \end{bmatrix} \quad , \qquad \bar{A}_{mm} = \begin{bmatrix} A_{nn} & \boldsymbol{h}_c \\ \boldsymbol{h}_w & \boldsymbol{h}_w^c \end{bmatrix} \quad , \qquad \bar{A}_{me} = \begin{bmatrix} A_{ne} \\ \boldsymbol{h}_{c_e} \end{bmatrix}$$

Consequently, in this model, wages are considered to be endogenous and are assumed to be a non-energy sector. Therefore, the effects of price changes in energy sectors on the non-energy sector can be calculated via this method (Bazzazan and Batley, 2003; Banouei, 1999).

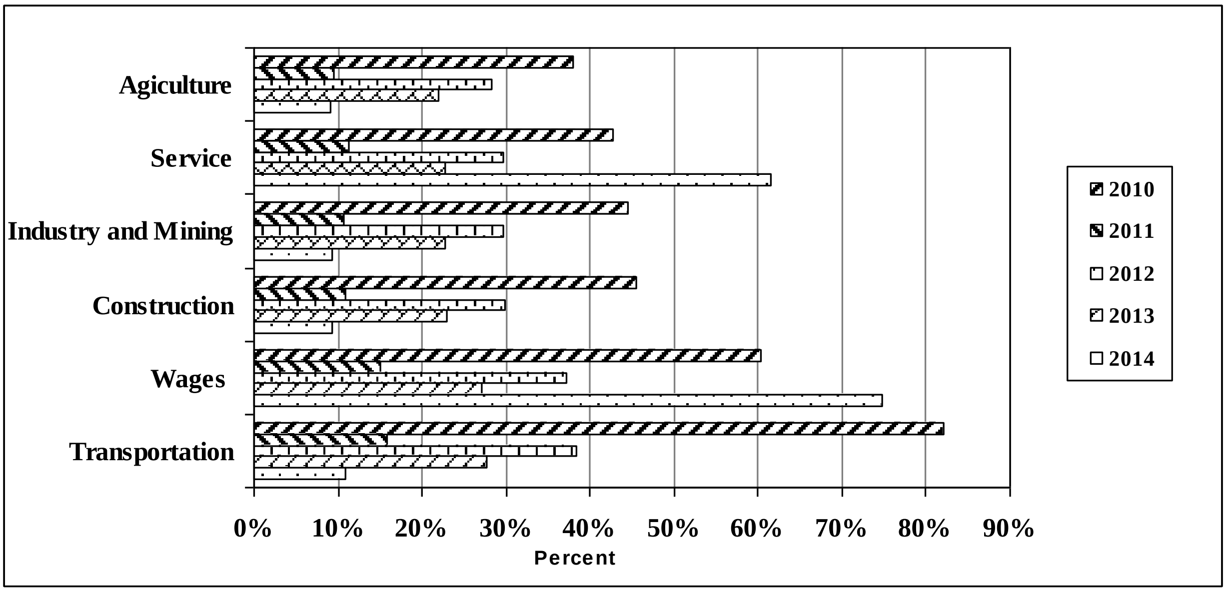
4. Calculation of Short Run Marginal Cost of Electricity during the Execution of the Plan

4.1. Analysis and Prediction of Prices in the Framework of Input-Output Tables

In this section, the effects of energy price rise on socio economic subsector's price indices in different scenarios are showed in Figure 1 and Figure 2. For instance, Figure 1 shows increase price index in subsectors based on first scenario; gradual price increases with a high growth at the beginning of the period, then closing the gap by 40, 40 and 20 percent successively each year over the period 2011-2014.

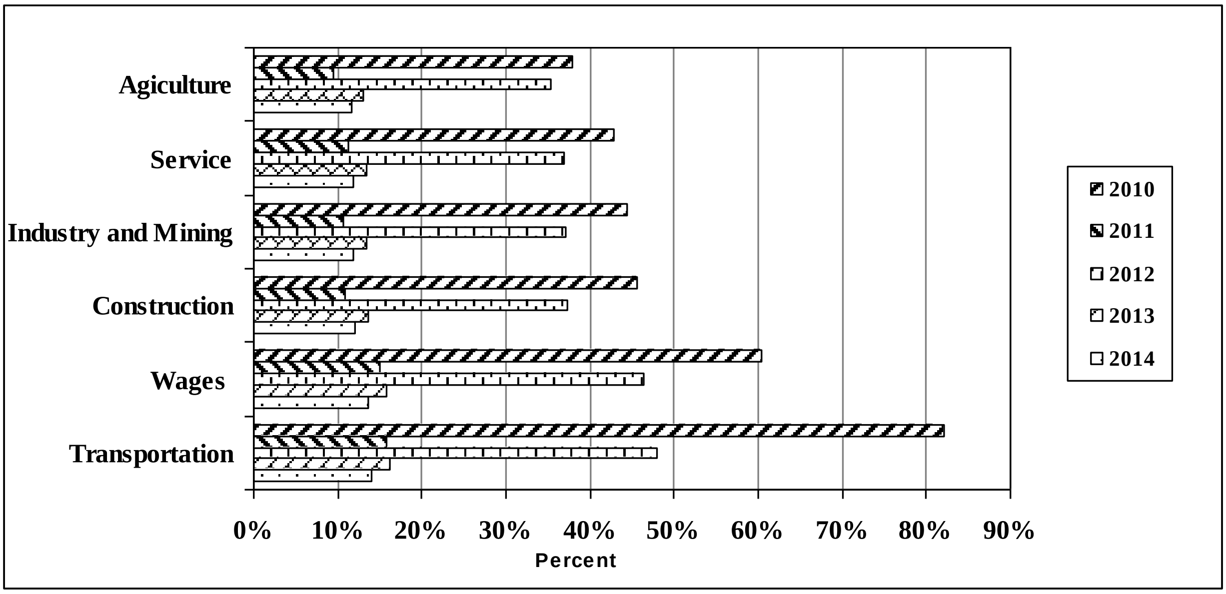
As it shows, transportation will be affected tremendously and its index grows more than 80% in 2010 due to significant oil products price rise, while agriculture sector will be less affected. Agriculture sector is supported by government and its price index reached approximately 40% in 2010. In 2012, the price indices hit the peak for the second time where transportation sector will experience a sharp increase, compared to the year 2011.

Figure 1. Average Percent of Price Index Increase in Different Sectors Based on the First Scenario



Source: own compilation

Figure 2. Average Increase Percentage of Price Index in Different Sectors Based on the 2nd Scenario



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In the second scenario, although we start with the same picture at the beginning of the period, in 2012 transportation and agriculture sector's index rise exceeds 40% and 30%, respectively. However, a substantial decline occurs in the next years.

Finally, changes in the average price indices or total inflation resulted by price changes of energy carriers in different sectors over the period 2011-2014 was calculated and showed in Table 2.

It simply implies that sharply price increase of energy carriers in 2012 and moderate rate in the next years culminate in 60 to 78 percent of inflation until 2014.

Table 2. Total Inflation Resulted by Price Changes of Energy over The Period 2011-2014 in Different Subsectors

Industry and mining	Agriculture	Construction	transportation	service	Labor compensation	
62	60	62	77	62	75	total inflation in the first scenario
62	60	63	78	62	76	total inflation in the second scenario

Source: own compilation

4.2. Short Run Marginal Cost of Electricity

In Iran, electricity tariffs are calculated on the basis of such traditional methods as cost accounting approach. The tariffs which were calculated by accounting approach do not properly reflect the actual cost of power supply (Malik and Al-Zubeidi, 2006). To specify the corresponding tariff precisely, marginal costs have to be calculated. Essentially, the cost of generating electricity includes:

•**Capital expenditure**, i.e. the initial level of investment required to engineer, procurement and constructs the plant itself.

•**Fixed costs of operation and maintenance**, e.g. staff salaries, insurance, rates and other costs, which remain constant irrespective of the actual quantum of electricity generated.

•**Variable costs of operation and maintenance**, e.g. lubricating oil and chemicals, which are consumed in proportion to the actual quantum of electricity generated; and

•**The cost of fuel** (if applicable) consumed in generating electricity (The Royal Academy of Engineering, 2004).

So, capacity-related costs are only a portion of the total cost of delivered electricity. Production costs including fuel, operating and maintenance costs make up the bulk of the remainder (Bright and Davitian, 1982)

Table 3 summarizes the cost shares of compensation of labor, fuel, chemical and non-chemical materials in total expenditures of two Combined-cycles, one Gas-turbine and one Steam-turbine power plants samples. For instance, Wages and Salaries account for 54% of all costs in the sample Gas-turbine power plant.

Table 3. Costs Shares for Selected Power Plants, in Percent

Cost shares	Combined- cycle		Gas- turbine	Steam-turbine
	power plant 1	power plant 2	power plant 1	power plant 1
Wages and Salaries cost shares	54	46	54	62
fuel cost shares (gas and gasoil)	36	49	31	34
Non-chemical materials cost shares	9	3	15	1
Chemical materials cost shares	1	2	--	3

Source: Management and Economic Power Department of Niroo Research Institute

According to data gathered from Steam-turbine sample, operation and maintenance costs around 17,324 Rls[4]/MWh. Compared to Steam-turbine plant, operation and maintenance cost of sample Gas- turbine and Combined-cycle power plants are around 11,680, 14,278 and 11,653 Rls/MWh respectively. Moreover, fuel costs of Combined- cycle plants account for 7,914 and 11,268 Rls/MWh due to assigned subsidies.

[4] The unit of Iranian currency is Rial. The currency exchange rate between the Iranian Rial and the US Dollar is around 19000 Rls.

Short run marginal cost (SRMC) of electricity accounts for fuel, operation and maintenance costs, that is, supply cost with fixed capacity (Munasinghe and Warford, 1982). Therefore, SRMC of electricity will be calculated based on the inflation of fuel (gas and gasoil), wages and salaries and chemical and non-chemical material costs during the plan execution. Changes in price indices of these subsectors were previously calculated. Short run marginal costs of electricity over the coming years is calculated with the growth rate of price indices as well as the cost shares of each of the above-mentioned costs in total expenditures of generating one kWh of electricity.

All sample power plants use natural gas and gasoil to generate electricity. The amount of fuel used for power generation in 2009 and the share of different fuel types in generating one kWh of electricity can be determined by considering the thermal value of each square meter of natural gas and also each liter of gasoil. The results of these calculations are presented in Table 4.

Table 4. The Amount of Fuel Used in Sample Power Plants in 2009

Steam-turbine	Gas- turbine	Combined- cycle		
power plant 1	power plant 1	power plant 2	power plant 1	
744156	743620	1432000	814214	Natural gas used for power generation (1000 m^2)
229	117248	234000	192496	Gasoil used for power generation (1000 liters)
0.27	0.27	0.19	0.17	Natural gas used for electricity generation (m^2 /kWh)
0.000084	0.04	0.03	0.04	Gasoil used for electricity generation (liters/ kWh)

Source: Tavanir Company

Considering the increase of fuel price until 2014 and the shares of different fuel types in power generation, the fuel cost growth trend will be as demonstrated in Figure 3, Figure 4 and Figure 5 for sample Combined-cycle, Gas-turbine and Steam-turbine power plants, respectively.

Figure 3. Fuel Cost Projection of the Two Sample Combined-Cycle Power Plants During The Execution of Targeted Subsidy Plan

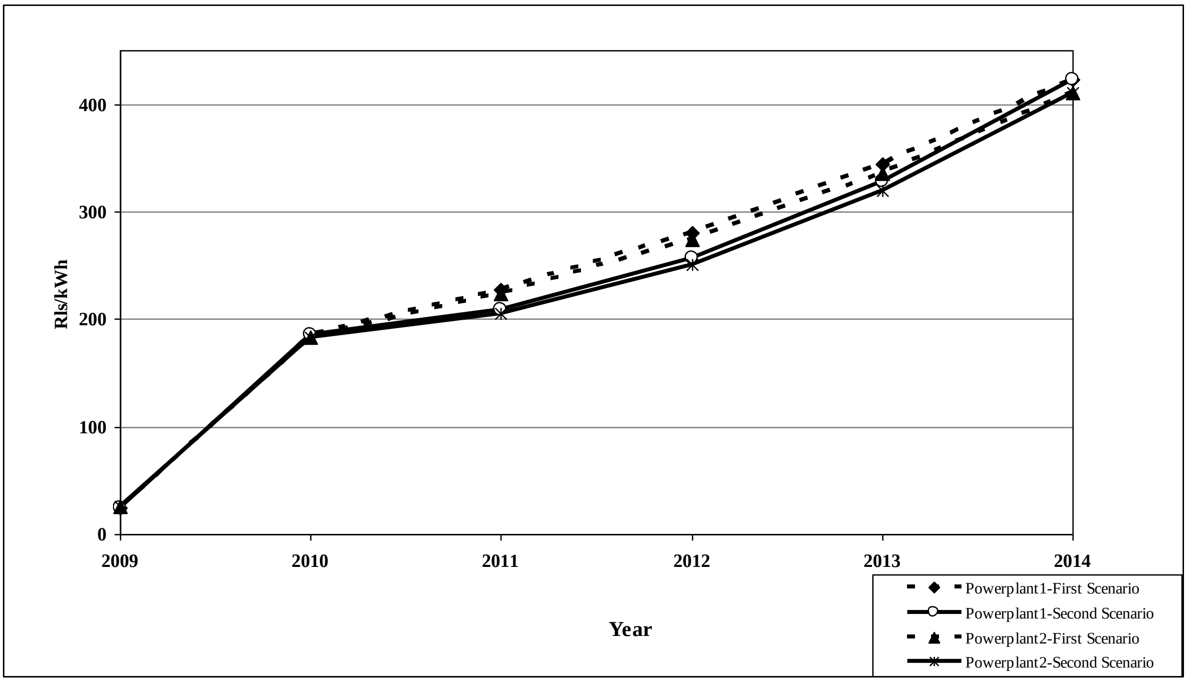

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Figure 4. Fuel Cost Projection of the Sample Gas-Turbine Power Plant During The Execution of Targeted Subsidy Plan

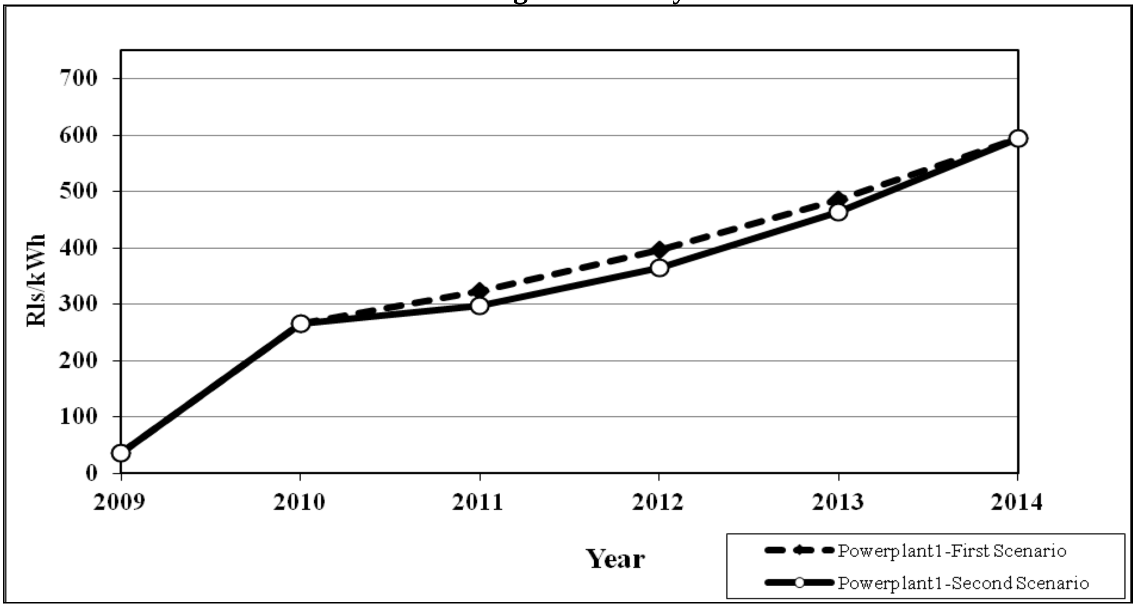

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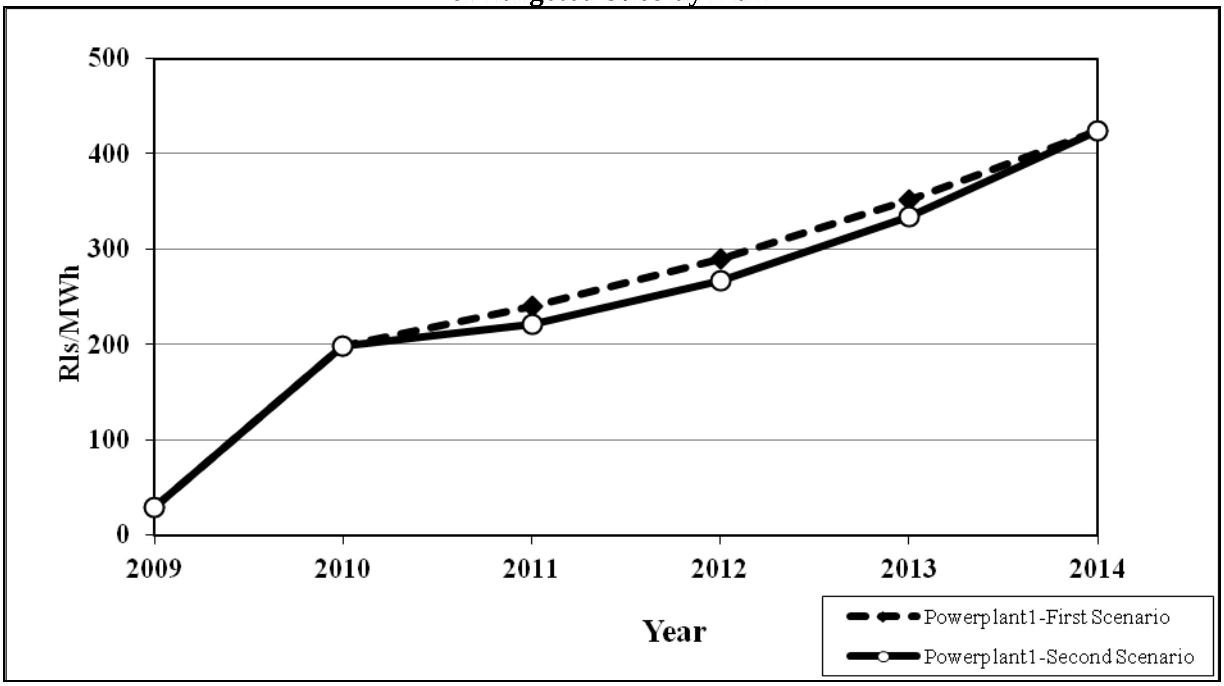
Figure 5. Fuel Cost Projection of the Sample Steam-Turbine Power Plant During The Execution of Targeted Subsidy Plan



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According to the Table 4, the significant proportion of expenditures is generated through operation and maintenance activities which are related to personnel compensation, chemical and non-chemical material sectors. As shown in Table 2, inflation rates of 75 and 76 percent are obtained for the labor compensation sector in the first and second scenarios, respectively. Moreover, chemical and non-chemical sectors will experience substantial rise in price indices, which is about 66.47 % and 66.37% in the first scenario and nearly 67% for both sectors in the second scenario. By considering their share in generating one kWh of electricity, short run marginal costs related to operation and maintenance (without fuel) can be calculated. The results which obtained for Combined-cycle, Gas-turbine and Steam- turbine power plants in the first and second scenarios are represented in Figures 6 to 8, respectively.

Figure 6. Operation and Maintenance Costs Projection of the Two Sample Combined-Cycle Power Plants During the Execution of Targeted Subsidy Plan

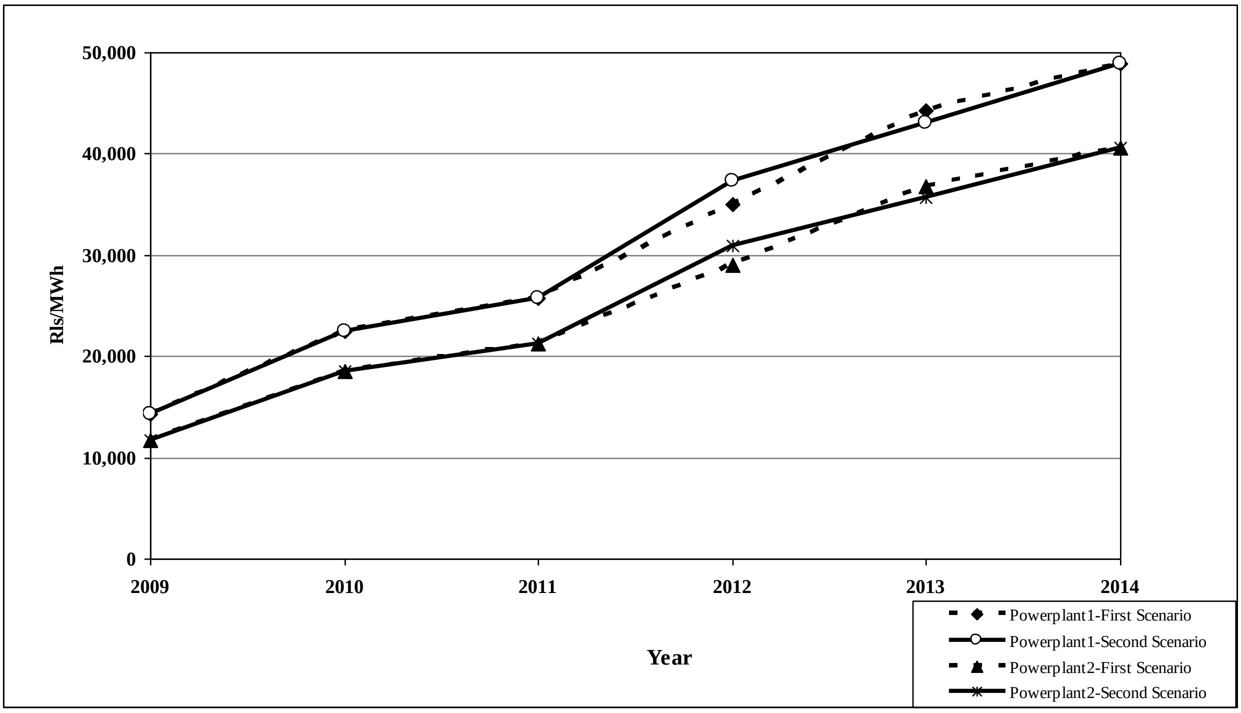

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Figure 7. The Sample of Gas-turbine Power Plant Operation and Maintenance Costs Projection During the Execution of Targeted Subsidy Plan

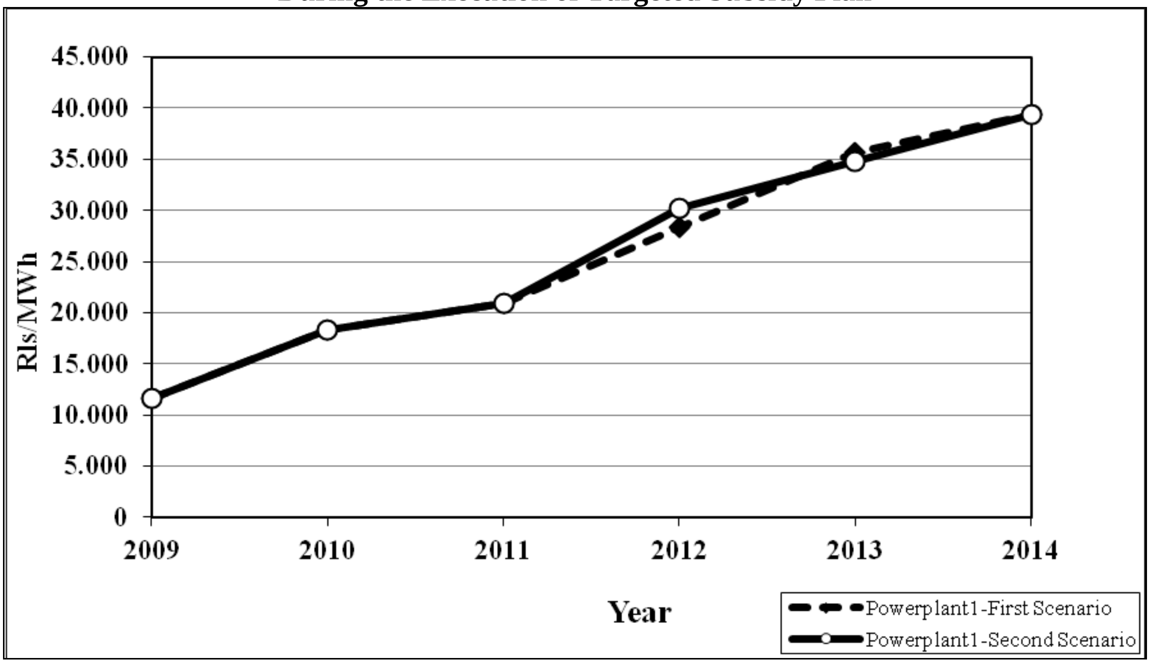

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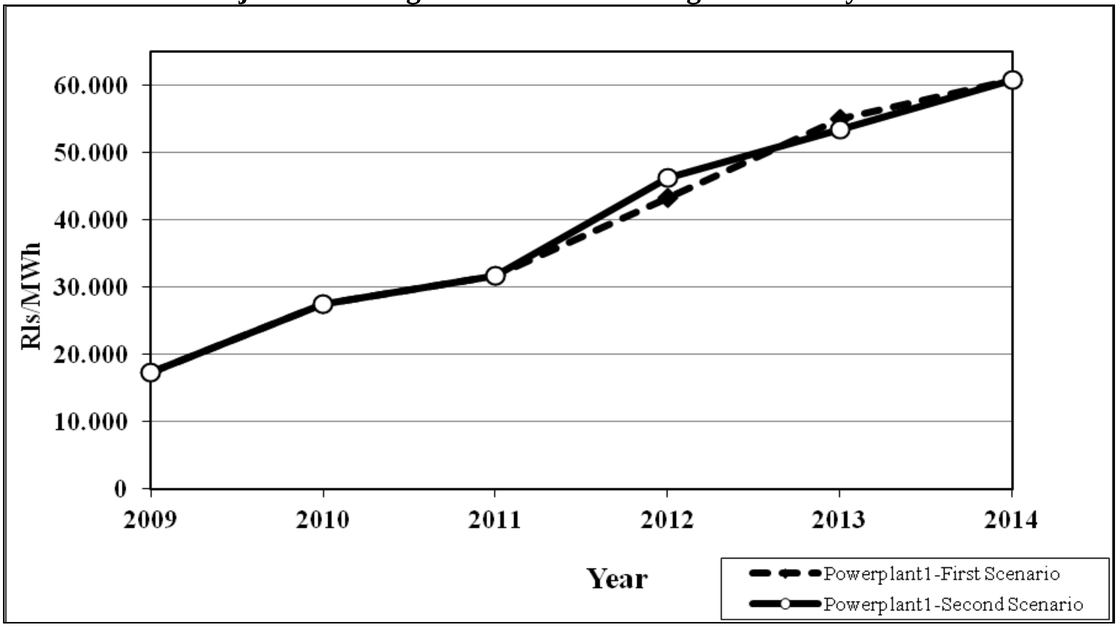
Figure 8. The Sample of Steam-turbine Power Plant Operation and Maintenance Costs Projection During the Execution of Targeted Subsidy Plan



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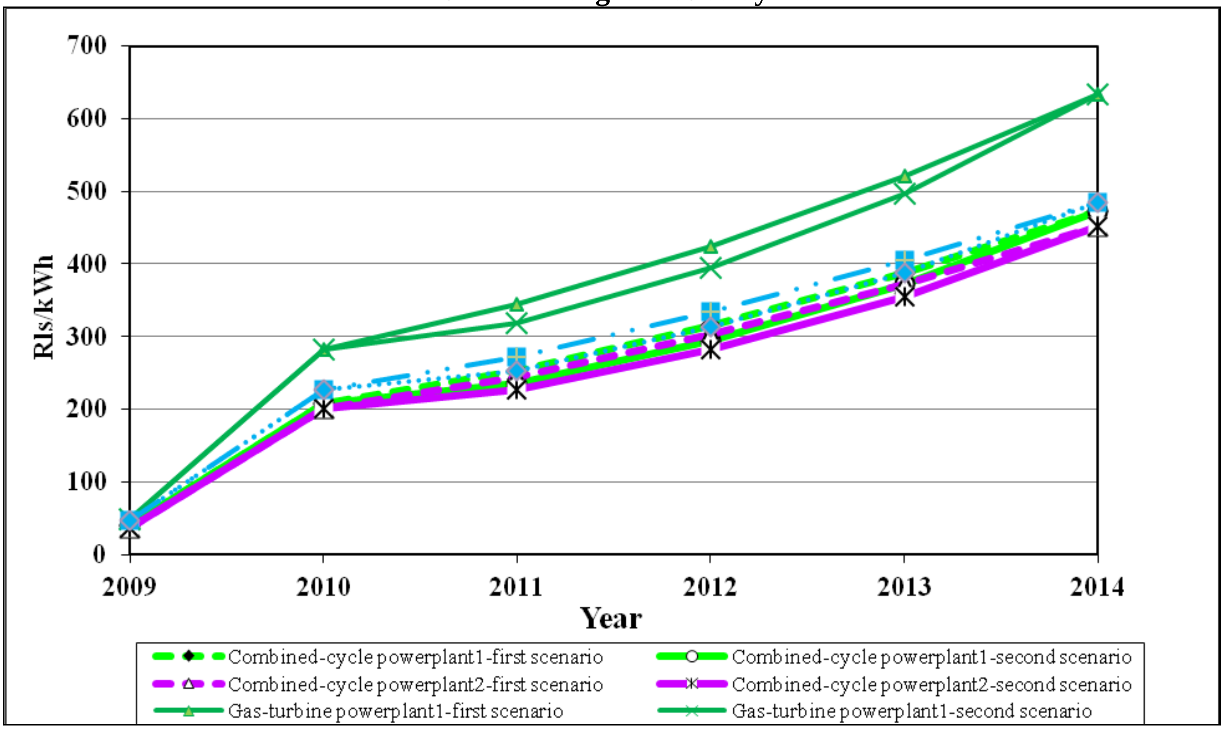
As these figures show, maintenance costs will be approximately higher for the Steam-turbine power plants than Combined-cycle and Gas-turbine ones. According to figures 6-8, Steam-turbine sample, operation and maintenance costs around 60,000 Rls/MWh in 2014. Compared to Steam-turbine plant, operation and maintenance cost of one sample Gas- turbine and two Combined-cycle power plants will reach around 40,000, 40,000 and 50,000 Rls/MWh in 2014.

Figure 9. Short-Run Marginal Costs Projection of the Five Samples Power Plants During the Execution of Targeted Subsidy Plan



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Therefore, the recent rise in such power generation cost components as fuel, operation and maintenance costs follows roughly a period of relatively increasing short run marginal costs which is shown in Figure 9.

5. Conclusion

In this study, we have surveyed two issues: (a) the expected impact of the Iranian targeted subsidy plan on price indices during subsidy reform execution, (b) the likely effects of the energy price rises on short- run generation marginal cost of electricity. We applied extended IO price model to simulate the effects of energy price rise on socio- economic subsector's price indices in different scenarios in Iran. Using the 2006 IO table of Iran, our empirical results indicate that energy price increases will increase the price index of salaries and wages, service, transportation, construction, agriculture and industry and mining between 75-76%, 62%, 77-78%, 62-63%, 60% and 62%, respectively. After considering the inflationary effects of energy price growth on non-energy subsectors, the production cost of electricity caused by the subsidy reform plan is calculated, with respect to three conventional power plants.

Until the end of 2009, about 32,257 MW of total nominal power in Iran corresponded to Gas-turbine and Combined-cycle power plants. In addition, about 23,528 MW of capacity will be added to the Combined-cycle power plants until the year 2014; it is noteworthy that the main part of this capacity rise is due to converting Gas-turbine plants to Combined-cycle plants.

In regards to the high capacity of Gas-turbine and Combined-cycle power plants and the continuation of subsidy reform plan until 2014, it is important to consider the trend of short run marginal electricity cost of these power plants during the execution of subsidy targeted plan.

Based on the results presented in Figure 9, short- run marginal cost of Combined-cycle, Gas-turbine and Steam-turbine power plants will reach 462, 634 and 485 Rls /kWh of electricity until 2014. The main difference between the short- run marginal costs of Gas- turbine and Combined-cycle power plants is the high efficiency of Combined-cycle plants compared to Gas-turbine plants. Lastly, the increase of fuel prices, share of O&M costs in the total production costs will gradually reduce from 30 to 50 percent in 2009 to 9-18 percent in 2014.

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