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The effects of rising energy carriers' prices on energy carriers' consumption in the two-digit industry

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Abstract: Industrialization of societies and fast movement of developing countries toward industrialization have accelerated the increase using of fossil energy and non-fossil energy and also it leads a lot of problems for these societies. Investigating these problems and also study in the field of using energy in any country is invertible. In today world, energy is one of the important factors of growth and development of economy and due to the importance and its role in production and services costs and also environmental issues; it has been always under the attention of improving the situation of using and more efficiency. In this study, in order to estimate carriers demand functions and the effects of the price increase on the amount of using that, the data of statistical consumption and energy price in the sectors of industry, labor force and used capital in these sectors and the share of industry of GDP and etc. are used for years during 1995 to 2010. One of the important results of this research is that elasticity of substitution among production inputs indicates substitution among capital inputs, labor force and energy. These results are confirmed by cross-price elasticity. In the energy model in below, Allen elasticity of substitution and cross-price elasticity indicate the substitution relationship among energy carriers and cross-price elasticity those are calculated by PinDik method confirmed these results and they consider used energy carriers as substitution for each other. Auto price elasticity of Pindik is obtained smaller than one for considered carriers and this issue shows low elasticity of energy carriers during the introduced period for identified industry.

Key words: Industry sector; The price elasticity of demand; Demand elasticity of substitution; Trans-log cost function; energy consumption; Energy intensity; Seemingly unrelated regression equations

1. Introduction

Since the structure of policy and economy of countries are depended to the way of accessing to energy, the way of using it and its price, therefore, energy and the issue related to energy are effective deeply in policies, orientations and development programs. Actuator motor economic development of the countries is energy safety and easy access to that. Using the energy basket with varieties of combinations in addition to energy safety poses economic explanatory of some types of energy to compare to other types of energy. Using the energy basket with different combinations, using of energy with environmental considerations those have minimum environmental costs and also energy correct pricing which has optimum energy consumption are the important issues in this field.

The important issues nowadays are the creation of optimum balance between energy supply and demand, increasing efficiency and correcting consumption pattern. Very low level of energy prices compared to the prices of other factors of production and goods have had incremental increasing energy consumption of the country that with property limitation and economic system capacity, society consuming model is not match with resources optimum allocation in economy. Therefore, the necessity of review in energy consumption process based on available leverages feels more than before. However, logical decision about increasing energy prices due to the conscious of increasing goods and services costs index adds on the sensitivity of this policy. Therefore, deciding about rationalizing prices requires that the effect of increasing energy price on energy consumption should be studied carefully and the experiences of other development plans in this field should be used. Performances of Subsidies on consider the important steps that the effectiveness of this plan on price and using other goods became clear after doing first level of this plan. Therefore, the effect of energy price on its consumption in industry sector has been studying in this research which can be suitable guidance to study the production effects of increasing energy carriers' price.

2. Theoretical framework

Industrialization of societies and rapid movement of developing countries toward industrialization have accelerated using the fossil and non-fossil energy and albeit, it has created many problems for societies. Investigating these problems and also study in the field of the way of using energy in any country is inevitable. In today's world, energy is one

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of the important factors of growth and development of the economy and due to the importance and its role in production and services costs and also environmental issues; it has been more attention to improve the situation of efficiency and consumption of energy. On the other hands, price system in any country and economic system are the guideline and sign of any economic activities. It means, price system shows what is produced, what is consumed and how it is distributed in society. Therefore, considering the efficiency of price system can lead to efficiency of economic system.

Low cost of one production factor can be effective on the structure of one sector. It means that if industries are energy consuming in Iran, its reason will return to low cost of energy carriers in Iran and change in this structure is along with cost and planning. In economic theories, relative price deviation from balancing amount causes to allocate resources in economy incorrectly. With short term investigation related to energy carriers' price in two decades of Iran, strong deviation of price is noted and this price deviation and beside that daily growth of population cause to increase the energy consumption and its losses in economy (Khiabani, 2008). The increase using of energy carriers causes industries and other economic sectors to face many problems and any correction for price and selecting replacement for these carriers can create serious problems for national economy. Even though, correcting subsidies energy carriers have reduced energy losses approximately, but the price of energy carriers have still much difference with global price. This issue has caused that main sector of factories and internal industry have exchanged to energy consuming industries, because consuming energy carriers has advantage to compare with other production factors and in fact, this production factor is cheaper and more economic than other replaced factors. Increasing the price of energy carriers in one side leads to saving in carriers consuming and on the other side, it faces industries to serious problems. Because, finding replacement for production factors in short term work is difficult and it is impossible for some industries. Anyway, the objective of this research is to study the amount of changes in carriers' consuming due to changes in their price and it leaves the study of other points to other researches in the field of production, industry and energy. Although such studies are required to investigate and evaluate the changes in the production of energy consumption, at the beginning, it is required the results those are extracted from this research. Also, to study the environmental effects caused by changing the price of energy carriers, using the results of this research can be effective.

Jahangard (2010) in an article has been dealt with to analyze and evaluate adjusted price of petrol and gasoil and its effect on career costs in Iran. The results indicate that due to increasing the price of petrol and gasoil in all options, most of the increasing costs of families are related to the services of transportation and communication and foods and drinks. Hengyun Ma et al. (2008) in an article have been dealt with to study the changes of technology, demanding factors, replacement among production factors and among energy components. Methodology of this research is based on previous research. It means that one trans log cost function biphasic is applied in this research. And one model for industry production factors and energy Sumodel has modeled by Velem Shefard cost function. Then, it has been dealt with to estimate self-price and cross elasticity by Allen and Pindik elasticity.

3. Research model and model estimation

3.1. Stationary test

This test is used to determine the level of collective of variables. The results of Hadri stationary test are presented in Table 1:

Table 1: The results of Hadri stationary test

Hadri		Method	
Probability	The amount of statistics in level or intercept	Variables	
(0/000)	11.0371	Cost share of input energy production	SE
)0/000(	13.6794	Share of the cost of labor input	SL
)0/000(	14.5917	The share of cost of capital production input	SK
(0/000)	7.86405	The share of electricity energy carrier	SEL
(0/000)	9.12057	The share of cost of gas-oil energy carrier	SGO
(0/000)	7.46016	The share of cost of other energy carriers	SOTH
(0/000)	12.4743	Energy price index	PE
(0/000)	10.7317	Labor force price index	PL
(0/000)	10.0927	Capital price index	PK
(0/000)	12.2339	The price index of electricity energy carrier	PEL
(0/000)	14.5973	The price index of gas-oil energy carrier	PGO
(0/000)	12.6281	The price index of other energy carriers	POTH
(0/000)	14.5380	Added value of industry sector	Y
(0/000)	11.4632	Time process and technology index	T

Source: research findings

As Table 1 show, all used variables in this research are co collective of zero level I (0) and the hypothesis of non-stationary of variables are rejected in confidence level of 99%.

The estimation of coefficient of energy Sumodel (Interfuel Sumodel)

$SEL=C_{EL}+C_{EL,EL}*LOG(PEL)+C_{EL,GO}*LOG(PGO)+C_{EL,OTH}*LOG(POTH)$

$SGO=C_{GO}+C_{GO,EL}*LOG(PEL)+C_{GO,GO}*LOG(PGO)+C_{GO,OTH}*LOG(POTH)$

$SOTH=1-(C_{EL}+C_{GO})-(C_{EL,EL}+C_{EL,GO})*LOG(PEL)-(C_{EL,GO}+C_{GO,GO})*LOG(PGO)-(C_{EL,OTH}+C_{GO,OTH})*LOG(POTH)$ **(1)**

As it is obvious from the equation in above, the third equation which means SOTH equation is deleted from system by applying Adding Up condition, because all its coefficients are obtained by coefficients of two equations SGO and SEL. However, other two equations can be deleted instead of third equation. However, due to the main objective of this research which is presenting the analysis related to electricity and gas-oil, the third equation which contains other carriers, is deleted. Adding Up condition is also symmetry constraints and collectivity. In the second equation, $C_{GO,EL}$ is equal to $C_{EL,GO}$ in the first equation.

The system of equations in above is estimated by technique of equation seemingly unrelated SURE which is defined by Zelner. The results of this estimation are presented in Table 2.

Table 2: The estimation of coefficients of energy Sumodel

	Coefficient	Std. Error	t-Statistic	Prob
C_{EL}	0.473189	0.024861	19.03326	0.0000
$C_{EL,EL}$	0.196792	0.019633	10.02370	0.0000
$C_{EL,GO}$	-0.000715	0.006476	-0.110420	0.9121*
$C_{EL,OTH}$	-0.151817	0.012391	-12.25195	0.0000
C_{GO}	0.056654	0.006388	8.868880	0.0000
$C_{GO,GO}$	0.000319	0.002365	0.135003	0.8926*
$C_{GO,OTH}$	0.000319	0.002365	0.135002	0.8926*

Source: research findings

Table 2 contains estimation coefficient, standard deviation, statistical t and significant level. In the part of Prob has shown that almost 60% of estimated coefficients in confidence level of 99% and one percent error are significant. The star sign in Prob part shows coefficients those are not significant in terms of statistics.

The estimation of model coefficients among production inputs

$SE=b_{E}+b_{E,L}*LOG(PL)+b_{E,E}*LOG(PE)+b_{E,K}*LOG(PK)+b_{E,Y}*LOG(Y)+b_{E,T}*T$

$SL=b_{L}+b_{L,L}*LOG(PL)+b_{E,L}*LOG(PE)+b_{L,K}*LOG(PK)+b_{L,Y}*LOG(Y)+b_{L,T}*T$

$SK=1-(b_{E}+b_{L})-(b_{LL}+b_{E,L})*LOG(PL)-(b_{E,E}+b_{E,L})*LOG(PE)-(b_{E,K}+b_{L,K})*LOG(PK)-(b_{E,Y}+b_{L,Y})*LOG(Y)-(b_{E,T}+b_{L,T})*LOG(T)$ **(2)**

Table 3: The estimation model coefficients among production inputs

	Coefficient	Std. Error	t-Statistic	Prob
b_{E}	0.098538	0.058930	1.672103	**0.0948
$b_{E,L}$	0.051854	0.009870	5.253481	0.0000
$b_{E,E}$	-0.022829	0.018026	-1.266412	***0.2056
$b_{E,K}$	0.016402	0.003282	4.997060	0.0000
$b_{E,Y}$	-0.009164	0.003142	-2.916282	0.0036
$b_{E,T}$	-0.003507	0.001831	-1.915787	**0.0557
b_{L}	0.784116	0.109069	7.189162	0.0000
$b_{L,L}$	0.124671	0.017500	7.124110	0.0000
$b_{L,K}$	-0.015994	0.007196	-2.222503	*0.0265
$b_{L,Y}$	-0.043907	0.006702	-6.551580	0.0000
$b_{L,T}$	0.003551	0.001834	1.936781	**0.0530

Source: research findings

With taking a look at Adding Up condition and the system of equation 2, it is observed that the functioning of this system estimation exactly like equation system of energy Sumodel. In order to apply asymmetry condition and collectivity, one of the equation is exactly deleted and in second equation $b_{E,L}$ is equal with its same name in the first equation. There is no any difference among equations that which one is deleted. The obtained results of estimating this system of equations are presented in Table 3.

In Table in above as Table 2, the part of Prob shows significant level of estimated parameters. According to Table in above, almost 55% of coefficients in confidence level of 99% are significant (coefficients those have no star in Prob part) and 64% of coefficients in confidence level of 95% are significant (the coefficients those have no star in Prob part and or thay have one star). More than 90% of coefficients are significant in confidence level of 90% (coefficients those have no star in Prob part and or they have one star or two stars). Therefore, there is only one coefficient that is significant in confidence level of 75% (the coefficient of b_{EE} which has three stars).

Up here, the required arrangements to access to the goals of the research are provided and the final step is to fulfill the research objectives which mean the effect of increasing the price of each carrier on its use can be made. The final step is to calculate the required elasticity for related description. The step contains two levels. In first level, Allen elasticity will be calculated and then Pindik elasticity will be able to calculate by Allen elasticity.

Allen partial elasticity for production inputs model

Elasticity of substitution is simply a numeric value which reflects the rate that substitution of inputs will be done by that (Henderson and Kovant, p109).

Table 4: Allen partial elasticity for production inputs model

σ_{ee}	-1.16573
σ_{ll}	-0.1077
σ_{kk}	-0.81046
σ_{el}	1.806319
σ_{ek}	1.9566
σ_{lk}	0.88392

Source: research findings

Table in above is presenting important results for this research. This table shows that the production factors of labor force, capital and energy have substitution relationship with each other. Therefore, if the energy price increases in industry sector and capital price and labor force price stay fix in this sector, the relative price of energy will be increased in industry sector. In this case, capital and labor forces are substituted of energy input. Another importance of this table is that it is needed the results of this table to calculate price elasticity for production inputs model.

Price elasticity of demanding the production factors for production inputs model

The self-price elasticity of demand is defined as the ratio of the rate of relative changes of consumer goods to the rate of relative changes price of goods, while the price of other goods and incomes is fix (Henderson and Kovant). Cross-price elasticity has also relationship with corresponding changes in the amount of one of the two goods to changes of other goods price in the literature of economy (Henderson and Kovant).

Price elasticity of demand is obtained by Allen elasticity and cost shares. The self-price and cross elasticity is used for the effect of price changes of each of factors on its demand and the demand of other factors. Price elasticity is calculated for inputs model and the results are presented in Table 5.

With using of table in above, total results about the effect of increasing energy price and other energy inputs can be deduced. This table shows that energy self-price elasticity is equal to -0.10428. It means that elasticity and sensitivity of energy to compare with its price change is less than one and energy is low elasticity goods for industry sector and with one unit increasing energy price index, the amount of energy consumption in this sector will be less than one unit which means it decreases 0.10428 unit.

On the other hands, self-price elasticity for work and capital also indicates that in industry sector, work and capital inputs are also low elasticity and there is low sensitivity about changing the price of work. With one percent increase in capital price index, the amount of consumer of capital input will decrease in amount of 0.15534.

Table 5: Price elasticity of production factors inproduction input model

ε_{ee}	-0.10428
ε_{el}	1.298519
ε_{ek}	0.375014
ε_{ll}	-0.07742
ε_{le}	0.161591
ε_{lk}	0.169417
ε_{kk}	-0.15534
ε_{kl}	0.635428
ε_{ke}	0.175034

Source: research findings

About labor force, with one unit increase in labor force price, the amount of consumer of labor input will decrease 0/07742. One of the reasons of low elasticity of these inputs can be returned to the low price of inputs during studied period in industry sector. On the other hands, the existence of substitution relationship of production inputs in industry sector is confirmed in here. It means with increasing energy price and decreasing its use, using of work inputs and capital will be increased. Also, Table 5 shows that there are most substitutions between two energy and labor inputs.

Allen partial substitution elasticity for energy Sumodel

In Table 6, Allen partial elasticity is calculated for electricity, gasoil and other energy carriers for the year 2010.

Table 6: Allen partial elasticity for energy Sumodel

$\sigma_{el,el}$	-0.11189
$\sigma_{el,go}$	0.979202
$\sigma_{el,others}$	0.227705
$\sigma_{go,go}$	-0.94019
$\sigma_{go,others}$	1.019213
$\sigma_{others,others}$	-0.2002

Source: research findings

Table 6 in above shows that the relationship between electricity carrier and gasoil carrier is substitution and also, the relationship between electricity carrier and other energy carriers is also substitution. However, with observing the number related to substitution elasticity of electricity-gasoil and electricity with other carriers, it can be concluded that the degree of substitution between electricity and gasoil is more than substitution between electricity and other carriers. On the other words, gasoil is more suitable substitution for electricity rather than other energy carriers. On the other words, the relationship between gasoil and other energy carriers is strong substitution relationship. It means with increase the gasoil price, the amount of its using will decrease and other energy carriers will be replaced by other energy carriers. In this table, there is strongest substitution between gasoil and other energy carriers. The important feature of this table is for calculating second kind of elasticity which means price elasticity of demand of energy carriers. It can be calculated by table in above.

Price elasticity of demand for energy Sumodel

The obtained results for price elasticity of demand of energy Sumodel are presented in Table 7:

Table 7: Price elasticity of demand for energy Sumodel

$\varepsilon_{el,el}$	-0.07139
$\varepsilon_{el,go}$	0.052766
$\varepsilon_{el,others}$	0.070161
$\varepsilon_{go,el}$	0.624724
$\varepsilon_{go,go}$	-0.05066
$\varepsilon_{go,others}$	0.314041
$\varepsilon_{others,el}$	0.145274
$\varepsilon_{others,go}$	0.054922
$\varepsilon_{others,others}$	-0.01901

Source: research findings

In here, price elasticity for Sumodel is extracted with assuming the independence of this model from inputs model. The results of Table 7 show that the relationship among electricity energy and gasoil carriers and other carriers is substitution. Self-price elasticity of electricity shows that with one percent increase electricity price, the demand for this carrier in industry sector is decreased only 0/0719 percent. It means electricity is low elasticity energy in industry sector. Based on this table, it can be seen that electricity carrier in industry sector is more elasticity to compare with other carriers and gasoil carrier. This table shows that industries of the country are really depended to energy carriers, in a way that the increase the price of them does not create strong changes in their consumer. Because, industry sector is energy consuming sector and it is impossible to correct its structure in short term. Correcting the process of energy consumption in this sector requires correcting the structure of industry sector and equipment and machinery energy consuming of this sector which is possible during long term period.

4. Pindik price elasticity for energy Sumodel

Pindik price elasticity is more close to reality to compare with extracted price elasticity in Table 7. Because Pindik price elasticity deletes the independence assumption of energy Sumodel from inputs model (unreal assumption) and it creates communication between energy model and production inputs model.

Table 8: Pindik price elasticity for energy Sumodel

$\varepsilon^*_{el,el}$	-0.13792
$\varepsilon^*_{el,go}$	0.106652
$\varepsilon^*_{el,others}$	0.378282
$\varepsilon^*_{go,el}$	0.558191
$\varepsilon^*_{go,go}$	-0.05628
$\varepsilon^*_{go,others}$	0.281909
$\varepsilon^*_{others,el}$	0.078741
$\varepsilon^*_{others,go}$	0.049302
$\varepsilon^*_{others,others}$	-0.05114

Source: research findings

Considerable results are obtained in comparing Table 7 and Table 8. The results of Pindik cross elasticity for energy Sumodel confirms Table 7 and it shows that the relationship among energy carriers is substitution relationship. However, this substitution relationship is stronger in Pindik elasticity. The extracted self-price elasticity by Pindik method is bigger than self-price elasticity in Table 7. It means when energy Sumodel is depended to inputs model, bigger self-price elasticity will be obtained. With refer to Table 8 and observing self-price elasticity, it is determined that even though self-price elasticity has become bigger but it is still smaller than one. It means that presented results for self-price elasticity in previous sector remains in its force. So, it can be concluded finally industry sector is energy consuming sector and it is depended to energy carriers strongly. With increasing one percent in energy carriers' prices, the amount of using these carriers in this sector, using energy carriers will be decreased less than one percent. Its reason returns to equipment's and machinery. Because these equipment's are energy consuming and replacing these equipment's takes time and costs.

5. Conclusions and recommendation

The general conclusion can be taken from this research and it indicates being energy consuming for industry sector of Iran and energy force is high in this sector and its sudden drop by increasing tools of energy carriers leads to the failure of this part of the country. Because equipment's, installations and machinery sector due to low energy prices in the country over the years are energy consuming. Now, if energy price increases strongly, this will be impossible to change these equipment's, installations and machinery in short term. Therefore, final price of production and finally last price of industry production might be increased due to reducing costs and it faces to decrease demands which finally lead to close industries and factories.

These recommendations are suggested in order to use in economic policies:

1- Since self-price elasticity of energy carriers is less than one in industry sector and in fact request for energy is low elasticity in this sector, therefore, applying only price policies to reduce demand for energy in short term leads to reduce production and occupation in society. Therefore, it is recommended beside normal price policies, encouragement and incentives provide for industries those use less energy.

Since substitution between input of labor force and energy is very strong, it is recommended to use this potential to increase occupation in the country.

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