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Full Length Research Paper

Studying the effect of targeted subsidies of energy carriers on agricultural products by using CGE model

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The agricultural sector is one of the most important consumer of electrical energy and the most significant oil product is gas oil; on the one hand, due to lack of some energy sources and their non-renewability and high financial burden for the government, we should find solutions to reduce energy consumption, thus, in this way, sustainable development is to be achieved and the interests of future generations would also have been provided. Therefore, a general equilibrium model was developed and related information was used in the framework of social accounting matrix year 2001 as statistical base. In order to derivate and solve the model, the technique of mixed combination issues were used, the increase in prices of energy carriers in the four scenarios of increasing prices to border prices level with exchange rates of dollar, free rate of dollar, 38% increase of all carriers and increase in the oil gas and electricity prices to the world prices level were examined on the prices of agricultural crops. In the first scenario by increasing the prices of energy carriers, agricultural activities level in manufacturing wheat and other agricultural products were faced with the most reduced production by 95.1, 92.1; in the second scenario like the first, production changes in most products accompany negative growth. In total, the results indicated that in four scenarios, the production growth of honey and bee's products and other agricultural products has been positive and others products were faced with reduced production.

Key words: Computable general equilibrium, agriculture, energy carriers.

INTRODUCTION

Supporting the agricultural products due to its role in creating the global food security, high risk in manufacturing agricultural products, mandatory for providing foods for humans, the government's involvement in the control of food prices, requirements of rural development in different countries, sustaining employment in agriculture sector and export development is accepted.

This term has more importance in developing countries where agriculture sector has a key role in economic and social development, and even World Trade Organizations (WTO) permitted the exerting of some supportive ways by the government. Given the aforementioned, it is necessary to develop tools for the agricultural sector that is particularly favored. One of these tools is the energy sources that can play a significant role in shaping the country's development potential (Sasoli and Saleh, 2007).

Since doing any economic activity requires energy, therefore, energy is one of the factors affecting the economic development of countries. The agricultural sector is one of the most important consumers of electric power and the most significant oil product is gas oil.

Unbroken, deep and vast dependence on the energy resources requires ongoing efforts to provide comprehensive and efficient solutions in order to optimize energy production and consumption, and determining proper price for it.

Also implementing the policy of paying energy subsidy and the continuation of the aforementioned policy by the government which has caused the ratio of energy prices to the prices of other factors of production is not compatible with the capabilities and limitations of

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economic system that caused it; the government is seriously pursuing a policy to increase the prices of energy carriers (Manzur et al., 2010).

Due to the complexities of elimination effects of energy subsidies on the country's economy structure, using the general equilibrium models would be essential that can give the appropriate response to policy makers in a short period.

Computable general equilibrium approach can provide a more detailed analysis of the results and implications of economic policies by considering both direct and indirect effects and scale and substitution effects of a policy. Hence, often in scientific circles, the effects of energy prices modification on economic and environmental variables are studied in terms of this model (Weyant, 1985).

In the study, by designing a computable general equilibrium model, the effects of energy price reform scenarios on agricultural production was examined.

Bandera and Cox Head (1999), applied a computable general equilibrium model to assess and quantify the effects of trade liberating and reducing tariffs on environmental benefits in agriculture in Sri Lanka. From their perspectives, the reforms policies result from liberalizing can lead to the relative profitability of production in different segments as well as, significant changes in the structure of production, income and consumption.

Tabet and Chemingoy (2001) determined the effect of internal and external reforms in agricultural policy on rural household's income and rural income distribution in Tunisia by simulating a Computable General Equilibrium Model (CGE). In this model, which the Tunisian households were divided into ten categories including nine rural categories and one urban category, the impacts of reducing domestic supports and agricultural tariffs on the economic welfare were evaluated. Model results indicated that agricultural reforms reduce of the majority rural classes' mean welfare and only the increase in crop yield can improve rural income levels.

Lofgren and Robinson (1999), analyzed the effects of reducing trade support in agriculture and industry on the urban and rural households' welfares in Morocco in format of computable general equilibrium and based on 1994 social accounting matrix which reduced support of agricultural sector created a general significant welfare interests but the effect of tariffs elimination was lower in the industrial sector that represented low relative effect of these tariffs on deviation of domestic prices.

Elyasyan and Hosseini (1996) studied the effect of subsides elimination in usage of agricultural inputs such as fertilizers, pesticides, seeds and machinery, and water and related impacts on the farmers' income by increasing exchange rate and increasing the prices of inputs. The results showed that the profitability index of one hectare of irrigated wheat in the crop year 1991 to 1992 after economic liberalization is equal to twice the year 1991 to 1992 before liberalization.

Nematolahi (2012) evaluated the effects of targeted energy carriers' subsidies on agricultural crops prices, food industries and household's welfare by using input-output table. The results indicated that if the law of targeted subsidies was implemented, horticultural crops among agricultural crops with 1.73% increase has had the greatest impact on increased consumer price index, the welfare of society in the condition of symmetrical price transmission reduced by 61.95% and asymmetric price transmission of 59.24% respectively.

Salami (2000) by analyzing economic impacts of Iran's accession to the WTO on agriculture and other economic sectors calculated price and non-price support for each unit of strategic goods by taking into account the fuel subsidy and without considering it in a general equilibrium model. In this study, it was shown that the fuel subsidy impacted on the final cost of products is significant.

MATERIALS AND METHODS

Among the numerical solving models, Computable General Equilibrium Models (CGE) are largely used by national and international organizations for analyzing economic policies at the partial and whole economy level in late 1970s. The main advantage of computable general equilibrium model is that of cross-market reactions related to price display compatible with wisdom level.

Simultaneous determination of source of income and its consumption place; this model enables that it takes into consideration the effects of policy making interventions both performance of the economy and income distribution. The CGE models have been a standard tool for quantitative analysis of policy interventions in many areas such as, fiscal policy, trade policy, environmental policy (Lofgren and Robinson, 1999; Bohringer et al., 2004).

In CGE models, economic interaction is performed in markets of domestic, imported and exported goods as well as, production factors market (job and capital) with transmission pays (tax and subsidy). For one analysis based on general equilibrium, it is required that economic minor data are classified in such a way that it can provide accurate figures of model parameters in base year. In general equilibrium model of the study, micro-data matrix (MCM) [1] year 2001 is used as database. Also, some studies used this matrix equivalent to one rectangular (SAM) [2] that showed how data is related with general equilibrium (Rutherford et al., 2006). Studied equations framework in form of Mixed Programming Problem (MCP) has been developed. Developed matrix offers a comprehensive picture of the economic and trade activities in 2001 in the account form. Manufacturing and service activities has been divided into five general groups (agriculture, energy, industry, mining and

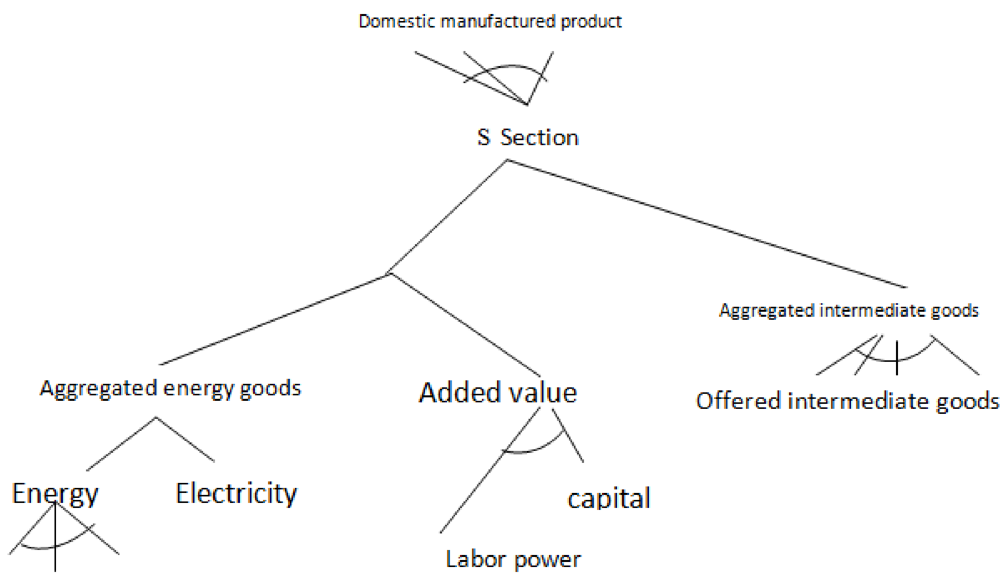

Figure 1. Production structure in studied general equilibrium model.

services) and into 21 groups of goods and services and are located in the format of General Equilibrium Models (GCE) with micro structure.

Production factors included labor power, mixed income, operational surplus and sector specific capital (in case of energy), that with attention to subdivisions, micro data matrix has been considered in model in both account of labor and capital. Government, companies (firms) and households are model institutions. Also, households are classified into urban and rural households. Institutions are suppliers of labor and capital. Households achieved their utility by consuming energy, compound good and non-energy compound good. Each compound good is a Centre for Economic Studies (CES) composition from related goods. In this model, households are faced with 21 consumable goods and one option for savings. The model of this study consists of 4 manufacturing sections, of which these manufacturing sectors offer 21 groups of goods and services. Layer functions with constant elasticity of substitution (NCES) show how inputs are combined and produce output. Production inputs are capital K, labor L, energy E (6 energy carriers) and intermediate materials, M (15 commodity categories), is shown in abbreviate form KLEM, in general equilibrium models. These inputs in layers of added value (including capital and labor work), energy layer (combining electricity and other energy carriers) and layer of other intermediate inputs are classified. These inputs with form function of National Centre for Education Statistics (NCES) between inputs show cost structure for each sector or manufacturing activity. Production factors, including labor, mixed income, sector-specific capital and operating surplus (in energy), are considered in model according to divisions of little data matrix.

Another important assumption made in this mode is taking exogenous supply of labor and capital by household. The assumption in dynamic general equilibrium models is excluded. Governments, corporations (enterprises) and households are model institutions. Households are classified as rural and urban segregation. Institutions are the suppliers of labor and capital. Household gain their utility through the consumption of energy combined commodity and non energy combined commodity. Each combined commodity consisted of a CES combination of related goods. In this model, households are faced with 21 commodities and one option for saving.

Production structure

Products are performed by using non-energy intermediate goods, energy goods and primary inputs. In all, these parts are satisfied with zero profit condition. Electricity is considered substitution by summing other energies. It should be noted that in the literature on computable general equilibrium, to avoid complexities of used mathematical equation, graphical representation of production structure is used. In other words, each mathematical equation can be represented in NCES as a layered graph.

Showing the layered presentation of production structure is trying to state all the necessary information for compiling for the zero profit condition for each part. In the stated structure, the elasticity of substitution in each layer is expressed as a parameter. The layered structure of the production for activities is shown in Figure 1.

According to layered structure CES, the relationship of production structure and accumulation of different inputs can be expressed mathematically as:

Table 1. Scenarios of increase in prices of energy carriers (to RLS.

Carriers	Current price	Scenarios 1: Increasing price to border price level (with exchange rate of dollar)	Scenarios 2: Increasing price to border price level (with free rate of dollar)	Scenarios 3: 38 Percent increase	Scenarios 4: Increasing prices of oil, gas and electricity to the global prices level (with free rate of dollar)
Petrol	7000	14510	20320	9800	-
Diesel	2500	14230	19920	3500	19920
Kerosene	2500	14300	20030	3500	-
Oil	2000	14560	20390	2800	-
Electricity	208	1240	1240	291	1240
Natural gas	600	1075	1075	840	-

Source: Energy balance and OPEC website.

$$KLE(S) = \alpha_{KLE}\left[\alpha_{KL}KL(S)^{1-\delta} + (1-\alpha_{KL})E^{1-\delta}\right]^{\frac{1}{1-\delta}}$$

$$Z(S) = \alpha_{KLEM}\left[\alpha_{KLE}KLE(S)^{1-\beta} + (1-\alpha_{KLE})M^{1-\beta}\right]^{\frac{1}{1-\beta}}$$

$$KL(S) = \alpha_{KL}\left[\alpha_{K}K(S)^{1-\varepsilon} + (1-\alpha_{K})L(S)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$

Where:

$Z(S)$ the product of S part; E energy input ($L(S$ manpower in S part, $K(S$ capital in S part; M the aggregated intermediate good; α_{KLE} the share between the energy and added value; α_{KLEM} the share of aggregated commodity and composite of energy and added value; α_{KL} the share between the labor and capital; β the elasticity of substitution between composite of energy and added value with aggregated commodity, the elasticity of substitution between labor and capital and δ the elasticity of substitution between energy and added value. Production structure is expressed based on zero profit conditions. Zero profit conditions indicated equality of unit cost with unit income for production sectors. Also, it indicated the production technology structure and how it composes the inputs.

Examined scenarios in this study

Changes in the prices of non-energy section such as agricultural sector is a function of changes in energy prices, the rate of use of energy data by non-energy sectors and the rate of use of non-energy data by non-energy sector. Studying the effect of price increase or removal of energy subsidies in this study in four scenarios 4 (Table 1) in separate price levels due to energy price and the world price was designed as follows:

- First scenario: Simultaneous rising of the energy price to the world price level (according to dollar with its exchange rate (reference).
- Second scenario: Simultaneous increasing of the price of energy carriers to the world price level (regarding dollars with free rate).
- Third scenario: 38% increasing price of energy carriers (due to the rising approval cost of integrating Commission of Parliament).
- Fourth scenario: Increasing prices of oil, gas and electricity to the border price level with the free rate of the dollar.

RESULTS AND DISCUSSION

In Table 2, the results of production changes in agricultural sector have been demonstrated in the presented scenarios. In the aforementioned four scenarios, the production growth of honey and bee products and other agricultural crops were found positive and other crops including wheat, rice and grain, sugar beet and sugar cane, and other industrial plants, horticultural products, livestock (including cattle, sheep, chicken and poultry), forestry and fisheries were faced with a decline in production.

It can be said that honey and bee products, as well as, other crops except wheat, sugar beet and sugar cane and industrial crops were faced with increased production costs and increased products prices because of subsidy elimination of oil products, electricity and natural gas but because of low relative prices of their products than other products (products that have negative growth of products), they were faced with increase in the final demand of products and had positive growth in production.

Table 2. Production changes of agricultural crops in the studied scenarios (percent).

Agricultural products	Scenarios			
	First	Second	Third	Fourth
Wheat	-1.95	-3.95	-7.83	-4.95
Paddy and rice	-7.26	-6.26	-8.3	-1.25
Sugar beet and sugar cane	-7.24	-3.24	-3.18	-6.23
Other industrial plants	-1.92	-100	-3.88	-9.90
Other products from agriculture	5.4	8.3	2	3
Horticultural products	-1.63	-1.91	-3.51	-6.60
Cattle, buffalo, sheep, goats and other live animals except poultry	-6.26	-37	-9.18	-3.34
Eggs, live chickens and other poultry	-1.64	-6.90	-8.87	-2.90
Livestock and poultry products	-8.38	-2.64	-53	-2.62
Honey, silk, Noghan eggs and other bees products etc	2.7	4.7	3.6	7
Forestry products and stumpage	-3.65	-7.67	-7.60	-9.75
Fish and other fishing products	3.1	-3	-8.0	-2.0

In the first scenario, by increasing energy carriers' prices, the level of agricultural activities in the production field of wheat, rice, sugar beets and other industrial and horticultural crops were faced with reduced production level of 95.1, 26.7, 24.7, 92.1 and 63.1 respectively. Brewing cattle's, sheep's, chickens, hens and live poultry and other livestock products and poultry had reduced production equal to 26.6, 64.1 and 38.8% respectively. The production of forestry and fishing products decreased to 65.3 and 1.3% respectively.

In the second scenario, a production change similar to the first scenario was associated with negative growth in most products. It is noteworthy that the reduction in growth production in wheat, industrial plants, crops, forestry, horticultural products and live poultry than other products is more. By 38% increase in energy carriers' price, reduced production level of wheat, rice, sugar beet and other industrial and horticultural plants became 83.7, 3.8, 18.3, 88.3 and 51.3% respectively. Brewing cattle's, sheep's, chickens, hens and live poultry and other livestock and poultry products declined to 18.9, 87.7 and 53% respectively. Manufacturing the forestry and fishery products by increased 38% carriers' cost would decrease 60.7 and 0.8%. However, in this scenario, the honey and bee products and other agricultural products faced 6.3 and 2% production growth respectively.

The results (Table 2) showed that in the fourth scenario only two factors, oil gas and electricity were taken into account. The results suggest that production change of products associated with reduced production has been neutralized approximately from one to two percent in a situation where all energy carriers' costs increased.

In line with targeted subsidies of energy carriers and increasing prices, manufacturers can compensate part of increasing costs by changing technology and using energy and also, consumers can reduce some load of increased prices by changing energy consumption pattern. In other words, they substitute expensive energy with cheaper energy.

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