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Food Security Impacts of Increasing Energy Prices on Iranian Meat Market

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Abstract;

In accordance with the Iranian government intention toward two step forward elimination of energy subsidies policy in coming years, we focus in this study on the extent by which the corresponding raising costs will be distributed across the livestock sector and how they affected food security. For this purpose, scenario of increasing energy prices and improving productivity at vertical and horizontal meat market is applied by a multi-market equilibrium displacement model to Iranian livestock sector for next five years. Results show that changing the price of poultry and beef have the highest impacts on animal protein intake. Improving productivity could compensate decreasing of protein and calorie intakes for successive four years but not at the last year.

Keywords: Equilibrium Displacement Model, Meat Market, Energy Prices, Food Safety.

Introduction

Policies of the Fifth Five-year Socio Economic Development Plan of Iran stress on the improvement of factors such as air quality and food security, reduction of risks and infections that threatens health as well as modification of dietary patterns by improving food composition and safety. To this end, the government is required to support measures to increase production of animal protein obtained from livestock and poultry.

That said, the Iranian targeted subsidy plan started in 2010 and increased energy prices significantly. The increase in energy price after the implementation of targeted subsidies included gasoline (3.6-6.2 times), kerosene (5.4 times), gas oil (8.1-18.9 times) and fuel oil (18.8 times) (Department of Energy, 2010). Based on the targeted subsidy plan, after the base year, energy prices are determined based on the exchange price considered in the annual budget. The purpose is to make domestic energy

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prices close or equal to world energy prices that is believed to be achieved at a 5 year period.

Implication of second phase of elimination of energy subsidy has started at 2013. The Prices per liter of gasoline increased from 4000 to 7000 Rials, gas oil from 1500 to 2500 Rials, kerosene from 1000 to 1500 Rials, liquid gas from 1800 to 2100 Rials and gas from 1500 to 3000 Rials.

Among the production units, energy consumption share of livestock and poultry industry in the agricultural sector is more than 40 % of the sector (Department of Energy, 2010). The real prices of energy implemented as required by the plan have changed the production costs which in turn have changed the final costs of meat production and supply. This has led to variation in meat prices and substitution of meat types in dietary patterns that can affect food security in families.

In terms of supply of animal protein, meat has an important role in nutrition and a major share in family food expenditure so that the willingness to consume it has been obvious in the country's consumer culture. On the other hand, according to international standards, every individual needs 70 grams of protein a day (for average body weight of 70 kg). About one-quarter of this amount (25 g) should be animal protein (Safavi, 2001 and Najafi and Shooshtarian, 2004). The highest proportion of animal protein and calorie intake belongs to red meat and poultry meat (Fathi and Bakhshoodeh, 2010). With implementing the second phase of targeted subsidy plan, it is important to get familiar with the effects of this policy on the livestock and poultry industry. Changes in livestock prices due to increased production and transport costs have increased the consumer price and have led to changes in the intake of animal protein and calories. With the introduction of this plan and recognition of its requirement in the country, there has been a need to investigate the effects of increasing energy prices on the livestock and poultry industries and to quantify the effects of these policies. This study is an attempt to investigate the effects of increase in energy prices on beef, sheep and poultry meat prices including on farm and retail prices under various scenarios, the amount of demand and supply and ultimately the effects on food security in Iran.

Technically, sheep and beef producing are resistant to temperature changes so increasing energy prices didn’t have affect them directly, but poultry producer showed greater response on temperature changes.

According to energy optimization company reports approximately 2500 out of the 14356 poultry producers in Iran are equipped by four systems at first phase of abolishing energy subsidies. These systems include isolation, trim heating system, ventilation systems and intelligent control system.

Although energy consumptions decrease by the equipped firms, they could increase chicken in each area by utilizing better breeds of chickens, vaccine and drug administration and suitable poultry nutrition. By implication of second phase of abolishing energy subsidies, the remaining producers are expected to react and to offset increasing costs by improving their productivities. For this, poultry firms presumably react as the same way as the first phase of abolishing energy subsidies.

Many studies have been carried out on goods subsidy and its impact on food security and include Bakhshoodeh and Abdeshahi (2003), Dini Torkamani (2005), Farajzadeh. and Najafi (2004), Najafi and Shooshtarian (2004), Heydari et al., (2007), Jafari Sani (2006), Goodarzi et al. (2007) and Majaver Hosseini (2007). In these studies, calorie intake from food has been introduced as food security index. It seems that there is a gap calling for other indices, especially family protein intake index. Muth (1964) used the EDM model for policy analysis by determining the elasticity of demand for production factors and supply function for an industry with one product and two inputs. Gardner (1975) expanded the model to a competitive industry and Piggott (1992) completed it. Analysis of different policies which generate exogenous shocks in different markets has been carried out by Zhao et al., (2000), Hill et al., (2001), Lusk and Anderson (2004), Balagtas and Kim (2007), Jones (2010) and Okrent and Alston (2012).

In the present study, food security is analyzed as affected by elimination of energy subsidies using Equilibrium Displacement Model (EDM) (relationship between vertical and horizontal markets) for meat products in Iranian to investigate direct effects of the policy on changes in supply and reactions of producers by improving productivity at different levels. Changes in family nutrition as well as the indirect effects were measured.

Materials and Methods

Equilibrium displacement models (EDMs) are used in applied economic and allow the researchers to focus on results of various supply and demand shifters. To determine the effects of abolishing energy subsidies on meat

producers and consumers, the model in this study comprises horizontally linked beef, sheep, and poultry demands at the retail level (R) as well as vertical linkages between the farm (F) and retail sectors. The model permits demand and supply by elasticity and proportional form in (1)-(12) equations. Where the subscripts B, P, and C denote beef, poultry and sheep, respectively. Equations (1)-(3) are demand equations in elasticity form for beef, poultry and sheep, respectively. Equations (4)-(6) are mark-up equations for each meat (or inverse retail supply curves); equations (7)-(9) represent derived demand for beef, poultry and sheep, respectively, and equations (10)-(12) are farm-level inverse supply curves for beef, poultry and sheep, respectively.

The terms $\hat{Q}_P^R, \hat{Q}_B^R, \hat{Q}_C^R$ denote percentage changes in quantity and $\hat{P}_P^R$, $\hat{P}_B^R, \hat{P}_C^R$, percentage changes in price of poultry, beef and sheep meats respectively in retail market level, (i.e. $d\ln(Q) \cong dQ/Q = \hat{Q}$). $\hat{Q}_P^F$, $\hat{Q}_B^F$, $\hat{Q}_C^F$ percentage changes in quantity and $\hat{P}_P^F, \hat{P}_B^F, \hat{P}_C^F$ percentage changes in price of denote, poultry, beef and sheep meats respectively in farm market level. In equations (1)-(3) η_{ij} is demand elasticities, S_i is the farmers' share of the retail in Rials and is defined as $S_i = \frac{Q_i^F P_i^F}{P_i^R Q_i^R}$ (i=B, P and C). In equations (7)-(9) σ is the elasticity of substitution between meat i (i=B, P and C) and marketing inputs and ε is the supply elasticity at farm level. Exogenous shocks to the system of equations are given by δ_i and κ_i where δ_i represents the percentage change in the initial equilibrium price for meat i due to an exogenous demand shift. In this study, δ_i is zero because the other conditions are assumed to be fixed. κ_i represent exogenous shocks, expressed in percentage terms, to farm supply. These parameters are negative because increasing cost occurs by abolishing energy subsidies and also positive by improving productivity of poultry production sector because its cost of production reduces.

Improved productivity of poultry production is modeled as reducing cost of production in the relevant sectors. This can be seen as an outward or downward supply shift.

The exogenous shifters examined are improved productivity and increasing energy prices in Iranian meat market measures. The relationships among changes in all endogenous variables due to exogenous

shifters can be derived by totally differentiating the system of equations at the initial equilibrium points. Changes in prices and quantities in all markets due to this exogenous shift are estimated, and consequent changes in food safety are presented.

$$\hat{Q}_B^R = \eta_{BB}(\hat{P}_B^R - \delta_B) + \eta_{BP}(\hat{P}_P^R - \delta_P) + \eta_{BC}(\hat{P}_C^R - \delta_C) \quad (1)$$

$$\hat{Q}_P^R = \eta_{PB}(\hat{P}_B^R - \delta_B) + \eta_{PP}(\hat{P}_P^R - \delta_P) + \eta_{PC}(\hat{P}_C^R - \delta_C) \quad (2)$$

$$\hat{Q}_C^R = \eta_{CB}(\hat{P}_B^R - \delta_B) + \eta_{CP}(\hat{P}_P^R - \delta_P) + \eta_{CC}(\hat{P}_C^R - \delta_C) \quad (3)$$

$$\hat{P}_B^R = S_B \hat{P}_B^F \quad (4)$$

$$\hat{P}_P^R = S_P \hat{P}_P^F \quad (5)$$

$$\hat{P}_C^R = S_C \hat{P}_C^F \quad (6)$$

$$\hat{Q}_B^F = -(1 - S_B)\sigma_B \hat{P}_B^F - \sigma_B \gamma_B + \hat{Q}_B^R \quad (7)$$

$$\hat{Q}_P^F = -(1 - S_P)\sigma_P \hat{P}_P^F - \sigma_P \gamma_P + \hat{Q}_P^R \quad (8)$$

$$\hat{Q}_C^F = -(1 - S_C)\sigma_C \hat{P}_C^F - \sigma_C \gamma_C + \hat{Q}_C^R \quad (9)$$

$$\hat{P}_B^F = (1/\varepsilon_B)\hat{Q}_B^F - \kappa_B \quad (10)$$

$$\hat{P}_P^F = (1/\varepsilon_P)\hat{Q}_P^F - \kappa_P \quad (11)$$

$$\hat{P}_C^F = (1/\varepsilon_C)\hat{Q}_C^F - \kappa_C \quad (12)$$

All sectors in this study are characterized by perfect competition as shown by Hosseni et al. (2008) for beef and sheep markets at farm and retail levels and by Hosseni and Permeh, (2010) for poultry market at farm and retail levels. Therefore, the shocks κ_i in the model is to be total abolishing of energy subsidies cost as a percent of average total production value. In the long-run competitive equilibrium, a change in the cost per unit produced is approximately equal to the change in marginal cost. The change in marginal cost κ_i is:

$$\kappa_i = \frac{C_i \overline{Q}_i}{P_i^F \, {}_i\overline{Q}_i} = \frac{C_i}{P_i^F} \qquad i = B, P \text{ and } C \quad (13)$$

In equation (13), $\overline{Q_i}$ is average quantity produced by poultry, beef and sheep. The rising energy prices have been stated in the introduction of this study. Approximately, a period of five years is needed to close domestic price to the world prices.

Scenarios for energy price rise are created following five steps as the same as first phase of abolishing energy subsidy. At first year, according to what has been mentioned above, increase is created in the prices of energy carriers. After this step and change in balance, second year is considered as the second stage. Up to this point we have about 30 % of farm poultry equipped. This process continues up to the fifth year.

In this study, to calculate the effect of improving productivity, it was necessary to calculate the cost reduction in poultry production resulting from improved productivity as the same as poultry producers in the first phase of implementing the policy. For this, reaction of producers assumed as the same as the first phase, that is each year 2500 poultry farm equipped by four systems.

The structural model of demand and supply relationships for the Iran meat market and source of them are presented in Table 1 at appendix.

Implication of abolishing energy subsidies cases change of retail meat prices. This has led to variation in meat prices and substitution of meat types in dietary patterns that can affect food security. Price elasticity of protein and calories for each type of meat is given by equation (14). In this equation, S_j is proportion of jth meat in protein and calories, e_{ji} is price elasticity of jth meat with respect to the ith meat:

$$e_{Mi} = (\partial Q_M / \partial P_i)(P_i / Q_M) = \sum_j s_j e_{ji} \qquad i = B, P \text{ and } C \qquad M = \text{Calories, Protein} \tag{14}$$

Quantity percentage changes of protein and calories at result of abolishing energy subsidies is (Laraki, 1989):

$$\frac{dQ_M}{Q_M} = \sum_i e_{Mi}\left(dP_i^R / P_i^R\right) = \sum_i e_{Mi}\hat{P}_i^R \qquad i = B, P \text{ and } C \qquad M = \text{Calories, Protein} \tag{15}$$

In equation (15), $\hat{P}_i^R$ is price percentage changes resulting from the EDM. Income elasticity of protein and calories (μ_M) are defined at equation 16. In this equation, μ_i is the meat income elasticity:

$$\mu_M = \sum_{i=1}^{n} \mu_i s_i \qquad i = B, P \text{ and } C \qquad M = \text{Calories , Protein} \tag{16}$$

Results

To examine the effects of energy price increase, the changes in the marginal cost and the shock on supply function were calculated and presented at Table 1.

Table l: Annual cost and production value by sheep, beef and poultry productions

	sheep	**beef**	**poultry**
Total of energy cost (million rails)	8596	119.89	2264683.45
Total production (tone)	318800	171000	1907194
Value of sales (million rails)	6570.787	8168.499	4353
Energy cost as percent of producers sales	1.3	1.5	5.2

Different scenarios were defined for changes in fuel costs of the units relative to production value in the base year and the shock on the supply function was calculated. According to results of this table, energy consumption has no significant effect on sheep production in Iran. To explain this, we can say that herds of small ruminants in Iran are bred by farmers in villages and by nomads. In both cases, pastures are used to feed them; therefore, no energy is required compared to production of poultry, which requires considerable energy consumption (Kamalzadeh et al., 2008). In raising poultry production which has a share of about 40 % of energy use in the agriculture sector, share of energy in sales value is approximately equal to 5.2 percent.

The case of increase in productivity that offset reduction in supply caused by abolishing energy subsidies was also considered in scenarios of energy price increase. Results of prices and quantity changes showed at table 2.

Although energy price increase has the highest effect on poultry market in terms of increase in marginal cost, in the 2015, the price and quantity show more variation in beef and sheep market, because an increase in poultry quantity leads to substitution with beef and sheep. However, price and quantity changes occur due to reduced supply. The improved productivity offsets the effect of supply reduction between 2015 and 2018.

At the first year of simulation, as expected, poultry price increases more than those of beef and sheep because the marginal cost of producing poultry increases sharply.

In 2014, the poultry price is significantly affected and beef and sheep prices increase by the policy. In 2015, 2016 and 2017 continuing increase in energy prices and improving productivity causes poultry market to be more affected and prices of poultry at farm and retail levels decrease. This is because more than 80% of poultry farms improve their productivities within four years and so production of poultry at farm level goes up. This is while at 2018, improving productivity can't offset increasing cost of abolishing energy subsidies, for the reason that increasing prices of energy is more than value of increasing production.

Table 2: Percentage changes in the endogenous variables for each simulation

Years		Markets	Poultry	Sheep	Beef
2014	Price	Retail Level	0.455	0.205	0.258
		Farm level	0.716	0.453	0.413
	Quantity	Retail Level	-0.405	-0.236	-0.112
		Farm level	-0.489	-0.300	-0.172
2015	Price	Retail Level	-0.061	0.212	0.556
		Farm level	-0.096	0.469	0.890
	Quantity	Retail Level	0.054	-0.244	-0.241
		Farm level	0.065	-0.289	-0.357
2016	Price	Retail Level	-0.364	0.175	0.472
		Farm level	-0.572	0.387	0.755
	Quantity	Retail Level	0.324	-0.202	-0.205
		Farm level	0.454	-0.344	-0.405
2017	Price	Retail Level	-0.364	0.175	0.472
		Farm level	-0.572	0.387	0.755
	Quantity	Retail Level	1.270	-0.426	-0.313
		Farm level	1.780	-0.726	-0.618
2018	Price	Retail Level	1.192	0.390	0.869
		Farm level	1.876	0.861	1.390
	Quantity	Retail Level	-1.061	-0.448	-0.377
		Farm level	-1.487	-0.764	-0.745

To investigate the effects of price policies on family nutrient intake, it is necessary to use elasticities of nutrient elements instead of calculating price elasticities. These elasticities show the impact of price policies on nutrient intake of families as shown in Table 3.

Table 3: Price and Income Elasticity of Protein and Calorie of Meat

	Beef	Sheep	Poultry
Protein price elasticity	-16.22	-27.2	-29.5
Calories price elasticity	-23.5	-35.1	-28.9
Protein income elasticity			35.7
Calories income elasticity			25.8

As result of one percent increase in prices of beef, sheep and poultry, all other conditions being constant, animal protein intake decreases by 16.22, 27.2 and 29.5 percent, respectively. A percentage change in the poultry price has the greatest effect on protein intake. In other words, the consumers are more sensitive to change in poultry price as related to protein intake and show more intense reactions. Changes in beef, sheep and poultry prices reversely change calories intake by 23.5, 35.1 and 28.9.

Income elasticity of protein and calories show that a percent increase in family income increases family animal protein and calorie intake by 35.7 and 25.8 percent and thus animal protein products are considered normal.

Given these elasticities and based on scenarios created, increase in prices of energy carriers, the effects of dietary changes are shown in Table (4).The results show that the highest effect of price increase (due to elimination of energy subsidies) on family calorie intake belongs to poultry. After first year, this effect reduces and poultry is substituted for beef and sheep. In 2014 increase in energy prices with changing productivity lead to an increase of 0.455, 0.205 and 0.258 presents in retail price of poultry, beef and sheep. It reduces by 13.167 and 13.463 percent of calories and protein intake from poultry, 7.181 and 5.577 percent of calories and protein intake from beef and 6.065 percent of calories and 4.185 percent of protein intake from sheep. By increasing productivity until 2017 calories and protein intake increases.

As can be seen in Table 4, for the same percent exogenous shift in the relevant market, improved productivity of poultry production resulting from government intervention at 2017 has the largest protein and calories intake (11.365 and 20.438 percent). Meanwhile, the steep rise energy

prices at 2018, decrease protein and calories intake (68.543 and 59.937 percent) because increased productivity by increasing production are unable to offset increased costs due to increases energy prices.

Table 4: Percentage of changes in calories and animal protein intake of Iranian families as a result of different scenarios of raising prices of energy carriers

		Poultry	Sheep	Beef	Total
2014	Calorie	-13.167	-7.181	-6.065	-26.413
	Protein	-13.463	-5.577	-4.185	-23.224
2015	Calorie	1.762	-7.443	-13.077	-18.759
	Protein	1.801	-5.780	-9.023	-13.002
2016	Calorie	10.518	-6.144	-11.090	-6.716
	Protein	10.754	-4.771	-7.652	-1.669
2017	Calorie	41.262	-12.970	-16.927	11.365
	Protein	42.189	-10.072	-11.680	20.438
2018	Calorie	-34.474	-13.645	-20.424	-68.543
	Protein	-35.249	-10.597	-14.092	-59.937

Poultry is relatively cheaper than other meats and constitutes a greater proportion of protein and calories intake among Iranian families. With implementation of the policies that increases energy prices, poultry price increases. Therefore, changes in intake from poultry are more significant than other products. As a result of the increased productivity, beef and sheep have a smaller proportion of protein and calories intake among families. However, as the results show, with the increasing energy prices, total protein and calorie intake increase. That is because with implementation of such price policies, poultry production increases in futures years by improving productivity. In this case, increased production alongside improving productivities, a result of reaction of poultry producers lead to a sharp decrease in price and as a result higher animal protein intake.

Conclusions and recommendations

Information on the improving of productivity is limited and therefore evaluation of the policies is required to guide future policy development. In this paper, an economic model of the Iranian meat market was developed to simulate various policies and exogenous changes to intake

calories and proteins. The results show that if the improved productivity is not proportional to the increase in production, it does not have a positive impact on families' food intake. The increases in prices of energy carriers have different effects on the production of meat. Increased prices of energy carriers encourage sheep production, because the increase in energy price does not have a significant effect on the industry which uses pastures as main feeding resource. Moreover, increased poultry, beef and sheep prices in 2014 and 2018 leading to substitution with sheep result to changes in animal protein intake. Because the meat market is competitive, increased supply arising from improved productivity will not lead to an increase in animal protein intake. To this end, production should increase so that the price is reduced and the family protein and calorie intake gets close to international standards. In other words, the supply shock effect should be neutral. Results show that increasing energy prices simultaneously improving productivity from 2015 to 2017 (during which most poultry farms equip with four systems), could offset the policy and at 2018 improving productivity may not compensate increasing energy prices because at 2018 more than 80% of existing poultry farm are assumed to be equipped with four systems and after this year, poultry farm face growing cost by increasing energy prices. It is recommended that producers be supported to modernize production industry for at least four years.

Moreover, to counter negative effects of the increase in prices of energy carriers, poultry production system that consumes a large share of energy should be modified to increase productivity that government intervention needed.

However more research is needed in several areas. In particular, since the data are quite scarce and there is much uncertainty about some of the assumptions made, such as reaction of poultry producers to improve productivity, different assumptions based on the available evidences are required to ensure that the generated results are not highly dependent on particular assumed values.

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Appendix

Reference	Value	Parameter
estimated	0.453	S_C
estimated	0.925	S_P
estimated	0.625	S_B
Fathi and Bakhshoodeh (2012)	0.26	σ_C
Fathi and Bakhshoodeh (2012)	0.319	σ_P
Fathi and Bakhshoodeh (2012)	0.389	σ_B
Fathi and Bakhshoodeh (2012)	0.671	ε_C
Fathi and Bakhshoodeh (2012)	0.623	ε_P
Fathi and Bakhshoodeh (2012)	0.353	ε_B
Falsafian and Ghahremanzadeh (2012)	-0.93	η_{BB}
Falsafian and Ghahremanzadeh (2012)	-1.17	η_{CC}
Falsafian and Ghahremanzadeh (2012)	-0.79	η_{PP}
Falsafian and Ghahremanzadeh (2012)	0.32	η_{BC}
Falsafian and Ghahremanzadeh (2012)	0.17	η_{CB}
Falsafian and Ghahremanzadeh (2012)	-0.096	η_{CP}
Falsafian and Ghahremanzadeh (2012)	0.076	η_{PB}
Falsafian and Ghahremanzadeh (2012)	-0.17	η_{PC}
Falsafian and Ghahremanzadeh (2012)	0.14	η_{BP}