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A Welfare Analysis of Wheat Self-Sufficiency Policy and the Influence on the Barley Market in Iran: A Game Theory Approach

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ABSTRACT- Iran achieved its self-sufficiency goal in wheat production a few years ago, perhaps at the expense of decreasing the production of other grains specially barley as stated by critics in the country. Considering the dependency of wheat and barley markets on each other, policy preference functions were estimated separately for each market. Incorporating political weights, a game theory approach was utilized to investigate welfare impacts of such attempt. Results not only justified the critics' claims, but also indicated that welfare had been transmitted from wheat producers to consumers and the government. Also despite the positive welfare surplus of producers and consumers in the wheat market, high government expenses have led to welfare losses, while barley is associated with welfare gains. Finally, an overall Nash equilibrium occurs as the best strategy between the two markets with a 15% increase in the consumer price of wheat and a 20% decrease in barley production costs. These results undoubtedly imply that optimal social welfare is associated with mitigating the government's role in the wheat market.

Keywords: Game Theory, Iran, Political Weighs, Wheat and Barley Markets, Wheat Polices

INTRODUCTION

The main goal of agricultural policies in many countries is food security, which concerns itself with the potential risk of a global shortage of food and its importance for securing the poor. In this context, governments intervene in agriculture markets worldwide. Intervention polices of governments in agricultural commodities markets cause welfare to be transmitted among producers, consumers and governments. Experiences of countries such as Japan and Korea show this transmission in the rice market

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(8). In Japan, government interference in the rice market was followed by the transmission of welfare from consumers to producers. In South Korea, welfare transmission in the rice market occurred after the negotiation of the Uruguay round in 1995, so that producers and the government were better off at the expense of consumers (8).

Iranian agricultural policies have aimed at food self-sufficiency on similar grounds after the 1979 revolution, and mitigating wheat imports has been considered as the first and the most important step towards achieving this goal. Wheat is the staple component of the national diet and more than 60% of the country's arable lands are under wheat cultivation. The government has employed a package with various measures to encourage wheat production in order to reduce wheat imports. Productions have thus responded favorably and increased rather satisfactorily ever since. The country achieved self-sufficiency in wheat by early 2000 (2).

In the first step, immediately after the revolution, the government increased producer prices of wheat by about 50% and protected the price to be above equilibrium one all the time. Due to its wide-ranging interventions in the wheat market, the government gradually turned into the market's principal agent. It buys wheat from farmers at guaranteed prices, and after milling, sells the flour to bakeries and other wheat products' processors. Fig. 1 shows the amounts of subsidies paid in wheat markets from 1978 to 2006. The Iranian government also imported large amounts of annual wheat in order to ensure food security for low-income groups.

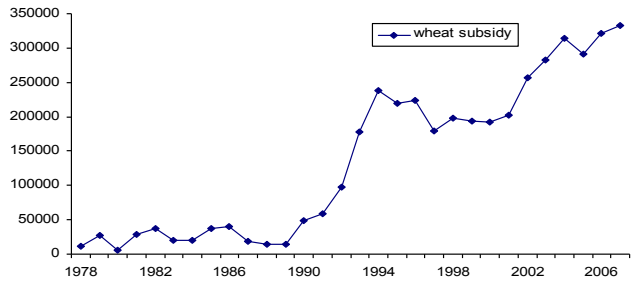


Fig. 1. Wheat subsidy in Iran per capita (Rials)

Furthermore, farming policies such as the establishment of rural cooperatives, modern irrigation systems, farmers' education and improved seeds have had favorable effects on the technical efficiency of wheat production (11). By virtue of such farming and pricing polices, production grew at an annual rate of 3.1% between 1997 and 2006. Compared to the average growth in the Near East and in developing countries, Iranian wheat production has had a desirable rate (5).

Although the self-sufficiency goal in wheat production was achieved in 2005, internal critics of wheat sector policies claim that wheat production has increased at the expense of a decrease in the production of other grains, especially barley. In comparison with other grains, barley has the most similar production conditions as wheat (such as cultivation, growth and harvest time) and when it comes to the use of major inputs, the two are almost same. Such competition can in turn cause the larger use of inputs such as land, water, fertilizers and capital in one product and less use in the other. According to

critics, transmission of resources from the barley market to the wheat market has been the substantial reason for promoting wheat production and any kind of welfare increase in the wheat market is at the expense of welfare reduction in the barley market. Fig. 2, which shows the amount of wheat and barley produced from 1961 to 2007, implicitly confirms this punctilio.

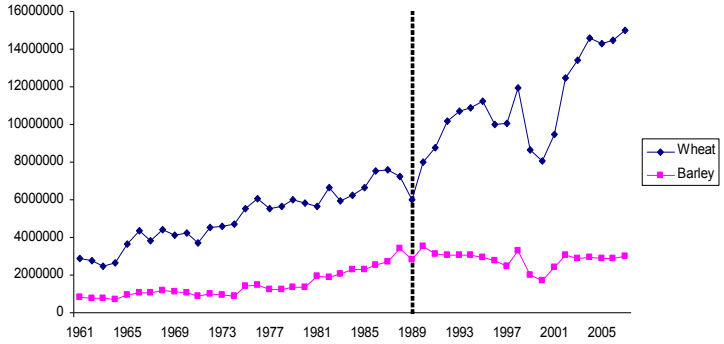


Fig. 2. Wheat and barley production in Iran (ton)

As shown, wheat and barley production steadily increased between 1961 and 1989. Wheat production exhibited rapid growth from 1989 to 1995 with fluctuations increasing in recent years. Barley, however, remained almost constant from 1989 onward. Therefore, the decrease in barley production could be attributed to encouragement policies and the diversion of resources to the wheat market,

More than 80% of the wheat consumption in Iran is for food purposes, predominantly for bread as a staple food. The share of bread in daily calorie requirements of a typical household increased from 34% to 46% in urban households and from 53% to 59% in rural households between 1977 and 1989 (14). Thus, wheat is amongst the main political commodities in Iran.

Applying a political preference function (PPF) is a common way to incorporate political economic components into market research. PPF consists of the surplus welfare of all groups interested in the market. Agricultural economists have estimated PPF in order to examine structural and reforming policies among groups interested in the agricultural sector (15). Im (8), for instance, benefited from PPF in order to analyze the agricultural reforms of rice market liberalization in South Korea. A new usage of PPF is its utilization as a payoff function in game theory models so that first, PPF is separately determined for each of the players and then, the best strategy is assigned to attain maximum welfare (9, 3, 10).

In this study, we investigated the effects of policies performed in the wheat market on the welfare of interested groups (i.e. producers, consumers and government) and its influences on the barley market through the PPF framework incorporating political weights. To determine a suitable strategy that is associated with the highest welfare, a Nash equilibrium was found by analyzing several scenarios within game theory frameworks.

The main contribution of this study is to introduce two markets seeking maximum welfare as players in the game theory approach. Intervention policies were

designed as a dynamic cooperative game model, without the possibility of separating farmers and consumers as either wheat and barley producers or users; hence the existence of common agents in these two markets. Cooperative games are those with full information where each player is aware of the others' decisions and payoffs so that the Nash equilibrium exists and is computable (6). In cooperative games, it is possible to make collusion among players in order to achieve maximum attainable payoff (6).

The next section briefly discusses the methodology including the political preference function and political weights and their estimation in wheat and barley markets.

MATERIALS AND METHODS

Regarding the fact that the government is a main element of decision making in agricultural markets and its policies become enforced by consumers and producers in the markets, we modeled wheat and barley markets as players in a two player cooperative game. To construct the game, we first needed to estimate PPF and evaluate the political weights of interest groups in these markets. The PPF could then be used as a payoff function in the game theory model. The PPF for the government is:

$$V = \sum_{t=0}^{\infty} \beta^t V_t(\Delta CS, \Delta PS, \Delta GS), \quad (1)$$

where ΔGS is the change in consumers' surplus, ΔPS is the change in producers' surplus, ΔG is the change in budget expenditure attributable to the government intervention, V_t is the instantaneous value function representing the government's preference at time t and β is a discount factor. The sum of consumers and producers' surplus is explained as a relevant measure of economic efficiency. According to (1) the distribution of benefits between consumers and producers could be important, so it is reasonable to treat their surplus separately. The third argument in (1) is government expenditures. The importance of the three components of PPF is twofold. First, due to the economical aspect, it is assumed that $\frac{\partial V}{\partial(\Delta CS)}, \frac{\partial V}{\partial(\Delta PS)} \succ 0$ and $\frac{\partial V}{\partial(\Delta GS)} \prec 0$. As a special case, when $V = \Delta CS + \Delta PS - \Delta GS$, the value function of PPF and the standard benefit-cost analysis of public policies are identical. Second, PPF is relevant to the selection of policy tools. This feature can be interpreted as the political aspect of PPF. Since policy instruments affect CS, PS, and G, the best choice of tools changes the function of (1) towards a maximum value (13).

In the policy-making process, governments consider the effects of their policies on consumers and taxpayers. Since these policies can make some groups more affluent at the expense of others, governments weigh the welfare gains of one group against the welfare losses of others. Such political weights can be determined through three main approaches in a political economic behavior model; a direct approach consists of interviews with policymakers to obtain the political weights. In an indirect approach or revealed preference method, policy preference weights can be inferred by optimizing the PPF subjected to appropriate constraints. Finally, utilizing an arbitrary approach, researchers simply choose political weights according to their own beliefs (16).

In this study, the second approach was used to determine political weights. Hence, rewriting PPF, we will have:

$$V = W_P \int_{P_W}^{P_S} S(P)dp + W_c \int_{P_W}^{P_D} D(P)dp$$
$$- W_G \{[\alpha P_S S(P_S) - \beta P_D D(P_D)] + [P_W (D(P_D) - S(P_S))] - [\tau (D(P_D) - S(P_S))]\}, \qquad (2)$$

where W_P, W_C and W_G represent producer, consumer and government political weights, $S(P)$ and $D(P)$ indicate supply and demand functions, and P_W, P_S, P_D and τ denote world price, producer price, domestic price and tariff ratio. Proportions purchased and sold by the government are represented by α and β. The third argument in (2), the government surplus, consists of three main components: direct purchase expenditure, state importing cost and the income tariff from private importers. Following Lee *et al* (10), in order to determine political weights, PPF was optimized with respect to P_D and P_S, defined in equations (3) and (4) as:

$$W_P = \frac{-3\alpha\varepsilon \mathrm{K}_1}{1 - \alpha\varepsilon \mathrm{K}_1 + \beta\eta \mathrm{K}_2}$$
$$W_C = \frac{3\beta\eta \mathrm{K}_2}{1 - \alpha\varepsilon \mathrm{K}_1 + \beta\eta \mathrm{K}_2} \qquad (3)$$
$$W_G = 3 - W_P - W_C,$$

where K_1 and K_2 are defined as

$$\mathrm{K}_1 = \left\{ \frac{P_S - P_W - \tau}{P_S} + \left(1 - \frac{1}{\alpha}\right) \frac{P_W + \tau}{P_S} + \frac{1}{\varepsilon} \right\} \qquad (4)$$
$$\mathrm{K}_2 = \left\{ \frac{P_D - P_W - \tau}{P_D} + \left(1 - \frac{1}{\beta}\right) \frac{P_W + \tau}{P_D} + \frac{1}{\eta} \right\},$$

and ε and η are the supply and demand price elasticities. For the purpose of this study, only relative weights were considered. Hence, the weights are normalized so that $W_P + W_C + W_G = 3$. In other words, the particular normalization chosen implies that in the case of no government intervention, $W_P = W_C = W_G = 1$. If any of these weights is over (less) than one, the related group of this weight will be favored (disfavored) from performing the policies. As stated earlier, it is possible to use equation (2) as a payoff function in the game theory model.

Specification and Estimation of Supply and Demand

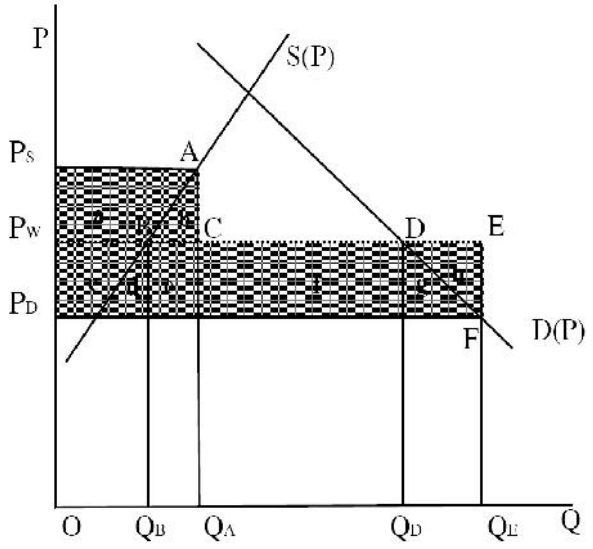
Due to the fixity of inputs and imperfect information, farmers tend to have a lagged response to market prices; a partial adjustment model (12) is therefore hypothesized to specify supply in the two markets. The model used for wheat and barley markets is composed of two equations: domestic acreage response and per capita consumption. Two identities are used to define supply and demand functions:

$$S(P)_{it} = yield_{it} \times Acreage_{it} - self\ consumptio\ n_{it} \qquad (5)$$
$$D(P)_{it} = per\ capita\ \ consumptio\ n_{it} \times population_{it} \qquad (6)$$
$$i = Wheat\ ,\ Barley \qquad t = 1971,...,2006$$

where self consumption is approximately 10% of the total production every year.

There are two important remarks in identities (5) and (6). First, regarding the fact that farmers have no control on yield, especially in the short-run, domestic acreage might be their only decision tool. Therefore, any change in economical conditions is expected to influence domestic acreage and production and marketable supply. Moreover, the yield function only describes the technical relation between the inputs and output, and is commonly applied to determine the optimum use of inputs, scale analysis and production efficiency. As a result, only acreage function, which consists of all instruments, is estimated for making the scenario. Second, similar to yield function, population is also considered to be exogenous; therefore, a per capita consumption model is also made up of adequate tools for making scenarios. Finally, with respect to identities (5) and (6) we can estimate supply and demand functions.

The Iranian government is performing a mutual subsidy system in the wheat market to encourage wheat production and secure the poor. The government sets a producer floor price and guarantees to buy at this specified price. In contrast, the price ceiling, which is fixed by the world price, is employed to support consumers. Fig. 3 shows the welfare effects of different policies in the Iranian wheat market. In this Fig., $S(P)$ and $D(P)$ represent supply and demand curves, and P_S, P_D, P_W denote producer, consumer and world prices. The price ceiling policy reduces domestic production and increases consumption, leading to a shortage equal to Q_AQ_D, to be imported by the government at the world price. On the other hand, the producer price is set higher than the world price, leading to an increased production equal to Q_BQ_A.



Government cost
Domestic purchase= OP_SAQ_A
Import= Q_AQ_ECE
Total cost= $OP_SAQ_A+Q_AQ_ECE$
Government gain= OP_DFQ_E
ΔGS = a+b+c+d+e+f+g+h
ΔCS = c+d+e+f+g
ΔPS = a
V = -(b+h)

Fig. 3. The effect of mutual policy in the wheat market of Iran

According to Fig. 3, this mutual subsidy system in the wheat market is associated with welfare losses equal to the –b-h area. In other words, government expenditure is not transmitted to producers and consumers perfectly. However, in the barley market the

government's role is negligible. Private importing agents usually import barley, and the government gains an income tariff by imposing a fixed tariff rate. Therefore, government expenditure is introduced in each market in the following order:

$$\Delta GS_w = 0.8\, S(P)_{wt}^{*}\ P_{sw} + 0.8 P_{Dw}\, D(P)_{wt} \quad (7)$$

$$\Delta GS_B = 0.5 S(P)_{Bt}^{*}\ P_{sB} + [t\,(D\,(P_{DB}) - S(P_{SB}))] \quad (8)$$

where P_{SW} and P_{SB} are producers' prices and P_{DW} and P_{DB} are consumers' prices in the wheat and barley markets respectively.

According to (7) and (8), the government purchases and sells 80% of the wheat (at floor and ceiling prices) and only 5% of the total barley annual productions (the Iranian Ministry of Agriculture, 2006).

Since Iran is self-sufficient in wheat production, the domestic demand for wheat is equal to the domestic supply; therefore, $S(P)_{wt}=D(P)_{wt}=Q\rightarrow GS_W=(P_D-P_S)Q$ is another explanation for the total subsidy payment in the wheat market.

The separation of the agents (i.e. producers and consumers) in wheat and barley markets is impossible, causing the welfare of each market to reciprocally influence the welfare of the other. Furthermore, to optimize social welfare in the agricultural sector, desirable agricultural policies should have a tendency to maximize welfare in each market. In order to achieve this goal, it is very important to find the best political strategy in the agricultural sector. In the present work, we studied the strategies between wheat and barley markets considering two instruments; the production cost of barley and the consumer price of wheat. These two instruments were selected to create a strategy on account of the consumers and producers, both to incorporate them widely for making decisions about wheat and barley cultivation and to carry out their expectations about production conditions. Therefore, using the mentioned tools within the framework of dynamic game theory, several strategies were investigated and a Nash equilibrium was founded. To assign the Nash equilibrium, G is considered as a normal form game, involving N players as follows (7):

$$G = \left(S_1, S_1, ..., S_i, ..., S_N, U_1, U_1, ..., U_i, ..., U_N\right) \qquad i = 1,2,...N \quad (9)$$

Each player chooses among a finite set of strategies S_i. In other words, player i (i = 1, …, N) has access to strategy set S_i from which they choose strategy $\sigma_i \in S_i$. Player i'*s* payoff, U_i, then, depends not only on their choice of strategy but on the whole set of strategic choices $(\sigma_1, \sigma_2, ..., \sigma_i, ..., \sigma_n)$ by all players (including their own). Therefore,

$$U_i = U_i(\sigma_1, \sigma_2, ..., \sigma_i, ..., \sigma_n) \quad (10)$$

A set of pure strategies $S^* = (\sigma_1^*, \sigma_2^*, ..., \sigma_i^*, ..., \sigma_N^*)$ where $S^* \in (S_1 \times S_2 \times ... \times S_i \times ... \times S_N)$ constitutes the Nash equilibrium if and only if for the i*th* player:

$$U_i(\sigma_1^*, \sigma_2^*, ..., \sigma_i^*, ..., \sigma_N^*) \geq U_i(\sigma_1^*, \sigma_2^*, ..., \sigma, ..., \sigma_N^*) \qquad \sigma \in S_i \quad (11)$$

Pure strategy σ_i^* is a best reply to the combination of strategies of all other players in S^* for all i = 1, …, N. As a consequence, if for all i = 1, …, N, i chooses their pure strategy in S^*, each player's predictions of their opponents' behavior will be confirmed (1). For our purpose, we considered the two markets as two players, five

strategies designed for each. Strategies with more details are presented in the next sections.

Data and Variables

Time series (1971- 2007) were collected from FAO statistic database and other sources such as the cost of production database (published annually by the Iranian Ministry of Agriculture) for the following variables; per capita consumption (PCON), production of each crop (PRO), domestic acreage (ACR), real exchange rate (REX), wholesale consumers' price (P_D), producers' price (P_S), production cost (PC), consumer price index (CPI), population (POP), yield of each crop (YIELD), national income (INCOME), world prices (P_W) and import tariff ratio (τ). All domestic prices were adjusted through CPI. World prices (border prices) were changed into domestic prices through real exchange rates, and were then transformed to wholesale prices by adding transfer costs.

In order to estimate functions, we first examined the existence of unit roots in the time series data by performing a Dickey–Fuller test. Per capita consumption of wheat was considered as a function of the consumer price of wheat, income, consumer price of barley and the lagged per capita consumption. In order to find an optimal estimation strategy, the Hausman simultaneous bias test was performed for each of the equations. The Breusch and Pagan diagonal test was also conducted. Results showed no simultaneous bias so we estimated the equations separately (4).

RESULTS and DISCUSSIONS

Equations (12) and (13) indicate per capita demand and acreage functions for wheat and the corresponding t statistics for each coefficient. Several functional forms were estimated and the mutual logarithmic form was shown to be associated with the best coefficients. Therefore, the estimated coefficients were interpreted as price and income elasticity of demand.

$$\underset{}{Ln(PCON_W)} = \underset{4.8}{3.52} - \underset{-3.803}{0.321}Ln(P_{DW}) + \underset{-2.506}{0.336}Ln(INC) + \underset{6.71}{0.365}Ln(P_{DB}) + \underset{3.15}{0.252}Ln(PCON)_{-1} \quad (12)$$

$$R^2 = 0.81$$

$$\underset{}{Ln(ACR_W)} = \underset{12.9}{10} - \underset{-3.49}{0.03}Ln(PC_W) + \underset{2.88}{0.185}Ln(P_{SW})_{-1} + \underset{5.38}{0.073}Ln(PC_B) + \underset{6.7}{0.625}Ln(ACR_W)_{-1} \quad (13)$$

$$R^2 = 0.52$$

All coefficients are in line with the expectations and a significance level of at least 10%. The own-price elasticity of demand for wheat was -0.321, as indicated by the $Ln(P_{DW})$ coefficient. One percent barely price increment was found to lead to an increase in wheat consumption by 0.365%.

Acreage is defined as a function of wheat production cost, lagged producer price of wheat, barley production cost and the lagged acreage harvested. Following the estimation of the acreage function through OLS, we found evidence regarding the existence of *heteroskedastisity* in the model. Since suitable tools to perform GLS could not be found, acreage function was estimated by Generalized Methods of Moments (GMM). Again, all coefficients were in line with expectations and significant at the 10%

level. Results, which are in favor of the critics, show that for a 1% increase in production costs of barley, wheat acreage increased about 0.073%.

Per capita consumption and acreage functions for barley are shown in equations (14) and (15). In these two functions, the coefficients are all significant at the 10% level. It is observed that a 1% increase in the barley consumer price leads to a per capita decrease in its consumption demand by 0.28%. Barely consumption decreases about 0.36% as a result of the consumers' 1% income increase. The results also show that the consumption of barley increases with the consumer price of wheat. As a result, these two products substitute each other.

$$\underset{}{Ln(PCON)} = \underset{2.93}{3.57} - \underset{-2.24}{0.284}\, Ln(P_{DB}) + \underset{3.13}{0.359}\, Ln(INC) + \underset{2.26}{0.532}\, Ln(P_{DW}) \qquad (14)$$

$$R^2 = 0.91$$

$$Ln(ACR_B) = \underset{-2.47}{-0.113}\, Ln(PC_B) + \underset{1.95}{0.293}\, Ln(P_{SB}) + \underset{3.96}{0.525}\, Ln(ACR_B)_{-1} - \underset{-2.27}{0.208}\, Ln(ACR_W) \qquad (15)$$

$$R^2 = 0.80$$

Conforming to our expectations, barley production costs, its producer price and harvested wheat acreage all influenced the domestic acreage of barley. All of the variables are statistically significant at the conventional level (95%) with an expected sign.

Considering identities (5) and (6) and equations (12) to (14), supply and demand functions for each market were specified. In the next step, political weights were computable with respect to supply and demand price elasticities of the two markets. Table1 demonstrates the weights for consumers, producers and the government in the two markets in different years.

Table 1. Political weights for wheat and barley markets

	Wheat market			**Barley market**		
	W_C	**W_P**	**W_G**	**W_C**	**W_P**	**W_G**
1971	**1.72**	**0.15**	**1.13**	**0.80**	**1.10**	**1.10**
1976	**1.60**	**0.20**	**1.20**	**0.78**	**0.98**	**1.24**
1981	**1.39**	**0.31**	**1.30**	**0.25**	**1.65**	**1.10**
1986	**1.54**	**0.52**	**0.94**	**0.76**	**1.32**	**0.92**
1991	**1.36**	**0.82**	**0.82**	**0.24**	**1.93**	**0.83**
1996	**1.24**	**0.91**	**0.85**	**0.23**	**2.49**	**0.28**
2001	**1.05**	**0.98**	**0.97**	**0.23**	**2.60**	**0.17**
2006	**1.25**	**0.84**	**0.91**	**0.23**	**2.51**	**0.26**

It can be seen that consumers and the government are better off at the expense of producers in the wheat market. The general trend in this market during the 1980s shows an increase in the producers' share of welfare due to the alleviation of the governments' share. From a welfare point of view, the government has paid more attention to the consumers than the producers, and most wheat market policies have been consumer oriented. For instance, in 2006 the political weights of the government and the producers are found to be 0.91 and 0.84, respectively, while the political weight of the consumers was 1.25. This means that in 2006, wheat policies led to the transmission of welfare from producers and the government to the consumers. On the other hand, in the barley market, producers have had a greater weight than that of the wheat market, so much so

that the benefits of producers has always been preferred over others. It must be mentioned that the level of government interventions in the barley market is negligible as compared to the wheat market. This lack of intervention has gained the producers better welfare status, especially in the long-run.

Welfare surpluses of the markets are calculated with respect to (2) and the political weighs at various years. Table 2 presents welfare surpluses of the two markets. As shown, due to excessive government costs, the wheat market confronted welfare losses confirming area b+h in Fig. 3. In spite of these losses, welfare surpluses of producers and consumers are positive.

Table 2. Total welfare of wheat and barley markets (billon Rials)

	Wheat market				Barley market			
	ΔCS	ΔPS	ΔGS	v	ΔCS	ΔPS	ΔGS	v
1971	**10.86**	**99.96**	**115.04**	**-96.32**	**2.29**	**4.79**	**2.99**	**3.81**
1976	**11.23**	**101.88**	**138.40**	**-127.74**	**2.5**	**5.11**	**3.25**	**2.93**
1981	**11.78**	**104.38**	**112.60**	**-97.65**	**2.66**	**5.61**	**3.75**	**5.80**
1986	**12.17**	**108.25**	**121.44**	**-39.12**	**2.91**	**8.31**	**6.66**	**7.05**
1991	**12.48**	**104.72**	**126.48**	**-0.87**	**3.13**	**6.65**	**5.26**	**9.22**
1996	**12.62**	**110.27**	**143.56**	**-6.03**	**3.29**	**7.14**	**3.68**	**17.50**
2001	**13.15**	**111.30**	**138.04**	**-11.02**	**3.51**	**7.64**	**7.41**	**19.41**
2006	**13.52**	**113.13**	**142.80**	**-18.02**	**3.71**	**5.13**	**1.34**	**13.38**

On the other hand, the total welfare of the barley market was always positive. Welfare surpluses of producers and consumers of the barley market are as positive as those of the wheat market. The results of Table 2 reveal useful information about these markets. For example, the mainspring of increase in wheat production and its consumption as compared to barley are justified in terms of the government's high expenses in the wheat market which cause welfare surpluses of producers and consumers to be larger than those of the barley market. In addition, wheat producers and consumers do not pay attention to the total market welfare because in Iran, the government's budget is not based on tax, and production and consumption decisions are made only according to their own welfare surpluses. In 2006, for instance, producers confronted a welfare of about 113.1 and 5.13 billion Rials in the wheat and barley markets. It was thus logical to allocate most of their input to wheat production. Similar to the producers, consumers achieved 13.5 and 3.71 billion Rials by consuming wheat and barley, which in turn, caused overconsumption and wheat waste. Moreover, welfare losses of the wheat, which comprises over 60% of all cereals cultivated in Iran, were associated with enormous social costs, the reason of which being the excessive government share in buying and selling this product.

Assigning the best policy strategy in the two markets

Table 3 shows the results of simulated scenarios in 2006 as a baseline for the two-player game matrix. The social welfare surplus in the baseline, which is the sum of welfare surpluses in the two markets, was calculated to be -4.64 billion Rials. This means that on the baseline, the two markets confronted 4.64 billion Rials of welfare losses. As shown in equations (7), (12) and (14), the effects of consumer prices of wheat are linked in the two markets. Therefore, increasing P_{DW} can be considered as a main tool for creating a

scenario in the wheat market based on which several other scenarios could be designed. According to these scenarios, increasing P_{DW} not only increases ΔGS but also the welfare surplus of the barley market by enhancing barley demand. In contrast, any increase in P_{DW} is associated with mitigating wheat demand and results in the reduction of welfare surpluses of the wheat market. If decrease in consumers' surplus is greater than the benefits of government savings, total welfare in the wheat market will decrease.

Table 3. Results of simulated scenarios in wheat and barley markets (billon Rials)

	Policy in Wheat market				
Policy in Barley market	**5%increase in P_{DW}**	**10%increase in P_{DW}**	**15%increase in P_{DW}**	**20%increase in P_{DW}**	**25%increase in P_{DW}**
5%reduction in PC_B	**15.11, -3.13**	**16.42 , 22.45**	**17.12, 92.22**	**18.33, 88.32**	**20.83, 81.31**
10%reduction in PC_B	**16.32, -4.38**	**17.54, 20.25**	**19.54, 88.55**	**22.61, 81.87**	**24.17, 80.19**
15%reduction in PC_B	**17.72, -5.78**	**22.11, 17.32**	**23.71, 84.67**	**27.64, 78.75**	**28.36, 77.07**
20%reduction in PC_B	**21.38, -6.32**	**25.61, 16.17**	**29.76, 80.56**	**31.47, 77.12**	**33.11, 74.94**
25%reduction in PC_B	**23.52, -8.15**	**28.43 ,12.84**	**30.15, 77.82**	**33.43, 75.53**	**36.13, 72.18**

Table 3 clearly shows this in the 20% P_{DW} decrease scenario. Furthermore, according to equations (13) and (15), alleviating barley production cost PC_B was considered to be an active policy tool in the barley market in order to expand the market's welfare and to make simulations. Any reduction in PC_B is associated with expanding the cultivation of barley and substituting it with wheat, which in turn causes the mitigation of the wheat market welfare. Alleviating PC_B increases domestic acreage, resulting in the increase of the producers' and the overall barley market's welfare. Due to the longitudinal nature of change in production costs and the decline of wheat production through its substitution with barley, the scenario of alleviating production costs to about 25% at most was considered.

Five scenarios were investigated in each market. The results of the simulated payoff function for scenarios within the framework of game theory show that dominant strategies, whose intersection resulted in a Nash equilibrium, existed in each market (i.e., 15% increase in P_{DW} and 25% decrease in PC_B). It is important to remember, though, that this equilibrium is valid for a non-cooperative game. Since there was no agreement among consumers and producers regarding consumption or production, no collusion and/or joint resolution existed among players. According to calculations, the overall Nash equilibrium occurs between the two markets with a 15% increase in P_{DW} and a 20% decrease in PC_B as a solution to the cooperative game. This pair of strategies is associated with the most social welfare surplus. A combination of the first two strategies obtaining social welfare surpluses equals 107.97 billion Rials, while for the second two strategies, a social welfare surplus of 110.32 will be attainable.

CONCLUSIONS

Food security, which has always justified government interventions in the agricultural commodity markets, especially cereals, has made the government the principal agent in these markets by trading the bulk of the total marketable supply. In the case of wheat, such interventions have had prejudicial effects on the markets of other crops, especially barley, which in terms of consumption and production, is very similar to wheat. Considering political weights, this article investigated the effects of executing policies in the wheat market on both wheat and barley market interest groups. Results indicated that in the barley market, consumers were better off at the expense of producers. However, the policy trends showed that welfare was gradually transmitted from the government to the producers. On the other hand, properties of the barley market were undoubtedly different. In comparison with the wheat market, there was no evidence of any special policy enforcement in the barley market which is generally regulated by market mechanisms. In the wheat market, welfare losses were observed because of excessive governmental costs, while the barley market has always been associated with welfare gains. Despite wide government interventions in the wheat market, which caused welfare losses, consumer and producer surpluses were positive. This was associated with the transmission of inputs from barley to wheat production, resulting in over consumption and waste.

Since the government's expenditures in the wheat market is not expected to be fully transmitted to consumers and producers, mitigating government interventions is strongly recommended, In addition, no connection was found between producer and consumer surpluses and government expenditures, which were secured by selling crude oil. Therefore, producers and consumers do not seem to pay attention to the welfare surplus of the wheat market, and base their production and consumption decisions only on their own surplus welfare. Finally, emphasizing wheat and barley consumer prices and production costs, the best political strategy between the two markets was found to exist within the framework of a cooperative game. These tools have had contradictory effects on other markets. The cooperative Nash equilibrium occurred between the two markets with a 15% increase in consumer prices of wheat and a 20% decrease in barley production costs. This pair of strategies ensures social welfare surpluses to increase from -4.64 to 110.32 billion Rials. Any contracting policy in the wheat market such as acreage restriction and mitigating the government's share will undoubtedly be associated with encouraging other closely related markets such as that of barley. Taking into account the fact that barley is a major livestock foodstuff, it seems that the government's attempts to achieve wheat self-sufficiency have been accompanied with losses in barley production, a point emphasized by critics.

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تحلیل رفاهی سیاست خودکفایی گندم و اثرات آن بر بازارجو با استفاده از تئوری بازی

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چکیده- مداخلات مستمر دولت در بازار گندم بویژه در دهه ۱۹۸۰ و سال‌های آغازین دهه ۱۹۹۰ زمینه مناسبی برای رشد تولید این محصول برای نیل به هدف خودکفایی و رهایی از واردات، ایجاد نمود. این مطالعه با هدف پی‌گیری آثار رفاهی این سیاست‌ها در بین گروه‌های ذینفع (تولید کنندگان، مصرف کنندگان و دولت) و نیز تغییرات رفاه در بازار محصول جو انجام گرفته‌است. بعد از تخمین تابع ترجیحات سیاستی برای هر یک از بازارهای مورد نظر و با در نظر گرفتن وزن‌های رفاهی، ارتباط رفاهی بین بازارها در چارچوب تئوری بازی مورد تحلیل قرارگرفت. بدین منظور سناریوهای مختلفی مورد ارزیابی قرار گرفتند و نتایج نشان داد که اعمال سیاست‌ها در بازار گندم موجب انتقال رفاه از تولیدکنندگان به مصرف‌کنندگان و دولت گردیده‌است. هم‌چنین علی رغم مثبت بودن مازاد رفاهی تولیدکنندگان و مصرف‌کنندگان در بازار گندم هزینه‌های بالای دولت موجب منفی شدن رفاه کل بازار گردید، این در حالی است که در مجموع بازار جو از مازاد رفاهی بالاتری برخوردار بوده. در نهایت تعادل تنش بین دو بازار گندم و جو به عنوان استراتژی بهینه سازی توام رفاه دو بازار در سناریو ۱۵ درصد کاهش سطح زیر کشت گندم و ۲۰ درصد کاهش هزینه‌های تولید جو حاصل گردید.

واژه های کلیدی: بازارهای گندم و جو، تغییرات رفاه، تئوری بازی، سیاست‌های گندم، وزن‌های سیاستی

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